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What North American retail food environment indices miss in Guatemala: Cultural considerations for the study of place and health

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Abstract

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The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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We evaluated the cross-context validity and equivalence of the US- and Canada-originated Retail Food Environment Index (RFEI) and modified RFEI (mRFEI) against a retail food environment dataset from the indigenous-majority city of Quetzaltenango (Xela), Guatemala. The RFEI/mRFEI failed to identify 77% of retailers and misclassified the healthiness of 42% of the remaining retailers in Xela, inaccurately labeling the city a food swamp. The RFEI/mRFEI are not currently suitable for mapping retail food environments in places like Quetzaltenango. Alternative functional and temporal classifications of retail food environments may provide measures with greater contextual fit, highlighting important cultural considerations for the study of place and dietary health.

Keywords

Retail food environment; Retail food environment index; Modified retail food environment index; Guatemala; Latin America

1. Introduction

The retail food environment that people rely on to purchase foods and beverages is regarded a social determinant of health (Atanasova et al., 2022). However, research examining the correlations between the healthiness of retail food environments and health outcomes has, to date, been inconclusive, with studies finding positive, negative, and null associations (Mah et al., 2019; da Costa Peres et al., 2020; Mackenbach et al., 2019). Variability of methods and approaches to measuring retail food environments and their healthiness is one factor contributing to the variation in findings (Carducci et al., 2021; Wilkins et al., 2017; Wilkins et al., 2019; Turner et al., 2020). This paper examines another methodological contributor: the application of retail food environment mapping tools developed in other settings without first evaluating whether they accurately reflect the most numerous or dominant local food and drink retailers and their healthiness.

The Retail Food Environment Index (RFEI) and its modified version (mRFEI) were developed for the United States and Canada using business code data to measure accessibility and healthiness of retail food environments by counting and *a priori* classifying four types of retailers: 1) supermarkets and 2) farmers markets, counted as “healthy” by both indices (RFEI/mRFEI) as they sell fresh groceries; 3) corner stores, counted as “unhealthy” by RFEI and as “less healthy” by mRFEI because, among other unhealthy items, they sell ultra-processed snacks and sugar-sweetened beverages; and 4) fast-food restaurants, counted as “unhealthy/less healthy” because of their sale of foods high in sugar, salt, and fat (Spence et al., 2009).

Many U.S.- and Canada-based researchers use business codes to measure RFEI/mRFEI. Researchers in the U.S. and around the world who lack access to such data or who seek more accurate data based on systematic observation instead walk neighborhood streets to geolocate retailers (Chew et al., 2020). Once researchers have data on the four retailer categories, depending on the version of the tool they use, they calculate either an RFEI score entailing the ratio of unhealthy to healthy retailers (Cooksey-Stowers et al., 2017) or an mRFEI percentage of healthy retailers in an area (calculated as the number of healthy

retailers divided by the total number of both healthy and less healthy retailers, multiplied by one hundred) (Mahendra et al., 2017; CDC, 2012). Areas that lack healthy food retailers are often designated as food deserts. Meanwhile, areas receiving an RFEI score (i.e., the ratio of unhealthy to healthy retailers) of 3.9:1 are designated as food swamps, which are broadly defined as areas where unhealthy retailers inundate healthy ones (Cooksey-Stowers et al., 2017).

Policymakers and practitioners have used retail food environment maps, RFEI/mRFEI scores, and food desert and food swamp classifications to help allocate resources and guide nutritional policies. However, researchers in North America have raised concerns about the data the tools are based on. The RFEI and mRFEI were developed in the United States and Canada using retailer categories officially recorded in government or commercial business data. When compared with systematic observations on the ground, studies in the U.S. have found such datasets to have low to moderate sensitivity, failing to identify between 25% and 63% of food retailers (Powell et al., 2011; Lucan, Maroko, Abrams, et al., 2020).

At the same time, public health commentators have questioned the suitability of RFEI/mRFEI outside higher-income country contexts where people rely on many different kinds of retailers in addition to the supermarkets, farmers markets, corner stores, and fast-food restaurants the tools measure (Ahmed et al., 2021). While the RFEI and mRFEI have been applied to other countries (Chew et al., 2020; Zhang & Huang, 2018; Mitchell et al., 2011), the tools have not been validated to measure food retail accessibility and healthiness outside the U.S. and Canada. To address this gap in the literature, we evaluated the RFEI/mRFEI in Quetzaltenango (*aka* and henceforth, Xela), Guatemala, a country to which the RFEI has been previously applied (Chew et al., 2020). Our maps visualize the difference between Xela's retailers that the RFEI/mRFEI captures and those observed. Our analysis assesses RFEI/mRFEI's validity (i.e., ability to provide useful analytical measurement of Xela's retail food environment) and cross-context equivalence (i.e., comparability across contexts) (Frongillo et al., 2019).

2. Setting

The city of Quetzaltenango is more commonly referred to by the shorthand of Xela [shey-la] stemming from its pre-conquest Nahuatl name, Xelajú. Xela is the capital city of the Department of Quetzaltenango in the western highlands of Guatemala with a population of approximately 181,000 people, 65% of whom are Mayan, predominantly K'iche' and Mam (MINECO, 2017). Recent government estimates show the Department to have below average rates of diabetes and cardiovascular disease (de Guatemala, 2022). However, these numbers hide disparities in health outcomes and risk factors faced by different groups. Health disparities include higher prevalence of overweight and obesity in children from families with higher incomes and higher prevalence of underweight in children from families with lower incomes (Groeneveld et al., 2007), as well higher stunting rates among indigenous children (Reurings et al., 2013). Overall, indigenous-majority areas require study because Mayan people in Guatemala face inequities in food insecurity and diet-related health that are driven partly by commercial activities that shape retail food environments and partly by centuries of racism, discrimination, and violence, including Guatemala's

1960–1996 Civil War and 1981–1983 Mayan genocide (Bogin, 2022; Yates-Doerr, 2015). Additionally, Xela provides an appropriate setting for assessing the RFEI/mRFEI given that the tool has been previously used to measure the healthiness of the retail food environment of a different indigenous-majority Guatemalan town of Chisec, finding it to be a food swamp (Chew et al., 2020). Although Chisec is smaller, the prior study provides a basis for meaningful comparison for assessing RFEI/mRFEI in Xela, allowing for the drawing of firmer conclusions.

3. Materials and methods

The lead author, a cultural anthropologist specializing in Guatemalan and U.S. food systems, surveyed the residential, commercial, and recreational center of Xela (total area of 1.702 km²) on foot over 20 days during late summer of 2017 for a total of 33 hours, geotagging all observed food vendors (i.e., any establishment or individual selling consumable items) using GPS Kit (Garafa, LLC, Provo, UT). For each food vendor, the types of foods and drinks sold were documented (and cross-checked with online menus, when available). The retail food environment data was collected as part of a larger mixed-methods, long-term, embedded, ethnographic study of Xela's food systems. While the largest and busiest throughfares were all captured in the dataset, along with many of the smaller roads, time and resource constraints prevented every single one of the smallest residential streets and cul-de-sacs from being mapped.

The retailer data was coded by the lead author and three Guatemalan researchers (and co-authors) with expertise in Guatemala's food systems and culture, nutrition, and health: an anthropologist, a nutritionist, and a physician. We developed maps with ArcGIS Pro 3.0 (ESRI, Redlands, California), using data from OpenStreetMap (openstreetmap.org) to display roads and building footprints.

Analysis began with a single coder (the lead author) first identifying those retailers in the dataset that the RFEI/mRFEI counts: supermarkets (healthy), farmers markets (healthy), corner stores (unhealthy/less healthy), and fast-food restaurants (unhealthy/less healthy). Replicating the methodology from the prior Guatemalan RFEI study that two co-authors conducted (Chew et al., 2020), this study counted municipal markets as farmers markets, and only well-known chains in the fast-food restaurants category, including international brands, like McDonald's and Pizza Hut, and the Guatemalan brand, Pollo Campero.

To ascertain all retailer types observed in Xela, the coder then classified the rest of the dataset inductively by iteratively coding the data points for emerging retailer categories, relying on ethnographic and contextual knowledge of the retail food environment in the city and in Guatemala. To ensure cultural resonance, to validate the findings, and to audit the coding, the data was member-checked by Guatemalan co-authors and other in-country contacts. This single coder with member-checking process was chosen because the retailer types have mutually exclusive local definitions and the retailers frequently self-identify their type in their names (e.g., Supermercados La Torre is a supermarket chain, Panadería San Martín is a *panadería* (bakery), Tortillería La Luz is a *tortillería* (hand-made tortilla vendor), etc.). In all, we report nine additional retailer types to the four measured by RFEI (see 4.

Results section below). The relative ease of identifying retailer types limits the possibility of bias and misinterpretation, especially by a subject matter expert with many years of local experience, and thus does not necessitate a multiple-coder approach. Meanwhile, member checking provides the necessary confirmation of cultural resonance (i.e., ground-truthing) of identified food retailer types.

To assess the validity of RFEI/mRFEI's healthiness measures, the entire dataset was then coded for the healthiness of items each retailer sold. Judging the healthiness of foods and drinks carries a risk of subjective bias. We therefore selected an expert rater approach for this step of the analysis (Moayyed et al., 2017a), with four raters independently providing healthiness ratings to a list of 174 common foods and beverages captured in our data and resolving differences in ratings by majority or consensus.

The four expert raters first attempted to follow the RFEI/mRFEI methodology by assigning dichotomous healthiness ratings to the foods and drinks. However, we were unable to do so because the items did not fit a healthy/unhealthy binary. This lack of contextual fit necessitated developing a different classification approach that better reflected the consumable items in our dataset. Existing methods for ascertaining the healthiness of foods and drinks range from binary healthy/unhealthy categorizations to twenty-one-point scales from unhealthiest (-10) to healthiest (+10) (Moayyed et al., 2017b). Our goal was to find a middle ground with a useful, easily replicable, proxy measure that fit Xela's context. The middle ground entailed expanding the binary healthy/unhealthy classification to a three-point scale of least healthy, middle healthy, and most healthy, which the expert raters had more success applying to the food and beverage items.

Nevertheless, we encountered additional problems while assigning the three-point scale to foods and drinks in a single 174-item list. For example, it was difficult to say whether a taco meal purchased from a restaurant at dinner time was more healthy or less healthy than a pound of tomatoes bought from a municipal market because, from a behavioral perspective, people never choose between these two foods when deciding what to eat. That is, these foods are not functionally equivalent. As a result, we grouped the foods and drinks into functional categories before applying the three-point healthiness scale, so that, for instance, raters decided the healthiness of a taco dinner meal when considering it in a group of other dinners, and of tomatoes in a group of other ingredients people buy for later cooking.

This novel grouping of consumable items built on an existing functional distinction made in the literature between grazing retail food environments (i.e., ready to consume foods and drinks) and grocery retail food environments (i.e., items bought for later preparation) (Lucan et al., 2018a). Xela's grocery food environment was captured in our category of ingredients. The city's grazing retail food environment was sub-divided into locally appropriate functional categories: meals (separating out breakfasts, lunches, and dinners); meal accompaniments (e.g., tortillas that are a culturally required part of a meal in the western highlands of Guatemala, especially among indigenous and peasant peoples); snacks; desserts; and drinks. Once the foods and drinks were organized in this way, the expert raters were much more readily able to assign to them a rating of most, middle, or least healthy, and resolve differences in their ratings. Most food and drink items (85%, 148/174)

received agreement either by all four (53%, 93/174) or three of the four (32%, 55/174) raters, indicating a strong overall measure fit (see Appendix A for full list of items and their final healthiness rating); the rest (15%, 26/174) were given a final healthiness measure after raters discussed their differences and came to a consensus. Retailers that sold items exclusively in the “most,” “middle,” or “least” healthy categories were rated accordingly. Vendors of items in more than one healthiness category, such as both “most” and “middle” healthy, were rated as “mixed”.

When making comparisons, those RFEI/mRFEI healthiness ratings that differed from expert ratings were deemed misclassifications. Misclassifications included retailers that were presumed to be unhealthy/less healthy by RFEI/mRFEI but were observed to be middle healthy, most healthy, or mixed healthy by expert raters, and retailers that were presumed healthy by RFEI/mRFEI but were observed to be least healthy, middle healthy, or mixed healthy by expert raters.

The healthiness of retailers whose primary focus was food (as opposed to drinks) did not take into account available sugar-sweetened beverages (SSB). Unhealthy SSBs were available in 60% of retailers in our sample (77% [292/377] of indoor retailers and 22% [39/175] of outdoor ones), so including the drinks in our overall healthiness measures would have rendered too many food-focused retailers “mixed healthy” (especially among the indoor subset) to allow for meaningful comparison of foods on offer. Other studies have similarly had to rely on excluding available SSBs in their estimates to retain sensitivity to differences in healthiness of foods on offer (Lucan et al., 2018a). The discussion details the implications of this methodological decision and contextual reality.

4. Results

4.1. Overall retailer counts

RFEI/mRFEI captured 125 food retailers in the Xela dataset that aligned with the tool’s four categories of focus: supermarkets, farmer’s markets, corner stores, and fast-food restaurants. In contrast, our Xela survey identified a total of 552 food retailers by counting all observable retailers in Xela, including vendors in nine types of retailers that RFEI does not measure, such as *panaderías* (bakeries) and *tortillerías* (hand-made tortilla vendors). Section 4.2. Retailer Types and Table 1 below detail the additional nine retailer types found in Xela.

The inductive coding of retailer types produced an important distinction between 68% (377/552) of retailers who were based indoors and 32% (175/552) that were based outdoors. RFEI/mRFEI missed 77% (427/552) of all observed vendors (Fig. 1, Map B), including 67% (252/377) of indoor and 100% (175/175) of outdoor ones. At 23% (125/552), RFEI/mRFEI’s overall sensitivity to Xela’s observed retail food environment is very low, indicating inadequate ability to accurately measure the city’s retail food environment (i.e., low validity). Map B shows all food retailers captured in our dataset, demonstrating a significantly higher density of food retailers than in Map A that shows only the sub-set of retailer types the RFEI/mRFEI assesses.

4.2. Retailer types

Across its four retailer types, the RFEI/mRFEI methodology captured 6 fast-food restaurants, 114 corner stores, 3 supermarkets, and 2 farmers markets in Xela. Table 1 details the categories of indoor retailers not captured by RFEI/mRFEI. These include one retailer type in the grocery environment, i.e., food-animal product vendors, and eight retailer types in the grazing environment: *comedores* and *restaurantes típicos*, international-food restaurants, cafés, bars/cantinas, frozen treats purveyors, chocolate and *dulces típicos* vendors, cake shops and *panaderías*, and *tortillerías*. *Comedores*, *restaurantes típicos*, *panaderías*, and *tortillerías* are culturally important culinary institutions with deep historic roots that have undergone some changes in their food preparation methods; the cases of *panaderías* and *tortillerías* are outlined in Figs. 2 and 3, respectively.

Some outdoor vendors, either individuals or teams, were stationary and permanent in that the same vendors returned daily with their foods to their assigned permanent stalls and other structures. Ambulatory vendors also used stands, carts, baskets, wheelbarrows, bags, and other tools to carry, display, and sell their goods, with many, but not all, returning regularly to cover similar areas. The foods and drinks sold by outdoor vendors inconsistently mirrored the range of offerings by the 13 indoor vendor types in this study (the nine types outlined above plus the four included in RFEI/mRFEI). Some outdoor stalls operated like corner stores, offering newspapers, snacks and drinks, and toys or household items while others functioned like *comedores*, specialty, or fast-food restaurants, or grocers, dessert sellers, and drinks retailers. However, some outdoor vendors' offerings were unique and did not cleanly match indoor vendor types, like those selling snack bags of freshly cut fruit or glasses of freshly milked goat milk, and numerous vendors offering single varieties of sweets, like shaved ice, lollipops, cotton candy, or popcorn. While these vendors did not correspond neatly to indoor retailer types, the foods they sold did align with different functional layers of the grazing retail food environment. For example, goat milk fit the drinks functional category, while cut fruit, shaved ice, lollipops, cotton candy, and popcorn fit the desserts functional category.

Table 2 details the sensitivity of RFEI/mRFEI to the eight higher-order categories of retailers into which we grouped all observed indoor and outdoor vendor types from the Xela context: four retailer types from the RFEI/mRFEI and four new ones. The tools had varied sensitivity to the four retailer categories they seek to measure. RFEI/mRFEI captured all supermarkets and farmers markets (locally called municipal markets) in the mapped Xela area (100% sensitivity, i.e., percentage of observed retailers in a category the index captured), although, our dataset does not take into account Xela's monthly, outdoor Sunday agroecological market nor *feria* (fair) markets that pop up in the city on weekends during celebratory seasons. At 91% (114/125), RFEI/mRFEI's sensitivity in the corner store category was also high. However, at 21% (6/29), RFEI/mRFEI's sensitivity in the fast-food retailer category was low. The methodology of counting only global fast-food brands overlooked local chain and independent fast-food restaurants and take out spots, like *Pollo Pinulito* and *Pollo Granjero*, which collectively made up 79% (23/29) of retailers selling fast food in our Xela dataset. RFEI/mRFEI's sensitivity to the four new Xela retailer categories that it does

not measure, i.e., retailers focused on other prepared foods, other grocers, other snacks or desserts, and drinks, was 0%.

The retailer categories in Table 2 do not include all the retailers where specific foods and beverages might be offered, counting instead only retailers whose primary focus is the type of food that is the emphasis of the category. For example, the figures for retailer categories of other prepared foods and snacks or desserts do not take into account drinks-focused retailers, like cafés and bars, offering meals and desserts, respectively. In other words, many cafés and bars focus on drinks, but also offer meals and desserts to accompany the drinks, but the establishments are only counted in the category of “Drinks-Focused Retailers”. Similarly, supermarkets also often offer groceries, snacks, desserts, and drinks, and some might even offer ready-to-consume meals. Meanwhile, restaurants, *comedores*, and most *tiendas* offer sugar-sweetened beverages, which are not included in the above drinks-focused retailer category counts. Overall, only 36% (200/552) of retailers in the Xela dataset sold foods and beverages from only one functional group. Half the retailers (274/552) sold items from two functional groups, and 14% of retailers (78/552) sold items from three or more functional groups.

Additionally, three of RFEI/mRFEI’s retailer categories are among the least numerous in Xela: supermarkets and markets each represent less than 1% of all retailers, while fast-food restaurants represent 5% (Fig. 4). Corner stores are the joint second most numerous with 23% (125/552) of all observed vendors. They are equaled by the 23% (125/552) of vendors who focus on snacks or desserts and outsized by the 41% (224/552) who focus on other prepared foods. In summary, with the exception of corner stores, the standard RFEI/mRFEI tool measures categories of retailers that are the least numerous in Xela, demonstrating low cross-context equivalence.

4.3. Retailer healthiness

With regards to healthiness, RFEI/mRFEI detected 120 unhealthy/less healthy and 5 healthy retailers, with corner stores making up 95% (114/120) of unhealthy/less healthy retailers. Xela’s resulting mRFEI score (% of healthy retailers) of 4% is very low and its RFEI score (unhealthy/healthy ratio) of 24 indicates a food swamp (i.e., area where unhealthy retailers outnumber healthy ones at a ratio of 3.9 or higher) (Map A). This result replicates the finding from the previous RFEI study of the Guatemalan indigenous town of Chisec, which documented a food swamp with an RFEI score of 12.9, in which corner stores far outnumbered other retailers (Chew et al., 2020).

In contrast, we observed 209 least healthy and 138 most healthy retailers (Table 3). If we divide the number of least healthy retailers by the number of most healthy ones (akin to an RFEI score), Xela’s ratio is 1.5, which would not be high enough to classify it a food swamp. This also gives the city a most healthy retailer percentage (akin to an mRFEI score) of 40%, which is ten times higher than the score generated by following the RFEI/mRFEI methodology. However, we additionally observed 26 middle healthy and 179 mixed-healthy retailers making the accessibility and healthiness of Xela’s retail food environment far more complex than RFEI/mRFEI captured.

Additionally, our alternative healthiness ratings differed from RFEI/mRFEI's for 42% (53/125) of retailers that RFEI/mRFEI detected (Table 4). While supermarkets carry produce, they sell and promote many more unhealthy items (Riesenberg et al., 2019), making all three Xela supermarkets “mixed healthy” rather than RFEI/mRFEI's pre-assigned “healthy.” Similarly, while sections of municipal markets carry fresh produce, meats, and dairy, depending on their size, they also have dozens, if not hundreds, of vendors selling foods and beverages of varying healthiness from different functional categories (Fig. 5), making both municipal markets in our dataset mixed healthy. Conversely, some fast-food restaurants' menus significantly differ between different mealtimes. One example is McDonald's, a fast-food restaurant rated mixed healthy in the Xela dataset. That is because its breakfast menu contains most healthy options, like hot oatmeal, and middle healthy options, like *desayuno chapín*, a typical Guatemalan breakfast of eggs, sausage, beans, plantains, artisanal cheese, tomato salsa, sour-cream, and tortillas, each consumed with coffee. Meanwhile, its lunch and dinner menus of beef burgers or chicken nuggets with fries and soda are least healthy.

Meanwhile, *tiendas* (corner stores) in Guatemala typically sell chip and pork rind snacks, sweets, sodas, and alcoholic beverages. This certainly makes them purveyors of unhealthy items. However, that is not all many of them sell. Frequently on offer are also fresh eggs and other small batches of basic produce staples like fruit, such as bananas or (when in season) apples, and vegetables, like tomatoes and onions. There are additional goods on sale that are visible neither from the street, nor from the doorway. Many such stores, for example, also house *tortillerías*, where indigenous and non-indigenous women sell hand-made tortillas three times a day. In other cases, women of the families who own the corner stores cook healthy meals and snacks that they sell at affordable prices to workers and families in their areas (Fig. 6). We observed “most healthy” options in 40% (46/114) of the corner stores the RFEI/mRFEI detected, rating them as “mixed healthy” rather than RFEI/mRFEI's predetermined “unhealthy”.

5. Discussion

Our findings add empirical evidence to commentaries questioning the suitability of RFEI/mRFEI outside higher-income country contexts (Ahmed et al., 2021), showing inadequacies in capturing retailer types, retailer healthiness, and cultural aspects of retail food environments.

5.1. Retailer types

RFEI/mRFEI were designed in the U.S. and Canada to primarily take advantage of government and commercial business datasets, even though many RFEI/mRFEI studies opt for observation surveys instead. By their original design, then, RFEI/mRFEI count only categories of legally registered food retail businesses, all of which, except outdoor farmers markets, are located indoors, and half of which are large-scale chain businesses that dominate wealthy-country contexts, i.e., supermarkets and fast-food restaurants. The tools presume their four categories to capture the most-prevalent retailers in a geographic area.

As a result, RFEI/mRFEI carry a built-in systematic bias that excludes the kinds of retailers on which people in many countries continue to rely to buy food, namely unregistered municipal (*aka wet*) markets, independent retailers, and individual mobile vendors, many of whom sell outdoors (Chuvileva et al., 2020). Indeed, the retail food environment literature in low- and middle-income countries is sometimes bifurcated into studies measuring brick-and-mortar retailers and those focusing on outdoor stationary and ambulatory vendors, calling the latter “street food” (Abrahale et al., 2019) or “the informal food environment” (Ambikapathi et al., 2021), producing an artificial split in the scientific understanding of retail food environments in those countries.

Our study shows that when RFEI/mRFEI was applied to Xela in an unchanged form that does not take into account Guatemala’s local retail food environment context, it captured only a third of indoor food retailers and none of the outdoor ones, with an overall sensitivity of less than a quarter. In such settings, growing, preparing, and selling food remains one of few available livelihood strategies for large swaths of populations, whose small, unregistered enterprises make up most of the retail food environment, and often its most healthy aspects (Ambikapathi et al., 2021), yet which are largely missed by unvalidated RFEI/mRFEI tools. Without significant changes, the tools are not sensitive enough to accurately guide public health policy and practice in many countries.

5.2. Retailer healthiness

The Xela example highlights a major underlying issue with RFEI/mRFEI and any other tools that rely on counting types of retailers instead of the food and drinks they sell and *a priori* deciding whether the retailer is healthy or not. They run the risk of inaccurately classifying retailer healthiness. For example, while in the Xela sample RFEI/mRFEI classified all 114 *tiendas* as unhealthy, our survey of the foods the corner stores sold showed that two out of five of them also carried most healthy options. Additionally, while only some outdoor vendors matched indoor retailer types, all retailers were more easily categorized into the functional group(s) of the food and drink items they sold. Finally, that two thirds of Xela retailers sold items from more than one functional group indicates that focusing on retailer types collapses and erases important distinctions between the culinary functions that different foods and drinks serve at different times for different people. These findings demonstrate that research which counts only types of retailers and predetermines their healthiness can lead to poor estimations of food availability and retail food environment healthiness.

The low validity and cross-context equivalence that RFEI/mRFEI had in Xela necessitates the use of more nuanced, mixed-method tools that focus on the consumable items on offer instead. Retail food environment mapping tools would be more accurate and provide more actionable insights if they map foods and drinks, not the retailers, and if they do so based on the culinary functions different consumable items serve for people in different locations.

This study also empirically validates researcher concerns about the use of crude binary and ratio healthiness measures in retail food environment research, which overly collapse nutritional values of food in a way that is both misleading and impractical (Thornton et al., 2020). This is evidenced by our expert raters’ inability to assign a binary healthiness

measure to a list of 174 foods and drinks frequently sold in Xela, which led us to develop a three-point healthiness scale of least healthy, middle healthy, and most healthy. Additionally, we built on the prior distinction of grazing versus grocery retail food environments to place Xela's foods into their functional categories before applying healthiness ratings. This method of categorization better connects with how people make decisions about what to eat when, thus improving the real-world accuracy and interpretability of Xela's retail food environment as captured by this study.

Additionally, because two thirds of Xela's retailers offered sugar-sweetened beverages, we excluded SSBs from our classifications of retailer healthiness in order to provide meaningful distinctions of the healthiness of the foods sold. Nevertheless, the success of beverage company distribution strategies has a marked negative effect on the overall healthiness of Xela's retail food environment. Retail food environment mapping tools that are sensitive to the most numerous sources of least healthy items, like SSBs, can provide insights for biggest potential levers of change.

Finally, this study showed that Xela is not easily understandable as a food swamp, which is the classification it would receive with the use of the standard RFEI/mRFEI tool. Given its plethora of options of different healthiness, Xela is more akin to different neighborhoods of New York City, which house healthy and unhealthy food options across grazing and grocery environments, including numerous mobile outdoor vendors, yet whose different groups of residents face both food insecurity and elevated chronic disease burdens (Lucan et al., 2013; Lucan et al., 2014; Lucan, Maroko, Patel, et al., 2020; Lucan, 2019; Lucan et al., 2018b). It is likely that the cornucopia of food availability seen in places like Xela and New York is indicative of many cities and other urban areas around the world that are now home to most of the world's population; this is an empirical question worthy of future research.

5.3. Cultural considerations for the study of place and health

This paper points the way to important considerations for retail food environment research. One of them is the need to capture locally important and most prevalent categories of retailers who shape availability of foods with different nutritional values. In this study, non-fast-food meal retailers outnumbered fast-food ones at a rate of almost eight to one, while there were five times more independent and specialized grocery suppliers than supermarkets and markets (even though the latter supply more customers per unit). At the same time, there were just as many other kinds of snack- and dessert-focused retailers as there were corner stores.

Standard, map-based, retail food environment analyses are an important starting point in understanding the role of place in the health of its residents and visitors. The Xela example demonstrates the need to also consider cultural dynamics to both create contextually-valid mapping tools and derive actionable insights. Looking beyond major food and beverage retailer types to the specific culinary customs of a given population in a particular place can help identify important intervention points for more healthy retail food environments. The breads and tortillas, respectively sold by *panaderías* and *tortillerías*, which provide important daily sources of calories for many people with every meal and during the customary afternoon snack, could be marked for public health intervention and promotion. Improving

the ingredients and cooking methods of these foods, for example, would make a public health impact four times every day. Looking beyond retailer types, locally appropriate, mixed-method retail food environment mapping tools might additionally highlight the role of women who provision the city with superior breads, tortillas, and other foods, making the case for public health practice to support these nutritional bright spots.

Much of the issue in North American RFEI/mRFEI research lies with the very design of the tools. They use available business record data and only a few retailer categories, predetermining their healthiness. This makes the tools understandably attractive, even if predictably flawed, to researchers because the data is easily accessible and analysis is simple. The tradeoff between accessibility/simplicity and the inaccuracy of the findings' representation of a retail food environment becomes problematic when they stop being used merely as an academic exercise and start being used to guide policymaking and program or service delivery. Retail food environments research using existing data sources can be improved to prevent deleterious effects. For instance, it can go beyond RFEI's/mRFEI's four retailer categories to paint a more nuanced picture since most business datasets contain information on other food retailer types, such as full-service restaurants, gas stations, farms with direct sales, etc. Such work can also be explicit about the shortcomings of the original data and simplistic analyses, especially its low to moderate sensitivity to retailer diversity, numbers, and healthiness on the ground, to caution policymakers and practitioners from relying on the findings to drive decision-making.

In many countries like Guatemala no business datasets exist to be analyzed. As a result, RFEI/mRFEI studies rely on researcher observation but continue to use only the tool's four predetermined retailer types and their healthiness, as well as the tool's food desert/food swamp categorizations. We have shown this to be an inadequate and problematic methodology for understanding the accessibility and healthiness of retail food environments in Xela.

Additionally, as we note above with New York City, RFEI/mRFEI's shortcomings in Xela are not unique to Guatemala compared to countries like the United States. Rather, the issues of missed types, underestimated volume, and miscategorized healthiness of food retailers are amplified outside of the North American wealthy country contexts. In other words, what the tools miss is exacerbated in Guatemala due to a different economic, geographic, and cultural context of the Central American country. For example, the tools miss more food retailers and more food retailer types, as well as a few unique retailer types, than in other settings. This leaves the tools' methodology less sensitive to observable food retail than in other countries where RFEI/mRFEI's four retailer categories of supermarkets, farmers markets, corner stores, and fast-food restaurants are more numerous or dominant. Overall, across contexts, especially where manual counting of retailers is the only methodology available to researchers, developing and locally validating retail food environment measurement instruments, rather than relying on tools developed elsewhere, remains a best practice.

5.4. Possible future research directions

Xela raises important questions for the study of retail food environments. If many urban places where food insecurity is high, chronic diseases are rising, and, as in the case of

Guatemala, stunting also persists, are not easily classifiable as food deserts that entirely lack healthy food options, nor as food swamps where unhealthy options outnumber healthy ones at a ratio of four to one or more, then how is public health to act? That is, if static, singular global measures of retail food environments (i.e., those based on surveys of food options in a particular place at a particular time) do not easily correlate with nutritional and health outcomes, where is research to look for data that can accurately and reliably guide public health policy and practice? How can the study of place and health yield more consistent answers to persistent questions about retail food environments as a social determinant of health?

Our study suggests the need to move away from simplistic tools like RFEI/mRFEI that seek to measure mere retailer availability at one point in time. More appropriate may be multi-method assessments that seek to study the geographies of food access that use social scientific approaches to interpret combinations of observation and survey-based food availability and healthiness assessments with consumer behavioral data through the lens of social and structural drivers of health (Shannon et al., 2021). That is, our work joins others in demonstrating the need to analytically separate out functional layers of retail food environments, their variability over time, and their use by different groups of people.

For example, some research already indicates significant changes in retail food environments over the course of a year (Lucan, Maroko, Jin, et al., 2020), and Xela's Municipal Market shows that options expand on weekends and during festivities. Our study's examples of Doña Conche's tienda and McDonald's healthier breakfast menu compared to its lunch/dinner offerings additionally demonstrate that retail food environments also significantly shift over the course of a single day. It is possible that different groups might, for different structural reasons, rely more or less frequently on purchasing snacks or specific meals, like breakfasts over dinners for those who rise early for work. This temporal dynamism between breakfasts, lunches, dinners, late night eating, and snacks and desserts available throughout the day has, to date, not been sufficiently taken into account in the study of retail food environments and health (Widener & Shannon, 2014). Linking this functionally and temporally nuanced mapping work with analyses of "how people actually navigate their foodscapes" (Battersby, 2012) and "who uses what food retailers" (Hoenink et al., 2023) will also be important in future work to shed light on inequities in availability and access within geographic areas and pointing to public health action strategies that can be tailored to diverse populations.

5.5. Policy and program implications

Ultimately, correctly classifying retail food environments has real-world implications for food access policies and programs. Using RFEI/mRFEI in Guatemala to *a priori* classify all *tiendas* as unhealthy risks stigmatizing corner-store operators when many of them offer healthy foods, when they face major structural barriers to reducing unhealthy food supplies (Chew et al., 2022), and when *tiendas* provide a rare safety net in indigenous and underserved communities by giving food on credit to those who need it (Way, 2012). Similarly, misclassifying places as food deserts or food swamps when local business owners might in fact be providing food options that are both healthy and responsive to local

food cultures and palates, as they do in Xela, risks stigmatizing entire neighborhoods, misguiding resource allocation, and producing tensions between public health initiatives and the communities they seek to serve. One example comes from a government produce market project aiming to address food deserts in Atlanta, Georgia, U.S., which risked competing with existing community-based, food-justice-oriented initiatives, like Black-owned urban farms, that were invisible to the locally-unvalidated retail food environment tools the city relied on to guide its decision-making (unpublished results (King, 2019)).

5.6. Strengths and limitations

This study has several strengths. It is the first systematic assessment of all food retailers and their healthiness in a central neighborhood of a Guatemalan city that additionally relies on ethnographic information for both data analysis and interpretation, providing a starting point for additional work into urban and peri-urban retail food environments in the country. It includes both indoor and outdoor retailers, providing a more complete picture of a retail food environment outside wealthy country contexts than research focusing on one or the other location. It advances the field of retail food environment measurement by making important distinctions between culturally-resonant categories of the grazing food environment of meals, meal accompaniments, snacks and desserts, and drinks and highlighting daily temporal changes in retail food environments.

Nevertheless, this study's findings should be interpreted within the constraints of its limitations. The study did not map all smaller street intercepts in the chosen area. This is unlikely to have affected estimates of larger food retailers and retail spaces, like supermarkets and municipal markets, but it likely did lead to undercounting corner stores, smaller eateries, and outdoor ambulatory vendors. Meanwhile, some ambulatory vendors may have been double counted since a single data collector mapped Xela's food retailers over several days instead of multiple researchers working in a single day. This study also undercounts meals sold in corner stores, which were often not visible, needing to be requested to be brought out of kitchens, because many *tiendas* were geotagged between mealtimes when the foods were absent.

Like most other retail food environment research, this study did not calculate relative size of each retailer, such as weighing supermarkets significantly more than an ambulatory outdoor vendor selling a single item. Future research should additionally not collapse municipal markets into a single data point but instead assess individual vendors. That is, studies should disaggregate the market into dozens or hundreds of datapoints, each individually assessing different retailers and the items they sell.

Like all retail food environment research, this study focused only on nutritional content of foods when assigning healthiness measures. It did not take into account possible food safety concerns. Adding hygiene-based non-nutritional indicators to food retailer healthiness measures could be an important innovation for the field as it would address the oversized role gastrointestinal infections play in poor nutritional health outcomes in many parts of the world (Millward, 2017). However, that would need to be done with extreme care and be based on objective assessments of sanitation infrastructure, hygiene practices, and contamination levels. Studies should not presume the food safety of different forms of

retail, such as assuming all outdoor food retailers to be less safe than indoor retailers, or assuming all municipal markets to be less safe than supermarkets. Doing so would go counter to existing evidence that industrialized food systems provide an “illusion of control” when it comes to food safety (Stuart, 2008). In Guatemala, for example, studies find high levels of pathogenic, antibiotic-resistant bacteria in foods sold in both, supermarkets and municipal markets (Jarquin et al., 2015; Castillo, 2008). Presuming municipal markets or outdoor vendors to be less safe would unfoundedly brand as unhygienic entire groups of food retailers, such as indigenous and/or female “street food” vendors, who are members of populations that have historically been marginalized and excluded based on hygienic racism (Colloredo-Mansfeld, 1998) and stigma (Brewis & Wutich, 2019).

6. Conclusions

Retail food environment measurement tools, like RFEI/mRFEI, should be validated to provide fair assessments across social, cultural, and geopolitical contexts and for diverse groups within given geographical areas. Public health policies and practices that rely on unvalidated retail food environment mapping tools can under-represent healthy food options, inaccurately and negatively labelling communities as food deserts/swamps and specific vendors as purveyors of unhealthy foods. Policymakers may also miss an opportunity to act on the biggest levers of change, support nutritional bright spots, and collaborate with grassroots food-justice-oriented healthy food initiatives. Indicators of healthiness of available functional food groups during different times of day, week, and year provided by mapping tools focused on assessing foods, not retailers, would provide more accurate estimates of retail food environments. The use of validated tools and multiple methods of inquiry can help equitably increase access to healthy retail food environments while minimizing unintended negative consequences of well-intentioned policies and programs.

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Data statement

The data for this manuscript will not be shared to protect the confidentiality of food retailers since the data contains their exact geo-locations and names.

Data not available/The data that has been used is confidential.

Appendix A

Expert Rated Healthiness of Food and Beverage Items in Functional Categories.

Groceries	Meal Accompaniments	Meals: Breakfasts	Meals: Lunches	Meals: Dinners	Snacks	Desserts	Drinks
Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy
Corn flour	Tamalitos	Bean Sandwich	Caldo de Gallina Criolla (creole chicken soup)	Burrito Bowl	Havas (Roasted Beans)	Cut Fruit	Atoles (un-sweetened)
Eggs	Tortillas	Burrito Breakfast (eggs, frijoles, etc)	Caldo de Marisco (seafood soup)	Chicken Mole	Nuts	Fruit Cocktail	Coconut Juice
Fresh fruit		Chuchitos	Caldo de Res (beef stew)	Chicken Salad	Seeds		Coffee (un-sweetened)
Fresh herbs		Desayuno Tipico/ Chapin	Ceviche	Chuchitos			Fresco Rosa de Jamaica (un-sweetened)
Fresh meats (beef, pork, chicken)		Egg Sandwich	Chicken Pasta	Encheladas			Freshly Squeezed Orange Juice
Fresh vegetables		Eggs with Tortillas	Chicken Salad	Grilled Chicken with Potatoes			Goat Milk
Milk (cow)		Fruit with Yogurt	Guisado	Paches			Licuaados/ Smoothie (un-sweetened)
Milk (goat)		Eggs (any style)	Jocom	Spaghetti Bolognaise			Sparkling water
Spices		Omlette Rice and Beans Tamalitos Yogurt (un-sweetened)	Pepian Vegetable Soup and Salad	Steak Dinner Sushi Tamales Tortillas with eggs and beans			Tea (hot and un-sweetened) Water
Middle Healthy	Middle Healthy	Middle Healthy	Middle Healthy	Middle Healthy	Middle Healthy	Middle Healthy	Middle Healthy
Cheese	Bread (white)	Bagel with Eggs and Bacon	Burrito	Burrito	Chicharron (Pork Rinds)	Arroz con Leche	Atol de Elote (sweetened)

Groceries	Meal Accompaniments	Meals: Breakfasts	Meals: Lunches	Meals: Dinners	Snacks	Desserts	Drinks
Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy
Honey		Chicharron en Frijol	Campero Grilled Chicken Meal	Chicken Chow Mein	Soda Cookies	(sweetened milky rice) Candied Peanuts	Atol de Hava with Sugar
Pasta		Chicken Sandwich	Chile Relleno	Elote Loco	Shaved Ice (Savory)	Chocofruit	Atol de Masa (sweetened)
Rice		Chile Relleno	Choripan	Fried Plantain	Japanese Peanuts	Chocolates	Atol de Platano (sweetened)
Wheat flour		Empanadas Granola, Yogurt, Fruta McD Desayuno Tipico Yogurt (sweetened)	Chuchitos Churasco Empanadas Estufado de Res (beef stew) Flautas Pollo Adobado (chicken with sauce) Pollo Asado (grilled chicken) with tortillas and guacamole Quesadillas Spinach Wrap with Chicken Tortas Mexicanas	Pupusas Tacos de Res Tortas Mexicanas Tostadas	Plantain Chips Popcorn (Salted)	Cookies (Fresh Baked) Dulces Tipicos - Fruit Icecream - Artisanal Icecream - Frozen Yogurt (Chogurt) Caramelized Apple Nuts/Seeds (candied) Popcorn (sweet) Rellenitos (sweet bean-stuffed plantains)	Coffee (sweetened) Fresco de Tamarindo (sweetened) Fresco Rosa de Jamaica (sweetened) Horchata (sweetened) Hot Chocolate (sweetened) Incaparina (sweetened) Licuados/ Smoothie (sweetened) Limonada (sweetened) Tea (hot and sweetened)
Least Healthy	Least Healthy	Least Healthy	Least Healthy	Least Healthy	Least Healthy	Least Healthy	Least Healthy
Ham (processed meats)		Pancakes with Honey	Burger and Fries	Cheveres	Dorito Chips	Baked Cheesecake	Cerveza
Sausage (processed meats)		Sugared Cereal with Milk	Pollo Campero Fried Chicken Meal	Loaded Nachos	Pringles Chips	Bunuelos	Coke Zero
Seasoning packets		Waffles with Honey	Dobladas	McDonald's Burger with Fries	Tortrix Chips	Candy Floss (algodones asucarados)	Coke/Pepsi
Sugar			Garnachas de Res Instant Soup Cup Longanizas McDonald's Burger, Fries and Soda Pizza Hut Pizza	Pizza Slice Fried Chicken with Fries		Chocolate Cake Churros Donuts Dulces Tipicos - Canitas de Leches Frozen Yogurt (industrial) Cookies (packaged)	Diet Coke/ Diet Pepsi Energy Drinks - Red Bull Quetzalteca Sprite/ SevenUp Tampico Cold Tea - Lipton

Groceries	Meal Accompaniments	Meals: Breakfasts	Meals: Lunches	Meals: Dinners	Snacks	Desserts	Drinks
Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy	Most Healthy
						Granizadas – Dulce Hard Candy Icecream - (industrial chain, e. g., Sarita) Lollypops Pan dulce (sweet breads) Tres Leches Cake	

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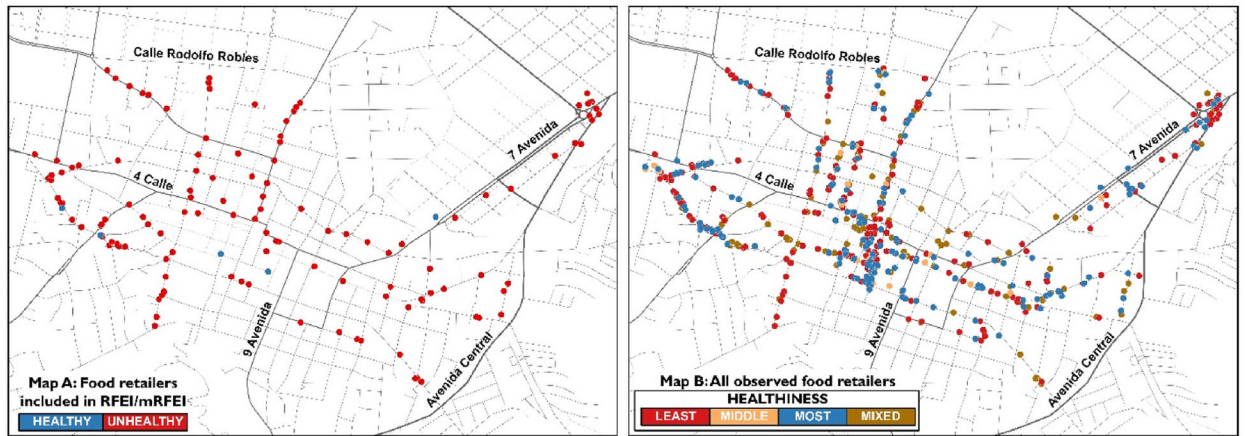


Fig. 1. Retail Food Environment Indices (RFEI/mRFEI) Missed 77% of Food Retailers in Xela.
Caption: Map A shows the 125 retailers captured by RFEI/mRFEI. Map B shows the 552 retailers observed in Xela.

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Panaderías, which in this study fall into the category of snack or dessert retailers, provision Xela residents with *pan dulces*, the food of choice of many Quetzaltecos (people living in or originating from Xela) for the ritual mid-afternoon coffee break. The custom dates back at least to the eighteenth century when Xela became the center of national wheat production that served as an important source of wealth for Mayan elites in the region²⁹. Nevertheless, the industrialization of the production of flour and the baking process has meant significant changes to the sweet breads' recipes, which are now made with highly processed (and often imported) white flour and significantly sweetened with sugar, providing cheap sources of densely-caloric foods. The savory breads *panaderías* sell have also undergone the same change.

Fig. 2.
Panaderías (Grandin, 2000).

Another example of important sources of daily sustenance in Xela are *tortillerías*. Accompanying breakfasts, lunches, and dinners with hot, palm-sized, hand-made tortillas has been customary in the Central American region for millennia. Maize was first domesticated in Mesoamerica, with the plant holding deep cultural significance among Mayan people, who are said to have been created from corn. Consuming the healthy tortillas daily, especially with beans and eggs, continues to be important throughout indigenous-majority areas of Guatemala, i.e., cities like Xela, and the Western Highlands at large, making up a large portion of the daily diet of those people with low incomes who struggle to afford other sources of food. Some *tortillerías* have transitioned to using only industrial corn flour (namely Maseca from Mexico). However, others continue to use locally-grown corn of black, red, white, yellow, and multicolored varieties, which they soak in limewater, a process called nixtamalization that results in a more bioavailable, digestible, and micronutrient-rich (e.g., calcium content) food product^{30,31}.

Fig. 3.

Tortillerías (Bello-Perez et al., 2014; de la Parra, Saldivar, & Liu, 2007).

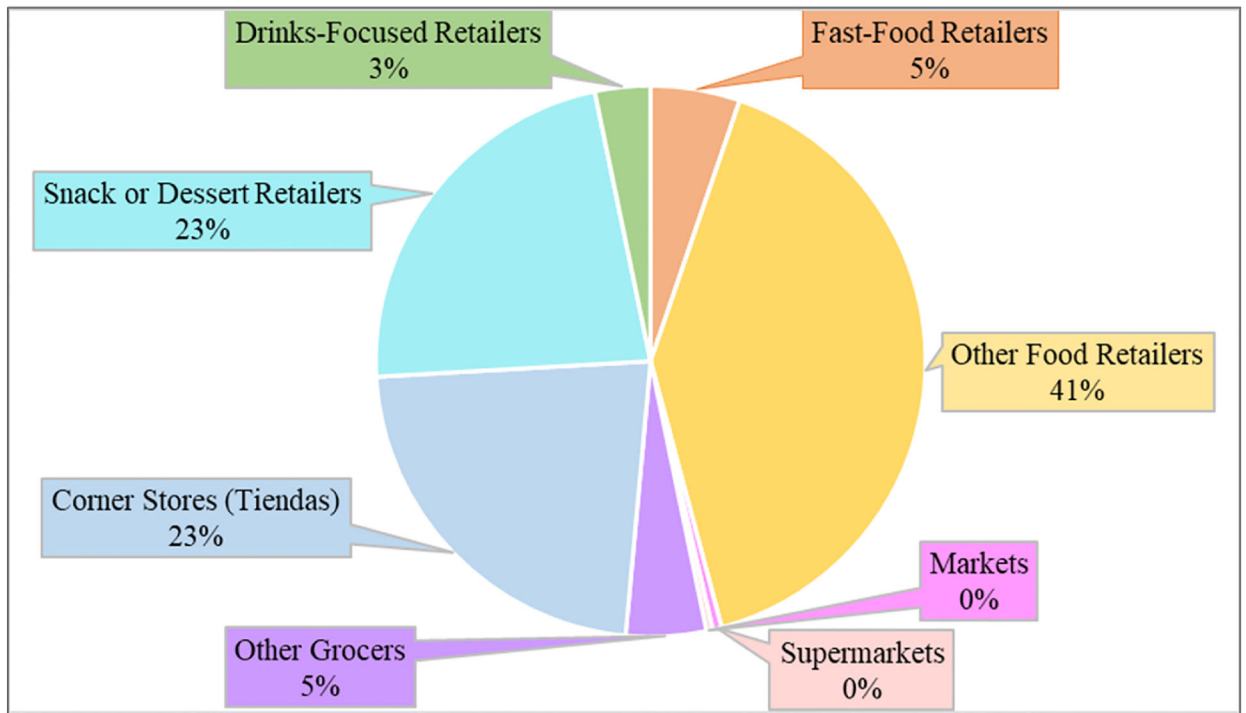


Fig. 4. Proportion of observed vendors in each retailer category.

Xela's Mercado Municipal (municipal market) is positioned on the right side of the Catholic Holy Spirit Cathedral that frames the southwest corner of Central Park. Dozens of stalls and *puestos* line the streets side-by-side selling snacks, freshly-squeezed juices, and meals, as well as clothes, housewares, and knock-off CDs, DVDs, and games. This outdoor portion of the market wraps around a large rectangular structure that makes up one of two indoor sections of the *mercado*. Inside, the main market has two levels and is roughly organized around types of goods on sale. The fresh produce section includes half a dozen vendors neatly displaying their goods on wooden stalls, with another half dozen just outside selling mainly fresh fruit. The meats and dairy section contains a dozen butchers displaying large meat cuts hanging on hooks and smaller cuts arranged on tiled or metal surfaces. The eating section has a lunch hall feel with dozens of vendors selling different kinds of prepared meals and refreshments, like smoothies and juices; the other adjacent building is reserved for four women-run *comedores* competing for clientele with similar menus. Peppered throughout the main indoor market are *tiendas* selling dry goods, snacks and drinks, and household items. Xela's central municipal market involves dozens of vendors selling foods across numerous functional categories throughout the week, significantly expanding on the weekends, yet it is one of the smaller markets in Xela. The city's other two major markets, which are based in Zone 3 and thus not captured by our dataset, include La Democracia, which is at least twice the size and attracts at least twice the number of vendors, and Mercado Minerva, the largest, containing hundreds of vendors selling consumable goods.

Fig. 5.
Xela's zone 1 municipal market.

Starting around midday each weekday, Doña Concha's (pseudonym) lunches attract lines of clientele to her corner store (*tienda*) just south of Xela's Central Park (and around the corner from the lead author's year-long residence in the city). She serves up dishes like boiled chicken with vegetable rice, empanadas, and a vegetable soup with small chunks of beef. A researcher mapping the food retailers on Doña Concha's street during early morning or in the afternoon would entirely miss her healthier offerings. If the mapper who is tasked with only counting retailer types stays out on the street and does not look inside, they would also miss the eggs, onions, and tomatoes people can buy to cook with, the chocolate-covered bananas she made in her ice-cream freezer, and the cooked-from-scratch and freshly made fat- and sugar-free tortillas on sale. That researcher would mark Concha's *tienda* as an unhealthy corner store despite the nutritional contribution her culinary labor makes to different functional sub-layers of her city's retail food environment: to the groceries, snacks/desserts, meal accompaniments, and meals.

Fig. 6.
Doña Concha's tienda.

Table 1

Retailer Types not Captured by RFEI/mRFEI.

Retailer Type	Retail Food Environment	Description
Food-animal product vendors	Grocery	Butchers, fishmongers, and other vendors of food animal products, like deli meats and eggs, both chain and independent.
<i>Comedores and restaurantes típicos</i>	Grazing	Differently sized eateries serving home-made meals comprised of dishes from the local indigenous and peasant gastronomy and those from other cuisines.
International-food restaurants	Grazing	Sit-down restaurants scratch-cooking cuisines from other countries and regions, e.g., French, Italian, Japanese, Mediterranean, Mexican, Taiwanese, etc.
Cafés	Grazing	National chains, like Café Barista, and independent cafes, like Café Armonía, that focus on coffees, teas, or other drinks, like smoothies, and offer a variety of meals, snacks, and desserts.
Bars and <i>cantinas</i>	Grazing	Retailers focusing on the sale of alcohol, along with snacks and meals. <i>Cantinas</i> are cheap drinking venues.
Frozen treats purveyors	Grazing	Ice-cream and frozen yogurt sellers, including Central American, national, and small regional chains (e.g., Helados POPS, La Nevería, and ChooGhurt), independent sellers, and non-food retailers, like computer/games shops and hardware stores, stocking brand ice-cream fridges for sale to their customers.
Chocolate shops and <i>dulces típicos</i> vendors	Grazing	Vendors specializing in artisanal chocolate and/or local delicacies of candied and jellied native fruits, nuts, seeds, and gourds, as well as condensed-milk-based candies known as <i>dulces típicos</i> .
Cake shops and <i>panaderías</i>	Grazing	Bakeries, either chain (e.g., San Martín and XelaPan) or independent (which often have <i>panadería</i> (i.e., bakery) in their name), selling a variety of breads, cakes, cookies, and <i>pan dulces</i> (sweet breads).
<i>Tortillerías</i>	Grazing	Retailers selling hand-made, palm-sized white, yellow, or black tortillas freshly grilled three times a day to accompany every meal, as well as other maize-based accompaniments like <i>tamalitos</i> and <i>chuchitos</i> .

Table 2

RFEI/mRFEI’s sensitivity to Xela’s major retailer categories (%).

Retailer Category (and primary functional groups)	Vendor Types Included in Retailer Category (retailer types not captured by RFEI/mRFEI (Table 1) are italicized)	# Retailers Captured by RFEI/mRFEI	# Retailers Observed	RFEI/mRFEI sensitivity for each category
Fast-Food Retailers (meals)	- International chain fast-food restaurants - National fast-food sit-down restaurants and take out spots - <i>Independent indoor fast-food restaurants</i> - <i>Outdoor fast-food stalls or stands</i>	6	29	21%
Other Prepared Food Retailers (meals)	- <i>Comedores and restaurantes típicos</i> - <i>International-food restaurants</i> - <i>Tortillerías</i>	0	224	0%
Supermarkets (grocery)	- Supermarkets	3	3	100%
Markets (grocery)	- Municipal markets - Periodic agroecological markets akin to small farmers markets	2	2	100%
Other Grocers (grocery)	- <i>Food-animal product sellers, like butchers, fishmongers, egg stores, and chicken stores</i> - <i>Outdoor vendors selling fruits, vegetables, nuts, and seeds</i>	0	26	0%
Corner Stores (snacks and desserts)	- Indoor tiendas - Gas station stores - <i>Outdoor stalls functioning like tiendas</i>	114	125	91%
Other Snack or Dessert Retailers (snacks or desserts)	- <i>Ice-cream and frozen yogurt stores</i> - <i>Non-food vendors carrying ice-cream fridges</i> - <i>Ambulatory outdoor ice-cream vendors</i> - <i>Cake shops and panaderías</i> - <i>Chocolate and dulces típicos vendors</i> - <i>Ambulatory outdoor vendors of granizadas (shaved ice), dulces típicos, candies, cotton candy, popcorn, lollipops, etc.</i>	0	125	0%
Drinks-Focused Retailers (drinks)	- <i>Cafés</i> - <i>Bars and cantinas</i> - <i>Liquor stores</i> - <i>Smoothy and juice bars</i> - <i>Stalls offering freshly squeezed juices and smoothies</i> - <i>Ambulatory vendors selling fresh goat milk or coconut juice</i>	0	18	0%

Table 3

Number and healthiness of food and drink retailers observed in Xela.

Type of Retailer	Least Healthy (#)	Middle Healthy (#)	Most Healthy (#)	Mixed Healthy (#)	Total (#)
Fast-Food Retailer	23	2	0	4	<i>29</i>
Other Prepared Food Retailer	24	20	99	81	<i>224</i>
Supermarket	0	0	0	3	<i>3</i>
Municipal Market	0	0	0	2	<i>2</i>
Other Grocer	1	0	22	3	<i>26</i>
Tienda (corner store)	79	0	0	46	<i>125</i>
Snack or Dessert Retailer	82	1	2	40	<i>125</i>
Drinks-focused retailer	0	3	15	0	<i>18</i>
Total (#)	<i>209</i>	<i>26</i>	<i>138</i>	<i>179</i>	<i>552</i>

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Comparison of healthiness ratings for 125 food and drink retailers identified by RFEI in Xela.

Table 4

Type of Retailer	# of retailers	RFEI Healthiness Rating			Alternative Healthiness Rating			Misclassified (#)
		Unhealthy (#)	Healthy (#)	Least Healthy (#)	Middle Healthy (#)	Most Healthy (#)	Mixed Healthy (#)	
Fast-Food Restaurant (Chain)	6	6	0	4	0	0	2	2
Corner Store	114	114	0	68	0	0	46	46
Supermarket	3	0	3	0	0	0	3	3
Farmers Market	2	0	2	0	0	0	2	2
Total	125	120	5	72	0	0	53	53