Availability, Density, Variety, and Distribution of Street Food Stands and Street Foods Across a Mexican City: An Assessment Using the Street Food Stand Assessment Tool

by

Jose Benito Rosales Chavez

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved October 2020 by the
Graduate Supervisory Committee:

Megan Jehn, Co-Chair
Meg Bruening, Co-Chair
Rebecca E. Lee
Punam Ohri-Vachaspati

ARIZONA STATE UNIVERSITY

December 2020

ABSTRACT

Background. Street food stands (SFS) are common ways in which people in Mexico access food, having been a part of the environment and culture of Mexican food for generations. However, no studies have used a validated assessment tool to reliably measure food and beverage availability at a variety of SFS. Nor have the availability, density, variety, and distribution of SFS and street foods and beverages been assessed across neighborhood income levels.

Objective: This dissertation's goal was to decrease gaps in knowledge about the role SFS may play in food availability in the Mexican food environment.

Methods: Survey design and ethnographic field methods were used to develop, test, and validate the Street Food Stand Assessment Tool (SFSAT). Geographic information system and ground-truthing methods were used to identify a sample of street segments across 20 neighborhoods representing low-, middle- and high-income neighborhoods in Mexico City on which to assess the availability, density, variety, and distribution of SFS and the foods and beverages sold at these food venues using the SFSAT.

Results: A sample of 391 SFS were assessed across 791 street segments. Results showed that SFS were found in all neighborhoods. Contrary to the initial hypothesis, most SFS were found in middle-income neighborhoods. While the availability of street foods and beverages was higher in middle-income neighborhoods, the variety was less consistent: fruit/vegetable variety was high in high-income neighborhoods whereas processed snack variety was higher in low-income neighborhoods. SFS were most often distributed near homes, transportation centers, and worksites across the three neighborhood income levels.

Conclusion: This study bridged the gap in knowledge about the availability, density, variety, and distribution of SFS and products sold at these sources of food by using an assessment tool that was developed, tested, and validated specifically for SFS. The findings showed that SFS were found across all neighborhoods. Furthermore, results also suggested that SFS can be a source of healthy food items. Additional studies are needed to understand the relationship between SFS availability, food consumption, and health outcomes in the Mexican population.

DEDICATION

I would like to dedicate this dissertation to my wife, Gisela Velazquez-Rosales, and my two sons, Abel and Oliver Rosales. Gisela, thank you for encouraging me to apply for graduate programs and for making the move with me to a different city so that I could start my graduate education. Thank you for being there the whole time and for being the tireless adviser and editor to my many projects. Thank you for your unconditional support. Thank you and the kids for the sacrifices you have made to get me where I am. This journey has not been easy. I am sorry for my divided attention and for working long days. I know you understand what this achievement means to me, to our family. Someone once told me: “once the educational barrier is taken down, nothing will erect it again.” I hope that our sacrifices will open the door for the kids so that they and their children not only graduate from college but also pursue higher education. You guys have been my foundation and inspiration to keep going when things got harder. ¡¡Los amo mucho!!

I would also like to dedicate this dissertation to my younger brother, Hector Jesus Rosales Chavez (1993-2019). Thank you for making my decision to leave our home in pursuit of a college degree easier. I dared to leave home because I knew that once I left you and our sister, Gloria, were going to rise to the occasion and be there for our mother and younger siblings. I am sorry that you left us so young. I am sorry that we are not going to grow old together. I know that wherever you are now, you have been helping me get across the finish line, especially with all the 2020 chaos and uncertainty. I know you will be celebrating this family accomplishment with me. Wherever you are Teto, I hope to see you once again. ¡¡Gracias carnal!

ACKNOWLEDGMENTS

This accomplishment was possible with the assistance of many people. The phrase “it takes a village to raise a child” applies to a Ph.D. student as well. I must go back to high school when my U.S. History teacher, Mr. Gokul saw my potential and encouraged me to apply to the Gates Millennium Scholarship (GMS). He served as my nominator and recommendatory and I was fortunate to receive this life-changing scholarship. Thanks to GMS I became the first person in my family to go to college. Thanks to the McNair Scholars Program at the University of San Diego I learned about research and Ph.D. programs. Thanks to its very passionate leaders: Noel Salunga, Shelley Barajas-Leyva, and Ramiro Frausto I became passionate about getting a higher education. Then, participating in the Leadership Alliance’s Summer Research Early Identification Program strengthened my desire to earn a Ph.D.

Thank you to my dissertation committee for overseeing my work. To Dr. Meg Bruening, for bringing me into her research team and for the many opportunities she has offered me to grow professionally. Thank you for all your dedication and all the time you have put into mentoring and advising me. To Dr. Megan Jehn for her advice, advocacy, and for helping me prepare for a successful job talk. To Dr. Rebecca E. Lee for including me in her research projects and for connecting me to my collaborators in Mexico City who facilitated a successful dissertation data collection, and to Dr. Punam Ohri-Vachaspati for all the helpful feedback and advice.

This study would not have been possible without the support of my collaborators in Mexico City: Dr. Luis Ortiz-Hernandez, Dr. Israel Lopez Reyes, and the students from

Universidad Autonoma de la Ciudad Mexico-Cuautepec. Without their help, I would not have been able to accomplish the objectives of this study. The financial support for the implementation and success of this project was generously given by the School of Human Evolution and Social Change, and by the Graduate and Professional Student Association Research Grants at Arizona State University. Thank you.

TABLE OF CONTENTS

Page

CHAPTER Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Statement of the Problem

Studying the availability of food venues and their distribution in a community is important because differences in food availability and variety may be associated with the type of food venues present (Gittelsohn, 2012). Research has indicated that the availability and variety of food are related to dietary consumption and health outcomes (Rose, Bodor, Hutchinson, & Swalm, 2010; Sallis & Glanz, 2006; Timperio et al., 2008). For example, food venues such as supermarkets and grocery stores have been associated with the availability and variety of healthy food items such as fruits and vegetables (FV) (Connell et al., 2007; Farley et al., 2009; Leone et al., 2011; Liese, Weis, Pluto, Smith, & Lawson, 2007; Morland, Wing, & Roux, 2002; Rose et al., 2009; Zenk et al., 2009) whereas food venues such as fast-food restaurants and convenience stores have been associated with high availability of unhealthy foods such as foods high in fat, sugar, or salt (Farley et al., 2009; Gittelsohn, 2012; Glanz, Sallis, Saelens, & Frank, 2007; Leone et al., 2011; Lucan, Karpyn, & Sherman, 2010).

In addition, studying the distribution of food venues can explain the types of populations different food venue owners may be targeting, the types of foods available for those populations, and disparities in food access among different groups of people. Food venue owners or vendors use customers' demographics to target specific populations. For example, there is a higher prevalence of supermarkets in high-income

white neighborhoods than in low-income ethnic neighborhoods (Cole, Filomena, & Morland, 2010; Morland & Filomena, 2007; Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007). The opposite has been observed with the availability of fast-food restaurants and convenience stores: low-income communities have a higher availability of fast-food restaurants than high-income (Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011; Larson, Story, & Nelson, 2009; Matsuzaki, Sánchez, Acosta, Botkin, & Sanchez-Vaznaugh, 2020). This differential access to food venues by race has been linked to disproportionately higher rates of conditions such as obesity and cardiovascular diseases among low-income minorities (Ford & Dzewaltowski, 2008; Singleton, Affuso, & Sen, 2016). Similarly, food venues are strategically located near points of access (e.g. places such as schools, worksites, and others where there are high concentrations of customers that vendors may be targeting) to reach populations. Studies have found a high presence of fast-food restaurants and corner stores near schools, and that children who go to school near fast-food restaurants and corner stores are more likely to be exposed to unhealthy foods (Day, Pearce, & Pearson, 2015; Farley et al., 2009; Gordon et al., 2011; Lucan et al., 2010; Matsuzaki et al., 2020; Sturm, 2008). Furthermore, consuming foods from either fast-food restaurants or convenience stores has been associated with obesity, and cardiovascular diseases (Jilcott et al., 2011; Matsuzaki et al., 2020; Spence, Cutumisu, Edwards, Raine, & Smoyer-Tomic, 2009). Studying the availability and distribution of food venues have been the first step in understanding the relationship between food venue availability and food availability.

Reliable and valid assessment methods and tools are needed to objectively measure the food environment and food availability. Variables such as availability, accessibility, price, quantity, promotion, quality, distance, diversity, and variety (Dean, Sharkey, Johnson, & Valdez, 2011; Glanz, 2009) are commonly included in assessment tools to record qualities in food environments. There are assessment tools designed to measure different types of food venues including supermarkets, grocery stores, convenience stores, sit-in, and fast-food restaurants. However, one important food venue where validated assessment tools are lacking is street food stands (SFSs)

A critique of food environment studies is that most research on food venues and food availability has been done in high-income countries such as the U.S. using assessment tools that have been developed, tested, and validated in the context of those countries and food venues such as supermarkets, grocery stores, convenience stores, table service, and fast-food restaurants. Reviews of the food environment have documented limited usage of validated assessment tools in low- and middle-income countries (Glanz, 2009; Gustafson, Hankins, & Jilcott, 2012; Kelly, Flood, & Yeatman, 2011; Lytle, 2009; McKinnon, Reedy, Morrissette, Lytle, & Yaroch, 2009; Ohri-Vachaspati & Leviton, 2010). In addition, the type of food venues found in high-income countries may not be culturally relevant in low- and middle-income countries.

In Mexico, and other low- and middle-income countries, the food environment is a complex system that incorporates westernized elements of the food environment such as supermarkets, fast-food restaurants, and convenience stores, but also culturally

relevant food venues. One of these culturally relevant food venues is SFS where street food is purchased. Street foods are defined as ready to eat food and beverages that are sold by peddlers who used a variety of mediums to cook, display, store, and move food items including highly mobile stands such as bicycles and wheelbarrows, semi-mobile stands such as portable tables, chairs, and cooking ware, and stationery stands which can stay in place overnight but can be easily moved to a different location (Bhowmik, 2005; Food and Agriculture Organization, 1989; World Health Organization, 1996).

SFS represent food security for millions of families (Long-Solís, 2007; Lucan et al., 2013; Moy, Hazzard, & Käferstein, 1996; Munoz de Chavez, Chávez Villasana, Chávez Muñoz, & Vuskovic, 2000; Nelia P Steyn & Labadarios, 2011) and a source of income for thousands of vendors (Arámbulo III, Almeida, Cuéllar Solano, & Belotto, 1994; Bhowmik, 2005; Choi, Lee, & Ok, 2013; Tinker, 2003). However, few assessments of the food environment have focused on food availability at SFS. According to a review of SFS studies from around the world, most studies on SFS have been done in Asian and African countries, and have focused on foodborne diseases (Abrahale, Sousa, Albuquerque, Padrão, & Lunet, 2018). Seven Mexican studies included observations about either street food consumption or SFS presence (Hernandez Barrera, Rothenberg, Barquera, & Cifuentes, 2016; Langellier, 2015; Long-Solís, 2007; López-Barrón, Jiménez-Cruz, & Bacardí-Gascón, 2015; Munoz de Chavez et al., 2000; Soltero et al., 2017; Taillie, Afeiche, Eldridge, & Popkin, 2017). These studies indicated that street food stands are a common element of the Mexican food environment and street foods are

consumed by both children and adults. One of these studies integrated geographic analyses and a validated assessment tool (Soltero et al., 2017), and found that SFS may be a source of healthy foods. However, SFS stands were not the unit of analyses in Soltero et al.'s study, and the validated assessment tool was not specific to SFS. Despite these studies, there are no assessments that document the availability, density, and distribution of SFS, and the type of food and beverage items sold at SFS using objective and validated assessment methods. Measuring the availability, variety, distribution, and density of SFS and the food sold at SFS is the first step in understanding the role that SFS play in the food environment and the relationship among street food, dietary intake, and health outcomes in the Mexican population.

Understanding the relationship between street food and health outcomes is particularly important in Mexico. The most recent Mexican Health and Nutrition Survey (ENSANUT) shows that Mexico has one of the highest overweight and obesity rates in the world; one out of three children ages 2-17 are either overweight or obese, and 73% of adult women and 69% of adult men are either overweight or obese (Simón Barquera, Campos-Nonato, Hernandez-Barrera, Pedroza-Tobias, & Rivera-Dommarco, 2013; Guiterrez et al., 2012). The high overweight and obesity levels are important health concerns due to the positive relationship that excess weight has with chronic diseases such as cardiovascular diseases (Hubert, Feinleib, McNamara, & Castelli, 1983; Saydah et al., 2014), and type 2 diabetes (S. E. Kahn, Hull, & Utzschneider, 2006; Saydah et al., 2014). Recent data show that Mexico has one of the highest type 2 diabetes prevalence in

the world and the highest on the American continent (Guariguata et al., 2014; OEDC, 2011). Studying food availability in SFS is the first step in understanding the relationship between SFS and health.

The previous observations of the association between obesity and chronic diseases are more concerning given that overweight/obese children are more likely to become overweight/obese adults (Deshmukh-Taskar et al., 2006; Serdula et al., 1993; Singh, Mulder, Twisk, Van Mechelen, & Chinapaw, 2008). Furthermore, overweight/obese children are more likely to develop health complications early in life than normal-weight children. Overweight/obese children are four times more likely to develop hypertension than normal-weight children (Flynn, 2013; Sorof, Lai, Turner, Poffenbarger, & Portman, 2004; Tu et al., 2011), and overweight/obese children are 73% more likely to develop glucose intolerance when compared to normal-weight children (Franks et al., 2010). Based on these observations, the Mexican population will likely be facing a serious public health burden in the years to come. The role that street food may be playing in the high overweight and obesity rates is unknown. This study is the first step in helping bridge that knowledge gap.

This dissertation will bridge the gap in knowledge about SFS in the food environment by accomplishing the following objectives: 1) Create, test, and validate a street food stand assessment tool (SFSAT); 2) Document the availability, density, and distribution of SFS across neighborhood income levels and points of access 3) Document the availability, density and distribution of foods and beverages sold at SFS and

differences in food and beverage availability and variety across neighborhood income levels and points of access.

To accomplish the previous objectives, this study will use a combination of research methods including ethnography, survey design, and geographic information systems. In the first part of chapter 1, a review of theories and constructs used to study the food environment and the relationship between elements of the food environment and food availability is provided. In the second part of chapter 1, methods that have been used to assess the food environment and food availability and how they can be used to study SFS are reviewed. In chapter 2, the ethnographic fieldwork, testing, and validation of SFSAT are described. In chapter 3, differences in availability, distribution, and density of SFS across neighborhood income levels and points of access in Mexico City are presented. In chapter 4, differences in the availability and variety of street foods and beverages across neighborhood income levels and points of access in SFS in Mexico City are explored. The dissertation concludes with a discussion about the availability of SFS in Mexico City and the role this type of food venue may play in food and beverage availability and variety in the Mexican food environment. The creation of the assessment tool and the findings from this study can help increase our knowledge of the role food venues like SFS may play in food and beverage availability in the Mexican food environment.

Eating Behaviors and Health Outcomes in Mexico

Mexico is a country that over the past few decades has undergone a nutritional transition (Hawkes, 2006). The traditional Mexican diet was composed primarily of healthy nutrient-dense foods such as corn products, legumes, and FV, and was limited in unhealthy energy-dense foods such as fast-foods, chips, and sugar-sweetened beverages (SSB) (Rodríguez-Ramírez, Mundo-Rosas, García-Guerra, & Shamah-Levy, 2011). However, in recent decades there has been a rise in the availability of unhealthy foods that are characterized by containing elevated levels of fats and added sugars (Hawkes, 2006; Rivera et al., 2002; Rivera, Barquera, Gonzalez-Cossio, Olaiz, & Sepulveda, 2004). Consumption of unhealthy foods is common in the Mexican population, especially among children (Jiménez-Cruz, Bacardí-Gascón, & Jones, 2002). SSB consumption increased by 226% between 1995 and 2003; this translates to a daily consumption of about 110.9 ml for children 1-4 years old, 245.1 ml for children 5-11 years old, 250.5 ml for adolescents (12-18 years old), and 249.5 ml for adults (Simon Barquera et al., 2010; Simon Barquera et al., 2008). The consumption of energy-dense foods has been associated with changes in health outcomes that include high rates of overweight and obesity (Rivera et al., 2002), and type 2 diabetes (Malik et al., 2010; Schulze et al., 2004) in the Mexican population.

Eating behaviors and the food people consume can play a key role by hindering or promoting positive health outcomes (Boushey, Coulston, Rock, & Monsen, 2001; Centers for Disease Control, 2013; Jenkins & Horner, 2005; Lin, O'connor, Whitlock, & Beil,

2010). The Mexican Dietary and Physical Activity Guidelines recommend that individuals, 2 years and older, eat a high-quality diet composed of a combination of foods including vegetables, fruits, grains, fat-free or low-fat dairy products, and a diversity of protein (e.g. fish, lean meats, legumes, eggs), and oils while limiting the intake of saturated fats, trans fats, added sugars and sodium (Bonvecchio Arenas et al., 2015). Although recommendations exist about what foods a high-quality diet should contain, people are not eating the recommended foods. Therefore, there is a need to understand what factors in the person's daily life might be associated with eating behaviors, and how those factors could help explain why people choose some foods over others. Individual, societal, and environmental factors interact to influence a person's food choices and eating patterns (French et al., 2001). Understanding the food environment and food availability is vital for creating a positive impact in individuals' eating behaviors (Gittelsohn, 2012), and addressing diet-related problems such as overweight (Campbell, Crawford, & Ball, 2006), obesity (Hill, Wyatt, Reed, & Peters, 2003), and diabetes (Ershow, 2009). The food available in the food environment can be positively or negatively associated with the health status of consumers.

Studies in the U.S. have shown that the food environment has a strong relationship with eating behaviors and health outcomes. On average, unhealthy food environments or environments characterized by having a high prevalence of fast-food restaurants, and convenience stores, and a low prevalence of supermarkets and grocery stores have been associated with adverse health outcomes (Holsten, 2009; Jeffery, Baxter,

McGuire, & Linde, 2006; Morland & Evenson, 2009; Morland, Roux, & Wing, 2006). Community members are more likely to sustain healthy eating patterns (e.g. consuming a variety of FV, grains, proteins, and fat-free or low-fat dairy products) and reduce risks for negative health outcomes in food environments characterized by a high prevalence of supermarkets and grocery stores (Morland & Evenson, 2009; Morland et al., 2006).

Studies of the food environment, food availability, eating behaviors and health outcomes in Mexico are limited (Aceves-Martins, Llauradó, Tarro, Solà, & Giralt, 2016; Rosales Chavez, Garcia, Jehn, Pereira, & Bruening, 2020). In a narrative review of obesity-promoting factors among Mexican children and adolescents in Mexico, Aceves-Martins et al. (2016) report that the socioeconomic and nutritional transition happening in Mexico over the last few decades has resulted in lower availability of healthy nutrient-dense foods. However, the studies that Aceves-Martins review did not contain direct assessments of the food environment. Data were primarily self-reported and might not have reflected what was available in the local food environment. In another review of the Mexican food environment, Rosales Chavez et al. (2020), assessed studies that used direct observations of the food environment and dietary intake methods to document food availability. Researchers found that in recent decades there has been a higher availability of processed food items and that people are more likely to consume food items that are readily available whether those are healthy or unhealthy foods. Both reviews discuss different elements of the food environment including grocery stores and convenience stores, however, culturally relevant food venues remain understudied.

The limited availability of studies from Mexico shows the need for further studies that systematically record the food environment, food availability, and their association with eating behaviors and health outcomes in the Mexican population. In middle-income countries like Mexico, there are food sources and venues that have been understudied. One of these culturally relevant food sources is SFS. Mexican SFS are an essential element of the food environment and a vital source of food for millions of families (Long-Solís, 2007; Lucan et al., 2013; Mahon et al., 1999; Moy et al., 1996; Munoz de Chavez et al., 2000; Nelia P Steyn & Labadarios, 2011). Most studies of SFS have focused on food-borne diseases, contamination, and sanitation practices (Chakravarty & Canet, 1996; Choi et al., 2013; Moy et al., 1996; Nago et al., 2010; Rheinländer et al., 2008). To my knowledge, there are no studies that have used validated observational tools to understand the role of SFS in dietary consumption.

CHAPTER 2

REVIEW OF ECOLOGICAL MODELS AND THEIR APPLICATION TO THE FOOD ENVIRONMENT

Several ecological models and theories can be used when studying the food environment and food availability. The first ecological models were created to study the natural environment. Amos Hawley (1950) was one of the early researchers to adapt the ecology concept to human populations. In his book Human Ecology, Hawley mentions that the life of any organism is strongly linked to the environment where that organism lives. He explains that the environment contains "the raw materials of life and the conditions, both favorable and unfavorable, that affect the use of those materials" (Hawley, 1950). However, the modern human food environment is the product of human activity. Therefore, when studying the human environment using an ecological approach we must take into consideration the fact that some people have a great level of control over their environment, and people modify the environment according to their needs (Hawley, 1950).

Other works that have been influential in ecological models include the Ecological Psychology Model by Kurt Lewin (1951). According to Lewin, behaviors are influenced by factors outside personal characteristics (Lewin & Cartwright, 1951). Those factors can be found in the environment as suggested by Roger Barker's Ecological Psychology. Barker added the idea that behaviors can best be predicted by the conditions a person lives in rather than on that person's characteristics (Barker, 1968). In the case of

eating behaviors, a person who knows what constitutes eating healthy might not be able to eat healthily if healthy foods are not available in her food environment.

One of the most influential works in ecological studies was that of Urie Bronfenbrenner's Systems Theory (Bronfenbrenner, 1979). Unlike previous researchers, Bronfenbrenner categorized modifying factors into levels of influence: individual, microsystem, mesosystem, exosystem, and macrosystem. These levels of influence can be thought of as layers, with each layer expanding from the center and becoming more complex as the levels move away from the center. The inner center of the layers is the individual or as Bronfenbrenner (1979) called it, "the developing person." The next layer is the microsystem and it includes the activities, roles, and social relationships that the developing person participates in. The microsystem is limited to the specific setting where the person can be physically found at any one point in time; home, school, worksites, etc. At a higher level, one can find the mesosystem.

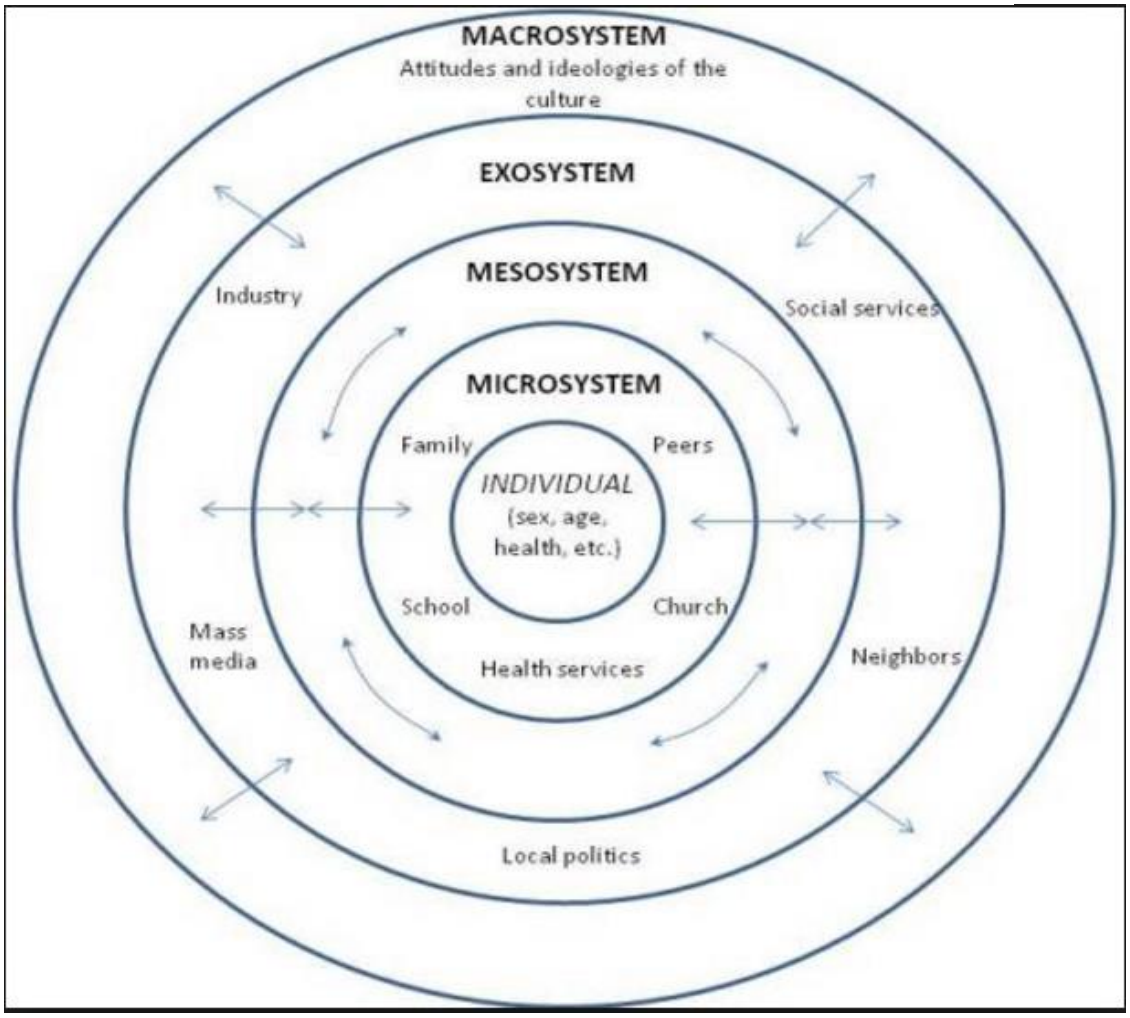
The mesosystem was described by Bronfenbrenner as a system of microsystems: it involves the relationship between the different settings where the developing person can be found (Bronfenbrenner, 1979). For example, a school-age child can be found at home, at school, or in the community at different times. The mesosystem represents the relationships between those three settings. The next level is the exosystem. Unlike previous layers, the exosystem does not contain the developing person, however, events that happen in this system can affect or be affected by events happening at the microsystem (e.g. policy decisions). The last and most outer layer is the macrosystem.

The macrosystem contains all previous systems, and it is defined by cultural patterns. It contains the shared beliefs and values of groups of people. Cultural patterns are different across settings, thus there are no truly identical macrosystems. Nevertheless, there are some characteristics in macrosystems that remain the same (Bronfenbrenner, 1979). For example, in many different societies and cultural settings individuals with limited resources such as limited access to healthy foods are more likely to experience negative health outcomes than individuals with more resources. Macintyre's (2007) deprivation amplification explains that a person's deprivation is more likely to increase by the deprivation found in their neighborhood (Macintyre, 2007). Thus, it can be argued that a person who does not consume healthy food items regularly is less likely to consume them if those foods are not available in the level of the environment where the person might be.

When considering all systems, Bronfenbrenner (1979) highlights that one must consider both the objective and subjective characteristics of the different systems. Problems arise when researchers fail to measure and acknowledge differences in objective and perceived measures. Studies that rely on subjective assessments (e.g. recalls, interviews) might report different data than objective measurements (e.g. food inventories, food checklists) which could affect findings when participants give under or overestimations answers (Alba & Hutchinson, 2000; House et al., 2005; Lechner, Brug, & De Vries, 1997; Nørnberg, Houlby, Jørgensen, He, & Pérez-Cueto, 2014). In some cases, subjective or perceived characteristics might be more important for the individual

than objective characteristics (Lewin & Cartwright, 1951). In areas with inadequate availability of healthy food items, some people may purchase and consume foods that are supersized and unhealthy but cost less than healthy food items. Some people may perceive that they are getting the most for their money when they purchase supersized products (Young & Nestle, 2002, 2003).

Figure 2.1 Bronfenbrenner's Systems Theory Model (Bronfenbrenner, 1979)



Reciprocal Determinism (Reciprocity)

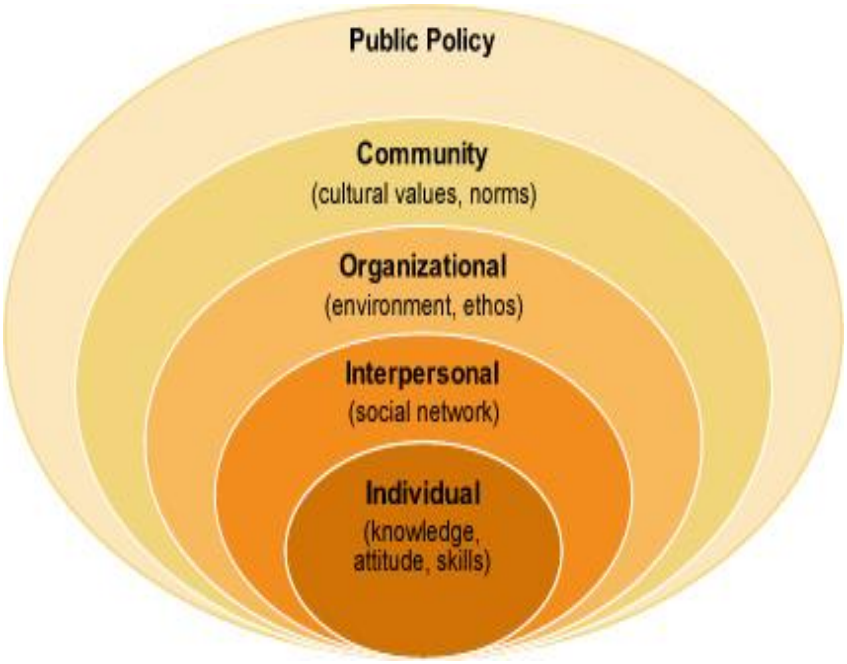
Bronfenbrenner also describes the concept of reciprocity. Reciprocity represents the idea that the environment is as likely to influence the individual as the individual is to influence characteristics in the environment. Reciprocity can happen anywhere in the model. Therefore, the relationship between the individual and its environment is a two-way process. The idea that people's behaviors can directly influence their environment has been borrowed by other models including McLeroy's Ecological Model of Health behavior, and Glanz et al.'s Model of Community Food Environment. Examples of reciprocity include farmers' markets or local organic foods. As people become more aware of controversial processes involved in the mass production and processing of foods, the demand for products (e.g. organic) that do not harm workers and the environment has increased, and consequently, the demand for these items at farmers' markets, grocery stores, and supermarkets have also increased (Brown, 2002; Conner, Montri, Montri, & Hamm, 2009; Sahota, 2009; Wolf, Spittler, & Ahern, 2005). Food outlets such as groceries and supermarkets operate on the concept of supply and demand. Therefore, when people demand healthy food options, like a higher variety of FV, those businesses are more likely to listen to their customers and offer items in demand (Sahota, 2009).

Ecological Model of Health Behavior

The Ecological Model of Health Behavior developed by McLeroy et al. (1988)

draws on ideas from Bronfenbrenner's System Theory. McLeroy et al.'s model shifted away from the life-style theories that made the individual solely responsible for changing behaviors. Using an individual approach diminished the impact of the environment on health behaviors and blames the person when interventions do not work (McLeroy, Bibeau, Steckler, & Glanz, 1988). Changes in lifestyles and individual behaviors are not sustained when environmental and social factors are not addressed (Crawford, 1979). Unlike Bronfenbrenner's model, McLeroy et al. added more specificity to their model by focusing on five distinct levels that can form a set of layers among themselves: 1) intrapersonal factors; 2) interpersonal processes and primary groups; 3) institutional factors; 4) community factors; and 5) public policy.

Figure 2.2 McLeroy et al.'s Ecological Model of Health Behavior



The intrapersonal level focuses on a person's psychological processes as well as how personal characteristics such as age, gender, and ethnicity, can be associated with behaviors. The interpersonal level involves the relationship between the individual and individuals within his or her social networks. Social networks include both immediate and distal social connections. The interpersonal level can facilitate access to social resources and provide psychological support. Another key element of the interpersonal level is that it is through association and interactions with individuals that norms, values, and beliefs develop. These three elements are essential in shaping the individual's psychological processes and social identity (McLeroy et al., 1988).

The third level of the Ecological Model of Health Behavior contains organizations to which a person belongs. Organizations are a critical component in a person's daily life because some people might spend large portions of their day in those organizations (e.g. schools, work-sites) (McLeroy et al., 1988). Organizations can support or hinder healthy behaviors. One way that organizations can facilitate healthy behaviors is through economic resources (e.g. incentives), social support, and through regulations (e.g. no smoking within the organization). McLeroy et al. suggested that healthy behaviors are more likely to happen when organizations commit to organizational changes which can create a culture of support between the organization and its members. A health intervention program at the organization level can be successful once the changes become institutionalized.

The community is the fourth level in McLeroy et al.'s model. McLeroy and colleagues (1988) defined community as 1) the mediating structures (e.g. family, social networks, organizations) where the person belongs; 2) the relationship between organizations and groups of people within a specified area, and 3) the population that can be found within a geographical and political area. Communities can define social identity and provide essential social support to its members. Communities can be a powerful tool that can drive change. Community members can come together to seek or demand resources for their members. However, the amount of power a community has varies depending on its member composition. Often, ethnic minorities and economically disadvantaged individuals have limited power, and as result, individuals of minority backgrounds become the object of interventions themselves (McLeroy et al., 1988).

The last layer in McLeroy et al.'s model is the public policy level. The policy level affects all previous layers through "regulatory policies, procedures, and laws" that can hinder or support the health of individuals (McLeroy et al., 1988). Although public policies are at the outer level, policies can be initiated at the community and organization level. For example, homeowner associations can regulate the type of traffic circulating in a neighborhood or the number of recreational facilities available for residents. Likewise, organizations like worksites can pass policies banning smoking on-site or create nutrition initiatives that facilitate the consumption of healthy foods. Significant reductions in infectious diseases and mortality rates have been the result of public policies (McKinlay & McKinlay, 1977).

McLeroy et al.'s model also borrows the idea of reciprocal determinism from Bronfenbrenner's model: factors in each level of influence interact with each other across levels to influence behavior (Bronfenbrenner, 1979). For example, national policies (e.g. farm bill) can affect the type of crops that farmers grow, which in turn can affect food production, and that can have an impact on the types of foods available in the community (e.g. in supermarkets) or available for consumption in organizations (e.g. free/reduced school lunches), and in households (e.g. SNAP benefits). In return, individuals' behaviors (e.g. lobbying) can shape public policy by advocating for specific food regulations or social programs.

Model of Community Food Environments

Glanz et al. (2005) took ecological models a step further by focusing on a specific level of McLeroy et al.'s model and a specific topic. Glanz et al. conceptualized the Model of Community Food Environments with the goal of documenting the relationships among policy, environmental factors, and individual variables such as eating behaviors (Glanz, Sallis, Saelens, & Frank, 2005). Glanz et al. believed that the food environment plays a key role in food availability and could explain disparities in health outcomes in different communities throughout the United States.

Like McLeroy et al.'s model, Glanz et al.'s model can also be described as layered. Behavior or eating patterns can be found in the inner layer. The next layer is individual variables that include the person's sociodemographic characteristics,

psychological factors, and how the individual perceives the food environment (Glanz et al., 2005). Environmental variables constitute the third layer. Glanz et al. defined four different types of food environments: community nutrition environment (which I refer to as community food environment), organizational nutrition environment, consumer nutrition environment, and information environment. Each of these food environments can be further divided into smaller elements. For example, the organization's food environment is composed of the home, school, work food environments. I also refer to these elements of the organization's food environment as points of access or places that food venue owners and vendors may be targeting to sell products to the population within those places (e.g. school-aged children, working adults).

The consumer nutrition environment is made up of products, price, promotion, placement, also known as the four p's of marketing. Studies on this element of the Model of Community Food Environment investigate how marketing is associated with food purchases. The information environment contains elements related to food advertisements and ways to distribute food messages. Studies of the information environment assess how messages can be targeted to specific populations to encourage them to consume or engage in specific behaviors (e.g. purchasing super-sized meals, etc.). The community food environment contains the type and location of stores and is the focus of my dissertation. Studies of the community food environment investigate how food venue availability and their distribution (i.e. location) relates to food availability and distribution. At the highest level of influence, we can find policy variables typically

associated with governments and organizations. Decisions taken at the policy level can have an effect on the other levels of the model. For example, local policies can influence the type of food venues available in a community through ordinances, and national policies can affect the type of food available at food venues (e.g. subsidies towards specific farm products).

Integration of the Ecological Model of Health Behavior, and Model of Community Food Environment

The food environment is a general term that refers to a place or set of places where individuals can find food for purchase and/or consumption. Food can be available in all sorts of settings, but availability and accessibility in each level of the food environment depend on other factors within and outside a specific level. As Glanz et al. (2005) suggested, the food environment can be divided into four large levels that interact with each other to influence behavior, and those behaviors have been shown to modify the food environment as well (reciprocity) (Bronfenbrenner, 1979). Availability refers to whether a food item is physically present; whereas, accessibility refers to whether a person can acquire the food item that is present. Access can be divided into potential access (i.e. food options) and realized access (i.e. food acquisition) (Dean, Sharkey, Johnson, et al., 2011). Low realized access means that the food item is present, but the person might not be able to purchase or consume the item due to factors such as price, transportation, distance, and income (Dean, Sharkey, Johnson, et al., 2011).

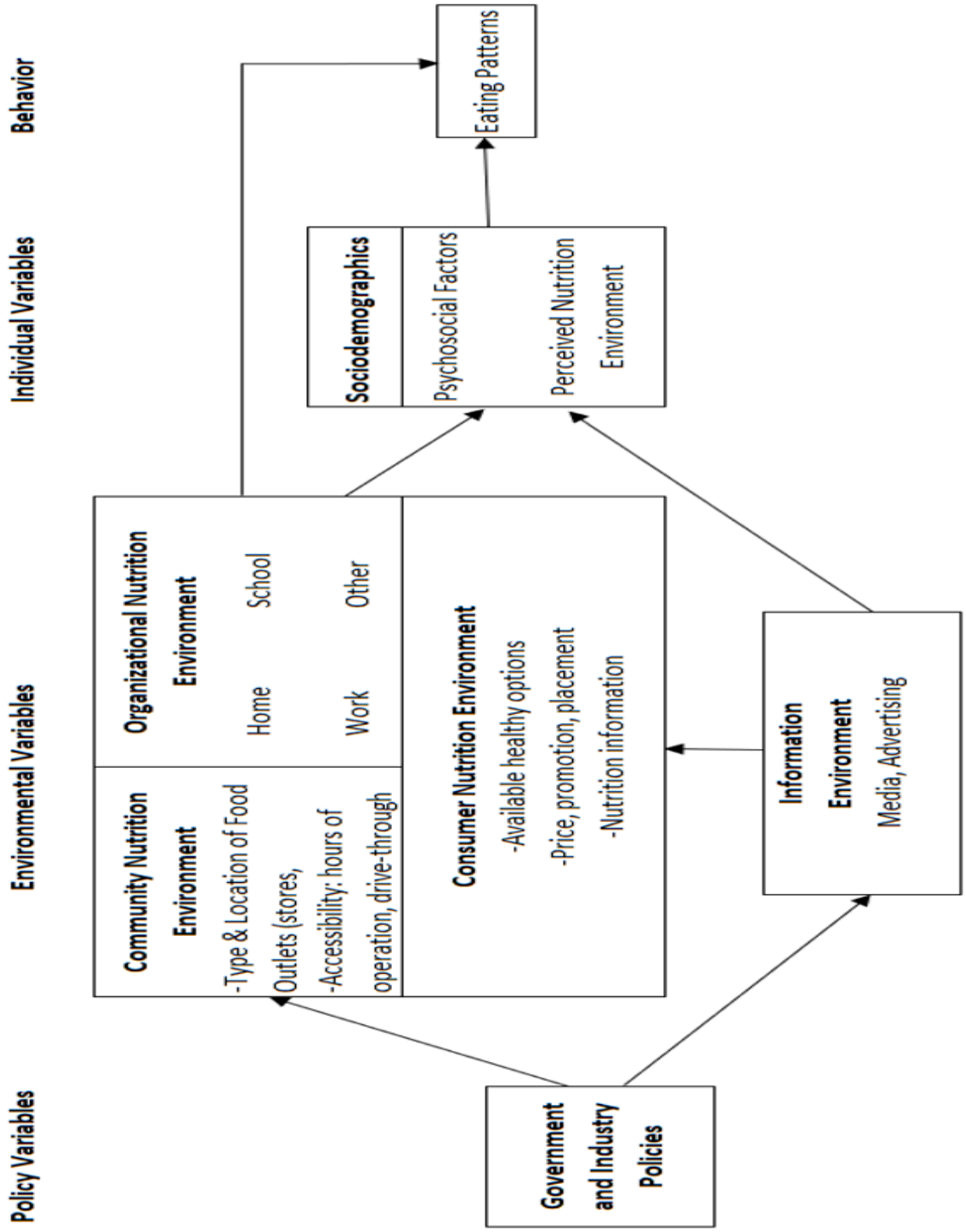
In the following sections, I talk about the relationship between the food environment and food availability at the level of the organizational food environment. The organizational food environment includes places that can serve as a point of access to a specific population by food venue owners and vendors.

Organizational Food Environment

Home Food Environment

The first type of food environment in Glanz et al.'s (2005) model is the organizational food environment which contains the home, school and work food environments. The home food environment, also known as family food environment, refers to food resources that can be found and eaten in a person's home (Campbell et al., 2006; Campbell et al., 2007; Sharkey, Johnson, & Dean, 2010). Multiple factors can be associated with food availability at home: spatial access to traditional food venues (Rose & Richards, 2004; Sharkey, Johnson, et al., 2010), convenience (Bodor, Rose, Farley, Swalm, & Scott, 2008; Sharkey, Dean, Nalty, & Xu, 2013), nontraditional retail food stores (Dean, Sharkey, & John, 2011; Gantner, Olson, Frongillo, & Wells, 2011),

Figure 2.3 Glanz et al. Model of Community Food Environment (Glanz, Sallis, Saelens, & Frank, 2005)



transportation (Dean, Sharkey, Johnson, & St John, 2012; Sharkey, Dean, St John, & Huber, 2010), behaviors, and sociodemographic characteristics of the individuals responsible for acquiring food at home (Kirkpatrick & Tarasuk, 2010; Sharkey et al., 2013).

Findings from the U.S. have shown that consumption of foods, both healthy and unhealthy, at home, is associated with the availability of those foods (Campbell et al., 2007; Ding et al., 2012; Hanson, Neumark-Sztainer, Eisenberg, Story, & Wall, 2005; Wyse, Campbell, Nathan, & Wolfenden, 2011). Campbell et al. (2007) found that participants were more likely to consume unhealthy foods (e.g. sweet snacks, savory snacks, take-out food) when these were readily available at home. Similar observations have been found for healthy food like FV (Arcan et al., 2007; Hanson et al., 2005). However, having food available at home does not guarantee its consumption. Befort et al found that the availability of FV was not associated with the consumption of those foods (Befort et al., 2006). Likewise, Rose and Richards (2004) found that although FV was readily available at home, the consumption of vegetables was not significantly associated with home availability. The previous results seem to indicate that besides availability, there are additional factors related to food consumption and eating behaviors that should be taken into consideration.

Food availability at home can vary depending on the type of food sources located near homes. The most commonly studied food sources around homes include grocery stores, supermarkets, corner stores, fast food restaurants, and table service restaurants

(Creel, Sharkey, McIntosh, Anding, & Huber, 2008; Dean, Sharkey, & John, 2011; Sharkey, Horel, Han, & Huber, 2009). Studies have indicated that having supermarkets near homes is associated with higher availability and consumption of healthy foods at home (Rose & Richards, 2004; Sharkey, Johnson, et al., 2010). Similarly, Sharkey et al. (2010) analyzed food access and perceptions of the community and home food environments and found that decreasing access to healthy foods limited the consumption of healthy food at home.

Convenience and someone's ability to physically reach food sources play a key role in home food availability. Bodor et al. (2007) found that having grocery stores conveniently located 100 meters or fewer from the home significantly increased vegetable consumption, but no significant relations were observed for fruit consumption. In cases where families do not have a safe or reliable way to reach healthy food outlets, the availability of healthy food items in the home food environment seems to decrease (Dean et al., 2012). Similar observations have been found for unhealthy foods. Living near fast-food restaurants and corner stores have been associated with a higher intake of unhealthy foods. In a review of fast-food access, Fleischhacker et al. (2010) found that increased exposure to fast-food restaurants was associated with a higher fast-food intake (Fleischhacker et al., 2011).

Nevertheless, there are cases when food availability at home is not associated with factors outside the home food environment (Elbel et al., 2015; Kirkpatrick & Tarasuk, 2010; Sharkey et al., 2013). For instance, Sharkey et al. (2013) found that the

distance and amount of convenience stores near homes were not associated with home food availability. Additionally, the frequency of purchasing foods at grocery stores or discount stores was not associated with home food availability (Sharkey et al., 2013). Jeffrey et al. (2006) found that proximity to restaurants was not associated with the consumption of energy-dense food (Jeffery et al., 2006). Some of these observations could be explained by social dynamics at home and the eating patterns of the head of the household (Glanz et al., 2005). Adults are responsible for purchasing decisions and food preparation. Thus, their knowledge, attitudes, and beliefs should be key factors to consider. Furthermore, researchers have observed that some families go outside of their neighborhood to buy groceries or other food items (Chaix et al., 2012; Drewnowski, Aggarwal, Hurvitz, Monsivais, & Moudon, 2012). Interventions aimed at increasing food venues within the immediate vicinity of homes will not work effectively if people are not utilizing those resources.

Worksite Food Environments

In addition to the home food environment, the work food environment also falls under the organizational food environment. Although providing food is not the main objective of worksites, these organizations have food available as part of institutional foodservice operations inside or near the worksite (Glanz, 2009; McKinnon et al., 2009). Many people spend a sizable portion of the day at work. In these locations, employees might have multiple opportunities to eat (Centers for Disease Control, 2013). A review of

the worksite food environment found that studies on this type of food environment have been done with the purpose of modifying the environment and helping people adopt positive eating behaviors (Ni Mhurchu, Aston, & Jebb, 2010; Rueff & Logomarsino, 2016). Worksites are ideal places for environmental interventions because individuals from different demographic backgrounds can be reached in these sites (Devine, Nelson, Chin, Dozier, & Fernandez, 2007; Pratt et al., 2007; Sorensen, Linnan, & Hunt, 2004). Some interventions at worksites have increased the variety of healthy food items (Backman, Gonzaga, Sugerman, Francis, & Cook, 2011; Jeffery, French, Raether, & Baxter, 1994; Mendes Gorgulho, Nogueira Previdelli, & Lobo Marchioni, 2012). Other interventions have reduced the cost of healthy food items like FV, salads, and low-fat snacks (French et al., 2001; Hua & Ickovics, 2016; Jeffery et al., 1994).

Although studies on work-sites in Mexico are limited, a recent intervention study in three low to middle-income countries (China, India, and Mexico) found that the daily consumption of at least five FV servings increased by 6.9% in the intervention group (Anthony et al., 2015). Creating healthy food environments near worksites is important for Mexican workers because thousands of individuals commute long distances to work (Arámbulo III et al., 1994; Tinker, 2003), and foods near their worksites might represent the only source of food during the day.

School Food Environment

The school food environment, which is composed of foods available inside and in the immediate vicinity of schools, can expose children to several types of food. During school hours, children in the U.S. have at least two opportunities to eat: breakfast and lunch (Dwyer, 1995). Similar observations have been done in Mexico where most school children consumed three to four meals a day, and half of those could be consumed at school (Alvear-Galindo et al., 2013). In the U.S., foods that are sold in school cafeterias have been regulated by the U.S. Department of Agriculture (USDA) through policies like the National School Lunch Program and the School Breakfast Program (Food and Nutrition Service, 2017). USDA regulations have been established so that school food is consistent with the Dietary Guidelines for Americans (U.S. Department of Health and Human Services, 2015).

USDA regulations used to only apply to the reduced price/free meals, and not to meals sold outside this program (Hartstein et al., 2008; Wechsler, Devereaux, Davis, & Collins, 2000), however, the Health Hunger Free Kids Act extended the regulations to foods inside and outside the breakfast and lunch programs (US Congress, 2010). Nevertheless, children at school are still exposed to competitive foods that include a la carte foods, vending machines, food sold at the school's store, at concessions, or as part of fundraisers (Chriqui, Pickel, & Story, 2014; M. K. Fox, Gordon, Nogales, & Wilson, 2009; Story, Nanney, & Schwartz, 2009). Competitive foods represent a problem because many of these foods do not meet standards for a healthy diet (Finkelstein, Hill, &

Whitaker, 2008). Around the time the Health Hunger Free Kids Act was enacted, the Mexican government passed the *Acuerdo Nacional para la Salud Alimentaria* which established recommendations on the type of foods and beverages that could be sold in public schools throughout the country (Federacion, 2011). Diet from foods and beverages offered at schools needed to be whole, balanced, diverse, and safe to provide the essential nutrients needed for a healthy lifestyle and growth. Like U.S. regulations, the *Acuerdo* was limited to foods and beverages sold inside Mexican schools, thus leaving children exposed to non-regulated foods outside the school.

In addition to school nutrition policies, other regulations such as open campus policies during lunch hours can also be associated with exposure to unhealthy food items outside the school. A study of students from 20 different schools with open campus policies found that students who left school during lunch hours were more likely to eat at fast-food restaurants than students from closed campuses (S. Fox, Meinen, Pesik, Landis, & Remington, 2005; Neumark-Sztainer, French, Hannan, Story, & Fulkerson, 2005; Sturm, 2008). One of the reasons that children who attend open campus schools are more likely to engage in negative eating behaviors is the high prevalence of unhealthy food venues like fast-food restaurants in the immediate vicinity of schools (Austin et al., 2005; Day & Pearce, 2011; Day et al., 2015; Sturm, 2008), especially in low-income communities (Day & Pearce, 2011; Day et al., 2015; Sturm, 2008). It would seem fast-food restaurants target schools and students by locating their venues near schools. For example, a longitudinal study in New Zealand found that from 1966 to 2006 the number

of fast-food restaurants near schools increased from one to four (Day et al., 2015). Similar observations have been done in the U.S. where there is at least one fast-food restaurant located nearby a school (Austin et al., 2005).

Unfortunately, in some cases decreasing competitive food availability did not change food consumption (Taber, Chriqui, Powell, & Chaloupka, 2012). Likewise, exposure to competitive foods might not be negative. A longitudinal study using the Early Childhood Longitudinal Study, Kindergarten class did not find any relationships between competitive food exposure and weight gain for middle schoolers (Van Hook & Altman, 2012). Furthermore, exposure to fast-food restaurants near schools was not associated with food consumption (An & Sturm, 2012; Williams et al., 2014). However, these observations could be explained by the fact that some students do not shop within the vicinity of their schools, especially if those students drive themselves (Inagami, Cohen, Finch, & Asch, 2006). This suggests the need to look at more than just the vicinity of schools for factors that might be associated with eating behaviors. These factors could be found in the community food environment.

Although there are limited studies on policy implementation, and the role that fast foods play in the Mexican school environment (Hernandez Barrera et al., 2016), several studies have documented the presence of another food source near schools: SFS (Hernandez Barrera et al., 2016; López-Barrón et al., 2015; Soltero et al., 2017). Hernandez Barrera et al. (2016) created a 100-meter buffer around schools and documented food venues within that buffer and found that the most prevalent type of

food outside participating schools was SFS with a median of 4 vendors per school site. Street foods were more likely to be associated with children's body size than other food sources (Hernandez Barrera et al., 2016). Similarly, Lopez-Barron et al. (2015) also assessed the relationship between children's school food environment, food consumption, and Body Mass Index (BMI). In this study, it was found that on average there were two SFS outside the participating schools, and the consumption of unhealthy foods was associated with higher body size (López-Barrón et al., 2015). Although both studies documented the presence of SFS, and there was a positive association between street food consumption and BMI, a full description and assessment of the SFS and food were not done. A survey of street foods in Mexico has shown that vendors can sell a variety of products including healthy and unhealthy items (Long-Solís, 2007); thus, an in-depth assessment of street foods would be needed to determine which specific street foods are associated with negative health outcomes such as overweight and obesity.

Community Food Environment

The community food environment is the next level in Glanz et al.'s (2005) model. The availability of both healthy and unhealthy foods at home or near worksites and schools depends, to some degree, on the type of food sources located in the community food environment. The community food environment can be divided into macro and micro levels (Gustafson et al., 2012; Kirkpatrick, Reedy, Butler, et al., 2014). The macro-level refers to the retail food environment which includes traditional (e.g. supermarkets,

grocery stores), convenience (e.g. corner stores), food service (e.g. fast-food restaurants, sit-in restaurants), nontraditional food venues (e.g. SFS) (Creel et al., 2008; Dean, Sharkey, Johnson, et al., 2011), their locations, and hours of operation (Glanz et al., 2005). The micro-level refers to the food options available within food venues (Dean, Sharkey, Johnson, et al., 2011), regardless of their nutritional quality.

The most studied elements of the community food environment are supermarkets, grocery stores, convenience stores, and fast-food restaurants (Creel et al., 2008; Dean, Sharkey, & John, 2011; Gustafson et al., 2012). The availability of food venues and food items in the community food environment play a key role in eating behaviors due to the number of food venues that can be found within a community (Dean, Sharkey, & John, 2011). On average, the presence of supermarkets and grocery stores has been associated with positive eating behaviors like consumption of FV (Bodor, Rice, Farley, Swalm, & Rose, 2010; Rose & Richards, 2004; Zenk et al., 2009). The presence of supermarkets and grocery stores was associated with higher FV consumption for the general population, and even higher for minority groups like Latinos (Zenk et al., 2009). Supermarkets and grocery stores are associated with higher healthy food intake because these businesses offer a larger selection of healthy and affordable food items than smaller food venues like convenience stores (Black et al., 2014; D. Block & Kouba, 2006; Farley et al., 2009).

Although supermarkets are associated with access to healthy foods, supermarkets also represent a risk factor for unhealthy behaviors. Studies measuring the shelf space in

food venues have found that supermarkets offer a large variety of unhealthy food items, allocating more shelf space to unhealthy processed foods than space for FV (Farley et al., 2009; Hutchinson, Bodor, Swalm, Rice, & Rose, 2012). Similarly, the presence of food venues like convenience stores has been associated with negative eating behaviors (Davis & Carpenter, 2009; Farley et al., 2009; Zenk et al., 2009). Convenience, liquor, and small grocery stores offer more shelf space for unhealthy food products than for healthy food items (Farley et al., 2009; Gibson, 2011). Furthermore, living near convenience stores was associated with 1.84 fewer daily servings of FV (Zenk et al., 2009).

Areas where there is a high prevalence of convenience stores and fast-food restaurants and limited availability of supermarkets are labeled "food deserts," and are typically found in low-income minority communities (Beaulac, Kristjansson, & Cummins, 2009; Raja, Ma, & Yadav, 2008; Walker, Keane, & Burke, 2010). It seems like the lack of supermarkets and the high prevalence of unhealthy food sources in food deserts can be associated with negative health outcomes attributed to the consumption of unhealthy foods (Bodor et al., 2010; Moore, Diez Roux, Nettleton, & Jacobs Jr, 2008). Furthermore, the price of food in food deserts plays an important role in food consumption; unhealthy foods are typically bigger and are relatively more affordable than healthy foods (French, 2003; Haws & Winterich, 2013; Wansink, 1996). The consumption of unhealthy products could be shifted by lowering the cost of healthy foods. Implementing this type of strategy can be associated with a higher purchase of healthy foods (French, 2003; Rosi et al., 2017; Waterlander, de Boer, Schuit, Seidell, &

Steenhuis, 2013). However, the cost of both healthy and unhealthy foods is driven by factors outside the community food environment such as policies passed at the government or organizational level.

Research Gaps

The findings provided in the previous sections have come from research in high-income countries, primarily in the U.S. Systematic literature reviews on the food environment have not included studies from low-income countries (Cummins & Macintyre, 2006; Glanz, 2009; Glanz et al., 2016; Gustafson et al., 2012). Only two reviews on the Mexican food environment are available (Aceves-Martins et al., 2016; Rosales Chavez et al., 2020). Those reviews discussed the limited number of studies done to assess elements of the food environment and food availability. The reviews found that on average, people were more likely to consume healthy foods at home when these were readily available. However, when both healthy and unhealthy foods were present, people were more likely to choose the unhealthy options (Kaiser & Dewey, 1991; López-Barrón et al., 2015; Rosales Chavez et al., 2020). Children in Mexican schools engaged in similar practices as students in the U.S.: when unhealthy foods were present, students were more likely to consume the unhealthy food options over the healthy foods (Alvear-Galindo et al., 2013; Hernandez Barrera et al., 2016; López-Barrón et al., 2015).

Although the results at the home and school food environments have been like the results in the U.S., findings at the community food environment level have not been fully

explored in Mexico. Studies in the U.S. have focused on sources of food such as supermarkets, convenience stores, and fast-food restaurants that are regulated by local, state, and federal agencies and are considered traditional food sources in the U.S. In contrast, in low-and middle-income countries like Mexico, people use other types of venues to access food that have less stringent regulations (Arámbulo III et al., 1994; Gomez Méndez, 2007). Some of these food sources include *tianguis* (street markets/farmers markets), *mercados* (in-door markets), *tienditas* (small family-own convenience stores), and SFS (Dean, Sharkey, & John, 2011; Dean, Sharkey, Johnson, et al., 2011; Long-Solís, 2007; Sharkey, Dean, & Johnson, 2012). The distinction between levels of the food environment that are clearly defined in Bronfenbrenner's, McLeroy's, and Glanz et al.'s models are difficult to distinguish in the Mexican food environment. For example, *tienditas* would fit under the community food environment using the Glanz et al.'s model. However, in the Mexican context, *tienditas* are also part of the home food environment. Unlike convenience stores in the U.S. that are found in major street intersections or commercial areas, *tienditas* are typically found in residential communities in people's homes. Leatherman and Goodman (2005) in "Coca-Colonization of diets in the Yucatan" documented that it was common for families to start a *tiendita* business in their home. These researchers recorded over 40 *tienditas* in a small developing community (Leatherman & Goodman, 2005). Leatherman and Goodman found that people who owned a *tiendita* had easy access to unhealthy food products, and were more likely to consume unhealthy foods, especially children.

Like *tienditas*, *tianguis* are a traditional element of the Mexican food environment that has been understudied (Dean, Sharkey, & John, 2011). *Tianguis* are the equivalent of U.S.' farmers' and flea markets but at a much more complex scale. Dean et al. (2011) have conducted studies of *tianguis* in colonias located in Texas borderlands. In this representative site of Mexican *tianguis*, Dean et al (2011) found that some of the food items sold included both healthy and unhealthy foods: traditional Mexican plates such as *tortas*, *tostadas*, *tacos*, *gorditas*, and stews, and a large variety of FV, but also sugar-sweetened beverages, and salty snacks (Dean, Sharkey, & John, 2011; Dean, Sharkey, Johnson, et al., 2011). *Tianguis* are accessible and represent an important source of food to members of the community. The Mexican community food environment is also known to have yet another important food source: SFS.

SFS are a key feature of the Mexican community food environment. SFS have been part of the Mexican culture long before the arrival of the Spaniards (Long-Solís, 2007; Munoz de Chavez et al., 2000). Street foods are foods or beverages prepared on demand by vendors or hawkers on the streets, and can be eaten on-site or taken away (Calloni, 2013; Winarno & Allain, 1991). These foods provide some of the most authentic food available to customers (Calloni, 2013; Winarno & Allain, 1991) such as *tacos*, *tamales*, and many different types of stews. For many people, SFS are a symbol of cultural identity (Calloni, 2013). In addition, SFS represent a source of food security for many (Arámbulo III et al., 1994; Bhowmik, 2005; Gelormini et al., 2015; Long-Solís, 2007; Nelia Patricia Steyn et al., 2014). The two main groups who benefit from SFS are

low-income families for whom SFS might be the only source of food available to them (Long-Solís, 2007), and individuals who commute long distances for work or school and cannot eat at home during the day (Arámbulo III et al., 1994; Tinker, 2003). The low cost (Choi et al., 2013; Winarno & Allain, 1991), availability (Choi et al., 2013), and convenience (Choi et al., 2013; Kim, Lim, & Kim, 2007; Tinker, 2003) of street foods can be associated with the high prevalence of SFS in countries such as Mexico.

SFS are also prevalent throughout Mexico because selling street food represents a source of income for millions of individuals who cannot find jobs in the formal sector (Arámbulo III et al., 1994; Bhowmik, 2005; Choi et al., 2013; Tinker, 2003). Although most street food vendors sell food without official permits, the need for accessible foods makes street foods a necessity. Furthermore, the Mexican constitution guarantees the right to work, even in informal businesses (Gomez Méndez, 2007), thus making SFS prevalent throughout Mexican cities. However, the informal nature of the business makes tracking and recording the number of SFS a challenge (Arámbulo III et al., 1994; Long-Solís, 2007).

The high mobility and adaptability of SFS allow them to be found at any level of the food environment in Mexico and other low- and middle-income countries. Although SFS are primarily found on the streets, making them part of the community food environment, SFS can also be found in or outside elements of the organizational food environment (e.g. schools, worksites). Studies on the Mexican school food environment found that SFS can be typically found outside public schools, exposing children to

different types of foods (Hernandez Barrera et al., 2016; López-Barrón et al., 2015; Vargas, Jiménez-Cruz, & Bacardí-Gascón, 2013). Street foods can also be found outside worksites like hospitals and government buildings where there is a high concentration of people (Long-Solís, 2007). Many of these people are workers who cannot go home during lunchtime and rely on SFS for their daily sustenance. Thus, SFS are perceived to be a necessary component of urban life (Arámbulo III et al., 1994; Choi et al., 2013; Long-Solís, 2007).

Given the high demand for street food, this informal component of the community food environment is expected to keep growing (Choi et al, 2003). Although SFS represent an important source of food for millions of people, A recent review of SFS across the world shows that much of the research done on SFS has focused on hygienic and sanitation conditions of street foods and on the foodborne disease, and only a small percentage of studies has focused on food availability, consumption or nutrition quality (Abrahale et al., 2018). An even smaller number of studies have discussed SFS in assessments of the Mexican community food environment (Hernandez Barrera et al., 2016; Langellier, 2015; Long-Solís, 2007; López-Barrón et al., 2015; Munoz de Chavez et al., 2000; Soltero et al., 2017; Taillie et al., 2017; Vargas et al., 2013; Wojcicki, Jimenez-Cruz, Bacardi-Gascon, Schwartz, & Heyman, 2012). Hernandez-Barrera et al. assessed the food environment around schools. These researchers classified food vendors into unhealthy, healthy, or mixed food items, and found that the presence of SFS had a positive relationship with BMI: the more SFS around schools, the higher the children's

BMI. However, Hernandez-Barrera's study is limited to the immediate vicinity of schools and the researchers did not provide evidence that their assessment methods had been validated. In addition, a different study found that obesity risk and risk for abdominal obesity decreased as street food consumption increased (Wojcicki et al., 2012). It would seem like some SFS could provide access to healthy foods and maybe protective of some negative health outcomes, however, more research is needed to confirm any of these associations.

In Mexico, it is common for some people to believe that healthy food can only be found in restaurants, especially given that SFS have been associated with poverty and with poor hygienic practices (Calloni, 2013). Nevertheless, some street foods can be healthy, and cases of foodborne illness can be hard to track back to a specific food item (Burt, Volel, & Finkel, 2003; Calloni, 2013). Healthy street food can be found, but the type of foods offered by SFS vary depending on the type of SFS, and on the customers' demand. Long-Solis (2007) conducted an ethnographic survey of SFS and noted that there was a wide range of SFS, some of which could be considered as selling healthy food while others sold unhealthy food. Unlike the typical food trucks and pushcarts that can be found in the United States, Long-Solis identified vendors in Mexico City selling their products from a variety of venues including baskets, boxes, trays, tricycles, cars' trunks, and pick-up truck beds. These types of vendors are highly mobile and can move from one location to the next looking for high concentrations of people. Many of these highly mobile vendors only operate during morning rush hours to provide customers with

a quick meal on their way to work or school. Another set of SFS includes those that have semi-mobile or stationary stands that remain in one location throughout the day or week, and even among these their level of complexity can also vary (Long-Solís, 2007).

Long-Solis (2017) also briefly described the foods associated with each type of vendor: highly mobile street food vendors offered simple items (e.g. *tamales* and *atole, tacos sudados*) or snacks (e.g. corn on the cob, fried snacks, and SSBs) whereas stationary vendors provided more elaborate and traditional Mexican dishes (e.g. stews, *tacos, sopes*). Both types of SFS can sell food items that would be considered healthy. For example, some vendors only sell fruits or vegetables. It is common to see customers approach *fruteros* (fruit vendors) to purchase cut up fruits that are traditionally accompanied by lemon juice, and chili powder. *Fruteros* can also use fruits and vegetables (e.g. carrots, beets) to sell fresh juice. *Fruteros* sell some of the healthiest foods on the streets: however, their prevalence and distribution have not been fully documented. Long-Solis's study is limited in that validated assessment methods were not discussed and without such, that study cannot be replicated.

Given what little is known on the relationship between SFS availability, food, and beverage availability, eating behaviors, and health outcomes, there is a need for a systematic assessment of foods sold at SFS in Mexico. McLeroy's and Glanz et al.'s ecological models can be used as a framework to understand the relationship between SFS availability and food and beverage availability in the Mexican food environment. By studying the availability, density, and distribution of SFS and the type of foods they are

selling, one can begin to understand the role that SFS may play in food availability and whether SFS may be targeting some sectors of the Mexican population-based on socioeconomic status (i.e. low-, medium-, high-income) or point of access (i.e. homes, schools, worksites).

CHAPTER 3

REVIEW OF VARIABLES AND RESEARCH METHODS USED IN THE ASSESSMENT OF THE FOOD ENVIRONMENT

Food Environment Assessment Tools

Availability, access, price, quantity, promotion, quality, distance, diversity, and variety can be captured using an environmental assessment tool. Table 1 provides a list of observational tools to measure several of the previously mentioned variables and document different types of food items in the food environment. Table 1 provides the tool's name, author's name, variables documented, the type of food environment measured, whether validity and reliability tests were done, the number of food items measured, and the specific sites where the tools have been used. It is essential for food environment tools to be validated and reliable to objectively capture the role food venues play in the food environment and to help make comparisons across time and settings. There have been multiple reviews discussing environment assessment tools, their current state, applicability, and limitations (Glanz, 2009; Glanz et al., 2016; Glanz et al., 2005; Gustafson et al., 2012; Kelly et al., 2011; Lytle, 2009; McKinnon et al., 2009; Ohri-Vachaspati & Leviton, 2010; Saelens & Glanz, 2009). The reviews have captured many different food environment tools. Ohri-Vachaspati and Leviton (2010) described 48 instruments, McKinnon et al. (2009) found 19 tools, Gustafson et al. described 16, and Kelly et al. described 11 tools.

Some of these assessment instruments were specific to one domain of the food environment (e.g. community, organizational, consumer, or informational food environments) while others could be used across food environment domains and populations (Ohri-Vachaspati & Leviton, 2010). Instruments could be divided into objective assessments (observational: checklists, market baskets, inventories), and perception assessments (surveys, interviews, food recalls) (McKinnon et al., 2009; Ohri-Vachaspati & Leviton, 2010). I am only providing a discussion on objective assessments and variables that can be used in the SFSAT.

Variable Definitions

Availability

The Food and Agriculture Organization (FAO) defines food availability as the existence of enough quantities of food with the appropriate quality and supplied via domestic production or imports to feed a population (El-Hage Scialabba, 2011), but in research studies availability can be defined simply as to whether something physically exists in a predetermined geographical location (Farley et al., 2009). For example, communities labeled as food deserts are characterized by having a limited number, or none at all, of supermarkets or grocery stores, and for having a high number of fast foods and corner stores (Beaulac et al., 2009; Cummins & Macintyre, 2002).

Distance

Distance is another factor that must be taken into consideration in food environment assessments. Distance can be divided into four dimensions: cultural, administrative, geographic, and economic (Ghemawat, 2001). Cultural and geographical distance seem more applicable to food environment assessments. Culture can be described as the set of social beliefs and norms shared by a group of people. Culture plays an important role in how people behave and interact with other members of the culture and with individuals from other cultures (Ghemawat, 2001). Eating behaviors can be influenced by culture or elements of culture (e.g. religion). For instance, in some cultures eating meat (e.g. beef, pork) is not allowed at any time of the year, while in others, eating meat is not allowed during specific times of the year. In the Mexican culture, Mexicans have an extensive cuisine that is limited during religious observations (e.g. Easter) for some sectors of society (e.g. Christians), however, there are some individuals (e.g. non-Christians) who might not follow the religious elements of the Mexican culture. Culture can also influence eating behaviors by creating a cultural identity associated with foods. Street foods have been part of the Mexican culture since before the Spaniards arrived and colonized the country (Long-Solís, 2007; Munoz de Chavez et al., 2000). To eat street food is to be part of the Mexican culture. This could also be one of the reasons street foods continue to be prevalent and popular in Mexico, and other food venues such as fast-food restaurants are not.

Geographical distance is a commonly studied dimension of distance in food environment assessments; many environmental assessments contain some type of geographical component (Farley et al., 2009; Gustafson, Christian, Lewis, Moore, & Jilcott, 2013; Heinrich et al., 2012; Hutchinson et al., 2012; Lee et al., 2010; Lee, Heinrich, Reese-Smith, Regan, & Adamus-Leach, 2014; McKinnon et al., 2009). Researchers are interested in questions such as how far do people live from food outlets (Fuller, Cummins, & Matthews, 2013; Galvez et al., 2009; McKinnon et al., 2009; Rose & Richards, 2004), how far do people travel to purchase or consume foods (Fuller et al., 2013; Rose & Richards, 2004; Sharkey et al., 2009), and how many and what kind of venues are located within a determined geographical location (diversity) (D. Block & Kouba, 2006; Hernandez Barrera et al., 2016; Liese et al., 2007; Soltero et al., 2017). It is common for researchers using geographical distance to establish a buffer zone that contains the area or population of interest. For example, Soltero et al. (2017) established an 800-meter buffer around schools while Hernandez Barrera et al. (2016) established a 100-meter buffer outside school gates. Next, researchers recorded food venues located within the buffer and proceeded to record the number and type of food venues outside the schools. Well-designed buffers could save time and resources as these buffers can be representative of larger geographical areas. SFS can be typically found near areas or points of access with a high concentration of people or high traffic areas (e.g. worksites, schools, downtowns) (Long-Solís, 2007; Munoz de Chavez et al., 2000). Creating buffers around these high concentration areas can help identify SFS and document their

distribution and density. However, the finding cannot be generalized to areas outside the specific points of access. For example, studies focusing on the availability of SFS outside schools can only be generalized to areas outside of schools.

Diversity and Variety

Diversity, not to be confused with variety, is another concept that can fall under geographical assessments. Diversity refers to the number and type of food venues in the food environment whereas variety measures the availability, price, and quality of the different types of foods within stores (McKinnon et al., 2009). Both diversity and variety can be assessed within a geographical area. For instance, the density of convenience stores and fast-food restaurants was higher than that of supermarkets and grocery stores in a study of the food environment in low-income communities (Sharkey et al., 2009). Increasing the number of supermarkets, grocery stores, and other food sources (e. g. farmers' markets) could increase diversity in low-income communities. In other cases, there might be diversity and people have access to healthy (e.g. supermarkets) and unhealthy food (e.g. fast-food restaurants) venues, but variety might be low. Places like supermarkets are associated with offering some of the largest variety of food items, including healthy, nutrient-dense foods such as FV (Connell et al., 2007; Farley et al., 2009; Morland et al., 2002; Rose et al., 2009). In the context of street foods and Mexico, two historical and cultural overviews on street foods (Long-Solís, 2007; Munoz de Chavez et al., 2000) have mentioned the wide spectrum of street foods available to

customers, but the diversity and variety of street foods have not been systematically captured using validated assessment tools. Diversity in this dissertation described the different types of SFS that can be found on the streets whereas the variety described the different types of food and beverage items sold at SFS.

Observational Assessment Tools

Table 1 summarizes the list of assessment tools available to measure different elements of the food environment and includes the tool's name, psychometric properties, number of items, and the types of venues the tool can assess.

Checklists

Checklists are observational tools that can help researchers document food availability, access, price, quantity, promotion, quality, distance, diversity, and variety (Gustafson et al., 2012; McKinnon et al., 2009). Checklists have been used in different domains of the food environment: at home environment, in schools, worksites, and community food environment (Ohri-Vachaspati & Leviton, 2010; Oldenburg, Sallis, Harris, & Owen, 2002). The items in checklists are a pre-defined list of indicators foods, and might not represent all the foods available in a food venue or food environment (McKinnon et al., 2009). Checklists do not have a standard number of food items. Kang et al. (2012) described the selection process for the creation of a food behavior checklist that evaluated children's food habits and diet quality. Their preliminary list contained 50

food items, but after revising the food items, the final tool only included 19 items (Kang et al., 2012). Other checklists, such as the Checklist of Health Promotion Environments at Worksites (CHEW) contain as many as 112-items. Thus, the type and number of foods included in checklists depend on the research team and research questions. Furthermore, checklists can be specific to a certain type of food items. Researchers interested in measuring the amount of total fat, saturated fat, and sodium consumed by children in middle schools created a checklist containing 28 groups of foods (Smith et al., 2001). The checklist contained both healthy and unhealthy food items, and researchers determined which kind of fats the participants were consuming the most.

One of the most commonly cited checklists is the Nutrition Environment Measures Survey for Stores (NEMS-S) and restaurants (NEMS-R) (Glanz et al., 2007; Saelens, Glanz, Sallis, & Frank, 2007). NEMS measures availability, access, diversity, variety, price, promotion, and location of foods within food venues. NEMS has been adapted and implemented in different food venues and populations (Andreyeva, Blumenthal, Schwartz, Long, & Brownell, 2008; Andreyeva, Luedicke, Middleton, Long, & Schwartz, 2012; Franco et al., 2009; Franco, Roux, Glass, Caballero, & Brancati, 2008; Hillier et al., 2011). Hillier et al. modified NEMS-S by adding food items that were part of changes to the Women, Infant, and Children (WIC) program's food package, and were commonly eaten by African Americans and Puerto Ricans. Reviews of food environment assessment tools have not reported any checklists available to measure SFS (Glanz, 2009; Glanz et al., 2016; Glanz et al., 2005; Gustafson et al., 2012; Kelly et al.,

2011; Lytle, 2009; McKinnon et al., 2009; Ohri-Vachaspati & Leviton, 2010; Saelens & Glanz, 2009). NEMS-S and NEMS-R could be used as a framework for the development of a street food assessment tool to assess the Mexican food environment and food availability at SFS.

Food Inventory

Food inventories, the reporting of all foods, are another observational tool that has been used to assess the food environment (McKinnon et al., 2009). Inventories can be done for any food source (e.g. convenience stores, grocery stores, supermarkets, restaurants, households, schools, worksites) and can be done in person (Fulkerson et al., 2008; Kendall, Olson, & Frongillo, 1996; Sallis, Nader, Rupp, Atkins, & Wilson, 1986) or through other forms (e.g. phone interviews, take-home questionnaires) (Glanz, 2009; Patterson, Kristal, Shannon, Hunt, & White, 1997). Food inventories can be as simple as whether something is available (e.g. yes/no), and as complex as documenting quantity and frequency of purchase and consumption, and food prices. Sallis et al. (1986) surveyed supermarkets, grocery stores, and convenience stores using a food inventory that contained a pre-determined list of food items. The researchers in that study recorded whether food items in their pre-determined list were available. In another food inventory study, the researchers called random households to assess the correlation between food availability at home and energy intake from fat (e.g. high-fat, reduced-fat foods) (Patterson et al., 1997). Patterson et al. found that individuals in households with high-fat

products had a higher energy intake from fat than individuals in households with low-fat products. Likewise, Ledoux et al. gave participants an inventory to take home. Once at home, the participants recorded whether they had food items listed in the inventory (T. A. Ledoux et al., 2012). Food inventories can also compare food availability and accessibility across different socio-economic backgrounds (Freedman, 2009; Lallukka, Laaksonen, Rahkonen, Roos, & Lahelma, 2007; Rose & Richards, 2004). Freedman found that stores stocked their products to meet the customers' race, class, gender, or environment, reflecting the idea that customers can also influence food venues or reciprocity as described in socio-ecological models.

Shelf Space

Shelf space assessment is a meticulous and complex environmental assessment that requires researchers to physically measure the amount of space allocated to each type of food item in food venues (Farley et al., 2009; Frank & Massy, 1970). Studies on shelf space have shown that space allocated to food items can be associated with food purchasing (Curhan, 1972; Eisend, 2014), and eating behaviors (Cheadle et al., 1991; Cohen, Collins, Hunter, Ghosh-Dastidar, & Dubowitz, 2015). For example, a meta-analysis on shelf space elasticity found that increasing shelf space increased sales of products such as candies and snacks (Eisend, 2014). Likewise, other shelf space assessments found that food sources considered the healthiest (e.g. supermarkets), could also be the source for the most unhealthy foods (Farley et al., 2009; Rose et al., 2009).

Tool Name	Author	Variables Measured	Environment Measured	Validity	Reliability	Number of items	Venues assessed
Healthy Eating Indicator Shopping Basket (HEISB) Tool	(Anderson et al., 2007)	Availability, quality, access, price	Community, consumer	No	No	~35 items	Grocery stores, supermarkets
Rudd Center "Access to Healthy Food" WIC Food Store Assessment Form	(Andreyeva, Luedicke, Middleton, Long, & Schwartz, 2012)	Availability, variety, quality, price	Community, consumer	No	Inter-rater, test-retest	~65 items	Convenience stores, delicatessens, food markets, grocers-retail, health and diet foods, FV retail, pharmacies, specialty stores
NEMS-S Latino Market Nutrition Environment	(Baier, 2017)	Availability, access, price, quality	Community, consumer	Construct	Inter-rater, test-retest	~55 items	Supermarkets, convenience stores, corner stores
Grocery Store Audit Tool	(Baker, Schootman, Barnidge, & Kelly, 2006)	Availability, quality, price	Community, consumer	No	No	~78 items	Fast-food restaurants, bakery, donut, cookies stores; ice cream stores; convenience stores; fish and
Australian Grocery Stores Food Checklist	(Ball, Timperio, & Crawford, 2009)	Availability, variety, price	Community, consumer	No	No	~53-items	Supermarkets, fast-food restaurants
Chicago Market Basket	(Block & Kouba, 2006)	Availability, quality, price, access	Community, consumer	No	No	~68 items	Supermarkets, FV stores
Produce Assessment	(Caldwell, Kobayashi, DuBow, & Wytinck, 2009)	Availability, quality, price	Community, consumer	Face	No	~70 items	Supermarkets, grocery stores, drug stores, gas stations, liquor stores with food, convenience stores, dollar stores, specialty stores
USDA Thrifty Food Plan	(Carlson, Lino, Juan, Hanson, & Basiotis, 2007)	Availability, access, price	Community, consumer	NA (used in multiple studies)	NA (used in multiple studies)	~68 items	Supermarkets, grocery stores,
Restaurant Menu Checklist	(Cassady, Housemann, & Dagher, 2004)	Availability, price	Consumer	No	Inter-rater	NA	Restaurants
Nutrition Environment Measures Survey in Corner Stores (NEMS-CS)	(Cavanaugh, Mallya, Brensinger, Tierney, & Glanz, 2013)	Availability, quality, price	Community, consumer	Construct	Inter-rater, test-retest	~110 items	Supermarkets, grocery stores, convenience stores

Tool Name	Author	Variables Measured	Environment Measured	Validity	Reliability	Number of items	Venues assessed
Survey of Grocery Store Product Displays	(Cheadle et al., 1991)	Availability, promotion	Community, consumer	NA	Inter-rater, test-retest	~8 items	Corner stores and convenience stores
Fruit and Vegetable Survey	(Cole et al., 2010)	Availability, quality, price	Community, consumer	No	No	~31 items	Supermarkets, grocery stores
Food Store Survey (FSS) Basket	(Connell et al., 2007)	Availability, quality	Community, consumer	No	Inter-rater	~102 items	Supermarkets, grocery stores, delicatessens, FV markets
Short-form Store Audit Tool (SCAT)	(DeWeese et al., 2016)	Availability	Consumer	Construct	Inter-rater	~7 items	Corner stores
Toxic Food Environment Study UBS Assessment Checklist for Grocery Stores	(Edmonds, Baranowski, Baranowski, Cullen, & Myres, 2001)	Availability	Community, consumer	No	Inter-rater	~99 items	Supermarkets, grocery stores, and convenience stores
Grocery Stores Observation Guide	(Emond, Madanat, & Ayala, 2012)	Availability, quality, price	Consumer	No	Inter-rater	~54 items	Supermarkets, grocery stores, restaurants
FV and Snack Shelf Space Assessment tool	(Farley et al., 2009)	Availability, access, price	Consumer	No	Inter-rater	~11 items	Supermarket, grocery stores
Food Ubiquity Study	(Farley, Baker, Futrell, & Rice, 2010)	Availability, access	Community, consumer	No	No	~11 items	Grocery stores, convenience stores
Food Store Survey	(Freedman, 2009)	Availability, access	Community, consumer	Face	No	~16 items	Pharmacy, gas station,

Tool Name	Author	Variables Measured	Environment Measured	Validity	Reliability	Number of items	Venues assessed
Corner Store Data Collection Form	(Gebauer & Laska, 2011)	Availability, price	Community, consumer	No	No	~28 items	Supermarkets, local markets, convenience stores
CX3 Food Availability and Marketing Survey	(Ghirardelli, Quinn, & Sugerman, 2011)	Availability, access, price, quality, promotion, distance, variety	Community, consumer	Face	Inter-rater	~20 items	Convenience stores
Brisbane Food Study Checklist	(Giskes, Van Lenthe, Brug, Mackenbach, & Turrell, 2007)	Availability, price	Community, consumer	No	Inter-rater	~58 items	Supermarkets
Nutrition Environment Measures Survey for Stores (NEMS-S)	(Glanz et al., 2007)	Availability, access, price, quality	Community, consumer	Construct	Inter-rater, test-retest	~55 items	Grocery stores, fast food, food banks, emergency food outlets, community gardens, produce stands, community-supported agriculture
Texas Nutrition Environment Assessment (TxNEA-S)	(Gloria & Steinhardt, 2010)	Availability	Community, consumer	Face	Inter-rater, test-retest	~106 items	Supermarkets, grocery stores, convenience stores
IMANEA	(Golfin, Murillo, Jensen, & Frongillo, 2017)	Availability, access, price, quality	Community, consumer	Construct	Inter-rater, intra-rater	~55	Supermarkets, convenience stores, corner stores
Retail Food Assessment	(Gordon et al., 2011)	Availability, price	Community, consumer	No	No	~39 items	Grocery stores, convenience stores
Culture Specific FV Checklist	(Grigsby-Toussaint, Zenk, Odoms-Young, Ruggiero, & Moise, 2010)	Availability	Community, consumer	No	No	~59 items	Supermarkets, grocery stores, fast-food restaurants, bodegas
Cross-sectional Survey of Retail Food Environment	(Grigsby-Toussaint, Moise, & Geiger, 2011)	Availability	Consumer	No	Inter-rater	~78 items	Grocery stores, convenience stores

Tool Name	Author	Variables Measured	Environment Measured	Validity	Reliability	Number of items	Venues assessed
A La Carte Food Item Survey	(Harnack et al., 2000)	Availability, quality, price	School	No	No	~22 items	Grocery stores, convenience stores, FV markets, pharmacies, and supercenters
Grocery Store Survey	(Hendrickson, Smith, & Eikenberry, 2006)	Availability, quality, price, access	Community, consumer	Content and fac	No	~68 items	Supermarkets, grocery stores
Healthy Foods Checklist	(Horowitz, Colson, Hebert, & Lancaster, 2004)	Availability, price	Community, consumer	No	Inter-rater	~5 items	Bodegas, grocery stores, supermarkets
Food Retail Outlet Survey Tool	(Hosler & Dharssi, 2011)	Availability, access, price	Community, consumer	No	Inter-rater	~4 items	Grocery stores
Food Store Survey Tool	(Hosler, Rajulu, Ronsani, & Fredrick, 2008)	Availability, variety	Community, consumer	No	Inter-rater	~10 items	Grocery stores, convenience stores, liquor stores, specialty stores, pharmacies, dollar stores
Food Environment Audit for Diverse Neighborhoods (FEAD-N)	(Izumi et al., 2012)	Availability, access, price	Community, consumer	Face and construct	Inter-rater	~213 items	Supermarkets, FV stores, convenience stores, grocery stores
NEMS-S Guatemala	(Kanter, Alvey, & Fuentes, 2014)	Availability, access, price, quality	Community, consumer	Construct	Inter-rater, test-retest	~55 items	Supermarkets
GroPromo Audit Tool	(Kerr, Sallis, Bromby, & Glanz, 2012)	Availability, promotion, price	Community, consumer	Construct	Inter-rater	~8 items	Grocery stores, convenience stores, liquor stores, specialty stores, pharmacies, dollar stores
Availability and Quality of Foods in Grocery Stores	(Kipke et al., 2007)	Availability, quality	Community, consumer	No	No	~175 items	Grocery stores

Tool Name	Author	Variables Measured	Environment Measured	Validity	Reliability	Number of items	Venues assessed
Healthy Food Item Checklist	(Laska, Borradaile, Tester, Foster, & Gittelsohn, 2010)	Availability, variety	Community, consumer	No	No	~28 items	Grocery stores, supermarkets
Food Availability in Supermarkets and Grocery Stores Checklist	(Latham & Moffat, 2007)	Availability, price	Community, consumer	No	No	~67 items	Supermarkets, grocery stores, variety stores, specialty stores
Restaurant Assessment Tool	(Lee, Heinrich, Reese-Smith, Regan, & Adamus-Leach, 2014)	Availability, price, promotion, type and placement of food outlet	Community, consumer	No	Yes	NA	Fast-food, buffet and table service restaurants
Food Stores Assessment	(Lee et al., 2010)	Availability, quality, price	Community, consumer		Yes	~23	Supermarkets, grocery stores, farmers' markets, pharmacies
Access to Healthy Food Options Checklist	(Lewis et al., 2011)	Availability, quality, promotion	Consumer	No	No	~62 items	Fast-food, sit-in restaurants
Rural Food Store Survey	(Liese et al., 2007)	Availability, price	Community, consumer	No	Inter-rater	~22 items	Supermarkets, grocery stores and convenience stores
TEEN Study Food Inventory	(Lytle et al., 2006)	Availability	School	No	No	~8 items	School cafeterias
University Grab-and-Go Assessment	(Lo, Minaker, Chan, Hrgetic, & Mah, 2015)	Availability, price	School	Construct	Inter-rater	~36 items	University cafeterias, coffee shops, takeaway restaurants
NEMS-S Brazil	(Martins et al., 2013)	Availability, access, price, quality	Community, consumer	Construct	Inter-rater	~44 items	Supermarkets, grocery stores and convenience stores

Tool Name	Author	Variables Measured	Environment Measured	Validity	Reliability	Number of items	Venues assessed
Nutrition Environment Assessment Tool (NEAT)	(Moore et al., 2008)	Availability, promotion, quality	Community, consumer	No	No	~37 items	Convenience stores, farmers markets, food pantries
Checklist of Health Promotion Environments at Worksite (CHEW)	(Oldenburg, Sallis, Harris, & Owen, 2002)	Availability	Worksite	Construct	Inter-rater	~6 items	Worksite cafeterias
NEMS Reduced-Item Food Audit	(Partington, Menzies, Colburn, Saelens, & Glanz, 2015)	Availability, price, quality	Community, consumer	No	No	~92	Grocery stores, convenience stores, sit-down, and fast-food restaurants
Food Desert Shopping Basket Survey	(Pearson, Russell, Campbell, & Barker, 2005)	Availability, access, price	Community, consumer	No	No	~9 items	Supermarkets
Nutrition Environment Measures Survey for Restaurants (NEMS-R)	(Saelens, Glanz, Sallis, & Frank, 2007)	Availability, access, price, quality	Community, consumer	Construct	Inter-rater, test-retest	~12 items	Fast food, and sit-in restaurants
Food Availability Survey	(Sallis, Nader, Rupp, Atkins, & Wilson, 1986)	Availability	Community, consumer	No	Inter-rater	~71 items	Supermarkets, grocery stores, convenience stores, health stores
Worksite Environment Measure (WEM)	(Shimotsu, French, Gerlach, & Hannan, 2007)	Availability	Worksite	No	Inter-rater	~18 items	Worksite cafeterias
REACH Healthy Food Assessment Survey	(Sloane et al., 2003)	Availability, quality, price	Community, consumer	No	No	~126 items	Supermarkets, grocery stores, convenience stores
Low-Fat Milk Inventory	(Wechsler, Basch, Zybert, Lantigua, & Shea, 1995)	Availability	Community, consumer	No	Inter-rater, test-retest	~4 items	Bodegas, supermarkets

Tool Name	Author	Variables Measured	Environment Measured	Validity	Reliability	Number of items	Venues assessed
Micro-Level Data Collection Worksheet for Fruiterer and Greengrocers	(Winkler, Turrell, & Patterson, 2006)	Availability, variety, price	Community, consumer	No	No	~10 items	Supermarkets, greengrocer, convenience stores
Community Health Environment Scan Survey (CHESS)	(Wong, Stevens, O'Connor-Duffany, Siegel, & Gao, 2011)	Availability, access, price	Consumer	Face	Inter-rater	~10 items	Supermarkets, grocery stores, convenience stores
Southwest Chicago Food Store Audit Instrument	(Zenk, Grigsby-Toussaint, Curry, Berbaum, & Schneider, 2010)	Availability, quality, price	Community, consumer	No	Inter-rater	~194 items	Grocery stores, liquor stores, convenience/corner stores, bakeries, delis, pharmacies
WIC Northern Illinois Vendor Survey	(Zenk et al., 2012)	Availability, variety	Community, consumer	No	Inter-rater	~120 items	Pharmacies, small vendors, large vendors

Farley et al. found that supermarkets had the largest shelf space for unhealthy food items, and that was greater than the shelf space for FV. Shelf space studies have also found that food availability varies by neighborhood income level, with low-income communities having the most shelf space for unhealthy food items than high-income communities (Cameron, Thornton, McNaughton, & Crawford, 2013; Leone et al., 2011). Although shelf space assessments have primarily been done in traditional food venues (e.g. supermarkets, grocery stores, and convenience stores), some stationary SFS might use shelves to organize and display their foods and in such cases, a shelf assessment methods could help document the type of foods street food vendors are stocking.

Menus

Menu analyses have focused on the quality of foods (e.g. number of calories, energy, macro and micronutrients available to or consumed by participants). By assessing menus, researchers have compared foods available in different food environments and food sources (Kirkpatrick, Reedy, Kahle, et al., 2014; Lassen, Hansen, & Trolle, 2007; Lucan et al., 2014). Lassen et al. compared buffet and a la carte menus in worksite cafeterias and found that people who ate from buffet-style menus consumed more FV than those who ate from a la carte menus. Similarly, in a study of fast-food menus, Kirkpatrick et al. found that most fast-foods were of poor quality. Menus could assess food availability and accessibility (through prices listed on the menus). Analyzing the availability and price of foods through menus could be a less intrusive process and would

provide reliable documentation of the site and the foods available for sale. Menus that have the food item and the price could also help analyze accessibility to health and unhealthy food items. The fact that menu analysis is less intrusive could be ideal for assessing SFS, however, there are no menu studies on SFS that can support this claim. Furthermore, personal experience with SFS has shown that most SFS (e.g. bicycles/tricycles, basket, bucket, pushcart vendors) do not have menus at all or their menus might be incomplete (e.g. missing prices). Thus, using menus as the basis of analyses would limit the number of SFS that can be reached.

Applicability to Street Food Vendors

Although there have been multiple reviews of the food environment and the different tools available to measure the different variable (e.g. as availability, accessibility, price, quality, distance, diversity/variety, and promotion/quantity) in different food environments (e.g. home, school, community), not one has identified or discussed the availability of an SFS assessment tool (Glanz, 2009; Glanz et al., 2016; Glanz et al., 2005; Gustafson et al., 2012; Kelly et al., 2011; Lytle, 2009; McKinnon et al., 2009; Ohri-Vachaspati & Leviton, 2010; Saelens & Glanz, 2009). Likewise, there are few studies on street foods' qualities (Chakravarty & Canet, 1996; Hernandez Barrera et al., 2016; Lucan et al., 2014; Mwangi, den Hartog, Mwadime, Van Staveren, & Foeken, 2002; Nago et al., 2010; Namugumya & Muyanja, 2012; C. Oguntona & Tella, 1999; C. R. Oguntona & Kanye, 1995; Tester, Yen, & Laraia, 2010; Valdez, Dean, & Sharkey,

2012), most of them have not discussed the role that street foods might play in the food environment using an ecological approach. Furthermore, only seven studies have focused on the availability of SFS in the Mexican food environment (Hernandez Barrera et al., 2016; Langellier, 2015; Long-Solís, 2007; López-Barrón et al., 2015; Munoz de Chavez et al., 2000; Soltero et al., 2017; Taillie et al., 2017). These studies show that both healthy and unhealthy foods can be found on the streets, but the studies have been limited to the school food environment or have not used validated and objective assessment tools. Other areas (e.g. worksites, city centers) where there might be a high concentration of SFS need assessment.

The nutrition quality of street foods can depend on the type of SFS. In a survey of Mexican street foods, Long-Solis (2007) points out that some SFS sell FV. These types of vendors offer high nutritional quality foods. Most *fruteros* can be found in semi-permanent stands, but some might be found in highly mobile and adapted bicycles or pushcarts. The nutrition quality of FV could change when other ingredients are added as is the case of *liquados* (fruit blended with milk and sugar) and *aguas frescas* (fruit-flavored water). *Liquados* and *aguas frescas* main ingredients are fresh fruits, but vendors add large quantities of sugar to make them sweeter. Adding large quantities of sugar decreases the nutritional quality of the items.

Additionally, there are SFS that primarily sell low nutrition quality products like soft drinks, fried snacks, and ice cream (Hernandez Barrera et al., 2016; Long-Solís, 2007; Soltero et al., 2017). Although Long-Solis does not directly assess the nutrition

quality of street foods, she mentions that such foods are considered a healthy diet regime by anthropologists and nutritionists who have studied street foods. Nevertheless, she does not list what street foods fall under that assessment or cite this claim.

Since there are no assessment tools developed for the assessment of SFS, a tool that can assess measure availability, density, and distribution of SFS and street foods is needed. One of the challenges when selecting an assessment tool is whether to use current assessment tools and adapting them to new populations and settings or creating a new assessment tool (Saelens & Glanz, 2009). Researchers oftentimes create new tools because current tools might not be able to capture the concept the research team is trying to study, but in doing so, current tools might be overlooked (Saelens & Glanz, 2009). It would seem like the most effective way to study an element (e.g. street foods) of the food environment for which a tool has not been previously developed, is to use items from current tools, and only create items that are missing (e.g. foods commonly consumed by the targeted population). This approach would seem more effective than creating a brand-new tool. However, this approach has an important limitation: many current food environment tools do not meet psychometric (e.g. validity and reliability) standards.

Reviews of assessment tools have pointed out the lack of adequate validity and reliability scores for assessment tools (Glanz et al., 2016; Lytle, 2009; McKinnon et al., 2009; Ohri-Vachaspati & Leviton, 2010; Saelens & Glanz, 2009). McKinnon et al. (2009) found that of 137 reviewed articles, only 13% tested for psychometric properties, and of these, only 5% performed a validity test. Glanz et al. (2016) analyzed 222 studies

and found that only 50.4% reported reliability, and 30.4% reported validity scores. Ohri-Vachaspati and Leviton (2010) identified 48 assessment tools and found that only 19 tested for reliability and validity, 6 for reliability only, and 1 for validity only. Lytle (2009) reported that the most assessed psychometric property is reliability (e.g. inter-rater, test-retest reliability).

Furthermore, Glanz et al. (2016) mentioned that only 56% of the studies named the assessment tool used to assess the food environment. It is difficult to discuss the psychometric properties of the tools when both the scores and tools' names are missing. In some cases, just knowing the tool's name can be an indication of the tool's reliability and validity. For example, tools such as NEMS-S and NEMS-R are widely known to have high reliability and validity scores (Glanz et al., 2016; Lytle, 2009; Ohri-Vachaspati & Leviton, 2010). Reliable and valid assessment tools are essential to collect accurate data, are required to assess relationships between the food environment and dietary behaviors, and are key in developing interventions that can improve the food environment and eating behaviors (Glanz, 2009; Lytle, 2009; McKinnon et al., 2009).

Besides considering the psychometric properties of tools, choosing an appropriate tool would also depend on what the targeted population would consider acceptable (Gustafson et al., 2012; Ohri-Vachaspati & Leviton, 2010). In the case of SFS, a tool that minimally disrupts the street food vendors' activities (i.e. food preparation and sale) and that can be done efficiently and quickly, especially for highly mobile vendors, would be ideal. A previous study of SFS in Bronx, New York, excluded highly mobile SFS

because their tool was not able to capture these types of SFS (Lucan et al., 2014). Excluding highly mobile SFS would not be representative of Mexican SFS as we expect a large proportion of vendors to fall under this category. Thus, the new tool should be adaptable to the many types of SFS that could be found in the Mexican food environment. Additionally, defining the scope of the tool and whether the scope fits within the resources available to conduct the assessments could help select the appropriate tool.

Checklists and food inventories are two types of tools that could be used to assess the availability, density, and distribution of SFS and foods in Mexico City. These two tools can be used in any level of the food environment and can capture availability, accessibility, quantity, promotion, and geographical elements (Gustafson et al., 2012; Kelly et al., 2011; McKinnon et al., 2009). Rather than creating and defining a list of food-items, Saelens & Glanz (2009) recommended adopting or using food-items from validated and reliable food assessment tools. Adapting already validated elements of a tool can save time, resources and can create a balance between using current instruments and adapting them to new populations and creating new tools. Nevertheless, even with this approach, there might be some food items specific to SFS that might still need to be created, defined, and validated. The Nutrition Environment Nutrition Surveys for stores (NEMS-S), restaurants (NEMS-R), and grab-and-go (NEMS-GG) are three reliable and valid tools from which food items can be adopted and implemented in the new SFSAT. Furthermore, both NEMS-S and NEMS-R are the only checklist tools available in

Spanish (Ohri-Vachaspati & Leviton, 2010). Availability in Spanish is important because the tools can be used among Spanish-speaking participants; however, researchers need to take into consideration Spanish language variations and dialects. Testing the tool with a subsample of the targeted population before implementing the study can address most potential language limitations.

Two other important elements to consider when selecting a tool are the resources and expertise available to the research team (Ohri-Vachaspati & Leviton, 2010). Lucan et al. (2013) report that it took the research team 320 hours in 40-nonconsecutive days to identify 372 mobile food vendors in Bronx, New York. The assessment was done over the summer and fall during business hours by two pairs of research assistants. Their direct observation included unique identified, location, type of SFS (e.g. functionally mobile, or stationary), whether vendors operated inside or outside vehicles and the type of foods and beverages sold at each site (Lucan et al., 2013). The study also included brief closed-ended interviews with the vendors. A study of this scope would take as long as Lucan et al.'s did when only four trained research assistants are collecting data from an entire city, and it could take longer with inexperienced assistants. A study with a larger research team could collect the same amount of data in a fraction of the time. Soltero et al. (2017) team gathered food environment data from 800-meter buffers around 32 elementary schools in three different Mexican cities. Soltero et al. assessment was an in-person audit of available food venues, but unlike Lucan et al. (2013), Soltero and her team only gathered data from 25% of the residential street segments and 100% of the

arterial street segments within each of the 800-meter buffers. Randomly selecting at least 25% of residential streets has been found to be representative of larger buffer zones, because of the little variability in residential street segments (Cerin, Chan, Macfarlane, Lee, & Lai, 2011; Griew et al., 2013; Lee, Mama, Medina, Ho, & Adamus, 2012; McMillan, Cubbin, Parmenter, Medina, & Lee, 2010), but 100% of arterial street segments were needed because these segments might be different from one another (McMillan et al., 2010; Soltero et al., 2017). The team also conducted in-depth field training sessions with the research assistants before data collection. These strategies allowed Soltero's team to collect data in two weeks.

Conducting the assessments of Mexican SFS would require a well-trained team that can identify and evaluate as many SFS as possible in the Mexican food environment. Since there are no directories available for the location of SFS, my approach would be to create buffers around areas that included point of access where there might be a high concentration of SFS: schools, and worksites (Long-Solís, 2007; Tinker, 1999). Based on previous studies, a 400-meter buffer, which represents a 15-minute walk, can be created around the targeted point of access (Heinrich et al., 2012; McAlexander, Banda, McAlexander, & Lee, 2009; Soltero et al., 2017; Spence et al., 2009). The buffer area is large enough to capture the variables the research team is interested in analyzing and small enough to be accomplished with limited resources. Once the buffer zones have been created, all the streets in each buffer zone can be mapped. Next, research assistants can walk through 25% of randomly selected residential streets and 100% of arterial street

segments and mark the location for each SFS. Then, research assistants can use the SFS assessment tool to record the foods sold by all SFS they encounter.

Research Design and Methods

Observational Areas (Research Sites)

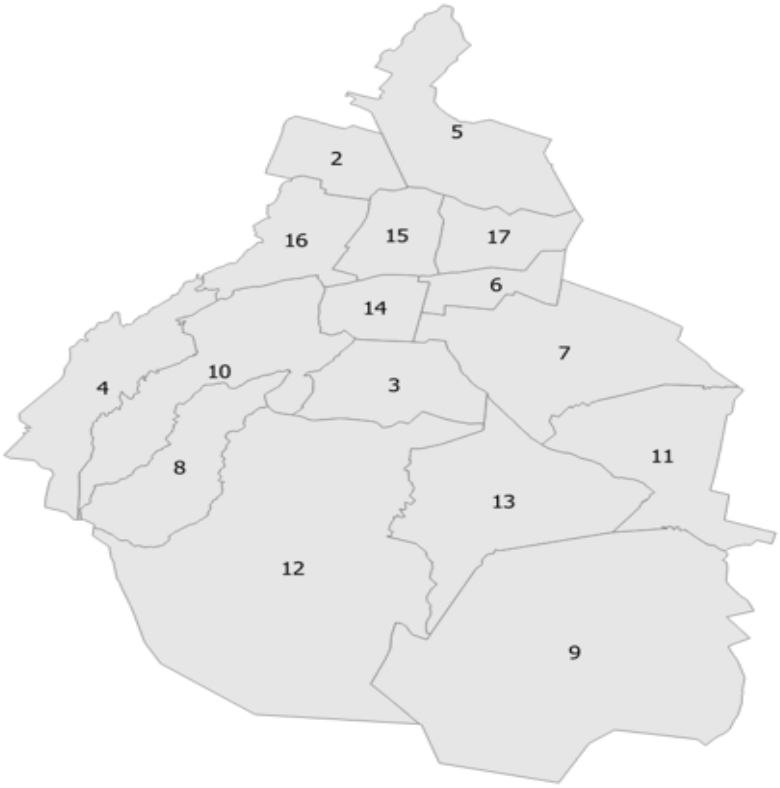
The observational sites were in Mexico City. Mexico is a country situated between the U.S. and Central America. Its capital, Mexico City, is one of the most densely populated cities in the world with about 8.8 million people (as of 2010). Mexico City is located within the metropolitan area of *Valle de Mexico* (Valley of Mexico), which is formed by Mexico City and two other state municipalities. Mexico City itself is formed by 16 different municipalities (*delegaciones)*. Figure 3.1 shows the location of each municipality within the city. Each municipality is made up of neighborhoods that can range in size from as little as a few census tracts to as large as several dozen census tracts. The sociodemographic characteristics of municipalities and respective neighborhoods can vary from one neighborhood to the other. Neighborhoods located on the outskirts of the city are less developed and are more likely to have high levels of poverty than those in central Mexico City.

Poverty in Mexico City is measured at the locality and municipality level using marginalization levels. There are five marginalization levels: very high, high, medium, low, and very low. These marginalization levels are created using three domains: education, living arrangements, and income. Education is defined by the proportion of

illiterate people in each locality. The living arrangement domain is defined by the number of households without running water, without a sewer system, without electricity, with

Figure 3.1 Mexico City's municipalities

Municipality name	
2. Azcapotzalco	10. Alvaro Obregon
3. Coyoacan	11. Tlahuac
4. Cuajimalpa	12. Tlalpan
5. Gustavo A. Madero	13. Xochimilco
6. Iztacalco	14. Benito Juarez
7. Iztapalapa	15. Cuauhtemoc
8. La Magdalena Contreras	16. Miguel Hidalgo
9. Milpa Alta	17. Venustiano Carranza



dirt floors, and by an average number of people per room. Income is defined by the number of individuals employed in formal business (Cortés, 2002). Overall, marginalization represents whether people have adequate access to goods and basic services.

Figure 2 shows the outline of each municipality (in bold black lines), and colored census tract representing the different marginal levels. Red represents very high marginal levels. Orange represents high marginal levels. Yellow represents medium marginal levels. Light green represents low marginal levels. Dark green represents very low marginal levels. This figure shows that census tracts are clustered around the same marginal levels. Figure 2 helped in defining observational areas. Marginalization levels are also referred to as neighborhood income levels in this dissertation with the highest marginalization level (i.e. very high marginalization) representing a very low neighborhood income level.

Observational Area Sampling Strategy

I relied on local collaborators' knowledge of Mexico City to help me create a list of sites that can be accessible and safe for data collection. Some areas with very high marginal levels in the outskirts of the city were excluded as those areas represent a safety concern for the research team. Each municipality in Mexico City is divided into census tracts characterized by marginal levels (see Figure 3.2). The number and size of the census tract depend on population density. For example, large municipalities like Milpa

Alta (#12 in figure 2), and Cuajimalpa de Morelos (#4 in figure 2) have 40 and 31 census tracts respectively (Table 3.2). In contrast, Cuauhtemoc (#15 in figure 2), Venustiano Carranza (#17 in figure 2), and Benito Juarez (#14 in figure 2) are smaller municipalities, but with a much larger population density and with 150, 145, and 102 census tracts respectively. Table 2 contains a list of the number of census tracts per municipality. Iztapalapa has the most census tracts with 407 whereas Cuajimalpa de Morelos has the least with 31.

Census tracts that have the same marginalization levels were identified to select observational areas. Figure 2 shows multiple areas with clusters of the same marginalization level. Clusters representing each of the five marginalization levels were selected. Once the clusters had been identified, a list containing the census tract ID for each census tract found in the clusters was created. A random selection of four census tracts per marginalization level was selected using the census tract IDs. A total of twenty observational areas were drawn throughout Mexico City.

Defining Observational Areas: 400-meter Buffers

Observational areas or neighborhoods were defined as the area within a 400-meter radius around the center point of each randomly selected census tract. The center point of each selected census tract was geocoded using geographic information systems. Next, a 400-meter radius around the center point of each census tract was drawn to represent the

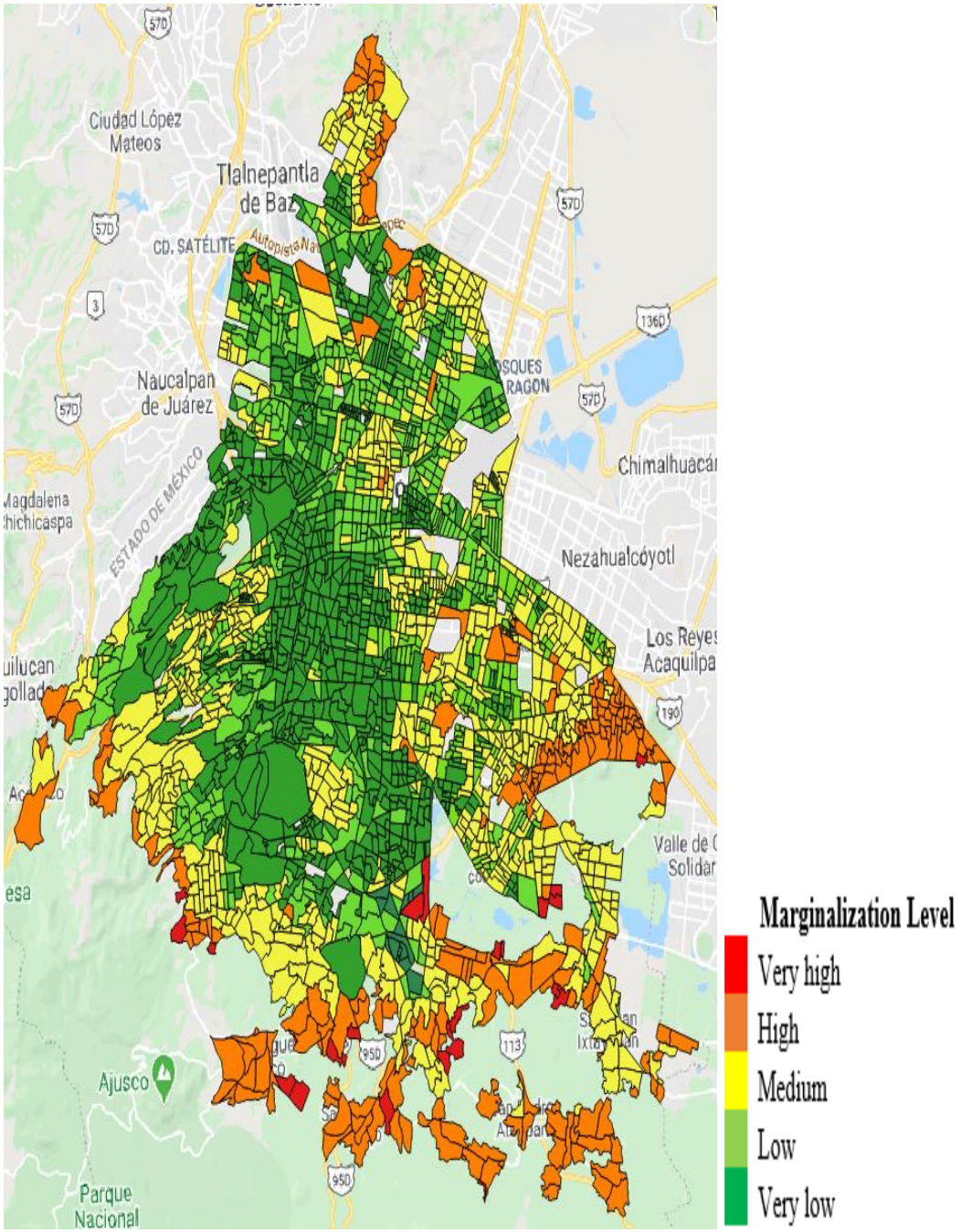
Table 3.2 Census Tract Breakdown per Municipality
Source: http://www.inegi.org.mx/geo/contenidos/geoestadistica/m_geoestadistico.aspx

Municipality Name (ID)	Number of Census Tracts
Alvaro Obregon (1)	196
Azcapotzalco (2)	102
Benito Juarez (3)	102
Coyoacan (4)	155
Cuajimalpa de Morelos (5)	31
Cuauhtemoc (6)	150
Gustavo A. Madero (7)	299
Iztacalco (8)	107
Iztapalapa (9)	407
La Magdalena Contreras (10)	52
Miguel Hidalgo (11)	118
Milpa Alta (12)	40
Tlahuac (13)	106
Tlapan (14)	196
Venustiano Carranza (15)	145
Xochimilco (16)	117

observational area or neighborhood. Observational areas of 400-meters have been shown to be an adequate distance to capture the food environment where people might purchase foods from (Charreire et al., 2010).

A buffer area approach to defining the observational area was selected over keeping the observational area within the confines of the census tract because data show that people are not limited to the census tract they live in when they engage in food

Figure 3.2 Marginalization levels in Mexico City by census tract



purchasing and eating behaviors (Charreire et al., 2010; Feng, Glass, Curriero, Stewart, & Schwartz, 2010; Forsyth, Lytle, & Van Riper, 2010). If we limit our observations to the area within the census tract where people live, we might miss a broader and more realistic observation of the food environment that these people utilize. Furthermore, census tracts are defined by population density. A census tract typically contains 2000-8000 residents but given that Mexico City is a very densely populated city, a census tract might be too small to capture the food environment to which a person might have access. A buffer area can capture multiple census tracts, and it might provide a better representation of the area's food environment. After the observational areas have been drawn, the next step was to map the residential and arterial street segments within each observational area.

Mapping Observational Areas (Neighborhoods)

Once the buffers were created, the next step was to number all residential and arterial street segments within each buffer. An arterial or residential street segment represents the distance between one corner of a street to the next. Residential street segments have been defined as moderate to low traffic roads with less than 5,000 cars circulating in 24 hours whereas arterial street segments have been defined as high traffic main roads where more than 5,000 cars circulate in 24 hours (McMillan et al., 2010). Given that a 400-meter buffer can contain hundreds of residential and arterial street segments, I randomly selected 25% of residential street segments and 100% of arterial street segments for observations. Previous findings suggest that only a quarter of all

residential street segments are needed to adequately represent the pedestrian environment (McMillan et al., 2010). In contrast, arterial street segments can vary depending on elements such as the number of car lanes, pedestrian crossings, major public transportation stops, among other factors. Therefore, it has been suggested to among other factors. Therefore, it has been suggested to include all arterial street segments for assessment (McMillan et al., 2010).

Research Assistant Training

RAs were undergraduate nutrition students from *Universidad Autonoma Metropolitana*. This university is in the southern part of Mexico City. RAs participated in a 2-day training session at the *Universidad Autonoma Metropolitana*. The training was divided into four sessions. As part of sessions one and two, there were four one-hour classes with PowerPoint presentations to discuss food items, observation, and data collection procedures. Session three included four hours of field practice with a convenient sample of SFS. These SFS were not included in the analysis and served as a practice only. Field practice helped determine how long it took to conduct assessments, and how willing SFS were to let RAs document the foods they sold. I expected times to vary depending on the type of SFS. Stationary vendors could take longer to assess because they sold a larger variety of food items, whereas mobile vendors (e.g. pushcarts, bicycles) sold a smaller number of items. Finally, session four included 2-hour training on observation and data collection practices. Modifications to the tool were done based

on fieldwork notes, and discussions with RAs. Group debriefings helped further refine the instrument.

Nine teams of two research assistants per team assisted in data collection. Teams assessed the same observational area at the time. Each team was assigned specific residential and arterial street segments to assess. The teams walked their assigned street segments within each buffer and documented the presence and number of SFS, the availability, and variety of street foods and beverages using the SFSAT created for this study. Each research team carried printed maps representing the selected observational areas and their respective residential and arterial street segments.

Street Food Stand Identification and Geocoding

SFS are part of an informal economy, and as such, there is not a list of SFS available from which a random sample can be selected. The identification of SFS depended on systematic direct observations. RAs walked the selected street segments looking for SFS. Upon encountering an SFS, RAs used the street segment scanning component of the SFSAT to mark the street segment where the SFS was seen. The SFS location was geocoded in QGIS, an open-source geographical analysis software.

Assessing the Observational Areas and Street Food Stands

Data collection took place from April to August of 2018. Systematic direct observations (i.e. walking the streets) are the gold standard for identifying food

establishments in the food environment (Hosler & Dharssi, 2011). Nine teams of 2 RAs performed direct observations following the same standard protocol and using the SFSAT. The research team assessed an observational area at a time. Street segments were randomly assigned to RAs for assessment. Each research team took a copy of the observational area with highlighted residential and arterial street segments. RAs carefully walked on the streets and documented the instances they had to avoid a street segment and the reasoning. Reasons included street closures, private/gated communities, and safety.

RAs carried printed copies of the SFSAT in case their digital device run out of battery or malfunction. Assessments took place during three different time points: morning (8:00 am to 11:59 am), afternoon (12:00 pm to 4:59 pm), and evening (5:00 pm-8:00 pm). Each street segment was randomly assessed to one of the three-time points. Local collaborators suggested using these three-time frames rather than just a one-time period because RAs may encounter different vendors and types of foods during the different time points. For example, some vendors might be available in the morning only. Thus, if I only survey the neighborhoods in the afternoon, I would be missing the vendors and foods from the morning time.

Observation Procedures

Each team arrived promptly at the start of their respective assessment times to begin data collection. Upon arriving at their first street segment, RAs first walked the

length of the segment and recorded the number of SFS per type of SFS using the street segment component of the SFSAT. The street segment component was needed in case that for some reason (e.g. vendor distrusts RAs and this distrust spreads to the rest of SFS in the segment) the RAs needed to leave the street segment. By assessing the street segment before assessing each SFS, I would at least have a count of the total number of SFS on that street segment. Once RAs assessed the street segment and recorded the number of SFS found on the segment, they returned to the beginning of the street segment and began the assessment of each SFS found on that segment. They proceeded first going from north to south, next south to north, and then from east to west, and from west to east. If the exact location for an SFS was missing, it was matched to the centroid of the observational area.

Upon encountering an SFS, RAs opened the Qualtrics link and completed the first section of the tool. The first section included rater ID, date of visit, municipality ID, street segment ID, assessment time (morning, afternoon, or evening), and SFS ID. The rater ID was the raters' initials. Street segment ID was a combination of the municipality ID (see table 2) plus the number assigned to each street segment when they were mapped and numbered. The SFS ID was the combination of the municipality ID, the street segment ID, and the nth number for each identified vendor. For example, the first SFS found in Benito Juarez' street segment number 22 was IDed as 032201. The second SFS was 32202, and so on.

Once the previous information was recorded, RAs approached the SFS and began collecting basic information: whether the stand was part of a street market; vendor's gender; type of advertisements on the stand; stand's mobility; and type of SFS. The RAs approached the vendor and informed her about the study after the previous information was recorded. RAs obtained consent from vendors before documenting the availability and variety of food and beverage items. The research team followed this procedure for each SFS found in their surveyed street segments. If a vendor chooses to not participate in the study, data on food and beverage availability and variety were not collected.

RAs recorded the physical presence of the items listed in SFSAT when consent was given by the vendors. Items not listed in the tool were entered in the write-in spaces available at the end of the tool. RAs were instructed not to interfere with the vendor's activities and to wait for the best opportunity to engage the vendors, especially when only one person was working the stand.

Digital photographs of the street segments and SFS were taken by RAs. Each RA team carried a small digital camera, embedded in the cellphone or table that was used to assess the SFS. The use of photographs can serve as a visual representation of the type of SFS encountered and the type of food items vendors were selling. One RA completed the assessment while the second RA took pictures of the street segment, stand, and items sold at the SFS. To keep track of the digital pictures, the RAs used a white notecard system that contained the municipality ID, street segment ID, and SFS ID. A picture of the notecard containing the previous data was taken before taking any pictures of the SFS.

Informed Consent

Research assistants took copies of the informed consent with them to obtain verbal consent from participants. Upon encountering an SFS, RAs identified themselves as students from *Universidad Autonoma Metropolitana* working on an observational study. They informed the vendor about the goals of the study and read the informed consent. Although the instrument was designed to be primarily observational, there were times when RAs require the vendors' assistance. Their assistance was needed to confirm food items were not available. Personal information was not requested. Participation in the study was completely voluntary, and vendors had the option to withdraw from the study or request RAs to stop documenting food availability at any point. Participating vendors received $3 as an incentive for their participation.

Street Food Vending Assessment Tool (SFSAT): Structured Checklist

The main objective of SFSAT is to measure the availability and variety of SFS and the foods and beverages sold at stands. A review of the literature was completed to identify tools that have been used to assessed different elements of the food environment (e.g. supermarkets, grocery stores, corner stores, fast and sit in restaurants) and to draw elements from those assessment tools rather than creating variables that already existed. Selected food and beverage items were adapted from tools that had been tested for reliability and/or validity such as the Nutrition Environment Measures Surveys (NEMS), Restaurant Assessment Tool, the Thrifty Food Plan (TFP), Communities of Excellence in

Nutrition, Physical Activity and Obesity Prevention Food Availability and Marketing Survey and Bridging the Gap-Food Store Observation Form (BTG-FSOF). Additional items were retrieved from Mexican databases and websites such as the Department of Health's *Plato del bien comer* (eating well plate) and the Mexican Dietary Guidelines to represent culturally appropriate food items and meals (Bonvecchio Arenas et al., 2015).

Availability and Variety Variables

The SFSAT's *availability* variable was defined as the presence or absence of food and beverage items and was recorded as a binary yes or no answer. The *variety* was defined as the number of individual forms of a general food item and was recorded as a continuous variable. For example, research assistants would record apples—which could be either red or green at an SFS—as having a variety of 2 in the fruit category, regardless of the total number of apples at the stand.

Street Food Stand Distribution

Type of venues located within 100 meters of the SFS were labeled as points of access to populations that street food vendors may be targeting. The points of access included homes, sports facilities, public transportation centers, food inns, schools, churches, worksites, parks, malls (shopping centers), and restaurants. To document the distribution of SFS, research assistants answered the question: what type of points of

access are located within 100-m of SFS. The question was a multiple-choice answer given that an SFS could be located near multiple points of access.

Street Food Stand Characteristics

SFSAT also contains the following variables to document SFS characteristics: *SFS mobility* (mobile, semi-mobile, stationary); whether SFS is a standalone business or part of a street market; type of SFS (e.g. tacos, tortas, fruit/vegetable); vendor's gender; images advertised at the SFS; type of promotions displayed; who prepares the food (e.g. vendors, third party); hours of operation; and sanitation practices (e.g. running water available, hand sanitizer available).

Standalone Assessment of Street Segments

The SFSAT contains a standalone component that can be used separately of the food and beverage availability and variety assessments. The standalone component documents the number and type of SFS found on street segments. One assessment is needed for each street segment assessed. The standalone is useful for instances when the research team has limited resources and can only document the number and type of SFS available in a selected area.

Pilot Testing

The assessment tool was designed as an online format using Qualtrics. The tool's link was readily available to researchers who downloaded it into a smartphone or tablet. Inter-rater reliability testing was done for all areas of the instrument. There is not a standard number of observations needed to test the assessment tool's psychometric properties, thus, a research team (2 RAs) tested the tool using a sample of 45-60 SFS. The researchers walked the streets together and individually assessed the same SFS in quick successions. Assessing the SFS in quick successions helped reduce differences that could have emerged if the second researcher had come at a different time of the day (e.g. stocking, higher demand for food items at a different time/day).

Walking the streets simultaneously helped researchers identify and assess highly mobile SFS that might not be present regularly and could not be found at other times. To make sure the researchers were independently assessing the SFS, one assessed the SFS first while the second waited at the distance. Once the first RA was done, the second RA began her assessment. Observation notes (e.g. missing prices for food items, etc.) were recorded in the tool's comments section.

Data Analyses

All analyses were done using Stata analytical software version 15. Percent agreement and inter-rater reliability scores were calculated to test the inter-rater reliability of the assessment tool. Inter-rater reliability scores were calculated for the

following items using kappa inter-rater reliability statistics: SFS characteristics, vendor hygienic practices, food, and beverage availability, and food and beverage variety. Landis and Koch's kappa scores were used to assess inter-rater reliability:

- 0.81-1.00 almost perfect
- 0.61-0.80 substantial
- 0.41-0.60 moderate
- 0.21-0.40 fair
- 0-.20 slight
- <0 poor

Descriptive statistics summarized SFS characteristics, SFS availability and variety, and street food and beverage availability and variety. Chi-squares statistics were calculated to explore differences in availability, variety, density, and distribution of SFS and the food and beverages sold at SFS across neighborhood income levels and points of access. ANOVAs were performed to explore differences in SFS and street food and beverage variety across neighborhood income levels.

CHAPTER 4

DEVELOPMENT AND VALIDATION OF A STREET FOOD STAND ASSESSMENT TOOL

Abstract

Objective: To develop, test, and validate a street food stand assessment tool (SFSAT) that can document the availability, density, and distribution of street food stand (SFS), availability, variety, and distribution of street foods and beverages sold at SFS.

Design: Assessment items were adapted from previously validated tools, field observations, and from the Mexican Dietary Guidelines. Two trained researchers independently tested the assessment tool in quick successions by observing SFS in 3 middle- to high-income neighborhoods. The SFSAT contains 58 individual items: 14 for street food stand characteristics and 44 for food and beverages. Percent agreement and kappa inter-rater reliability scores were calculated for SFS characteristics and food availability and variety.

Results: The percent agreement for SFS characteristics ranged from 25–100%; however, the inter-rater reliability scores for some of these items were low. Almost perfect kappa inter-rater reliability scores (0.81–1.00) were reported for 62% of items, including for SFS locations, days of operation, and some types. The percent agreement for food and beverage availability ranged from 81–100%, whereas the percent agreement for food and beverage variety ranged from 60–100%. Inter-rater reliability scores ranged from 0.00–1.00 for both types of items. The availability of items tended to have a high percentage of

almost perfect inter-rater reliability scores (63%) compared to the variety of items (21%). For most (23%) scores for the variety of items, inter-rater reliability scores were moderate and ranged from 0.42–0.59.

Conclusions: The SFSAT is a valid and reliable tool to measure the availability and variety of SFS foods and beverages in Mexico City. Future research is needed to test the validity and reliability of the SFSAT in other cities in Mexico and abroad.

Background

Over the years, an increasing number of studies have examined the food environment, which consists of the physical presence of food, the location and distribution of food venues, and the systems that facilitate or hinder food access (Centers for Disease Control and Prevention, 2010). Public health officials and policymakers are interested in how the food environment may be associated with disparities in the availability and access to food and the potential effects of these disparities on health outcomes (Freedman, 2009; Glanz et al., 2005; Gordon et al., 2011). To document these relationships, food environment assessment tools are essential. The types of food venues that are present in a community may be associated with the types of foods and beverages available in that community. For example, studies have suggested that the presence of supermarkets and grocery stores in communities is associated with the availability of fruits and vegetables (Anderson et al., 2007; Baier, 2017; Carlson, Lino, Juan, Hanson, & Basiotis, 2007; Glanz et al., 2007), whereas the presence of convenience/corner stores

(Andreyeva et al., 2012; Baier, 2017; Cavanaugh, Mallya, Brensinger, Tierney, & Glanz, 2013; Cheadle et al., 1991; DeWeese et al., 2016), gas stations (Caldwell, Kobayashi, DuBow, & Wytinck, 2009; Freedman, 2009), and fast-food restaurants (Baker, Schootman, Barnidge, & Kelly, 2006; Ball, Timperio, & Crawford, 2009; Glanz et al., 2007; Lewis et al., 2011) is associated with the availability of high-fat, sugary, and salty foods (Borradaile et al., 2009; Gibson, 2011; Sharkey, Johnson, Dean, & Horel, 2011; Zenk et al., 2009) and with a reduced availability of fruits and vegetables (Laraia, Siega-Riz, Kaufman, & Jones, 2004; Widener, Metcalf, & Bar-Yam, 2012; Zenk et al., 2009). Meanwhile, the consumption of high-fat, sugary and salty foods has been associated with negative health outcomes such as obesity, diabetes, cardiovascular diseases, and some forms of cancer (G. Block, Patterson, & Subar, 1992; Morland & Evenson, 2009; Pereira et al., 2005).

One important limitation of food environment studies is that most assessment tools have been developed in the context of high-income countries, primarily in the US (Creel et al., 2008; Grigsby-Toussaint, Zenk, Odoms-Young, Ruggiero, & Moise, 2010; Sharkey et al., 2013). This is a critical issue, as food venues typical of the US may not exist or be culturally relevant in low- and middle-income countries (Bridle-Fitzpatrick, 2015). For example, in middle-income countries such as Mexico, culturally relevant food venues include indoor and outdoor markets, *tienditas* (small family-owned stores), item-specific stores (e.g., meat shops, fruit and vegetable shops), and street food stands (SFS). Of these, street food stands are among the most popular, having been a part of the

environment and culture of Mexican food for generations (Long-Solís, 2007). Street foods are defined as ready to eat foods and beverages that are prepared and sold on the streets by vendors using facilities such as mobile, semi-stationary, and stationary stands (Food and Agriculture Organization, 1989; World Health Organization, 1996).

While SFS are an important aspect of the Mexican food environment and culture and they represent a source of income for vendors (Arámbulo III et al., 1994; Bhowmik, 2005; Choi et al., 2013; Tinker, 2003) as well as a source of food security for millions of Mexican families (Long-Solís, 2007; Lucan et al., 2013; Moy et al., 1996; Munoz de Chavez et al., 2000; Nelia P Steyn & Labadarios, 2011), research on SFS has been limited. Most studies have focused on food-borne diseases (Abrahale et al., 2018; Alimi, 2016; Asiegbu, Lebelo, & Tabit, 2016; P. Mensah, Yeboah-Manu, Owusu-Darko, & Ablordey, 2002) related to SFS in African and Asian countries (Abrahale et al., 2018; Akhtar, Riaz, Ismail, & Farooq, 2013; Choudhury, Mahanta, Goswami, Mazumder, & Pegoo, 2011; Tinker, 1999). Only a handful of studies have investigated food availability (Abrahale et al., 2018), and very few have focused on Mexico (Castillo, Villarruel-López, Navarro-Hidalgo, Martínez-González, & Torres-Vitela, 2006; Cerna-Cortes et al., 2016; Díaz-López et al., 2011; Estrada-Garcia, Cerna, Thompson, & Lopez-Saucedo, 2002; Estrada-Garcia et al., 2004; Langellier, 2015; Ortiz-Bautista, Freyre, Zamora-Ortiz, & Sanchez-Salas, 2009; Quiñones-Ramírez, Vázquez-Salinas, Rodas-Suárez, Ramos-Flores, & Rodríguez-Montaño, 2000; Saltijeral, Alvarez, & Garcia, 1999; Soltero et al., 2017; Torres-Vitela et al., 1997). Furthermore, to our knowledge, no studies have used a

validated assessment tool to reliably measure food and beverage availability at a variety of SFS. Thus, the objective of this observational study was to develop, test, and validate an objective assessment tool that can document SFS food and beverage availability and variety. Through extensive fieldwork, the researchers developed the Street Food Stand Assessment Tool (SFSAT) and then tested the percent agreement and inter-rater reliability using an SFS sample in Mexico City.

Methods

Site Selection

Data were collected in Mexico City in May of 2018. Mexico City is Mexico's capital; the researchers chose it as the data collection site since it is one of the country's largest urban centers. People throughout the country migrate to Mexico City in search of better economic opportunities, bringing their culinary traditions with them. As a result of these migratory patterns, one can find foods from all regions of Mexico in Mexico City. With the assistance of local experts, we selected a convenience sample of 3 middle- to high-income Mexico City neighborhoods with a high prevalence of SFS, with all SFS operating in these neighborhoods serving as the sample frame. To initiate data collection, researchers approached street food vendors, explained the objective of the study, and obtained informed consent from vendors who expressed interest in participating in the assessments. As the research team did not collect any personal information from street food vendors, the study was deemed exempt under federal regulation 45 46. 101 (b) CFR

and by the Institutional Review Board at the researcher's university. There were 2 phases of tool development, as described in the next section.

Tool Development

In phase one, researchers identified the following assessment tools to use to develop the SFSAT: the Nutrition Environment Measures Survey (NEMS) (Glanz et al., 2007; Saelens et al., 2007) and the Thrifty Food Basket (TFB) (Center for Nutrition Policy and Promotion, 1999). The selected food and beverage items reflected the dietary intake guidelines recommended by the Mexican Health Department (Salud, 2018). Researchers pretested the SFSAT by conducting direct observations of Mexico City SFS.

The first SFSAT draft was developed in paper format as a structured checklist to document the availability, price, quality, and variety of food items sold at SFS. Food items were selected that were representative of the Mexican diet, and additional, culturally relevant foods and beverages were incorporated based on direct observations of Mexico City SFS. In the first draft of the SFSAT tool, a comprehensive list of food items was created, and the food items were divided into categories. In addition, the tool captured relevant SFS characteristics, such as vendor sex; whether the SFS was mobile, semi-stationary, or stationary; the SFS type based on the main type of food sold (17 unique types were identified through direct observations); and the types of facilities or points of access (e.g. schools, transportation centers, etc.) located within 100 m of the SFS as a way to explore the distribution of SFS.

Researchers pretested the tool, collecting data via direct observations of a small convenience sample of Mexico City SFS (n = 10). Street vendors participated in the study by confirming what food and beverage items were not available. Some of the main issues that emerged in phase 1 were as follows: 1) the length and format of the tool; 2) environmental factors; and 3) earning the trust of street food vendors. Regarding the first issue, using a comprehensive list of food items resulted in the assessments being quite time-intensive. To shorten assessment times, researchers retain only the overarching food categories in the tool. For example, the list of individual fruits was dropped, while the overarching category of "fruit" was retained. We retained the variety variable to capture customers' options, with variety being defined as the number of individual forms of a general food item. For example, we would record apples—which could be either red or green at a SFS—as having a variety of 2 in the fruit category, regardless of the total number of apples at the stand. Although we were originally interested in recording the prices of the different food and beverage items, we ultimately dropped this variable due to the lack of price displays in SFS. Requesting food prices would have been burdensome to vendors, who would have had to gather price information on all the SFS items and options, which were at times quite numerous.

The second issue that emerged was environmental factors, such as the weather. We noted that a paper format for the tool would not have been conducive to rainy weather, as the paper is easily damaged by water. Although we collected this study's data during the dry season, collection during a rainy season could result in damage to the

surveys. Vendor trust emerged as the third salient issue, with some vendors not appearing comfortable with the paper format of the assessment. While we informed vendors about study objectives before data collection, many associated our printed survey with governmental work as the vendors explained that it is common for government officials to conduct inspections using clipboards and paper. Vendors expressed concerned that the questions on hygienic practices (e.g. having running water) could jeopardize their business. To circumvent the issues of weather conditions and vendor trust, we decided to use a digital format in the next draft of the tool, and to expedite the assessment times, we organized the food categories under the 17 types of SFS identified during fieldwork. Although many of the SFS had food categories in common, several were unique in terms of their food items and food preparation methods. For example, the grilled taco and steamed taco stands shared food categories (i.e., dairy, meat, and vegetables) but differed in terms of their stand size, preparation methods, and item availability (e.g., most steamed taco stands did not sell beverages). Moreover, the tool contained a skip logic feature that facilitated selecting the food and beverage categories associated with each type of SFS, and it had open answer sections for typing in items not listed.

A revised SFSAT draft was designed online using Qualtrics survey services. The digital format was tested with an additional sample of SFS (n = 7). The results showed that several functions of the digital format, such as the display and the skip logic feature, allowed raters to move more efficiently through the food categories, shortening assessment times. Furthermore, vendors more positively perceived using the cellphone

version of the assessment compared to using the printed version. However, internet connectivity occasionally presented challenges, with a lack of connectivity increasing assessment times. This problem was solved by researchers downloading the survey into mobile devices and completing the assessment offline.

In phase 2, we developed protocols and training materials and audited a sample of SFS to test the inter-rater reliability of the final SFSAT. Two raters participated in 3-day training sessions involving didactic and field training for inter-rater reliability testing. Day 1 introduced the SFS, research methods, research protocols, and the variables in the SFSAT. On day 2, the raters practiced data collection procedures and performed mock assessments. On day 3, the raters discussed ways to improve the data collection procedures and the tool itself. At the end of the development process, the SFSAT contained 58 individual items: 14 about SFS characteristics and 44 about foods and beverages.

Data Collection

Tool Validation

A standard number of observations is not needed to test an assessment tool's psychometric properties. For example, studies have created assessment tools with as few as 25 (Emond, Madanat, & Ayala, 2012) or 37 (Cheadle et al., 1990) assessments. Our goal was to evaluate a sample of 45–60 SFS, and an SFS was eligible for assessment if it sold ready-to-eat foods and beverages on the street. We targeted locations near

transportation centers, worksites, and city squares, where SFS are typically congregated (Long-Solís, 2007), identifying 3 middle- to high-income neighborhoods with major transportation centers and clusters of hospitals and clinics. Raters walked the main streets within these neighborhoods, searching for SFS, carrying school identifications, and informed consent letters explaining the study's purpose. When the raters located SFS, they approached the vendors and obtained informed consent, being careful to address any vendor discomfort or hesitation. The raters provided vendors who permitted audits with a small incentive ($3).

The raters approached the SFS as a pair and then conducted their observations/assessments in quick succession. This approach eliminated the possibility that a rater would miss an opportunity to assess a vendor already assessed by the other rater, particularly since highly mobile vendors in a neighborhood could quickly relocate to another area. This strategy also reduced the chances that raters would discover differences in food and beverage availability at the same SFS due to restocking issues or demand fluctuations depending on the time of day. The raters assessed stands one after the other, performing their audits independently. To ensure independence between raters, rater 1 audited the SFS first, while rater 2 waited at a distance, and raters were not allowed to assist each other during the audits. Moreover, raters were instructed not to interfere with vendor activities. Phase 2 was carried out between 9:00 pm and 4:00 pm in May of 2018.

Data Analysis

STATA version 15 was used for data management and analysis. We used descriptive statistics to characterize SFS mobility level, vendor gender, SFS advertisements/promotions, nearby venues, SFS type, vendor hygienic practices, and the average assessment completion time. Using kappa inter-rater reliability statistics, we assessed inter-rater reliability for the following items: SFS characteristics, vendor hygienic practices, food, and beverage availability, and food and beverage variety. We calculated kappa inter-rater reliability statistical scores to measure the agreement between the 2 observers.

Results

Sample Description

In the validation stage, the research team encountered 59 street food stands and assessed 52 of them. Seven stands were not assessed because the vendors chose not to participate in the study. The assessed SFS were stand-alone businesses that were not part of farmers' markets or street markets (Table 1). Mobile stands (e.g., bicycles, shopping carts, wheelbarrows) represented 36% of the sample; these could move from street to street while searching for customers. Semi-stationary (e.g., merchants selling food out of pots and pans on a table surrounded by several chairs) and stationary (e.g., merchants selling food out of a metal structure that could be locked at night and left in place) SFS represented 37% and 28% of the sample, respectively. There were more men than women

selling street food (64% vs. 21%, respectively), but 14% of the SFS, men, and women were working together. The use of images, pictures, or other advertisements at the SFS was not common among mobile and semi-stationary stands; however, images of sugar-sweetened beverages (i.e., soda), fast food (i.e., chips, cookies), and traditional food (e.g., *tacos, tortas*) were noted among the stationary stands (10%). The SFS assessed in this study were primarily found near homes (43%), recreational parks (20%), and restaurants (14%). The most common types of SFS were snack stands (47%), followed by cooked meal stands (34%). The average assessment time per stand was 7.34 minutes (SD 3.49).

Inter-Rater Reliability Scores

The percent agreement for SFS characteristics ranged from 25–100%; however, the inter-rater reliability scores for some of these items were low (Table 1). Almost perfect kappa inter-rater reliability scores (0.81–1.00) were reported for 62% of items, including for SFS locations, days of operation, and some types. Substantial reliability (0.61–0.80) was reported for 21% of the items, including for stand mobility. Fair and moderate reliability (0.21–0.40 and 0.41–0.60) was reported for 5% of items, including for sanitation practices, types of venues located within 100 m of SFS, and advertising images of soda at the SFS. Slight reliability (0.00–0.20) was reported for less than 7% of items, including for the following types of venues located within 100 m of the SFS:

Table 4.1 SFS Characteristics' Percent Agreement and Inter-Rater Reliability Scores

		Inter-Rater Reliability	
SFS Characteristics (n = 52)	**Percent (n)**	**% Agreement**	**Kappa**
Located on street	100 (52)	100.0	1.00
Mobility		84.6	0.77
Mobile	35.5 (19)		
Semi-mobile	36.5 (19)		
Stationary	27.8 (14)		
Gender of attendant		88.5	0.78
Male	64.4 (33)		
Female	21.2 (11)		
Both	14.4 (8)		
Who prepares the food		97.8	0.94
Vendor	76.1 (40)		
Third provider	23.9 (12)		
Venues within 100 m			
Households	43.3 (23)	25.0	0.03
Recreational park	20.2 (11)	98.1	0.94
Restaurant	14.4 (8)	78.9	0.21
Shopping center	9.62 (5)	100.0	1.00
School	5.77 (3)	100.0	1.00
Public transportation center	1.93 (1)	96.2	0.00
Food inn	1.93 (1)	96.2	0.00
Sanitation practices			
Food is kept warm (n = 36)	90.6 (33)	88.0	0.21
Food is kept cold (n = 37)	34.9 (13)	95.2	0.90
Has hand sanitizer	0 (0.00)	96.7	0.65
Has running water	0 (0.00)	91.3	0.82
Days of operation			
Monday	72.8 (38)	88.9	0.84
Tuesday	99.9 (52)	93.3	0.9
Wednesday	97.7 (51)	93.3	0.91
Thursday	99.9 (52)	93.3	0.9
Friday	97.8 (51)	93.3	0.91
Saturday	91.3 (47)	88.9	0.85
Sunday	74.0 (39)	88.9	0.86

Type of images on SFS			
Chips/snacks	9.62 (5)	100.0	1.00
Traditional food	8.65 (5)	98.1	0.88
Soda	7.69 (4)	92.3	0.46
Fruits	4.81 (3)	98.1	0.79
Vegetables	2.88 (2)	98.1	0.66
Fast food	2.88 (2)	98.1	0.66
Type of SFS			
Snacks	47.1 (25)	98.1	0.96
Candy	18.3 (9)	98.1	0.94
Snacks	14.4 (7)	98.1	0.92
Desserts	10.6 (6)	98.1	0.89
Ice cream	3.90 (2)	100.0	1.00
Cooked meals	33.6 (17)	98.1	0.96
Tortas	7.70 (4)	100.0	1.00
Fair-style food	4.80 (3)	98.1	0.79
Appetizers	4.80 (3)	98.1	0.79
Broth	3.90 (2)	92.6	1.00
Hamburgers	3.90 (2)	100.0	1.00
Stew tacos	3.90 (2)	100.0	1.00
Tamales	3.90 (2)	98.1	0.79
Fruit	15.4 (8)	100.0	1.00
Fruit cocktail	9.60 (5)	100.0	1.00
Corn	5.80 (3)	100.0	1.00
Other	3.85 (2)	96.2	0.48

households (0.03), food inns (0.00), and public transportation centers (0.00). The percentages of agreement for these values were 25%, 96.2% and 96.2%, respectively.

The percent agreement for food and beverage availability ranged from 81–100%, whereas the percent agreement for food and beverage variety ranged from 60–100% (Table 2). Inter-rater reliability scores ranged from 0.00–1.00 for both types of items. The availability of items tended to have a higher percentage of almost perfect inter-rater

reliability scores (63%) compared to the variety of items (21%). For most (23%) scores for the variety of items, inter-rater reliability scores were moderate and ranged from 0.42–0.59. Slight reliabilities were found for availability (14%) and variety (19%) for the following food and beverage items: crackers, nuts, granola bars, yogurt, energy drinks, and sports drinks. The percentages of the agreement for these same food and beverage items ranged from 83–98%. Inter-rater reliability scores were not obtained for 3 items (*tortilla,* white bread, and *gorditas de nata*) in the variety variable, as the tool did not include an option to document variety for these items. This was because, ubiquitously, stands carrying these items only offered one type of the item.

Discussion

This study assessed the percent agreement and inter-rater reliability scores of an assessment tool designed to capture SFS characteristics and SFS food and beverage availability and variety. To our knowledge, this is the first assessment tool developed specifically for SFS that has been tested for percent agreement and inter-rater reliability. The measures in this assessment tool had high inter-rater reliability scores for both the availability and variety of items. Most items (63%) in the availability section showed almost perfect inter-rater reliability scores, with a few items having slight reliability scores. However, the percentages of the agreement for those items was high (ranging from84–98%). In contrast, most items (23%) in the variety section had moderate reliability scores. This can be explained by the fact that it was easier to document

Table 4.2 Food and Beverage Availability and Variety's Percent Agreement and Inter-Rater Reliability Scores

Food and Beverage Items	**Inter-rater reliability score**			
	Availability		**Variety**	
Food Categories	**% Agreement**	**Kappa**	**% Agreement**	**Kappa**
Snacks	98.1	0.96	71.2	0.54
Amaranth	100	1.00	100	1.00
Bubble gum	100	1.00	92.3	0.58
Chips/fries	100	1.00	88.5	0.65
Cookies & pastries	100	1.00	96.2	0.74
Crepes	100	1.00	100	1.00
Hot cakes	100	1.00	98.1	0.66
Palanqueta	100	1.00	100	1.00
Ice cream	100	1.00	100	1.00
Pan dulce	100	1.00	98.1	0.74
Gorditas de nata	100	1.00	a	a
Hard candy	98.1	0.88	94.2	0.65
Seeds	96.2	0.81	86.5	0.38
Churros	98.1	0.79	96.2	0.59
Chocolates	94.2	0.70	90.4	0.52
Traditional Mexican candy	94.2	0.37	92.3	0.17
Nuts	84.6	0.17	82.7	0.08
Crackers	98.1	0.00	98.1	0.00
Granola bars	98.1	0.00	98.1	0.00
Meat	98.1	0.95	82.7	0.59
Cereal	98.1	0.94	98.1	0.79
Whole bread	100	1.00	100	1.00
Tortilla	100	1.00	a	a
White bread	100	1.00	a	a
Granola and other cereals	98.1	0.66	98.1	0.66
Fruits and vegetables	88.5	0.76	55.8	0.42
Salsa	96.6	0.81	92.3	0.61
Vegetables	80.8	0.62	59.6	0.40

Fruits	82.7	0.61	71.2	0.44
Dairy	90.4	0.76	80.8	0.58
Beverage categories				
Natural juice	100	1.00	100	1.00
Milk-based	98.1	0.85	92.3	0.48
Atole	100	1.00	98.1	0.74
Milk	100	1.00	100	1.00
Flavored milk	98.1	0.66	94.2	0.24
Yogurt	98.1	0.00	98.1	0.00
SSB[1]				
Soda	96.2	0.90	80.8	0.58
Aguas frescas/flavored water	96.2	0.83	84.6	0.38
Processed juice	88.5	0.66	76.9	0.42
Probiotic drink	96.2	0.49	96.2	0.49
Energy drinks	98.1	0.00	98.1	0.00
Sports drinks	98.1	0.00	98.1	0.00
Coffee	98.1	0.88	92.3	0.48
Diet soda	98.1	0.88	98.1	0.88
Water	96.2	0.85	94.2	0.81

Note: [a]A kappa score was not computed due to 2 or fewer observations per crosstabulation. [1]SSB = sugar-sweetened beverages

whether an item was available than to document all the varieties of that item, especially among SFS that were continuously selling items. This study's scores were similar to those of other inter-rater reliability studies assessing food and beverage availability (Cavanaugh et al., 2013; Cohen et al., 2007; Ghirardelli, Quinn, & Sugerman, 2011; Glanz et al., 2007; Izumi et al., 2012). Using a retail store tool in Detroit, Michigan, Izumi et al. found that most items had almost perfect reliability, whereas only 2% of items had fair to moderate reliability (0.21–0.40) (Izumi et al., 2012). In 2 other studies,

inter-rater reliability scores for fruit and vegetable availability ranged from 0.68–1.00 (Cavanaugh et al., 2013; Ghirardelli et al., 2011). In Glanz et al., they could not calculate the inter-rater reliability scores for several items as a result of having 2 fewer levels per crosstabulation for those items; however, the percent agreement for those items was high (greater than 92%) (Glanz et al., 2007).

The SFSAT also assessed several SFS characteristics, including the type of marketing strategies used to draw customer attention and the types of venues located near the stands. Most vendors did not advertise prices or special promotions. A few vendors used advertising images, including those for sugar-sweetened beverages, traditional foods (e.g., *tacos*), and fast foods (e.g., hot dogs). A study assessing marketing strategies in retail stores found low to moderate results for similar items (Ghirardelli et al., 2011). Other studies have assessed the allocation of space to food items in stores (Cohen et al., 2007; Emond et al., 2012; Glanz et al., 2007), but this approach was not possible in our study due to the lack of consistency in how SFS displayed food and beverage items. SFS do not demonstrate the level of organization found in retail food venues such as supermarkets, where items are organized by food categories and are visible in displays or on shelves. In some cases, vendors stored SFS food and drink items behind counters, such that they were not even visible. In other cases, food items could not be easily distinguished because they were cooked or blended (e.g., salsas) or were part of a meal (e.g., tacos). In these cases, purchasing a meal or asking the vendor to list the ingredients in a meal helped complete the assessment. However, these actions required vendors to

shift their attention away from customers to help the research team, and in some cases, these assessments took longer to complete, as vendors were busy. Not being able to document the types of food and beverage items available in SFS represents a challenge for public health interventions aimed at promoting the sale and consumption of nutritious food items.

Three items in the SFS characteristic portion of the tool had slight inter-rater reliability scores (0.00–0.03): SFS located within 100 m of households, transportation centers, and food inns. In a densely populated city such as Mexico City, residential and professional buildings exist in proximity, and at times it was difficult to distinguish between the two. This is especially the case in downtown Mexico City, where most buildings are high towers. As for public transportation centers, Mexico has both government and private bus transportation systems. At times, it was difficult to distinguish between the two systems, as they run similar routes and have stops in the same areas. Similarly, the low score for the food inn item could be due to the lack of distinction between types of restaurants in the training protocol. There were 2 terms used in the assessment tool to capture venues at which people could sit and consume their meals: restaurants and food inns. The term restaurant refers to franchise food venues with table service, whereas food inn refers to small, “mom and pop” restaurants. It is important to differentiate between these types of restaurants because, in a middle-income country like Mexico, franchised restaurants are less common than “mom and pop” ones. In addition, franchised restaurants seem to be less popular, primarily as a result of their

higher cost (de Bem Lignani, Sichieri, Burlandy, & Salles-Costa, 2011). When documenting that an SFS exists near one of these types of restaurants, it is important to understand whether the SFS is addressing a gap or complementing the existing food environment. Thus, the training manual was revised to help researchers differentiate between the two types of restaurants.

Overall, the high inter-rater reliability scores suggested that the tool was adequate for collecting information about the characteristics of street food stands and about the types of food and beverages that community members can purchase at these venues. This is the first step in understanding the role that SFS play in the community food environment and health outcomes.

Implications for Research and Practice

Assessment tools are needed to document the role that various aspects of the food environment play in food access, dietary intake, and health outcomes. Research has shown that access to venues that sell fruits and vegetables (e.g., supermarkets and grocery stores) is associated with the consumption of these food items and with positive health outcomes (Leone et al., 2011; Liese et al., 2007; Morland et al., 2002; Zenk et al., 2009). In comparison, researchers have observed associations between venues (e.g., fast food restaurants and convenience stores) that sell highly processed food items and negative health outcomes, such as for overweight, obesity, and diabetes (Isganaitis & Lustig, 2005; Jilcott et al., 2011; Larson et al., 2009; Pereira et al., 2005; Spence et al., 2009).

Meanwhile, the role that SFS may play in food access, dietary intake, and health outcomes has not been fully documented. One of the reasons for this gap in the literature could be the absence of tools to capture foods and beverages sold at SFS. This study's tool is the first step in providing systematic answers to questions about the nutritional value of food and beverage items sold at SFS and to shed light on the relationship between SFS and health outcomes.

The assessment tool is an indicator tool with potential value for nutrition educators, public health advocates, urban planners, and policymakers. These stakeholders can use the tool to identify the types of foods and beverages sold at SFS, the types of stands selling specific food items (e.g. fruits, vegetables), and the populations (e.g., schoolchildren, working adults) targeted by street food vendors. The information gathered from this tool can inform policies and interventions to promote access to nutritious foods. In addition, the capacity of SFS to change locations and operate in locations (e.g., parks, alleys, parking lots, and sidewalks) without complex infrastructure can enhance access in areas with scant resources for nutritious food. For example, in New York City, the local government approved a measure referred to as the Green Cart Program to allow street food vendors to operate in the streets as long as they sold fresh produce in underserved communities (Lucan, Maroko, Shanker, & Jordan, 2011). Mexican communities could attempt a similar approach.

Having a tool like this one is important in the food context and communities of Mexico, given that SFS are ubiquitous in the Mexican food environment (Long-Solís,

2007) and also given that Mexico is currently facing high rates of obesity and diabetes (S Barquera, Campos-Nonato, Hernández-Barrera, Pedroza-Tobías, & Rivera-Dommarco, 2013; Gutierrez et al., 2012; OEDC, 2011). Future research is needed to understand how foods and beverages sold at SFSs contribute to these public health crises in Mexico and other low- and middle-income countries.

Strengths and Limitations

A study's strengths and limitations should be considered when interpreting findings. To our knowledge, this is the first study that assesses the percent agreement and inter-rater reliability scores of an SFS assessment tool. One of the strengths of this study was its use of a digital assessment tool. Most assessment tools have been designed as printed versions (DeWeese et al., 2016; Glanz et al., 2007; Saelens et al., 2007), but these have been shown to have limitations: they are resource-intensive and can be easily damaged by weather and improper handling. A digital assessment tool can conserve resources and time: it does not need to be printed; it can be downloaded into an electronic device (i.e., a phone, tablet, or laptop); and it can be taken into the field to conduct assessments. In addition, a digital version can save time by using display and skip logic commands that can bypass questions or items not applicable to the stand in question. Furthermore, the digital assessment tool can be used offline to avoid issues with internet connectivity.

A second strength of the study was that we consulted with local community members and used a ground-truthing technique to identify and assess the SFS. Most studies on food environments have used business directories to identify food venues (Andreyeva et al., 2012; Baker et al., 2006; Ball et al., 2009; Glanz et al., 2007). However, business directories are not available for SFS given that many SFS vendors do not register their stands with the local authorities. Research has proven that ground-truthing techniques can be effective approaches for identifying informal food venues (Barker, 1968). The technique requires researchers to systematically walk the streets in search of food venues. In the current study, the researchers sometimes walked several streets without encountering an SFS, but on other occasions, researchers encountered multiple SFS on a single street.

A limitation of this study was the sampling strategy. Since a directory with information about the locations of SFS was not available, we had to use a convenience sample technique. Thus, it was not possible to select a random sample across different observational times to represent all types of SFS in the Mexican food environment. The PI identified 17 different types of SFS in the pre-testing phase, but researchers did not encounter the following 3 stands during the testing phase: pizza, steamed taco, and sweet potato stand. Pizza and steamed taco stands were found near schools (i.e., a university and a high school) during the pre-testing phase, but in the observational areas of the validation phase, only one school (i.e., an elementary school) was identified, and these specific SFS were not present near this school.

Conclusion

The SFSAT is the first food and beverage availability assessment tool designed specifically for SFS. The high inter-rater reliability scores showed that the variable definitions, training methods, and instruction manual can be used to train researchers interested in studying SFS and that the tool can be used to document SFS food and drink availability. The creation of this tool is the first step in understanding the role SFS can play in food environments, dietary intake, and health outcomes. The assessment tool could be helpful for researchers, nutrition educators, urban planners, and policymakers who are engaged in health promotion by encouraging the sale and consumption of nutritious food and beverage items.

Table 4.3 Street Food Stand Assessment Tool Items

SFS Characteristic	Food Categories	Beverage Categories
Stand location	Fruits	Coffee
Sidewalk	Vegetables	Diet soda
Street-market	Salsa	Milk
Type of mobility	Dairy	Natural juice
Mobile	Cereal	Natural water
Semi-stationary	Tortilla	Sugar-sweetened beverages
Stationary	Bread	*Aguas frescas*/bottled flavored water
Vendor's sex	White	*Atole*
Male	Whole wheat	Energy drink
Female	Snacks	Flavored milk
Images on stand	Amaranth	Probiotic drink
Soda	Chips/fries	Processed juice
Processed food	Chocolates	Soda
Traditional food	Churros	Sport beverage
Fast food	Cookies/cakes	Yogurt
Fruit	Crackers	
Vegetables	Crepes	
Venue within 100-meter of stand	Dried nuts	
Church	Dried seeds	
Food inn	Flan/gelatin	
Home	*Gorditas o tostadas de nata*	
Park	Granola bars	
Public transportation center	Gum	
Restaurant	Hard candy	
School	Hotcakes	
Shopping center (mall)	Ice cream	
Sports venue	Meringue	
Worksite	Milk-based popsicle	
Type of food stand	*Palanquetas*	
Appetizer	*Pan dulce*	
Both	Shaved iced	
Candy	Traditional Mexican candy	

	Water-based popsicle
Corn	
Dessert	
Fair-style food	
Fruit cocktail	
Grilled tacos	
Hamburgers and hot dogs	
Ice cream	
Pizza	
Snacks	
Steam tacos	
Stew tacos	
Sweet potato	
Tamales	
Tortas	
Other	
Who prepares food	
Vendor	
Third provider	
Hours of operation	
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	
Saturday	
Sunday	
Hygiene	
The stand has running water	
The stand has hand sanitizer	
The stand has ways to keep food warm	
Stands have ways to keep food cold	

CHAPTER 5

STREET FOOD STAND AVAILABILITY, DENSITY, AND DISTRIBUTION ACROSS NEIGHBORHOOD INCOME LEVELS IN MEXICO CITY

Abstract

Objective: To assess differences in the availability, density, and distribution of street food stands (SFS) across neighborhood income levels in Mexico City.

Methods: This was a cross-sectional study that used geographical information system (GIS) and ground-truthing methods to select and assess a random sample (n=761) of street segments representing twenty low-, middle-, and high-income neighborhoods. Data were collected between May and August of 2018. The validated Street Food Stand Assessment Tool (SFSAT) was used to record availability (i.e. physical presence), density (i.e. average number of SFS), and distribution (i.e. presence of SFS near points of access) of four types of SFS: cooked meals; fruits/vegetables; snacks; and "others." Chi-square tests of independence were performed to examine differences in SFS availability and distribution. Analysis of Variance (ANOVA) tests was performed to explore differences in SFS density.

Results: Availability, density, and distribution of SFS across neighborhood income levels varied depending on the type of SFS. Availability of cooked meal stands was higher in high-income neighborhoods ($p<.001$) whereas availability of snack stands was higher in middle-income neighborhoods ($p<.001$). In comparison, the variety of cooked meal,

snack and other stands was higher in middle-income neighborhoods compared with the other neighborhoods ($p<.01$). The distribution of SFS showed that SFS were most often found near homes, transportation centers, and worksites.

Conclusions: SFS were found across all neighborhoods in Mexico City. Additional studies are needed to assess food the type of foods and beverages sold at these types of food venues, and how that is related to consumption.

Background

The food environment can significantly impact individuals' eating behaviors and is an important factor to consider when addressing diet-related problems such as overweight, obesity, and diabetes. The types of foods available in a community and the quality of those foods have been shown to be correlated with consumer health status (Campbell et al., 2006; Ershow, 2009; Gittelsohn, 2012; Morland & Evenson, 2009). Food environments with a high prevalence of fast-food restaurants and convenience stores are associated with adverse health outcomes, such as cardiovascular diseases, diabetes, and some types of cancer (Holsten, 2009; Jeffery et al., 2006; Morland & Evenson, 2009; Morland et al., 2006). In contrast, food environments with ample supermarkets and grocery stores are associated with reduced risks for these same negative health outcomes (Morland & Evenson, 2009; Morland et al., 2006).

Studies of food environments can help us understand the variations in numbers, locations, and types of food venues across communities. A community's socioeconomic

characteristics can explain some of these variations. For example, supermarkets and grocery stores are less likely to be found in low-income and ethnic communities (Cole et al., 2010; Larson et al., 2009; Powell et al., 2007), with corner stores, liquor stores, and fast-food restaurants as the more likely options (Fleischhacker et al., 2011; Larson et al., 2009; Lee et al., 2010). Evidently, some food venues target specific populations. For example, studies have noted a higher concentration of fast-food restaurants and convenience stores near schools, where children can be enticed by food and beverage products (Day et al., 2015; Forsyth, Wall, Larson, Story, & Neumark-Sztainer, 2012; Matsuzaki et al., 2020; Sturm, 2008).

One critique of existing food environment studies is that most have focused on high-income countries such as the U.S, whereas only a few studies have assessed low- and middle-income ones (Glanz, 2009; Gustafson et al., 2012; Kelly et al., 2011; Lytle, 2009; McKinnon et al., 2009; Ohri-Vachaspati & Leviton, 2010). Supermarkets, grocery stores, and convenience stores as well as table-service and fast-food restaurants are the traditional food venues in countries similar to the U.S. However, these food venues may not be present or culturally relevant in low- and middle-income countries (Bridle-Fitzpatrick, 2015). In addition to the aforementioned venues of corner stores, liquor stores, and fast-food restaurants, residents of low- and middle-income countries tend to purchase food and beverages from small venues selling fruit, meat, or fish; indoor and street markets; and street food stands (SFS) (Garipe et al., 2014). However, very few

studies have formally assessed the characteristics (e.g., the types of foods and beverages) of culturally relevant food venues, including SFS.

Street foods are defined as ready-to-eat foods and beverages sold on the streets by vendors who cook, transport, and display these items in a variety of ways, including in pushcarts, modified bicycles, tricycles and wheelbarrows, buckets, balance poles, and stationary stalls or ships (Food and Agriculture Organization, 1989; World Health Organization, 1996). SFS degrees of mobility can range from highly mobile to stationary. One important element of SFS, which is emphasized in the definition, is that they are not permanently fixed—even stationary SFS can easily be moved (Bhowmik, 2005). Usually, street foods are cooked onsite at the SFS, but sometimes, they are prepared at home and transported to selling points where customers are likely to be found. Street foods can also include highly processed, prepackaged foods such as chips and candy.

In most places, SFS are part of the informal economy, meaning that the vendors do not pay city fees to operate on the streets and are not regulated by city officials (Acho-Chi, 2002; Bhowmik, 2005; Long-Solís, 2007; Lucan et al., 2013). The nature of these casual arrangements can precipitate conflicts with city officials and formal business owners, who may claim that the SFS vendors have unfair advantages and steal customers (Arámbulo III et al., 1994; Long-Solís, 2007). On some occasions, street food vendors have been harassed by authorities and even forcefully removed from the streets in city-wide cleanses (Acho-Chi, 2002; Bhowmik, 2005; Donovan, 2008). Nevertheless, SFS are an urban necessity: they enable many inhabitants of the city to meet their dietary needs.

SFS offer affordable food and beverage options and represent food security for millions of individuals and families around the world (Arámbulo III et al., 1994; Bhowmik, 2005; Gelormini et al., 2015; Long-Solís, 2007; Nelia Patricia Steyn et al., 2014). This is especially the case for families and individuals in low-income groups who commute long distances to work and do not return home for meals and cannot afford food from more expensive venues, such as restaurants (Arámbulo III et al., 1994; Bhowmik, 2005; Gelormini et al., 2015; Long-Solís, 2007; Nelia Patricia Steyn et al., 2014; Winarno & Allain, 1991). SFS are also a source of income for millions of workers, as they provide opportunities to be self-employed and self-sufficient. These workers include individuals who have fewer opportunities to access formal government or private jobs due to limited formal education or social biases (e.g., gender discrimination) (Acho-Chi, 2002; Bhowmik, 2005; Long-Solís, 2007; Martinez & Estrada, 2017; Mwangi et al., 2001; Nelia Patricia Steyn et al., 2014; Tinker, 1999; Winarno & Allain, 1991). More recently, however, even individuals with higher education are starting to view street-food vending as an entrepreneurial opportunity, as it can often generate more income than working in a government position (Bhowmik, 2005; Martinez & Estrada, 2017).

The number of SFS studies has grown in the last decade, but most of these have focused on only two continents: Africa and Asia (Abrahale et al., 2018; Akhtar et al., 2013; Al Mamun, Rahman, & Turin, 2013; Choudhury et al., 2011; Gelormini et al., 2015; Liu, Zhang, & Zhang, 2014; J. O. Mensah, Aidoo, & Teye, 2013; Tinker, 1999). Outside these areas, research on SFS has been quite limited, despite the fact that some

Latin American countries (including Mexico) have a rich history of SFS dating back to pre-colonial times (Long-Solis 2007). The few studies on SFS in Mexico have primarily focused on food safety and food contamination (Castillo et al., 2006; Cerna-Cortes et al., 2016; Díaz-López et al., 2011; Estrada-Garcia et al., 2002; Estrada-Garcia et al., 2004; Langellier, 2015; Ortiz-Bautista et al., 2009; Quiñones-Ramírez et al., 2000; Saltijeral et al., 1999; Soltero et al., 2017; Torres-Vitela et al., 1997). Although findings from these studies can help prevent food-borne diseases and inform street-food vendors and consumers about sanitation and food-handling practices, we need studies that can shed light on other aspects of SFS. For example, we need a better understanding of the populations targeted by SFS vendors and the roles that SFS play in food availability.

In Mexico, SFS are a popular source of food and beverages in communities, and they are an integral aspect of the food environment, especially in areas where other venues—such as supermarkets and restaurants—are limited. In a nationally representative food intake survey assessing food expenditure and food consumption away from home, approximately19% of respondents reported consuming a meal at a restaurant at least once a month, whereas 60% reported consuming a meal, snack, or beverage from SFS at least once a month (Langellier 2015). Thus, evidence suggests that SFS are a popular source of food consumed away from home, but the evidence is lacking on the groups (e.g. low-, middle- or high-income) targeted by SFS and on the numbers of SFS operating near specific points of access (e.g. schools, homes, and worksites). There is a need for more research, as a lack of understanding of the role of SFS in exposing communities to

unhealthy food could lead to negative health outcomes. Addressing this issue is particularly important in Mexico, where a large percentage of the population is either overweight, obese, or suffers from type 2 diabetes (Aceves-Martins et al., 2016; S. Barquera, I. Campos, & J. A. Rivera, 2013; Bonvecchio et al., 2009).

To our knowledge, no study to date has assessed the availability, density, and distribution of SFS in Mexico City using reliable and validated methods. Most studies have focused on selecting a convenience sample of SFS without fully discussing their numbers, types, and locations. Therefore, the objective of this study is to document the availability, distribution, and density of SFS by neighborhood income level in Mexico City and to identify populations targeted by vendors via specific points of access.

Methods

Case Selection

Data in this observational study were collected through ethnographic fieldwork and direct observations of Mexico City street segments between May and August in 2018. Mexico City is the largest and most populated city in Mexico, and it attracts migrants from all over the country, who bring their culinary traditions with them from their home regions. Thus, the city has a rich history of SFS offering foods from a wide array of regions in Mexico (Long-Solis 2007). This study included only SFS that met the criteria of the UN's street food definition: ready to eat foods and beverages that are prepared and sold on the streets by vendors using facilities such as mobile, semi-

stationary, and stationary stands (Food and Agriculture Organization, 1989; World Health Organization, 1996). As such, SFS were excluded from the study if 1) stands were part of establishments with four permanent walls; 2) stands were part of a store or an extension of a vendor's home, and 3) vendors sold nonfood items or raw foods meant to be prepared and consumed at home. SFS were categorized according to the main type of food or dish they sold. The categories of stands were as follows: cooked meals, snacks, fruits/vegetables, and "other." Cooked meal stands (e.g., those selling tacos, tortas, tamales, hamburgers, and pizza) mostly offered street foods prepared on the streets, but some foods were prepared at home and taken to selling points where customers were likely to be found. Foods sold at cooked meal stands could be sources of protein and vitamins (Blair, 1999; Long-Solís, 2007; C. R. Oguntona & Kanye, 1995). Snack stands (e.g., those selling candy, ice cream, chips, and salted dried seeds) sold highly processed, prepackaged foods, whereas fruit/vegetable stands offered minimally processed foods, such as pieces of raw fruit (e.g., mango) or vegetables (e.g., corn) that could be prepared for consumption onsite. The "other" stands were SFS that sold individual food items than did not fall under any other category (e.g., stands selling coffee, traditional Mexican beverages, or toasted crickets) or that sold a mixture of the aforementioned items.

Research assistants (RA) from the *Universidad Autonoma de Mexico-Ecatepec* were trained in mapping and ground-truthing techniques to assist with data collection. The research team used a standalone component of the Street Food Stand Assessment Tool (SFSAT) (Rosales Chavez in progress) to record the availability (i.e., the presence),

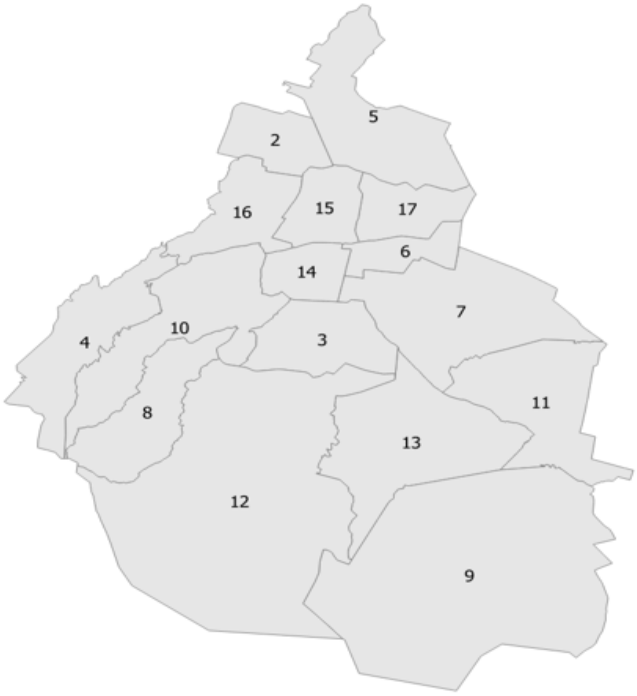
density (i.e., number), and distribution (i.e., location) of SFS in different neighborhoods throughout Mexico City. The study was deemed exempt under federal regulation 45 46. 101 (b) CFR and by Arizona State University's Institutional Review Board, as the research team did not collect any human data or personal information from street food vendors or customers.

Neighborhood Income Level

Mexico City is divided into sixteen municipalities (Figure 5.1), and these municipalities are further divided into census tracts. The size of the census tracts is dependent on population density (Table 5.1). Census tracts are characterized by marginalization levels, which are also referred to as neighborhood income levels in this paper (Figure 2). These were as follows: very high-, high-, middle-, low-, and very low-marginalization levels representing very low-, low-, middle-, high-, and very high neighborhood income levels, respectively (Cortes, 2002). The five income categories were used to select observational areas. However, in the analysis phase, the neighborhood income levels were merged into three categories: low-income level (encompassing very high- and high-marginalization levels); middle-income level (the middle-marginalization level); and high-income level (encompassing very low- and low-marginalization levels).

Figure 5.1 Mexico City's municipalities

Municipality name	
2. Azcapotzalco	10. Alvaro Obregon
3. Coyoacan	11. Tlahuac
4. Cuajimalpa	12. Tlalpan
5. Gustavo A. Madero	13. Xochimilco
6. Iztacalco	14. Benito Juarez
7. Iztapalapa	15. Cuauhtemoc
8. La Magdalena Contreras	16. Miguel Hidalgo
9. Milpa Alta	17. Venustiano Carranza



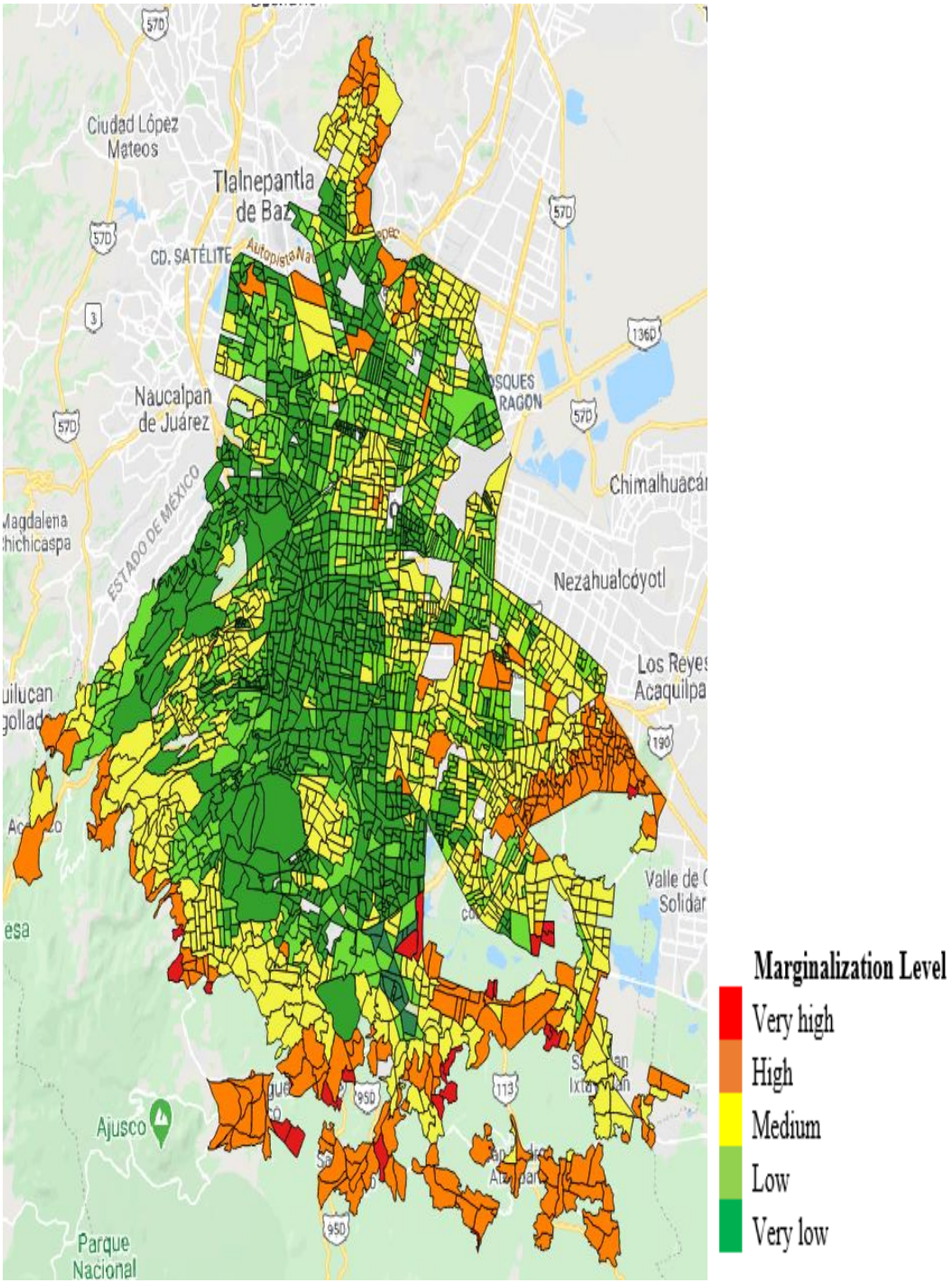
Identifying Street Food Stands by Street Segments

A business directory with information about SFS locations was not readily available due to the informal nature of SFS. Therefore, the research team implemented an

alternative strategy to identify a representative sample of SFS across Mexico City. This strategy involved capturing a random sample of street segments to explore the availability, density, and distribution of SFS operating in Mexico City per street segment. First, the census tracts in Mexico City were stratified by neighborhood income level, and a random sample of four census tracts per income level was selected. A 400-meter observational area was drawn around the center of each selected census track using open geographic information system methods to create observational areas (QGIS Development Team, 2009). Previous studies have shown that a 400-meter observational area can capture multiple features of a neighborhood, including points of access that street food vendors may be targeting (e.g., schools, parks, worksites, and transportation centers) (Atash, 1994; Gordon et al., 2011). In addition, a 400-meter buffer can capture more than one census tract depending on the size of the tract, the center of which acts as the centroid of the observational area (which is also referred to as the neighborhood).

Once the neighborhoods were drawn, all the street segments within each neighborhood were mapped. A street segment was defined as a part of a street intersected by two cross streets or by a cross street on one side and a dead end on the other (Kurban, Henry-Nickie, Green, & Phoenix, 2008). Street segments were then subdivided into residential and arterial street segments. A random sample of residential street segments (25%) plus all the arterial street segments was selected for observation (McMillan et al., 2010). The selected street segments were randomly assigned to morning (8:00–11:59 am), afternoon (12:00–4:59 pm), or evening (5:00–8:59 pm) assessment times to

Figure 5.2 Marginalization levels in Mexico City by census tract



document the SFS variability throughout the day. The research team selected twenty observational areas representing different neighborhoods across Mexico City (Figure 3).

Observational Area Assessments

Assessments were completed during weekdays to control for weekend events that could attract vendors to certain areas of the city, which could alter the regular patterns of SFS. Research assistants (RAs) worked in teams of two, and the teams were assigned to assess a random group of street segments. Copies of the neighborhood maps with the selected residential and arterial street segments were given to each team. The RAs conducted street-by-street assessments: they walked the length of the street segments within each neighborhood and assigned a unique identifier to each identified SFS. Subsequently, they documented the following information: the type and total SFS found per SFS category; the points of access within 100 meters of the SFS vending sites; and the geographic locations of the SFS. The information was captured using a standalone component of the SFSAT. The teams were trained to record any instances of and reasons for a street segment not being evaluated (e.g., it was a private or missing street, safety issues, etc.)

Measures

SFS Availability

SFS availability was defined in this study as the physical presence of any of the four kinds of SFS: cooked meal, snack, fruit/vegetable, or "other" stands. The SFS availability was measured by the following question: "Is the ____ type of stand present on the street segment?" This question appeared four times (i.e., one question for each of the four SFS categories) for each street segment. The RAs selected "yes" if there was at least one SFS of that type present on the street segment and "no" otherwise

SFS Density

SFS density was defined in this study as the average number of SFS across street segments within each neighborhood income level. Density was calculated by dividing the total number of SFS in a category by the total number of street segments assessed in each neighborhood income level, based on the RAs' responses to the following question: "How many _____stands are there on the street segment?" For each street segment, this question appeared four times: one per each SFS category.

SFS Distribution

SFS distribution was defined in this study as the arrangement of SFS near points of access to certain populations, which may have been the targets of SFS vendors. Point of access included major venues or institutions. The distribution was measured based on

the RAs responses to the following question for each SFS on a street segment: “Is the _____ SFS located within 100 m of ___?” The options for points of access included home, sports facility, public transportation center, food inn (mom and pop restaurant also known as *fondas*), school, church, worksite, park, mall, and restaurant. RAs could select multiple points of access for each type of SFS on a street segment. The points of access were treated in this study as a proxy for the populations potentially targeted by the SFS vendors.

Statistical Analysis

Descriptive statistics (frequencies) were used to summarize the following neighborhood characteristics: the percentages of segments containing SFS in a particular category; the type of street segments where the SFS were found; and the points of access located within 100 m of the SFS. It is important to highlight that a street segment could contain more than one type of SFS and that the SFS could be found near more than one type of access point. For example, a cooked meal stand and a snack stand could both be present on the same street segment, and those two stands could both be located near a home, a public transportation center, and a worksite. Chi-square tests of independence were performed to examine differences in the SFS availability across neighborhood income levels and in SFS distribution across points of access within 100 m of the SFS by neighborhood income levels. Analysis of variance (ANOVA) were performed to explore differences in the means of the SFS per street segment across neighborhood income

levels. Bonferroni adjustments were performed to account for multiple comparisons. Statistical analyses were conducted using Stata statistical software 15 (StataCorp, 2017). We hypothesized that there would be higher SFS availability and density in low-income observational areas and areas with heavy pedestrian traffic and high levels of food demand, such as transportation centers, worksites, and schools.

Results

Descriptive Characteristics

A total of 884 street segments were selected for the assessment (Table 5.1) in 20 observational areas (Figure 5.3). However, 13.9% of these segments were not ultimately assessed due to safety or inaccessibility issues (e.g., it was a private, uninhabited, or missing street segment). Of the assessed segments (n=761), 36.6% were low-income street segments, 20.4% were middle-income street segments, and 43.0% were high-income street segments. Across all twenty neighborhoods, 66.5% of the assessed segments were residential street segments, and 33.5% were arterial street segments. SFS were present in 27% (n=205) of the assessed street segments. In street segments containing SFS, the teams identified 153 SFS (27%) in low-income segments; 238 SFS (41%) in middle-income segments; and 184 SFS (32%) in high-income segments.

SFS Availability

Table 5.2 shows the differences in the SFS category availabilities across neighborhood income levels. Middle-income street segments contained a higher availability of cooked meal stands (27.7%) compared to low-income (10.4%) and high-income (15.0%) street segments (X^2 (2, N =761) = 22.8, p < .001). Middle income street segments had a higher availability of snack stands (27.1%) compared to low-income (8.24%) and high-income (12.2%) street segments (X^2 (2, N = 761) = 30.9, p<.001). Middle-income street segments also had a high availability of fruit/vegetable stands (10.9%) compared to low-income (6.45%) and high-income (7.95%) street segments, but these differences were not statistically significant (X^2 (2, N =761) = 2.76, p = .25). Middle-income street segments contained a higher availability of "other" stands (14.2%) compared to low-income (4.66%) and high-income (6.12%) street segments (X^2 (2, N = 761) = 14.6, p=.001).

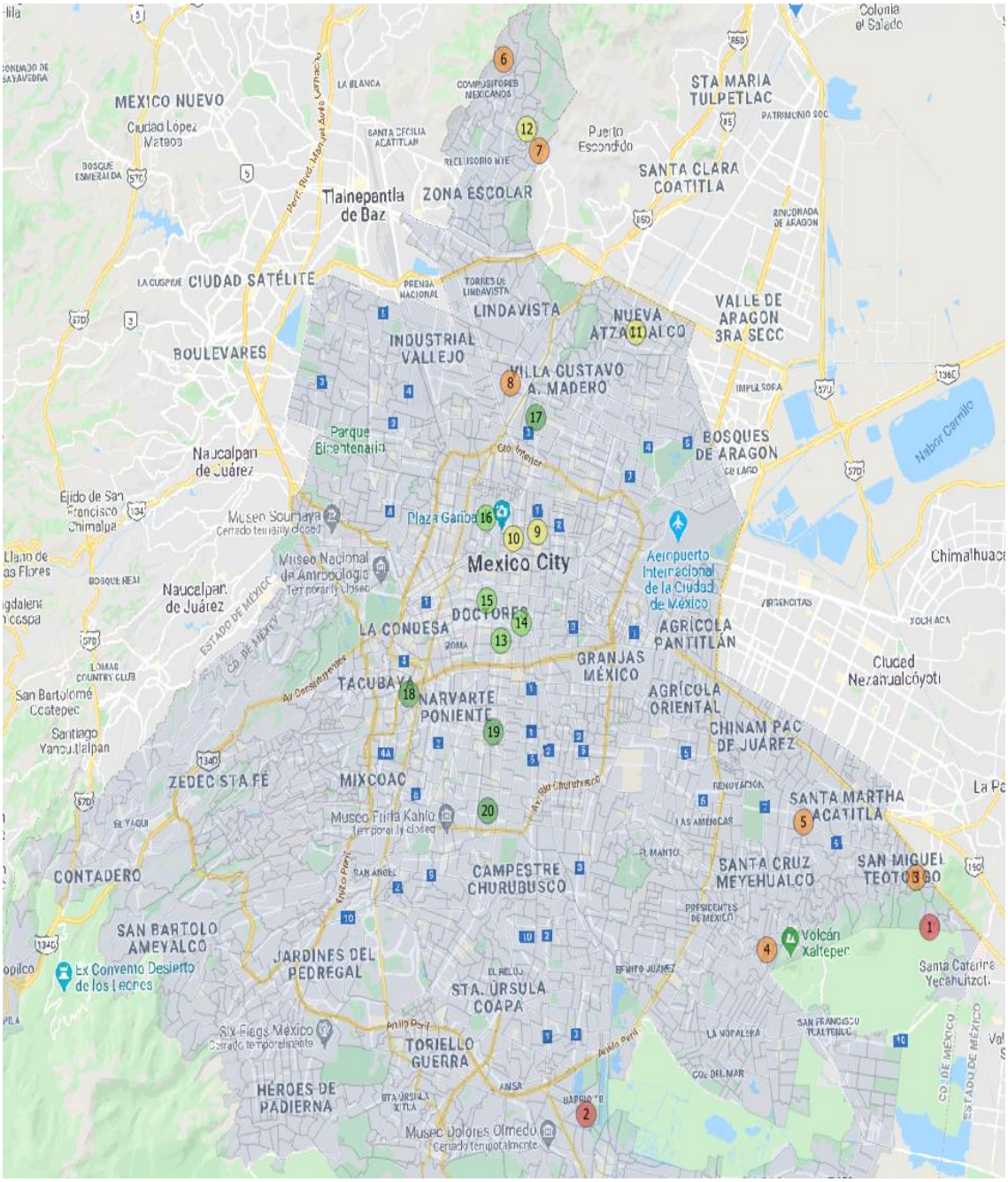
SFS Density

The density (average number) of SFS across neighborhood income levels is shown in Table 5.3. The density of cooked meal stands was higher in middle-income (M=0.63, SD = 1.35) compared to low- (M = 0.20, SD = 0.83) and high-income street segments (M = 0.23, SD = 0.62; F (2,759) = 13.4, p<.001). In the snack category, there was a higher density of SFS in middle-income (M = 0.43, SD = 1.04) compared to

Table 5.1 Street Segment Characteristics Across Neighborhood Income Levels

		Neighborhood Income Levels		
Street Segment Characteristics (n=761)	**Number of Street Segments**	**Low**	**Middle**	**High**
	n (%)	**n (%)**	**n (%)**	**n (%)**
Publicly accessible				
Yes	761 (86.1)	279 (78.6)	155 (93.4)	327 (90.1)
No	123 (13.9)	76 (21.4)	11 (6.63)	36 (9.92)
Type				
Residential	506 (66.5)	240 (86.0)	101 (65.2)	165 (50.5)
Arterial	255 (33.5)	39 (14.0)	54 (34.8)	162 (49.5)
Observation time				
Morning	303 (39.8)	133 (47.7)	49 (31.6)	121 (37.1)
Afternoon	270 (35.5)	78 (27.9)	70 (45.2)	122 (37.4)
Evening	188 (24.7)	68 (24.4)	36 (23.2)	84 (25.5)
SFS found on segment				
SFS found	205 (26.9)	53 (19.0)	67 (43.2)	85 (26.0)
SFS not found	556 (73.1)	226 (81.0)	88 (56.8)	242 (74.0)
Street segments not assessed (n=123)				
Observation time				
Morning	9 (7.32)	7 (9.21)	2 (18.2)	0 (0.00)
Afternoon	30 (24.4)	19 (25.0)	3 (27.3)	5 (13.9)
Evening	84 (68.3)	50 (65.8)	6 (54.5)	31 (86.1)

Figure 5.3 Selected Observational Areas



Note: Red and yellow = low-income neighborhoods; yellow = middle-income neighborhoods; green = high-income neighborhoods

Table 5.2 Availability SFS Across Neighorhood Income Levels

Street Segments Containing SFS (%)					
Type of SFS	**Low-income (n=279)**	**Middle-income (n=155)**	**High-income (n=327)**	**X2 (df)**	***p*-value**
	n (%)				
Cooked meals	29 (10.4)	43 (27.7)	49 (15.0)	22.8 (2)	<.001[ab]
Snacks	23 (8.24)	42 (27.1)	40 (12.2)	30.9 (2)	<.001[ab]
Fruits/vegetables	18 (6.45)	17 (10.9)	26 (7.95)	2.76 (2)	.25
Other	13 (4.66)	22 (14.2)	20 (6.12)	14.6 (2)	<.001[ab]

Note: a= higher availability in middle- than in low-income neighborhoods; b=higher availability in middle- than high-income neighborhoods.

low-income (M = 0.21, SD = 0.94) and high-income street segments (M = 0.16, SD = 0.51; F (2,759) = 6.20, p<.01). The density of fruit/vegetable stands was also high in middle-income (M = 0.14, SD = 0.43) compared to low-income (M = 0.08, SD = 0.32) and high-income street segments (M = 0.09, SD = 0.31), but these differences were not statistically significant, p >.05. The "other" stands had a higher density in middle-income (M = 0.34, SD = 1.72) compared to low-income (M = 0.06, SD = 0.32) and high-income street segments (M = 0.09, SD = 0.40; F (2,759) = 5.95, p<.01). See Figure 5.4 for SFS density maps.

Table 5.3 SFS Density Across Neighborhood Income Levels

	Neighborhood Income Level				
Type of SFS	**Low-income**	**Middle-income**	**High-Income**	**F(df)**	***p-value***
	Mean (SD)				
Cooked meals	0.20 (0.83)	0.63 (1.35)	0.23 (0.62)	13.4 (2,759)	<.001[ab]
Snacks	0.21 (0.94)	0.43 (1.04)	0.16 (0.51)	6.20 (2,759)	<.01[ab]
Fruits/vegetables	0.08 (0.32)	0.14 (0.43)	0.09 (0.31)	1.91 (2,759)	0.15
Other	0.06 (0.32)	0.34 (1.72)	0.09 (0.40)	5.95 (2,759)	<.01[ab]

Note: a= higher density in middle- than in low-income neighborhoods; b=higher density in middle- than high-income neighborhoods.

SFS Distribution

Table 5.4 examines the distribution of SFS across points of access located within 100 m of SFS and neighborhood income levels. Most stands were located near homes (86%), public transportation centers (58%), and worksites (31%). Among cooked meal stands near food inn restaurants, a higher availability of stands was also observed in high-income (49.0%) compared to low-income (24.5%) and middle-income (26.5%) street segments (X^2 (2, N = 129) = 15.1, p=.001). Among cooked meal stands found near worksites, there was a higher availability in high-income (56.9%) compared to low-income (12.3%) or middle-income (30.8%) street segments (X^2 (2, N = 145) = 6.24, p=.04), but these differences were not statistically significant after adjusting for multiple comparisons (p>.05). In contrast, among snack stands found near public transportation

centers, there was a higher availability in low-income (41.1%) compared to middle-income (37.0%) and high-income (21.9%) street segments (X^2 (2, N = 273) = 5.98, p=.05), but these differences were not statistically significant after adjusting for multiple comparisons (p>.05). There was also a higher availability of snack stands near food inn restaurants in middle-income (44.1%) compared to low-income (41.2%) and high-income (14.7%) street segments (X^2 (2, N = 273) = 5.98, p=.05). Snack stands were also found near worksites, but unlike the cooked meal stands, they exhibited a higher availability in middle-income (38.9%) compared to low-income (33.3%) and high-income (27.8%) street segments (X^2 (2, N = 145) = 11.5, p=.003). There were no statistically significant differences in SFS availability near homes, sports facilities, schools, churches, recreational parks, and shopping centers across neighborhood income levels.

Discussion

The purpose of this study was to explore differences in the availability, density, and distribution of SFS across neighborhood income levels in Mexico City. The availability of SFS was high in middle-income neighborhoods compared to low-income and high-income neighborhoods. These differences were consistent for the four SFS categories. Similarly, SFS density was consistently higher in middle-income neighborhoods across all four SFS categories. SFS in all four categories were consistently found near homes, transportation centers, and worksites; at least 8% of SFS were found near these points of access. However, the distribution of SFS near these points of access

varied across neighborhoods. For example, fruit/vegetable stands were found near homes in middle-income neighborhoods but near worksites in high-income neighborhoods. Differences in the availability, density, and distribution of SFS categories across neighborhoods could signify differences in the types of food and beverage exposure among customers in different income groups. Additional studies are needed to document the food and beverage availability at SFS and whether differences persist across neighborhoods.

Contrary to our hypothesis, low-income neighborhoods did not exhibit the highest availability of SFS. Middle-income neighborhoods exhibited the highest availability across the four type of SFS categories. We observed a low availability of cooked meal and fruit/vegetable stands particularly in low-income neighborhoods. This finding suggests that low-income communities in Mexico City may be in a vulnerable position, given that street food provides individuals with limited resources with an affordable source of calories and nutrients (Bendech, Chauliac, & Malvy, 1998; Namugumya & Muyanja, 2012; C. Oguntona & Tella, 1999; Sujatha et al., 1997). In other words, without adequate SFS in their communities, individuals from low-income neighborhoods may not have access to essential nutrients. More research is needed to better understand the roles played by SFS in the diets of those from different income groups in Mexico and especially for those in the low-income groups.

While SFS availability assessed whether SFS were present on a street segment, SFS density assessed the numbers and types of SFS present on the street segments. This

study found that low-income neighborhoods exhibited the lowest density of cooked meal, fruit/vegetable, and "other" stands, with high densities of these stands found in middle- and high-income neighborhoods. In this study, the presence of SFS across all three neighborhood income levels suggests that SFS are sources of food for individuals from all income groups in Mexico City. Studies of other low- and middle-income countries have also found a high availability of SFS outside of low-income communities, indicating that individuals from varying economic backgrounds consume street food (Acho-Chi, 2002; Ag, Chauliac, Gerbouin, Kante, & Malvy, 2000; Gelormini et al., 2015; Winarno & Allain, 1991). However, it is important to note that the presence of SFS in a community does not prove that residents of that community are the ones mainly consuming street food. It may be that the high availability of street food in middle- and high-income neighborhoods is due to people from low-income groups congregating in these neighborhoods for work and other activities. Future research is needed to assess the socioeconomic backgrounds of SFS customers and the distances they travel to consume street food.

The research team was interested in exploring the distribution of SFS within 100 m of different points of access to better understand which populations the vendors may have been targeting. All the points of access had nearby SFS. Differences in SFS distribution across neighborhoods were observed for the following SFS categories and points of access: snack stands near food inns, worksites and transportation centers; and cooked meal stands near food inns, and worksites. However, statistically significant

Table 5.4 SFS Distribution by Point of Acess Across Neighborhood Income Levels

Type of SFS	Point of Access	Neighborhood Income Levels			X^2 (df)	p-value
		Low	Medium	High		
		n (%)				
Cooked meals						
	Homes (n=163)	33 (20.2)	69 (42.3)	61 (37.4)	3.44 (2)	.18
	Sports Facilities (n=23)	3 (13.0)	10 (43.5)	10 (43.5)	1.77 (2)	.41
	Transportation Centers (n=110)	29 (26.4)	44 (40.0)	37 (33.6)	1.96 (2)	.37
	Food Inns (n=49)	12 (24.5)	13 (26.5)	24 (49.0)	15.1 (2)	.001[ab]
	Schools (n=37)	15 (40.5)	10 (27.0)	12 (32.4)	1.80 (2)	.41
	Churches (n=28)	9 (32.1)	11 (39.3)	8 (28.6)	0.35 (2)	.84
	Worksites (n=65)	8 (12.3)	20 (30.8)	37 (56.9)	6.24 (2)	.04*
	Parks (n=26)	10 (38.5)	8 (30.8)	8 (30.8)	0.16 (2)	.92
	Malls (n=15)	0 (0.00)	14 (93.3)	1 (6.67)	-	-
	Restaurants (n=26)	0 (0.00)	6 (23.1)	20 (76.9)	-	-
Snacks						
	Homes (n=111)	35 (31.5)	43 (38.7)	33 (29.7)	3.87 (2)	.14
	Sports Facilities (n=9)	4 (44.4)	1 (11.1)	4 (44.4)	5.78 (2)	.06
	Transportation Centers (n=73)	30 (41.1)	27 (37.0)	16 (21.9)	5.98 (2)	.05*
	Food Inns (n=34)	14 (41.2)	15 (44.1)	5 (14.7)	5.98 (2)	.05[a]
	Schools (n=35)	22 (62.9)	8 (22.9)	5 (14.3)	5.04 (2)	.08
	Churches (n=28)	11 (39.3)	13 (46.4)	4 (14.3)	3.66 (2)	.16
	Worksites (n=36)	12 (33.3)	14 (38.9)	10 (27.8)	11.5 (2)	.003[a]
	Parks (n=23)	11 (47.8)	5 (21.7)	7 (30.4)	2.57 (2)	.28
	Malls (n=11)	0 (0.00)	9 (81.8)	2 (18.2)	-	-
	Restaurants (n=20)	0 (0.00)	8 (40.0)	12 (60.0)	-	-
FV[1]						
	Homes (n=75)	21 (28.0)	28 (37.3)	26 (34.7)	0.88 (2)	.64
	Sports Facilities (n=6)	1 (16.7)	2 (33.3)	3 (50.0)	0.67 (2)	.72
	Transportation Centers (n=51)	16 (31.4)	18 (35.3)	17 (33.3)	0.64 (2)	.73

	Food Inns (n=27)	6 (22.2)	14 (51.8)	7 (25.9)	1.45 (2)	.48
	Schools (n=20)	10 (50.0)	4 (20.0)	6 (30.0)	0.50 (2)	.78
	Churches (n=19)	4 (21.1)	7 (36.8)	8 (42.1)	3.32 (2)	.19
	Worksites (n= 32)	4 (12.5)	13 (40.6)	15 (46.9)	0.50 (2)	.78
	Parks (n=15)	5 (33.3)	5 (33.3)	5 (33.3)	0.01 (2)	.94
	Malls (n=9)	0 (0.00)	7 (77.8)	2 (22.2)	-	-
	Restaurants (n=15)	0 (0.00)	5 (33.3)	10 (66.7)	-	-
Other						
	Homes (n=60)	12 (20.0)	31 (51.7)	17 (28.3)	2.82 (2)	.24
	Sports Facilities (n=25)	5 (20.0)	15 (60.0)	5 (20.0)	4.91 (2)	.09
	Transportation Centers (n=39)	8 (20.5)	20 (51.3)	11 (28.2)	2.96 (2)	.23
	Food Inns (n=19)	5 (26.3)	12 (63.2)	2 (10.5)	5.17 (2)	.07
	Schools (n=13)	4 (30.8)	5 (38.5)	4 (30.8)	2.05 (2)	.34
	Churches (n=5)	0 (0.00)	4 (80.0)	1 (20.0)	-	-
	Worksites (n=12)	0 (0.00)	8 (66.7)	4 (33.3)	-	-
	Parks (n=16)	3 (18.8)	9 (56.2)	4 (25.0)	4.86 (2)	.09
	Malls (n=4)	0 (0.00)	3 (75.0)	1 (25.0)	-	-
	Restaurants (n=5)	0 (0.00)	4 (80.0)	1 (20.0)	-	-

Note FV[1] = fruits and vegetables. - = calculation not performed due to small sample size. *= no statistically significant differences after adjusting for multiple comparisons. a= higher distribution in high- than in low-income neighborhoods; b=higher distribution in high- than middle-income neighborhoods.

differences across neighborhoods for snack stand stands near transportation centers, and for cooked meals stands near worksites disappeared after adjusting for multiple comparisons. Nevertheless, the high distribution of stands near transportation centers and worksites may be explained by the high number of commuters traveling through Mexico City. It is estimated that during working hours, the population in Mexico City swells to over 25 million people (Cerna-Cortes et al., 2015). On weekdays, thousands of people from nearby cities and towns use the public transportation system to commute to work in

Mexico City, and some spend up to six hours a day during these commutes (de Jong & Graf, 2017). Other studies have also found that transportation centers and worksites tend to draw SFS (Acho-Chi, 2002; Drabo et al., 2009; Gelormini et al., 2015; Mahon et al., 1999). Individuals who commute long distances or who do not have the time to prepare food at home probably consume most of their food outside their homes. For these people, SFS can act as mobile food sources that can be conveniently located to facilitate access.

The distribution results showed that a small proportion of SFS were found near food inns. Studies have mentioned the proximity of SFS to restaurants when discussing conflicts between formal business owners (i.e., restaurant owners) and SFS vendors regarding the unfair advantages of vendors, who may not pay city, service, or permit fees (Arámbulo III et al., 1994; Long-Solís, 2007). The proximity of SFS to restaurants may also be associated with the cost of food. In Mexico, the cost of a restaurant meal ranges from 100–500 pesos (equivalent to approximately $5–25 USD)(Daily, 2020; Numbeo, 2020), whereas the price of a meal at an SFS ranges from 20–100 pesos (equivalent to $1–5 USD). Thus, the cost of restaurant food may be prohibitive for individuals from low and middle-income groups, and SFS may provide more affordable options for these individuals. Future research is needed to better understand restaurant and SFS co-availability, including the products and prices of products at both types of venues, especially when they are adjacent. Studying customer perceptions and food preferences in relation to the adjacent venues could also yield meaningful insights.

Strengths and Limitations

One of the strengths of this study is its unique and comprehensive approach, using geographic information system methods, and direct observations of street segments to identify a representative sample of SFS and to explore the availability, density, and distribution of SFS across neighborhoods. Other food environment studies have relied on business directories to identify the locations of food venues (Bader, Ailshire, Morenoff, & House, 2010; Bitler & Haider, 2011; Bridle-Fitzpatrick, 2015; Caspi, Kawachi, Subramanian, Adamkiewicz, & Sorensen, 2012). However, this approach would not have been suitable for SFS, given that many stands operate informally and thus, are not listed in business directories. The research team captured a representative sample of SFS by selecting a random sample of observational areas and street segments across income and points in time and then conducting direct observations of the street segments. In addition, the study captured several points of access, including worksites, schools, public transportation centers, and other busy locations by selecting 400-m observational areas throughout Mexico City. Previous studies of SFS in Mexico have focused on SFS near schools (Hernandez Barrera et al., 2016; López-Barrón et al., 2015; Soltero et al., 2017), limiting the scope of the study to children and schools. Our study's approach is more representative, as it included multiple points of access, meaning that the findings can be generalized to various populations within Mexico City. However, even though we selected twenty observational areas across income groups, our findings cannot be generalized to other Mexican cities, and this is one limitation of our study. As Mexico's

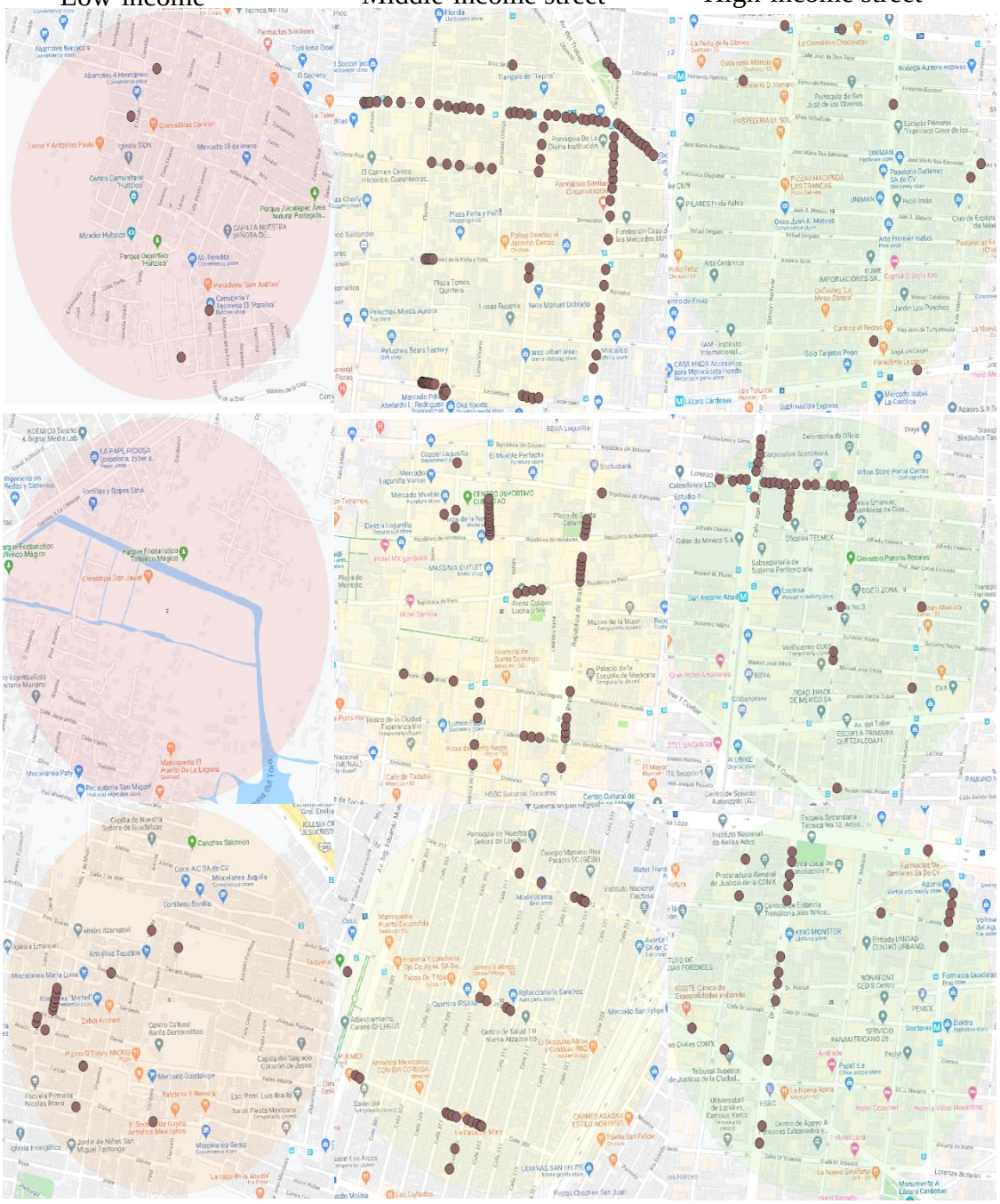
capital and economic heart, Mexico City is unusual in that it is highly urbanized and is the country's most densely populated city. Thus, our findings should not be generalized to less urbanized and less densely populated cities in Mexico. An additional limitation of this study seasonality. Data collection took place from May to August, which is summertime in Mexico when some workers and their families take vacations. Thus, the SFS availability, density, and distribution may be different during the summer than during other times of the year. Therefore, our findings may not be generalizable to other times of the year.

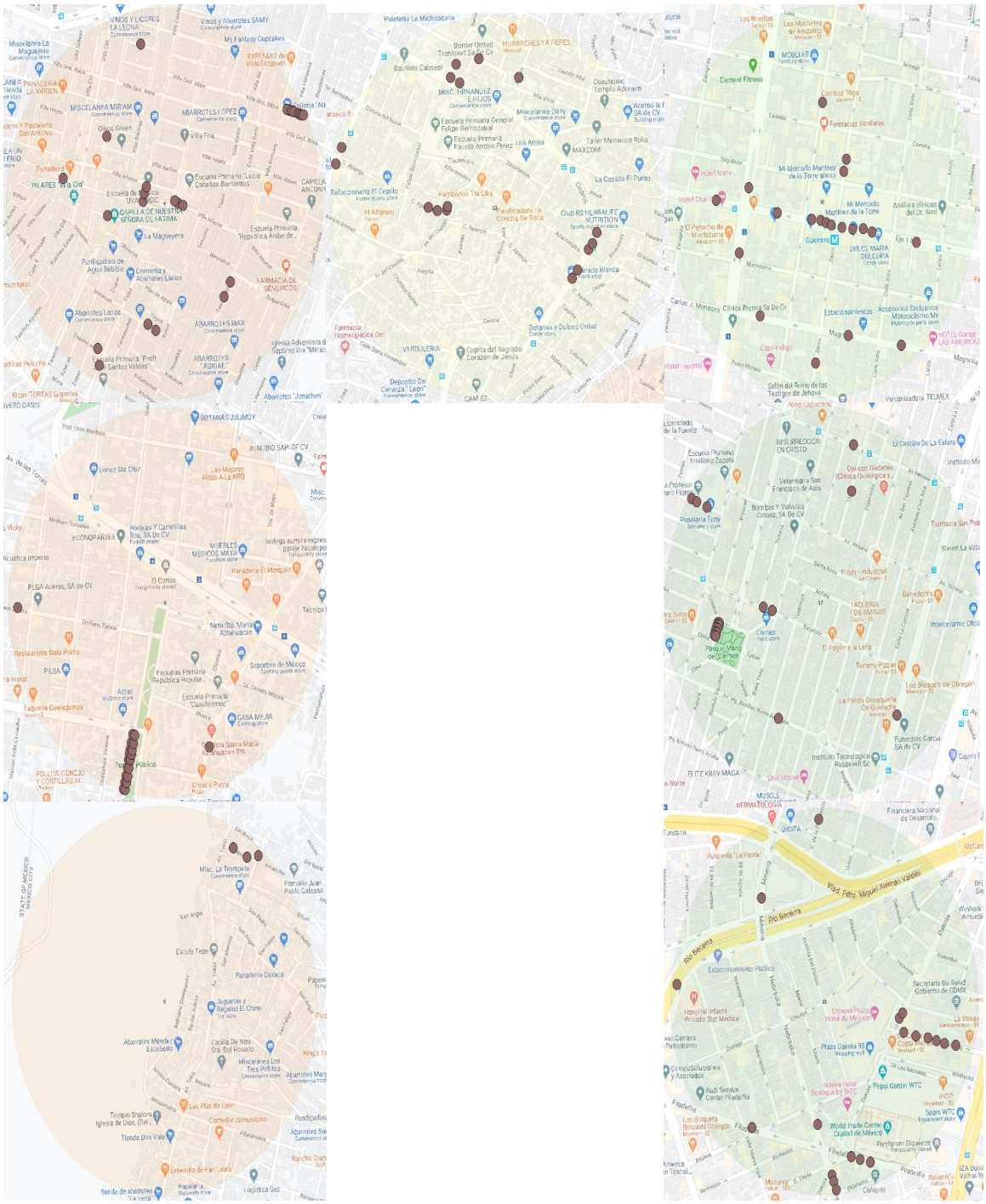
Conclusion

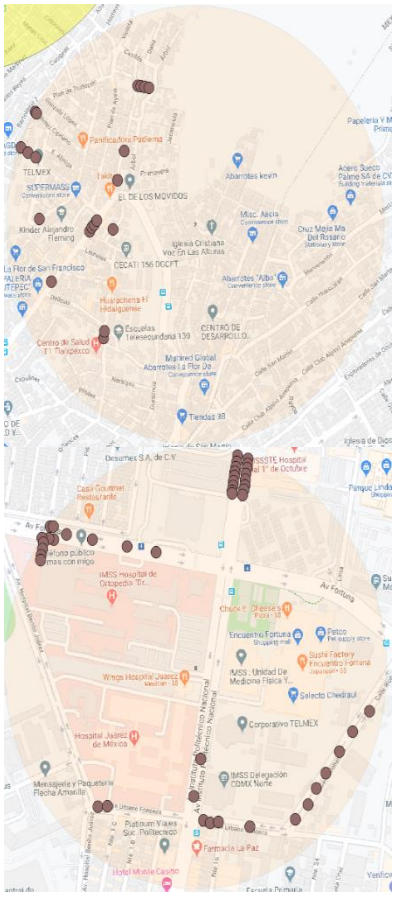
This study explored differences in the availability, density, and distribution of SFS across income groups in Mexico City. While SFS were found on low-income neighborhoods, there was a higher availability and density of SFS in middle- and high-income neighborhoods. These findings suggest that SFS are a source of food for people from different economic backgrounds. In addition, the high availability and density of cooked meal stands suggest that SFS may also be a source of healthy food. Future studies are needed to better understand the types of food and beverages sold at SFS and the nutritional value of these items.

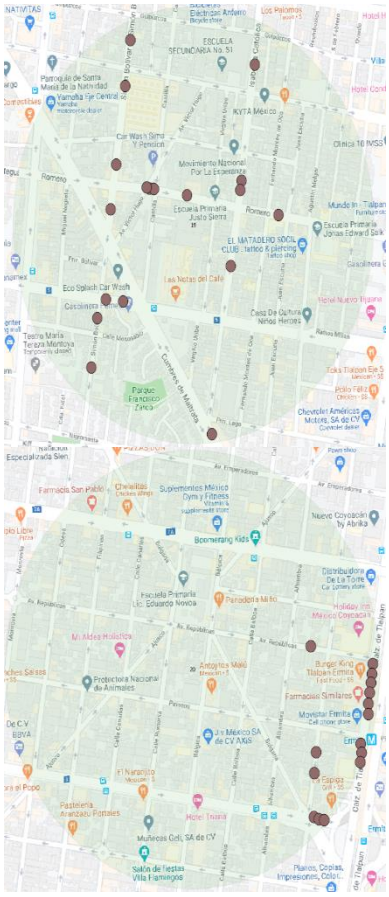
Figure 5.4 SFS Density Maps

Low-income Middle-income street High-income street









CHAPTER 6

AVAILABILITY, VARIETY, AND DISTRIBUTION OF HEALTHY AND UNHEALTHY FOODS AND BEVERAGES AT STREET FOOD STANDS IN MEXICO CITY

Abstract

Objective: To examine differences in the availability, variety, and distribution of foods and beverages sold at street food stands (SFS) across income groups in Mexico City.

Methods: A random sample of street segments (n=761) from twenty neighborhoods representing low, middle, and high-income neighborhoods in Mexico City were selected and randomly assigned to morning, afternoon, or evening assessment time periods. Researchers walked the selected street segments and recorded the type of foods and beverages available at SFS (n=391) on those segments using the validated Street Food Stand Assessment Tool. Chi-square tests of independence were performed to describe differences in food and beverage availability across income groups, and differences in food and beverage distribution by points of access located within 100-meters of SFS across neighborhoods. Analysis of Variance (ANOVA) were performed to assess differences in the means of food and beverage variety across the three income groups.

Results: The availability of healthy foods such as fruits/vegetables was high in middle- and high-income neighborhood whereas the availability of unhealthy foods such as processed snacks was higher in low-income neighborhoods. However, statistically

significant differences in food availability across neighborhoods were only observed for processed snack items (p<.01). Similarly, the variety of fruits/vegetables was high in middle- and high-income neighborhoods (p>.05) whereas the variety of processed snacks was higher in low-income neighborhoods (p>.01). No statistically significant differences across neighborhoods were observed for beverage availability and variety (p>.01). Street foods and beverages were most often distributed near homes, public transportation centers, and worksites, but no differences were observed across neighborhoods (p>.01). **Conclusions:** Findings suggest that SFS can be a source of both unhealthy foods and healthy foods for communities across neighborhoods in Mexico City. Additional studies are needed to assess the relationship between street food and beverage availability, and consumption.

Background

Street foods and street food stands (SFS) are an essential element of food environments and vital sources of food and employment for millions of families in low- and middle-income countries (LMIC), including Mexico (Arámbulo III et al., 1994; Bhowmik, 2005; Gelormini et al., 2015; Long-Solís, 2007; Nelia Patricia Steyn et al., 2014). Street foods are defined as ready-to-eat foods and beverages that vendors sell on the streets. Street-food vendors use a variety of mediums to cook, display, store, and transport food items: highly mobile stands such as bicycles and wheelbarrows; semi-mobile stands consisting of portable tables, chairs, and cooking ware; and stationary

stands, which may stay in one place overnight but can be easily moved to a different location (Bhowmik, 2005; Food and Agriculture Organization, 1989; World Health Organization, 1996). While most street foods are cooked on-site, some vendors prepare the food at home and transport it to key locations to sell it. Street food is popular due to its affordability and convenience (Acho-Chi, 2002; Bhowmik, 2005; Choi et al., 2013; Long-Solís, 2007; Tinker, 1999; Winarno & Allain, 1991), and individuals from all socio-economic backgrounds consume foods and beverages from SFS (Acho-Chi, 2002; Ag et al., 2000; Calloni, 2013; Gelormini et al., 2015; Winarno & Allain, 1991).

Even though SFS are an important food source, few studies have systematically documented SFS food and beverage availability and variety. In a recent review of 441 SFS studies from around the world, researchers reported that 85% of the studies focused on food safety, and only 31% (including several studies that also addressed food safety) discussed food availability (Abrahale et al., 2018). Only seven studies addressed aspects of SFS or the availability of street foods and beverages in Mexico (Hernandez Barrera et al., 2016; Langellier, 2015; Long-Solís, 2007; López-Barrón et al., 2015; Munoz de Chavez et al., 2000; Soltero et al., 2017; Taillie et al., 2017). Nonetheless, findings from previous studies in this area have shown that SFS can be a source of healthy items such as fruits, vegetables, and water but can also be a source of unhealthy ones, such as processed snacks, regular sodas, and other sugar-sweetened beverages (SSB).

Previous SFS studies have suffered from the following limitations: 1) using indirect or intermediate methods such as 24-hour dietary intake recall to measure usual

dietary intake rather than using direct observations (Langellier, 2015; Taillie et al., 2017); 2) not using validated assessment tools to objectively document food availability (Hernandez Barrera et al., 2016; Long-Solís, 2007; Munoz de Chavez et al., 2000); 3) employing an overly narrow scope in terms of points of access (e.g., studies focusing on the school food environment only rather than on the broader community food environment) (Hernandez Barrera et al., 2016; Soltero et al., 2017); and 4) not reporting how they chose their SFS sample, which would allow for determinations about whether a sample was representative of the broader SFS population, such that a study's findings could be generalized to this population (Long-Solís, 2007; López-Barrón et al., 2015). Moreover, none of the studies explored differences in food and beverage availability, variety, and distribution across points of access and neighborhoods using validated observational assessment methods. Not using validated objective assessment tools to capture food and beverage availability can result in misleading or biased results that under or over report food availability. Thus, a better understanding of the types of food and beverage items sold at SFS and the availability, variety, and distribution of these items across neighborhoods is needed.

Mexico has one of the highest rates of overweight and obesity in the world. Between 1999 and 2012, among children aged 5 to 11 years old, the prevalence of obesity increased from 28.2% to 36.9% and from 25.5% to 32.0% in boys and girls, respectively. Among adolescents over the same time period, the prevalence of overweight increased from 11.1% to 35.8% and from 33% to 34.1% in girls and boys, respectively

(Aceves-Martins et al., 2016; Bonvecchio et al., 2009). Currently, in Mexico, 70.6% of adult women and 69.4% of adult men are either overweight or obese (S. Barquera, I. Campos, & J. Rivera, 2013). This high prevalence of overweight and obesity in the Mexican population is a serious public health concern, as overweight and obese individuals are more likely to develop conditions such as diabetes and cardiovascular diseases (Daniels, 2006; Franks et al., 2010). Documenting the types of food and beverages sold at SFS is the first step toward understanding the role that street foods may play in these adverse health outcomes and food security.

Another notable gap in the street food literature is in the area of street food and beverage availability, variety, and distribution across neighborhoods. Studies assessing other types of food venues have shown that food availability varies with neighborhood income levels and that venues such as fast-food restaurants and convenience stores seem to target low-income, ethnic families (Fleischhacker et al., 2011; Forsyth et al., 2012; Sturm, 2008). Conversely, supermarkets and grocery stores are more likely to be found in high-income neighborhoods (Gloria & Steinhardt, 2010; Powell et al., 2007; Zenk et al., 2005). In Asian and African countries, SFS have been associated primarily with low-income communities (Calloni, 2013; Long-Solís, 2007), while several other studies have shown that customers from all backgrounds consume street food (Acho-Chi, 2002; Ag et al., 2000; Calloni, 2013; Gelormini et al., 2015; Winarno & Allain, 1991). Meanwhile, whether street food vendors in Mexico target customers from specific socioeconomic backgrounds is not well documented.

Studies have shown that the types of food venues present in a community largely influence people's access to and consumption of foods, the quality of people's diets, and their health (Drewnowski et al., 2012; Glanz et al., 2005; Jilcott et al., 2011; Larson et al., 2009; Liese et al., 2007; Moore et al., 2008; Pereira et al., 2005). For example, some studies have found associations between the presence of supermarkets and grocery stores and the availability of healthy food and beverage items (e.g., fruits, vegetables, and water) (Bodor et al., 2008; Rose & Richards, 2004; Sharkey, Johnson, et al., 2010). Similarly, other studies have found associations between the presence of fast-food restaurants and convenience stores and the availability of highly processed, unhealthy food and beverage items (e.g., processed snacks and foods, regular sodas, SSB) (Davis & Carpenter, 2009; Forsyth et al., 2012; Larson et al., 2009; Neumark-Sztainer et al., 2005). Notably, food items such as fruits and vegetables can prevent negative health outcomes including obesity, cardiovascular diseases, and some forms of cancer (G. Block et al., 1992; Mente, de Koning, Shannon, & Anand, 2009; Slavin & Lloyd, 2012). In contrast, food items such as fast foods, processed snacks, and regular sodas can increase the risks for negative health outcomes (Imamura et al., 2015; Malik et al., 2010; Mirmiran, Bahadoran, Delshad, & Azizi, 2014; Schulze et al., 2004). By documenting the types of food and beverage items sold at SFS, our study explores whether SFS are a source of healthy or unhealthy food items in a Mexican city.

Food venues and food availability vary according to points of access (e.g., schools, worksites, and other locations with high concentrations of target customers). For

example, some studies have found a higher prevalence of fast-food restaurants and convenience stores near schools (Davis & Carpenter, 2009; Day et al., 2015; Matsuzaki et al., 2020; Sturm, 2008). Unfortunately, children's access to these food venues has been linked to higher exposure to unhealthy foods and a greater risk for obesity (Day et al., 2015; Matsuzaki et al., 2020; Sturm, 2008). Two Mexican SFS studies addressed the subject of points of access, but these were limited to schools (Hernandez Barrera et al., 2016; Soltero et al., 2017). Meanwhile, the relationship between food availability and variety and other points of access (e.g., worksites and transportation centers) or target populations (e.g., low-income neighborhoods) has not yet been addressed.

Against this backdrop, the objectives of this study were as follows: 1) to document the types of foods and beverages sold at SFS; 2) to describe differences in food and beverage availability and variety across low-, middle-, and high-income neighborhoods; and 3) to describe differences in food and beverage availability across different points of access (e.g., schools, transportation centers, worksites, etc.) located within 100 m of an SFS. Our hypotheses were as follows: 1) there would be a higher availability of healthier food and beverage items (e.g., fruits/vegetables and water) in high-income neighborhoods and near locations such as worksites and transportation centers, which tend to have higher concentrations of adults; and 2) there would be a higher availability of unhealthy items (e.g., processed snack items and regular sodas) in low-income neighborhoods and near locations such as parks and schools, which tend to have higher concentrations of children.

Methods

Selection of SFS

A sample of SFS in Mexico City was selected for assessment. In Mexico City, we expected to find a diverse array of foods and beverages at SFS, representing the cuisine of various regions in Mexico. Given that many street food vendors do not register their business with the local government, it was not possible to use a business directory to draw the random sample of SFS. Therefore, we devised an innovative approach to identify SFS throughout the city, which involved recruiting SFS on particular street segments. To identify street segments for the assessment, we selected a random sample of census tracts representing five different marginalization levels throughout Mexico City: very high marginalization (i.e., very low-income), high (i.e., low-income), middle (i.e., middle-income), low (i.e., high-income), and very low (i.e., very high-income). The Mexican government defines marginalization levels using three domains: education, living arrangements, and income. Education is based on the proportion of people 15 years and older in an area who cannot read and by the percentage of people 15 years and older who did not finish elementary school in each locality (Consejo Nacional de Poblacion, 2019). The living arrangement domain is a composite of the number of households in an area with dirt floors and that lack running water, sewer systems, and electricity and by the average number of people per room. Income is defined by the number of individuals in an area who are employed in formal business (Consejo Nacional de Poblacion, 2019).

We selected a random sample of five census tracts per marginalization level; henceforth, we refer to marginalization levels as neighborhood income level in this paper. Once the census tracts were randomly selected, we used geographic information system methods to draw a circle (i.e., a buffer) with a 400 m radius around the center point of each tract. Previous literature has suggested that a buffer of this size is adequate to represent the food environment in a neighborhood, given that residents are willing to walk for approximately five minutes to reach a food source (Atash, 1994; Gordon et al., 2011). A buffer of this size can also capture various elements of the built environment, including homes, schools, transportation centers, worksites, and other locations used as points of access for SFS target populations. Next, we mapped the street segments within each census tract, selecting all arterial street segments for observation but only 25% of residential ones, as previous research has suggested that residential street segments tend to be quite homogenous. Thus, using 25% of the residential streets in a census tract can suffice to capture the street segments' overall characteristics (Griew et al., 2013; Lee et al., 2012; McMillan et al., 2010).

Data collection proceeded as follows. If a stand was not busy with customers, research assistants (RAs) would approach the vendor(s) to explain the study's objectives and to request permission to document the types of foods and beverages sold at the stand. SFS were excluded from assessments under the following conditions: 1) vendors were selling raw foods meant to be prepared at home; 2) stands had four permanent walls (e.g., kiosks); and 3) stands were an extension of a store, food inn (*fonda*), or restaurant. There

were no risks associated with participating in the study. However, some vendors seemed uncomfortable upon being approached and declined to participate in the study (n=81); they seemed to suspect the RAs of being government officials who had come to verify a city permit or conduct a health inspection. Thus, distrust was the main reason that some vendors refused participation. Given that the unit of the analyses was the stand and its merchandise, this study was deemed exempt under federal regulation 45 46. 101 (b) CFR and by Arizona State University's Institutional Review Board. The RAs collected most of the information through direct observation, with minimal contact with vendors. They gave vendors a small monetary incentive to encourage their participation but did not collect any vendor personal information. In this observational study, data were collected from May to August of 2018.

Measures

The data pertaining to the measures in this study were collected using the Street Food Stand Assessment Tool (SFSAT), which was previously validated as capturing SFS characteristics, street food vendors' points of access, and food and beverage availability and variety (Rosales Chavez et al., under review).

SFS Characteristics

Selected street segments were randomly assigned to one of three assessment times: morning, afternoon, or evening. Teams of RAs walked the full lengths of the street

segments moving first north to south and then south to north, east to west, and west to east, respectively, within each neighborhood, searching for SFS. Upon encountering an SFS, an RA would assign a unique identifier to the stand and mark its location on a paper map. Next, the RA would approach the stand and document its basic characteristics, including the stand's level of mobility (i.e., mobile, semi-mobile, or stationary); the stand's type (i.e., cooked meals, fruits/vegetables, snacks, or 'other'); the vendor's gender; the neighborhood income level; the street segment's type; and whether the SFS was a stand-alone business or part of a street market.

Neighborhood Income

The five neighborhood income levels were merged into three: the very high- and high-marginalization levels into the low neighborhood income level; the very low- and low-marginalization levels into the high neighborhood income level; while the middle neighborhood income level remained the same.

Food Availability and Variety Assessment

The SFSAT is an indicator tool that can be used to record the availability and variety of foods and beverages sold at SFS, in five food categories (fruit and vegetables, meat, dairy, cereals/grains, and snacks/candies) and five beverage categories (regular soda, diet soda, water, natural juice, and sugar-sweetened beverages including flavored water, coffee, processed juice, energy/sports beverages, and dairy beverages). The RAs

treated availability as a binary variable, recording ‘yes’ when a food or beverage item was present and ‘no’ when it was not. Variety was recorded as a continuous variable, defined as the available varieties or forms of the general food item. For example, if a stand sold both red and green apples, variety was documented as ‘2’ in the fruit variety category, regardless of the total number of apples at the stand.

Distribution Assessment

Distribution was measured as the presence of SFS within 100 m of a point of access and was recorded as a ‘yes’ or ‘no’ answer. The SFSAT contains a list of different types of venues that can serve as points of access for populations targeted by street food vendors. These fall into the following categories: a) homes, referring to places where individuals or families reside; b) sports centers, such as gyms and athletic fields; c) public transportation centers, where people can access buses, subways, or trains; d) food inns or *fondas*, referring to small family-owned restaurants (i.e., ‘mom and pop’ restaurants); e) schools, or places where people receive a formal education, such as elementary, middle, and high school and college; f) churches or places of worship; g) worksites, or places of employment; h) recreational areas, or open spaces where children can play (i.e., playgrounds); i) malls, or shopping centers; j) restaurants, referring to franchise fast-food restaurants and large sit-in restaurants. The RAs recorded all the various points of access within 100 m of the SFS; in other words, an SFS could be located near multiple points of

access or venues. For example, a cooked meal stand could be located near a home and a public transportation center as well as multiple worksites.

Statistical Analysis

The frequencies summarized food and beverage availability, SFS mobility levels, SFS types, vendor gender, and points of access within 100 m of the SFS. Chi-square tests of independence were performed to detect differences in food and beverage availability across neighborhoods and differences in availability by the types of venues located within 100 m of SFS across neighborhoods. Analyses of variance (ANOVA) were performed to assess differences in the means of food and beverage varieties across the three neighborhood income levels. An alpha level of .05 was used for all statistical tests and Bonferroni adjustments were performed to account for multiple comparisons. Statistical analyses were performed using Stata statistical software 15 (StataCorp, 2017).

Results

SFS Characteristics

The SFS characteristics by neighborhood income level are presented in Table 6.1. The research team assessed 391 (82.7%) of the 473 identified SFS, with some vendors not giving consent for the RAs to document food and beverage availability and variety at their stand. Almost half of vendors selling street food were men (49.4%). The SFS were more likely to be on residential street segments (51.3%) than on arterial ones (48.7%).

The highest percentage of SFS assessments (44.6%) took place during the afternoon observation time, followed by the morning (39.6%) and evening (15.8%) observation times. Most SFS were semi-mobile (54.0%). The most common type of SFS were cooked meal stands (38.1%), followed by snacks (29.8%) and fruits/vegetables (19.7%) stands. The numbers of SFS varied across neighborhoods. Middle-income neighborhoods had the highest number of SFS (41.9%), followed by high-income (31.2%) and low-income (26.9%) neighborhoods.

Street Food and Beverage Availability Across Neighborhood Income Levels

The differences in street food and beverage availability across neighborhood income levels are shown in Table 6.2. SFS in middle-income neighborhoods had the highest availability of fruits/vegetables, meat, dairy products, and cereals when compared to low- and high-income neighborhoods. There was a high availability of unhealthy food items such as processed snacks in low-income (34.3%) compared to middle- (32.8%) and high-income (32.8%) neighborhoods. However, statistically significant differences in food item availability across neighborhoods were only observed for dairy (X^2 (2, N=391) =7.68, p=.02) and processed snack items (X^2 (2, N=391)=8.44, p< .01).

The availability of water was high in high-income (44.1%) compared to low- (17.6%) and middle-income (38.2%) neighborhoods. The availability of unhealthy beverages such as regular sodas was high in middle-income (43.9%) compared to low- (19.6%) and high-income (36.4%) neighborhoods. A similar observation was made for

Table 6.1 SFS Characteristics (n=391)

SFS Characteristics (n=391)	Neighborhood Income level			
	Low (n=105)	Middle (n=164)	High (n=122)	Number of SFS
	n (%)	n (%)	n (%)	n (%)
Segment publicly accessible				
Yes	105 (78.4)	164 (89.6)	122 (78.2)	391 (82.7)
No	29 (21.6)	19 (10.4)	34 (21.8)	82 (17.3)
Type of street segment				
Residential	70 (68.0)	86 (52.4)	43 (35.5)	199 (51.3)
Arterial	33 (32.0)	78 (47.6)	78 (64.5)	189 (48.7)
(missing)[a]	2 (1.90)		1 (1.00)	3 (0.01)
Observation time				
Morning	48 (45.7)	56 (34.6)	49 (41.2)	153 (39.6)
Afternoon	48 (45.7)	82 (50.6)	42 (35.3)	172 (44.6)
Evening	9 (8.57)	24 (14.8)	28 (23.5)	61 (15.8)
(missing)[a]		2 (1.22)	3 (2.46)	5 (0.01)
Street food stand categories				
Cooked meals	32 (30.5)	68 (41.5)	49 (40.2)	149 (38.1)
Snacks	40 (38.1)	41 (25.0)	35 (28.7)	116 (29.8)
Fruits/vegetables	24 (22.9)	29 (17.7)	24 (19.7)	77 (19.7)
Other	9 (8.57)	26 (15.8)	14 (11.5)	49 (12.5)
SFS mobility				
Mobile	34 (32.4)	56 (34.1)	27 (22.1)	117 (29.9)
Semi-mobile	63 (60.0)	85 (51.8)	63 (51.6)	211 (54.0)
Stationary	8 (7.62)	23 (14.0)	32 (26.2)	63 (16.1)
Vendor present at SFS				
Male	49 (46.7)	84 (51.2)	60 (49.2)	193 (49.4)
Female	44 (41.9)	60 (36.6)	46 (37.7)	150 (38.4)
Both	12 (11.4)	20 (12.2)	16 (13.1)	48 (12.3)
Street segments not assessed (n=81)				
Observation time				
Morning	21 (72.4)	13 (72.2)	17 (50.0)	51 (63.0)
Afternoon	5 (17.2)	5 (27.8)	10 (29.4)	20 (24.7)
Evening	3 (10.3)	0 (0.00)	7 (20.6)	10 (12.3)

Note: The percent distribution is based on the observed (non-missing) values, and the percent missing is based on the total number of observations.

SSBs, with a high availability of these beverages in middle-income (38.9%) compared to low- (23.3%) and high-income (37.8%) neighborhoods. The availability of a healthier soda option such as diet soda was high in high-income (50.0%) compared to low- (25.0%) and middle-income (25.0%) neighborhoods. There were no statistically significant differences in beverage availability across neighborhoods.

Street Food and Beverage Variety Across Neighborhood Income Levels

The food and beverage variety and differences across neighborhoods are presented in Table 6.3. Fruit/vegetable variety was high in high-income neighborhoods (M=5.25, SD=0.47) compared to both low- (M=4.61, SD=0.51) and middle-income (M=5.01, SD=0.41, p>.05) neighborhoods. Similarly, processed snack variety differed across neighborhoods: in low-income neighborhoods, SFS had a higher variety of processed snacks (M=10.8, SD=1.84) compared to middle- (M=4.91, SD=1.47) and high-income neighborhoods (M=9.05, SD=1.70; F (2,388)=3.55, p=.03).

Water variety (e.g., brand variety) was high in high-income neighborhoods (M=0.33, SD=0.08) compared to low- (M=0.18, SD=0.09) and middle-income neighborhoods (M=0.24, SD=0.07). This finding suggests that customers in high-income neighborhoods may have more beverage options than those in low- and middle-income neighborhoods. The regular soda variety was also high in high-income neighborhoods

Table 6.2 Differences in Food and Beverage Availability at SFS (n=391) Across Neighborhood Income Levels

	Neighborhood Income Levels				
Type of Food or Beverage	**Low (n = 105)**	**Middle (n = 164)**	**High (n = 122)**	**X^2 (df)**	**p-value**
	n (%)				
Fruits/Vegetables (n=233)	54 (23.2)	105 (45.0)	74 (31.8)	4.3 (2)	.11
Meat (n = 141)	30 (21.3)	65 (46.1)	46 (32.6)	3.6 (2)	.16
Dairy (n = 102)	18 (17.6)	53 (52.0)	31 (30.4)	7.68 (2)	.02[a]
Cereal (n = 126)	30 (23.8)	53 (42.1)	43 (34.1)	1.15 (2)	.56
Processed snacks (n = 134)	46 (34.3)	44 (32.8)	44 (32.8)	8.44 (2)	.01[a]
Regular Soda (n = 107)	21 (19.6)	47 (43.9)	39 (36.4)	4.3 (2)	.11
Diet Soda (n = 8)	2 (25.0)	2 (25.0)	4 (50.0)	1.49 (2)	.47
Water (n = 34)	6 (17.6)	13 (38.2)	15 (44.1)	3.28 (2)	.19
SSB (n = 90)	21 (23.3)	35 (38.9)	34 (37.8)	2.42 (2)	.29

Note*:* SSB = sugar-sweetened beverages. a= higher availability in middle- than in low-income neighborhoods.

Table 6.3 Differences in Food and Beverage Variety in SFS (n=391) Across Mexico City

	Neighborhood Income Levels			
Food and Beverage Items	**Low (n= 105)**	**Middle (n= 164)**	**High (n= 122)**	**ANOVA**
	Mean (SD)			**p-value**
Fruits/Vegetables	4.61 (0.51)	5.01 (0.41)	5.25 (0.47)	.65
Meat	1.28 (0.28)	2.04 (0.23)	1.91 (0.26)	.10
Cereal	1.08 (0.23)	0.35 (0.19)	1.06 (0.22)	.02[ab]
Dairy	0.53 (0.12)	0.80 (0.10)	0.70 (0.11)	.23
Processed snacks	10.8 (1.84)	4.91 (1.47)	9.05 (1.70)	.03[a]
SSB	1.44 (0.30)	0.66 (0.66)	1.61 (0.28)	.30
Regular soda	1.07 (0.26)	1.29 (0.20)	1.71 (0.24)	.16
Water	0.18 (0.09)	0.24 (0.07)	0.33 (0.08)	.46
Diet soda	0.04 (0.03)	0.04 (0.02)	0.08 (0.03)	.48

Note: SSB = sugar-sweetened beverages. a= higher variety in middle- than in low-income neighborhoods. b= higher variety in middle- than in high-income neighborhoods.

(*M*= 1.71, *SD*=0.24) compared to low- (*M*=1.07, *SD*=0.26) and middle-income neighborhoods (*M*=1.29, *SD*=0.20, *p*>.01).

Street Food and Beverage Distribution Near Points of Access

The distribution of foods and beverages varied across points of access and neighborhood income levels, but these differences were not always statistically significant. Among all points of access, homes, transportation centers, and worksites

were the three venues that were consistently reported (at >10%) within 100 m of SFS (Table 6.4). SFS selling fruits/vegetables were more often found near homes (47.6%) and transportation centers (48.2%) in middle-income neighborhoods and near schools (50.0%) and parks (44.1%) in low-income neighborhoods, but these differences were not statistically significant (p>.01). In comparison, SFS selling processed snacks were more often found near homes (36.2%) and transportation centers (37.2%) in middle-income neighborhoods and near schools (54.3%) and parks (43.5%) in low-income neighborhoods (p>.01), but again, these differences were not statistically significant. The distribution of meat items near food inns was higher in high-income neighborhoods (42.5%) than in middle-income (27.5%) (X^2 (2, N = 40) = 11.5, p=.003). The distribution of dairy items near transportation centers was higher in middle-income (56.9%) than in low-income (20.0%) neighborhoods (X^2 (2, N = 65) = 7.37, p=.02). The distribution of cereal items was higher near worksites in high-income (61.4%) than in both low- (15.9%) and middle-income (22.7%) neighborhoods (X^2 (2, N = 44) = 12.3, p=.002).

The distribution of water across points of access and neighborhood income levels was limited (Table 6.5). SFS selling water were often found near homes (46.4%), transportation centers (45.0%), and schools (66.7%) in middle-income neighborhoods, but these differences were not statistically significant (p>.01). Regular sodas had a high distribution across neighborhoods, and points of access compared to other types

Table 6.4 Distribution of Street Food Found at SFS (n=391) Across Neighborhood Income Levels and Points of Access in Mexico City

		Neighborhood Income Levels				
Type of Food Item	**Point of Access**	**Low**	**Middle**	**High**	**X^2 (df)**	**p-value**
Fruits & Vegetables						
	Homes (n=210)	45 (21.4)	100 (47.6)	65 (31.0)	3.92 (2)	.14
	Sports facilities (n=26)	2 (7.69)	11 (42.3)	13 (50.0)	4.14 (2)	.12
	Transportation centres (n=139)	38 (27.3)	67 (48.2)	34 (24.5)	3.30 (2)	.19
	Food inns (n=69)	19 (27.5)	28 (40.6)	22 (31.9)	1.99 (2)	.36
	Schools (n=52)	26 (50.0)	11 (21.1)	15 (28.8)	4.12 (2)	.12
	Churches (n=40)	12 (30.0)	19 (47.5)	9 (22.5)	0.04 (2)	.97
	Worksites (n=82)	13 (15.8)	33 (40.2)	36 (43.9)	1.62 (2)	.44
	Parks (n=34)	15 (44.1)	10 (29.4)	9 (26.5)	1.37 (2)	.50
	Malls (n=24)	0 (0.00)	22 (91.7)	2 (8.33)	-	-
	Restaurants (n=31)	0 (0.00)	13 (41.9)	18 (58.1)	-	-
Snacks						
	Homes (n=166)	35 (30.2)	42 (36.2)	39 (33.6)	4.81 (2)	.09
	Sports facilities (n=10)	3 (30.0)	2 (20.0)	5 (50.0)	4.23 (2)	.12
	Transportation centers (n=78)	29 (37.2)	29 (37.2)	20 (25.6)	2.53 (2)	.28
	Food inns (n=34)	12 (35.3)	15 (44.1)	7 (20.6)	1.14 (2)	.56
	Schools (n=35)	19 (54.3)	8 (22.9)	8 (22.7)	0.15 (2)	.92
	Churches (n=28)	10 (35.7)	14 (50.0)	4 (14.3)	1.85 (2)	.39
	Worksites (n=43)	10 (23.4)	16 (37.2)	17 (39.5)	0.82 (2)	.66
	Parks (n=23)	10 (43.5)	5 (21.7)	8 (34.8)	1.92 (2)	.38
	Malls (n=12)	0 (0.00)	10 (83.3)	2 (16.7)	-	-
	Restaurants (n=21)	0 (0.00)	8 (38.1)	13 (61.9)	-	-
Meat						
	Homes (n=130)	26 (20.0)	61 (46.9)	43 (33.1)	2.67 (2)	.26
	Sports facilities (n=20)	1 (5.00)	9 (45.0)	10 (50.0)	3.48 (2)	.17

	Transportation centers (n=83)	20 (24.1)	40 (48.2)	23 (27.7)	3.02 (2)	.22
	Food inns (n=40)	12 (30.0)	11 (27.5)	17 (42.5)	8.44 (2)	.01[c]
	Schools (n=27)	14 (51.8)	5 (18.5)	8 (29.6)	1.83 (2)	.39
	Churches (n=19)	7 (36.8)	9 (47.4)	3 (15.8)	0.81 (2)	.66
	Worksites (n=51)	8 (15.7)	18 (35.3)	25 (49.0)	2.32 (2)	.31
	Parks (n=22)	9 (40.9)	6 (27.3)	7 (31.8)	0.46 (2)	.79
	Malls (n=13)	0 (0.00)	12 (92.3)	1 (7.7)	-	-
	Restaurants (n=16)	0 (0.00)	6 (37.5)	10 (62.5)	-	-
Dairy						
	Homes (n=92)	16 (17.4)	48 (52.2)	28 (30.4)	4.63 (2)	.09
	Sports facilities (n=11)	0 (0.00)	7 (63.6)	4 (36.4)	-	-
	Transportation centers (n=65)	13 (20.0)	37 (56.9)	15 (23.1)	7.37 (2)	.02[a]
	Food inns (n=32)	8 (25.0)	13 (40.6)	11 (34.4)	1.32 (2)	.51
	Schools (n=24)	10 (41.7)	7 (29.2)	7 (29.2)	1.95 (2)	.37
	Churches (n=17)	5 (29.4)	10 (58.8)	2 (11.8)	1.9 (2)	.38
	Worksites (n=43)	7 (16.3)	18 (41.9)	18 (41.9)	0.29 (2)	.86
	Parks (n=13)	6 (46.1)	5 (38.5)	2 (15.4)	1.63 (2)	.44
	Malls (n=11)	0 (0.00)	11 (100)	0 (0.00)	-	-
	Restaurants (n=12)	0 (0.00)	6 (50.0)	6 (50.0)	-	-
Cereal						
	Homes (n=117)	26 (22.2)	52 (44.4)	39 (33.3)	0.85 (2)	.65
	Sports facilities (n=14)	0 (0.00)	5 (35.7)	9 (64.3)	-	-
	Transportation centers (n=73)	20 (27.4)	30 (41.1)	23 (31.5)	2.39 (2)	.30
	Food inns (n=33)	10 (30.3)	6 (18.2)	17 (51.5)	16.4 (2)	<.001[bc]
	Schools (n=88)	14 (56.0)	2 (8.00)	9 (36.0)	7.43 (2)	.02[c]
	Churches (n=17)	5 (29.4)	9 (52.9)	3 (17.6)	0.45 (2)	.79
	Worksites (n=44)	7 (15.9)	10 (22.7)	27 (61.4)	12.3 (2)	.002[bc]
	Parks (n=18)	7 (38.9)	6 (33.3)	5 (27.8)	0.06 (2)	.97
	Malls (n=10)	0 (0.00)	9 (90.0)	1 (10.0)	-	-
	Restaurants (n=11)	0 (0.00)	2 (18.2)	9 (81.8)	-	-

Note*:* - = calculation not performed due to small sample size. a= higher distribution in middle- than in low-income neighborhoods. b= higher distribution in high- than in low-income neighborhoods. c= higher distribution in high- than in middle-income neighborhoods.

of beverages. SFS selling regular sodas were often found near homes (46.9%) and transportation centers (47.4%) in middle-income neighborhoods, near schools (44.4%) in low-income neighborhoods, and near parks (50.0%) in the high-income neighborhood, but these differences were not statistically significant ($p>.01$).

Discussion

The purpose of this study was to document the availability, variety, and distribution of SFS food and beverage items in Mexico City and to explore differences in these variables across neighborhood income levels. The availability and variety of processed snacks were higher in low-income neighborhoods, while the availability and variety of water and diet soda was high in high-income neighborhoods. Fruit/vegetable and regular soda availability was high in middle-income neighborhoods, but varieties of both fruit/vegetable and regular sodas were high in high-income neighborhoods. Homes, transportation centers, and worksites were the most common points of access near street foods and beverages, but the types of foods found near points of access varied across neighborhoods. For example, processed snacks were more often found near worksites in high-income neighborhoods, but they were found near transportation centers in middle-income and near schools in low-income neighborhoods. These findings are partially in line with our initial hypothesis.

We hypothesized that SFS in low-income neighborhoods would have a higher availability of unhealthy items such as processed snacks and regular sodas, and we found

that this was indeed the case for processed snacks. We also predicted that the availability of healthy items such as fruits/vegetables and water would be high among SFS in high-income neighborhoods, and we found that this was indeed the case for water. This study is the first to document SFS food and beverage availability across neighborhood income levels in a Mexican city using a validated assessment tool. Future research is needed to confirm this study's results.

The high availability of unhealthy food items such as processed snacks in SFS in low-income neighborhoods presents a serious concern for public health practitioners. The consumption of processed snacks (which often have a high content of fat, salt, and sugar) is associated with negative health outcomes such as obesity, diabetes, and some types of cancer (Bostick et al., 1994; Lucan et al., 2010; Mirmiran et al., 2014; Sallis & Glanz, 2006). In addition, low-income communities are vulnerable populations that may not have access to healthy food items via other venues, such as supermarkets. However, we found it encouraging that when the availability of all food categories was considered within neighborhood income level rather than across, fruits/vegetables had the highest availability in all three neighborhood income levels compared to any other food or beverage items, including processed snacks. This finding regarding the high availability of healthy food items is in line with previous SFS studies suggesting that street foods can be an important source of calories and nutrients for vulnerable populations, such as

Table 6.5 Distribution of Street Beverages Found at SFS (n=391) Across Income Levels and Points of Access in Mexico City

		Neighborhood Income Levels				
Type of Beverage Item	**Point of Access**	**Low**	**Middle**	**High**	**X^2 (df)**	**p-value**
Regular Soda						
	Homes (n=96)	16 (16.7)	45 (46.9)	35 (36.5)	5.15 (2)	.07
	Sport facilities (n=12)	0 (0.00)	6 (50.0)	6 (50.0)	2.98 (2)	.22
	Transportation centers (n=57)	12 (21.0)	27 (47.4)	18 (31.6)	3.97 (2)	.13
	Food inns (n=23)	8 (34.8)	7 (30.4)	8 (34.8)	1.75 (2)	.41
	Schools (n=18)	8 (44.4)	5 (27.8)	5 (27.8)	0.81 (2)	.66
	Churches (n 15)	6 (40.0)	8 (53.3)	1 (6.7)	2.81 (2)	.24
	Worksites (n=43)	7 (16.3)	17 (39.5)	19 (44.2)	0.40 (2)	.81
	Parks (n=18)	5 (27.8)	4 (22.2)	9 (50.0)	4.63 (2)	.09
	Malls (n=12)	0 (0.00)	11 (91.7)	1 (8.33)	0.14 (2)	.70
	Restaurants (n=18)	0 (0.00)	5 (27.8)	13 (72.2)	1.87 (2)	.17
Diet Soda						
	Homes (n=6)	2 (33.3)	2 (33.3)	2 (33.3)	0.34 (2)	.84
	Sports facilities (n=0)	0 (0.00)	0 (0.00)	0 (0.00)	- -	- -
	Transportation centers (n=5)	1 (20.0)	1 (20.0)	3 (60.0)	3.34 (2)	.18
	Food inns (n=3)	1 (33.3)	2 (66.7)	0 (0.00)	1.27 (2)	.53
	Schools (n=1)	1 (100)	0 (0.00)	0 (0.00)	-	-
	Churches (n=1)	0 (0.00)	1 (100)	0 (0.00)	-	-
	Worksites (n=6)	1 (16.7)	1 (16.7)	4 (66.7)	1.89 (2)	.38
	Parks (n=3)	0 (0.00)	0 (0.00)	3 (100)	-	-
	Malls (n=1)	0 (0.00)	0 (0.00)	1 (100)	-	-
	Restaurants (n=6)	0 (0.00)	2 (33.3)	4 (66.7)	0.15 (2)	.69
Water						
	Homes (n=28)	3 (10.7)	13 (46.4)	12 (42.9)	3.91 (2)	.14

	Sports facilities (n=3)	0 (0.00)	2 (66.7)	1 (33.3)	0.75 (2)	.68
	Transportation centers (n=20)	3 (15.0)	9 (45.0)	8 (40.0)	3.77 (2)	.15
	Food inns (n=7)	0 (0.00)	5 (71.4)	2 (28.6)	3.75 (2)	.15
	Schools (n=3)	0 (0.00)	2 (66.7)	1 (33.3)	4.01 (2)	.13
	Churches (n=4)	0 (0.00)	4 (100)	0 (0.00)	-	-
	Worksites (n=12)	0 (0.00)	6 (50.0)	6 (50.0)	3.08 (2)	.21
	Parks (n=5)	0 (0.00)	1 (20.0)	4 (80.0)	6.75 (2)	.03
	Malls (n=4)	0 (0.00)	3 (75.0)	1 (25.0)	0.87 (2)	.34
	Restaurants (n=13)	0 (0.00)	5 (38.5)	8 (61.5)	0.03 (2)	.84
SSB[1]						
	Homes (n=84)	20 (23.8)	33 (39.3)	31 (36.9)	1.95 (2)	.37
	Sports facilities (n=14)	1 (7.14)	6 (42.9)	7 (50.0)	1.63 (2)	.44
	Transportation centers (n=54)	13 (24.1)	23 (42.6)	18 (33.3)	3.05 (2)	.21
	Food inns (n=27)	7 (25.9)	8 (29.6)	12 (44.4)	5.45 (2)	.06
	Schools (n=18)	10 (55.6)	2 (11.1)	6 (33.3)	3.21 (2)	.20
	Churches (n=9)	4 (44.4)	4 (44.4)	1 (11.1)	1.20 (2)	.54
	Worksites (n=34)	4 (11.8)	12 (35.3)	18 (52.9)	3.15 (2)	.20
	Parks (n=15)	4 (26.7)	3 (20.0)	8 (53.3)	4.98 (2)	.08
	Malls (n=9)	0 (0.00)	7 (77.8)	2 (22.2)	1.50 (2)	.22
	Restaurants (n=20)	0 (0.00)	5 (25.0)	15 (75.0)	3.25 (2)	.07

Note SSB[1] = Sugar-sweetened beverages. - = calculation not performed due to small sample size.

residents of low-income communities (Blair, 1999; Food and Agriculture Organization, 2018; Korir, Imungi, & Muroki, 1998; Nelia Patricia Steyn et al., 2014; Sujatha et al., 1997; Winarno & Allain, 1991). While our findings suggest that SFS can indeed be a source of healthy food items, such as fruits/vegetables, we do not know which customers vendors were targeting with these items or who ultimately purchased and consumed these items. Furthermore, the preparation and cooking methods of street foods should be

examined to understand the full nutritional value of the street foods and how different preparation methods might improve the healthiness of the food.

Surprisingly, our findings suggest that low-income neighborhoods have little availability of unhealthy beverages, such as regular sodas. The low availability of regular sodas in low-income neighborhoods could be associated with efforts by the Mexican government to curb consumption of these beverages. In 2014 the Mexican federal government passed the added sugar tax. Following these efforts, the most significant decreases in purchases of regular sodas have been observed in low-income communities(Colchero, Rivera-Dommarco, Popkin, & Ng, 2017). Possibly, the higher cost of the products with added sugar (such as regular sodas) has reduced the demand for them, and this has led to lower availability of regular soda at SFS in low-income neighborhoods. More research is needed to confirm these findings.

In terms of differences in food and beverage varieties, our findings showed that the variety of processed snacks was high. This is concerning, as processed snacks have been associated with negative health outcomes (Bostick et al., 1994; Poti, Braga, & Qin, 2017; Sallis & Glanz, 2006; Ward & López-Carrillo, 1999). Furthermore, some research has suggested that food intake increases as food variety increases (B. E. Kahn & Wansink, 2004; Rolls et al., 1981). Thus, a high variety of unhealthy foods may lead to higher consumption of those foods. Many of the snacks observed by the RAs were small items such as bubble gum and pieces of hard candy, which would not contribute substantial calories to an individual's diet. However, from a public health perspective, the

variety of processed snacks should be reduced and that of healthy foods expanded, particularly since the consumption of healthy foods such as fruits/vegetables can be protective against negative health outcomes (T. Ledoux, Hingle, & Baranowski, 2011; Mente et al., 2009; Slavin & Lloyd, 2012; Ward & López-Carrillo, 1999). Further studies are needed to assess the relationships between food variety, food consumption, and individual eating behaviors to determine whether a high variety of healthy food items at SFS leads to more frequent purchases and higher consumption of those items.

This study's findings regarding the distribution of SFS near specific locations are in line with those from an ethnographic study of SFS in Mexico (Long-Solís, 2007). Our study, however, is the first to report the distribution of street foods and beverages across neighborhood income levels. The observed differences in distribution across neighborhoods depended on the types of food and beverage items. However, we did see similar patterns in the distribution of fruits/vegetables, processed snacks, and regular sodas: these foods were frequently found near schools in low-income neighborhoods; near homes and transportation centers in middle-income neighborhoods; and near worksites in high-income neighborhoods. The distribution of unhealthy and healthy foods in the same location is, again, concerning. This is because when both healthy and unhealthy foods were available at the same location, people were more likely to consume unhealthy foods (Rosales Chavez et al., 2020). Future studies on street food and beverage consumption could help guide nutrition interventions and shape the distribution of foods in Mexican communities. It would be important to identify and remove barriers that may

be limiting the availability of or access to healthy foods and to implement strategies to discourage unhealthy food availability and consumption. Recently, two Mexican states banned the sale of processed snacks, sodas, and other unhealthy foods to anyone under the age of 18, akin to laws banning the sale of alcohol to minors (Agren, 2020; Reiley, 2020). It remains to be seen whether this strategy will help to reduce the distribution of unhealthy foods. Alternatively, the versatility and informal nature of street food vending could mean that the SFS continue to provide minors with access to the unhealthy foods even when regulated businesses (e.g., supermarkets, convenience stores) can no longer sell these products to minors.

Strengths and Limitations

This study has several notable strengths. It is the first study to employ a randomized approach and a validated assessment tool to document the availability and variety of street foods and beverages across neighborhood income levels in a Mexican city. The study methods made it possible to assess a representative sample of SFS and to objectively document the types of foods and beverages being sold there. Previous SFS studies have relied on indirect or intermediate approaches such as interviews and dietary intake recall (Langellier, 2015; Taillie et al., 2017), allowing researchers to draw inferences about food and beverage availability, variety, and distribution. However, direct observations are preferable, as they can reduce the discrepancies from recall errors or biased responses and thus, would be expected to produce more accurate descriptions of

SFS food and beverage availability. An additional strength of this study is its assessment of different points of access to document the distribution of street foods and beverages. An advantage of including multiple points of access in the assessments is that it shed light on which populations the street food vendors may have been targeting. Other studies have described the distribution of street foods and beverages, but those studies have not compared distribution across neighborhood income levels, or they have focused on only one point of access (Hernandez Barrera et al., 2016; Long-Solís, 2007; Soltero et al., 2017). For example, several studies documented the distribution of SFS near schools, and the results of these studies can only be generalized to the immediate vicinity of schools. In contrast, the results of our study can be generalized to a broader population.

At the same time, this study's limitations must be considered when interpreting its findings. This was an exploratory study; therefore, the power and direction of the relationships between SFS availability, food and beverage availability and variety, and neighborhood income levels were not established. This study was also seasonal. As such, it captured only a snapshot of food and beverage availability, variety, and distribution across time. It is possible that food and beverage availability and variety fluctuate throughout the year. For example, this study conducted SFS assessments from May to August 2018, which would have been the summer break for many school-aged children. Consequently, the distribution of SFS near schools may have been different during this time compared to when school was in session. A further limitation is that there were some highly mobile street food vendors that we could not include in this study. For

example, some vendors were selling food in the middle of the road, right through traffic, and we were unable to assess these stands for safety reasons. This may have led to underreporting some types of food/beverage items.

Conclusion

Documenting the availability, variety, and distribution of foods and beverages sold at SFS can give stakeholders such as health practitioners, policymakers, and urban planners beneficial information to develop strategies for creating healthy food environments. The findings from this study suggest that SFS can be a source of both healthy and unhealthy foods and beverages. Future studies could explore whether SFS, with their versatility and mobility, could target needy areas and deliver healthy food items to populations in need of them.

CHAPTER 7

DISCUSSION AND CONCLUSION

Summary of Findings

The objective of this dissertation was to address the following gaps in the food environment literature: (1) lack of a validated assessment tool that can document food and beverage availability and variety at SFS; (2) limited knowledge on the density and distribution of SFS across points of access and neighborhood income levels; and (3) limited knowledge of food and beverage availability, variety, and distribution across points of access and neighborhood income levels in Mexico City. The Street Food Stand Assessment Tool (SFSAT) successfully captured SFS characteristics including type, availability density, and distribution of SFS, and availability, variety, and distribution of street foods and beverages. Results showed that SFS can be found in all neighborhoods and near different points of access where street food vendors sell their products to children and working adults. Contrary to our initial hypothesis, most SFS were found in middle-income neighborhoods. While the availability of street foods and beverages was high in middle-income neighborhoods, the variety was less consistent. For example, fruit/vegetable variety was high in high-income neighborhoods whereas the processed snack variety was high in low-income neighborhoods. Homes, transportation centers, and worksites were points of access were street foods and beverages were more often found across the three neighborhood income levels.

We found the SFSAT to be a valid tool to assess SFS. Before this project, there were no assessment tools that had been developed, tested, and validated to measure food availability and variety at SFS (Glanz, 2009; Gustafson et al., 2012; Kelly et al., 2011; Lytle, 2009; McKinnon et al., 2009; Ohri-Vachaspati & Leviton, 2010). Previous work in the Mexican food environment context had used indirect or intermediate methods such as interviews or dietary recalls to document food availability at SFS (Langellier, 2015; Taillie et al., 2017). Although some of those methods have been validated, tools like dietary recalls measure dietary intake rather than food availability. Thus, an assessment tool that relied on direct observations and that objectively recorded food and beverage availability at SFS was needed. The newly developed SFSAT can fill this gap. Researchers, health experts, and policymakers can use the SFSAT to study the role that SFS play in the food environment. These types of assessments are the first step in a larger picture: understanding the relationships among food availability, food intake, and health outcomes.

Our findings show that low-income neighborhoods had the least availability of SFS which contrasts with previous studies (Bendech et al., 1998; Hernandez Barrera et al., 2016; Long-Solís, 2007; Namugumya & Muyanja, 2012; C. Oguntona & Tella, 1999; Sujatha et al., 1997). However, it is important to note that the availability of SFS, or the lack of them, in a community does not necessarily indicate that residents in that community are purchasing and consuming street food. It may be the case that SFS vendors set up their stands near points of access in middle- and high-income

neighborhoods that attract commuters and working adults from different backgrounds. For example, most low-income neighborhoods assessed in the study were in the periphery of the city, whereas worksites were in middle- and high-income neighborhoods closer to the center of the city. Many low-income residents may have to commute to work outside their neighborhoods daily. Our results showed that SFS were more often found near transportation centers and worksites. SFS may be serving commuters from low-income neighborhoods in middle- and high-income neighborhoods as they travel from home to work. However, data on customers' background were not collected in this study. Collecting customer data and the distance consumers travel to eat at SFS will be an important area of future study to understand what populations may benefit from SFS in Mexico City.

Regarding street food and beverage availability, the results found that the number of SFS selling healthy foods such as fruits/vegetables was high compared to the number of SFS selling unhealthy foods such as processed snacks. Furthermore, while the variety of processed snacks was higher compared to fruits/vegetables variety, the processed snacks category included many varieties of small items such as bubble gum and hard candy. From a health promotion perspective, those types of food items do not add many calories to a person's daily intake. Thus, the findings in this study suggest that SFS can be a source of healthy foods in Mexico City. Similar conclusions were found in other countries where SFS were available. For example, several studies found that street foods were a key source of essential nutrients and minerals for customers (Blair, 1999; Food

and Agriculture Organization, 2018; Korir et al., 1998; Nelia Patricia Steyn et al., 2014; Sujatha et al., 1997; Winarno & Allain, 1991). Other researchers argued that street foods could be fortified to increase the nutritional value of these foods (Becquey & Martin-Prevel, 2010; Draper, 1996), thus making SFS a potential source of nutrition interventions that could benefit people in need, especially low-income communities that may not have access to other food sources.

Results from this study showed that the variety of processed snacks was high compared to the variety of fruits/vegetables. Having a larger variety of processed snacks is concerning because a higher variety of a food product has been associated with a higher consumption of that product (B. E. Kahn & Wansink, 2004; Rolls et al., 1981), and in the case of processed snacks a higher consumption can result in adverse health conditions such as obesity and some types of cancer, (Bostick et al., 1994; Poti et al., 2017; Sallis & Glanz, 2006; Ward & López-Carrillo, 1999). Researchers and nutrition experts must work with policymakers to address the high variety of processed snacks, soda, and other-sugar sweetened beverages sold at SFS. Policy interventions could nudge vendors into offering a higher variety of healthy foods. Those types of policies can be possible in Mexico given that the Mexican government is at the forefront of major health intervention policies such as the added sugar tax from 2014 that resulted in considerable soda consumption reductions (Colchero et al., 2017) and the recent ban of unhealthy food sales to minors, which has been passed to reduce COVID-19 related risk factors (e.g. obesity, diabetes) (Agren, 2020; Reiley, 2020). However, researchers and policymakers

should give special attention to SFS because SFS are part of the informal economy and governmental policies can be circumvented by vendors who already do not pay taxes to local governments. Close collaboration with SFS vendors is needed to further understand strategies that can have a mutually beneficial impact on the health of street food consumers and the financial livelihood of street food vendors.

SFS also have the potential to help communities in need outside the Mexican context. Health practitioners, policymakers, and urban planners in high-income countries like the U.S. should take advantage of the versatility and mobility of SFS to increase the availability of healthy foods in areas where those foods are limited. Low-income ethnic communities in the U.S. have limited access to supermarkets and grocery stores where fresh healthy foods are typically found (Cole et al., 2010; Larson et al., 2009; Powell et al., 2007). Unlike supermarkets, corner stores, and bodegas, which are a fixed feature of the food environment, SFS can move from location to location serving those with reduced access to food. Moreover, given the mobile nature, SFS can be set up in open spaces such as back alleys, parking lots, school playgrounds, parks, and sports fields without additional infrastructure. SFS require low start-up and operational costs (Calloni, 2013; Long-Solís, 2007; Nelia Patricia Steyn et al., 2014), which can make it attractive to low-income entrepreneurs and can keep the cost of food low, which could benefit communities with limited economic resources. Future research is needed to understand the relationships among access to healthy food via SFS and a person's purchasing and eating behaviors.

Strengths and Limitations

There are several strengths of this study that should be considered. A strength in this study was the development and subsequent use of the validated SFSAT. We also used mixed-methods (e.g., geographical information systems, ground-truthing, direct observations) to assess availability, density, and distribution of informal food sources. Ground-truthing and direct observations are especially useful at capturing food and beverage availability at highly mobile SFS. Highly mobile SFS move constantly and the only way to capture them is by being physically present on the streets when these vendors walk by the street segments researchers were assessing. Assessing a random sample of residential street segments (25%) and all arterial street segments within the observational areas is also a strength because this strategy saves resources while capturing a representative sample of streets where SFS may be found. Using geographical information systems to map 400-m observational areas and the street segments within those areas included observational areas captured multiple points of access (e.g. homes, transportation centers, worksites) that street food vendors may be targeting.

The cross-sectional nature of the study is a limitation, which does not allow us to make any causal associations with SFS availability and food availability. Seasonality is another limitation. Data collection happened from May through August, when schools are not in session and when some workers may be on summer vacation. This time of year is also the rainy season which may have impacted the types of SFS present in Mexico City and seasonal variability was not assessed. Another limitation was the inability to assess

street segments deemed unsafe by the research team due to factors that included dangerous street segments with heavy street traffic and criminal activity. The third limitation was the exclusion of highly mobile street food vendors who walked through traffic at street intersections offering their food items to drivers. Researchers did not assess these types of vendors because attempting to reach them exposed researchers to potential automobile-related injuries. It is unknown what type of foods the research team missed by not assessing unsafe street segments and vendors selling their products in intersections. The results of this study cannot be generalized to the entire Mexican street food environment. The level of urbanization and population density in Mexico City is unmatched by any other place in Mexico. Moreover, the types of meals found in Mexico City may include different types of food items than meals found in other regions of the country. The SFSAT can serve as a template to be tested and adapted to other Mexican cities.

The SFSAT does not measure food purchase and consumption. As such, it is unknown what populations are consuming street food, how often, and how much. The tool did capture points of access that vendors may be targeting by locating their SFS within 100 m of those points of access. However, the presence of SFS does not necessarily mean that the food is being consumed by people in those points of access. Dietary intake recalls (i.e., 24-h recalls) can be used in combination with the SFSAT to assess associations between food availability and food consumption. Furthermore, collecting anthropometric data from consumers over an extended period is needed to

understand the role that street foods may play in health outcomes in the Mexican population.

Conclusions

SFS are an understudied element of the food environment. This study bridged the gap in knowledge about the availability, density, variety, and distribution of SFS and products sold at these sources of food by using an assessment tool that was developed, tested, and validated specifically for SFS. The findings showed that SFS were found across all neighborhoods. Furthermore, results also suggested that SFS can be a source of healthy food items. Policies are needed to increase the availability and variety of healthy foods and reduce the availability and variety of unhealthy foods. This study was not meant to answer all questions related to street food availability. Additional studies are needed to understand the relationship between SFS availability, food consumption, and health outcomes in the Mexican and other middle and low-income country populations.

REFERENCES

Abrahale, K., Sousa, S., Albuquerque, G., Padrão, P., & Lunet, N. (2018). Street food research worldwide: a scoping review. *Journal of Human Nutrition and Dietetics, 32*(2), 152-174.

Aceves-Martins, M., Llauradó, E., Tarro, L., Solà, R., & Giralt, M. (2016). Obesity-promoting factors in Mexican children and adolescents: challenges and opportunities. *Global health action, 9*(1), 1-13.

Acho-Chi, C. (2002). The mobile street food service practice in the urban economy of Kumba, Cameroon. *Singapore journal of tropical geography, 23*(2), 131-148.

Ag, M. B., Chauliac, M., Gerbouin, P. R., Kante, N., & Malvy, D. (2000). Food consumption patterns in the urban milieu of Bamako. *Sante publique (Vandoeuvre-les-Nancy, France), 12*(1), 45-63.

Agren, D. (2020). Mexico state bans sale of sugary drinks and junk food to children. *The Guardian*. Retrieved from https://www.theguardian.com/food/2020/aug/06/mexico-oaxaca-sugary-drinks-junk-food-ban-children

Akhtar, S., Riaz, M., Ismail, T., & Farooq, U. (2013). Microbiological safety of street vended fresh fruit juices, drinks, and conventional blends in Multan-Pakistan. *Pak. J. Agri. Sci, 50*(2), 255-260.

Al Mamun, M., Rahman, S. M. M., & Turin, T. C. (2013). Knowledge and awareness of children's food safety among school-based street food vendors in Dhaka, Bangladesh. *Foodborne Pathogens and Disease, 10*(4), 323-330.

Alba, J. W., & Hutchinson, J. W. (2000). Knowledge calibration: What consumers know and what they think they know. *Journal of consumer research, 27*(2), 123-156.

Alimi, B. A. (2016). Risk factors in street food practices in developing countries: A review. *Food Science and Human Wellness, 5*(3), 141-148.

Alvear-Galindo, M. G., Yamamoto-Kimura, L. T., Morán-Álvarez, C., Solís-Días, M. G., Torres-Durán, P. V., Juárez-Oropeza, M. A., . . . Ferreira-Hermosilloc, A. (2013). Consumo alimentario dentro y fuera de la escuela. *Revista Medica del Instituto Mexicano del Seguro Social, 51*(4), 450-454.

An, R., & Sturm, R. (2012). School and residential neighborhood food environment and diet among California youth. *American Journal of Preventive Medicine, 42*(2), 129-135.

Anderson, A. S., Dewar, J., Marshall, D., Cummins, S., Taylor, M., Dawson, J., & Sparks, L. (2007). The development of a healthy eating indicator shopping basket tool (HEISB) for use in food access studies—identification of key food items. *Public Health Nutrition, 10*(12), 1440-1447.

Andreyeva, T., Blumenthal, D. M., Schwartz, M. B., Long, M. W., & Brownell, K. D. (2008). Availability and prices of foods across stores and neighborhoods: the case of New Haven, Connecticut. *Health Affairs, 27*(5), 1381-1388.

Andreyeva, T., Luedicke, J., Middleton, A. E., Long, M. W., & Schwartz, M. B. (2012). Positive influence of the revised Special Supplemental Nutrition Program for Women, Infants, and Children food packages on access to healthy foods. *Journal of the Academy of Nutrition and Dietetics, 112*(6), 850-858.

Anthony, D., Dyson, P. A., Lv, J., Thankappan, K. R., Fernández, M. T., & Matthews, D. R. (2015). Reducing Health Risk Factors in Workplaces of Low and Middle-Income Countries. *Public Health Nursing, 32*(5), 478-487.

Arámbulo III, P. V., Almeida, C. R., Cuéllar Solano, J. A., & Belotto, A. J. (1994). Street food vending in Latin America. *Bulletin of PAHO, 28*(4), 344-354.

Arcan, C., Neumark-Sztainer, D., Hannan, P., van den Berg, P., Story, M., & Larson, N. (2007). Parental eating behaviours, home food environment and adolescent intakes of fruits, vegetables and dairy foods: longitudinal findings from Project EAT. *Public Health Nutrition, 10*(11), 1257-1265.

Asiegbu, C. V., Lebelo, S. L., & Tabit, F. T. (2016). The food safety knowledge and microbial hazards awareness of consumers of ready-to-eat street-vended food. *Food Control, 60*, 422-429.

Atash, F. (1994). Redesigning suburbia for walking and transit: emerging concepts. *Journal of urban planning and development, 120*(1), 48-57.

Austin, S. B., Melly, S. J., Sanchez, B. N., Patel, A., Buka, S., & Gortmaker, S. L. (2005). Clustering of fast-food restaurants around schools: a novel application of spatial statistics to the study of food environments. *American Journal of Public Health, 95*(9), 1575-1581.

Backman, D., Gonzaga, G., Sugerman, S., Francis, D., & Cook, S. (2011). Effect of fresh fruit availability at worksites on the fruit and vegetable consumption of low-wage employees. *Journal of Nutrition Education and Behavior, 43*(4), S113-S121.

Bader, M. D., Ailshire, J. A., Morenoff, J. D., & House, J. S. (2010). Measurement of the local food environment: a comparison of existing data sources. *American Journal of Epidemiology, 171*(5), 609-617.

Baier, J. (2017). *Development of an Assessment Tool to Measure the Latino Market Nutrition Environment.* Iowa State University.

Baker, E. A., Schootman, M., Barnidge, E., & Kelly, C. (2006). Peer reviewed: The role of race and poverty in access to foods that enable individuals to adhere to dietary guidelines. *Preventing Chronic Disease, 3*(3).

Ball, K., Timperio, A., & Crawford, D. (2009). Neighbourhood socioeconomic inequalities in food access and affordability. *Health & Place, 15*(2), 578-585.

Barker, R. G. (1968). *Ecological psychology: concepts and methods for studying the environment of human behavior*. Stanford, CA: Stanford University Press.

Barquera, S., Campirano, F., Bonvecchio, A., Hernández-Barrera, L., Rivera, J. A., & Popkin, B. M. (2010). Caloric beverage consumption patterns in Mexican children. *Nutrition Journal, 9*(1), 47.

Barquera, S., Campos-Nonato, I., Hernández-Barrera, L., Pedroza-Tobías, A., & Rivera-Dommarco, J. (2013). Prevalencia de obesidad en adultos mexicanos, 2000-2012. *Salud Publica de México, 55*, S151-S160.

Barquera, S., Campos, I., & Rivera, J. (2013). Mexico attempts to tackle obesity: the process, results, push backs and future challenges. O*besity Reviews, 14*(S2), 69-78.

Barquera, S., Campos, I., & Rivera, J. A. (2013). Mexico attempts to tackle obesity: the process, results, push backs and future challenges. *Obesity Reviews, 14*(S2), 69-78.

Barquera, S., Hernandez-Barrera, L., Tolentino, M. L., Espinosa, J., Ng, S. W., Rivera, J. A., & Popkin, B. M. (2008). Energy intake from beverages is increasing among Mexican adolescents and adults. *The Journal of Nutrition, 138*(12), 2454-2461.

Beaulac, J., Kristjansson, E., & Cummins, S. (2009). Peer reviewed: A systematic review of food deserts, 1966-2007. *Preventing Chronic Disease, 6*(3).

Becquey, E., & Martin-Prevel, Y. (2010). Micronutrient adequacy of women's diet in urban Burkina Faso is low. *The Journal of Nutrition, 140*(11), 2079S-2085S.

Befort, C., Kaur, H., Nollen, N., Sullivan, D. K., Nazir, N., Choi, W. S., . . . Ahluwalia, J. S. (2006). Fruit, vegetable, and fat intake among non-Hispanic black and non-Hispanic white adolescents: associations with home availability and food consumption settings. *Journal of the American Dietetic Association, 106*(3), 367-373.

Bendech, M. A., Chauliac, M., & Malvy, D. (1998). Assessment of dietary intake at home and outside the home in Bamako (Mali). *Ecology of Food and Nutrition, 37*(2), 135-162.

Bhowmik, S. K. (2005). Street vendors in Asia: a review. *Economic and Political Weekly*, 2256-2264.

Bitler, M., & Haider, S. J. (2011). An economic view of food deserts in the United States. *Journal of Policy Analysis and Management, 30*(1), 153-176.

Black, C., Ntani, G., Inskip, H., Cooper, C., Cummins, S., Moon, G., & Baird, J. (2014). Measuring the healthfulness of food retail stores: variations by store type and neighbourhood deprivation. *International Journal of Behavioral Nutrition and Physical Activity, 11*(1), 69.

Blair, D. (1999). Street food vending and nutritional impact. *Agriculture and Human Values, 16*(3), 321-323.

Block, D., & Kouba, J. (2006). A comparison of the availability and affordability of a market basket in two communities in the Chicago area. *Public Health Nutrition, 9*(07), 837-845.

Block, G., Patterson, B., & Subar, A. (1992). Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. *Nutrition and Cancer, 18*(1), 1-29.

Bodor, J. N., Rice, J. C., Farley, T. A., Swalm, C. M., & Rose, D. (2010). The association between obesity and urban food environments. *Journal of Urban Health, 87*(5), 771-781.

Bodor, J. N., Rose, D., Farley, T. A., Swalm, C., & Scott, S. K. (2008). Neighbourhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment. *Public Health Nutrition, 11*(04), 413-420.

Bonvecchio, A., Safdie, M., Monterrubio, E. A., Gust, T., Villalpando, S., & Rivera, J. A. (2009). Overweight and obesity trends in Mexican children 2 to 18 years of age from 1988 to 2006. *Salud Publica de México, 51*, S586-S594.

Bonvecchio Arenas, A., Fernández-Gaxiola, A., Plazas-Belausteguigoitia, M., Kaufer-Horwitz, M., Perez-Lizaur, A., & Rivera Dommarco, J. (2015). *Guías alimentarias y de actividad física en contexto de sobrepeso y obesidad en la población mexicana*. Instituto Nacional de Salud Publica, Mexico Retrieved from https://www.insp.mx/epppo/blog/3878-guias-alimentarias.html.

Borradaile, K. E., Sherman, S., Vander Veur, S. S., McCoy, T., Sandoval, B., Nachmani, J., . . . Foster, G. D. (2009). Snacking in children: the role of urban corner stores. *Pediatrics, 124*(5), 1293-1298.

Bostick, R. M., Potter, J. D., Kushi, L. H., Sellers, T. A., Steinmetz, K. A., McKenzie, D. R., . . . Folsom, A. R. (1994). Sugar, meat, and fat intake, and non-dietary risk factors for colon cancer incidence in Iowa women (United States). *Cancer Causes and Control, 5*(1), 38-52.

Boushey, C. J., Coulston, A. M., Rock, C. L., & Monsen, E. (2001). *Nutrition in the Prevention and Treatment of Disease*: Academic Press.

Bridle-Fitzpatrick, S. (2015). Food deserts or food swamps?: A mixed-methods study of local food environments in a Mexican city. *Social Science and Medicine, 142*, 202-213.

Bronfenbrenner, U. (1979). *The ecology of human development: experiments by nature and design*. Cambridge, Massachusetts: Harvard University Press.

Brown, A. (2002). Farmers' market research 1940–2000: An inventory and review. *American Journal of Alternative Agriculture, 17*(04), 167-176.

Burt, B. M., Volel, C., & Finkel, M. (2003). Safety of vendor-prepared foods: evaluation of 10 processing mobile food vendors in Manhattan. *Public Health Reports, 118*(5), 470-476.

Caldwell, E. M., Kobayashi, M. M., DuBow, W., & Wytinck, S. (2009). Perceived access to fruits and vegetables associated with increased consumption. *Public Health Nutrition, 12*(10), 1743-1750.

Calloni, M. (2013). Street food on the move: A socio-philosophical approach. *Journal of the Science of Food and Agriculture, 93*(14), 3406-3413.

Cameron, A. J., Thornton, L. E., McNaughton, S. A., & Crawford, D. (2013). Variation in supermarket exposure to energy-dense snack foods by socio-economic position. *Public Health Nutrition, 16*(7), 1178-1185.

Campbell, K. J., Crawford, D. A., & Ball, K. (2006). Family food environment and dietary behaviors likely to promote fatness in 5–6 year-old children. *International Journal of Obesity, 30*(8), 1272-1280.

Campbell, K. J., Crawford, D. A., Salmon, J., Carver, A., Garnett, S. P., & Baur, L. A. (2007). Associations between the home food environment and obesity-promoting eating behaviors in adolescence. *Obesity, 15*(3), 719-730.

Carlson, A., Lino, M., Juan, W., Hanson, K., & Basiotis, P. P. (2007). Thrifty food plan, 2006. *US Department of Agriculture*.

Caspi, C. E., Kawachi, I., Subramanian, S., Adamkiewicz, G., & Sorensen, G. (2012). The relationship between diet and perceived and objective access to supermarkets among low-income housing residents. *Social Science and Medicine, 75*(7), 1254-1262.

Castillo, A., Villarruel-López, A., Navarro-Hidalgo, V., Martínez-González, N., & Torres-Vitela, M. (2006). Salmonella and Shigella in freshly squeezed orange juice, fresh oranges, and wiping cloths collected from public markets and street booths in Guadalajara, Mexico: incidence and comparison of analytical routes. *Journal of Food Protection, 69*(11), 2595-2599.

Cavanaugh, E., Mallya, G., Brensinger, C., Tierney, A., & Glanz, K. (2013). Nutrition environments in corner stores in Philadelphia. *Preventive Medicine, 56*(2), 149-151.

Center for Nutrition Policy and Promotion. (1999). *The Thrifty Food Plan, 1999*. Retrieved from Washington, D.C. https://www.fns.usda.gov/cnpp/thrifty-food-plan-1999-administrative-report

Centers for Disease Control. (2013). Make a difference at your school. https://eric.ed.gov/?id=ED505189

Centers for Disease Control and Prevention. (2010). *Healthy Places: General Food Environment Resources*. Retrieved from https://www.cdc.gov/healthyplaces/healthtopics/healthyfood/general.htm

Cerin, E., Chan, K.-w., Macfarlane, D. J., Lee, K.-y., & Lai, P.-c. (2011). Objective assessment of walking environments in ultra-dense cities: Development and reliability of the Environment in Asia Scan Tool—Hong Kong version (EAST-HK). *Health & Place, 17*(4), 937-945.

Cerna-Cortes, J. F., Cortes-Cueto, A. L., Cano-Gaona, M. R., Leon-Montes, N., Helguera-Repetto, A. C., Rivera-Gutierrez, S., . . . Gonzalez-y-Merchand, J. A. (2016). Microbiological quality and occurrence of nontuberculous mycobacteria in fresh-squeezed orange juice samples purchased from street vendors in Mexico city. *Journal of Food Protection, 79*(12), 2190-2195.

Cerna-Cortes, J. F., Leon-Montes, N., Cortes-Cueto, A. L., Salas-Rangel, L. P., Helguera-Repetto, A. C., Lopez-Hernandez, D., . . . Gonzalez-y-Merchand, J. A. (2015). Microbiological quality of ready-to-eat vegetables collected in Mexico City: occurrence of aerobic-mesophilic bacteria, fecal coliforms, and potentially pathogenic nontuberculous mycobacteria. *Biomed Research International, 2015*.

Chaix, B., Bean, K., Daniel, M., Zenk, S. N., Kestens, Y., Charreire, H., . . . Weber, C. (2012). Associations of supermarket characteristics with weight status and body fat: a multilevel analysis of individuals within supermarkets (RECORD study). *PloS One, 7*(4), e32908.

Chakravarty, I., & Canet, C. (1996). Street foods in Calcutta. *Food Nutrition and Agriculture, 17*(18), 30-37.

Charreire, H., Casey, R., Salze, P., Simon, C., Chaix, B., Banos, A., . . . Oppert, J.-M. (2010). Measuring the food environment using geographical information systems: a methodological review. *Public Health Nutrition, 13*(11), 1773-1785.

Cheadle, A., Psaty, B., Wagner, E., Diehr, P., Koepsell, T., Curry, S., & Von Korff, M. (1990). Evaluating community-based nutrition programs: assessing the reliability of a survey of grocery store product displays. *American Journal of Public Health, 80*(6), 709-711.

Cheadle, A., Psaty, B. M., Curry, S., Wagner, E., Diehr, P., Koepsell, T., & Kristal, A. (1991). Community-level comparisons between the grocery store environment and individual dietary practices. *Preventive Medicine, 20*(2), 250-261.

Choi, J., Lee, A., & Ok, C. (2013). The effects of consumers' perceived risk and benefit on attitude and behavioral intention: A study of street food. *Journal of Travel & Tourism Marketing, 30*(3), 222-237.

Choudhury, M., Mahanta, L., Goswami, J., Mazumder, M., & Pegoo, B. (2011). Socio-economic profile and food safety knowledge and practice of street food vendors in the city of Guwahati, Assam, India. *Food Control, 22*(2), 196-203.

Chriqui, J. F., Pickel, M., & Story, M. (2014). Influence of school competitive food and beverage policies on obesity, consumption, and availability: a systematic review. *JAMA pediatrics, 168*(3), 279-286.

Cohen, D. A., Collins, R., Hunter, G., Ghosh-Dastidar, B., & Dubowitz, T. (2015). Store impulse marketing strategies and body mass index. *American Journal of Public Health, 105*(7), 1446-1452.

Cohen, D. A., Schoeff, D., Farley, T. A., Bluthenthal, R., Scribner, R., & Overton, A. (2007). Reliability of a store observation tool in measuring availability of alcohol and selected foods. *Journal of Urban Health, 84*(6), 807.

Colchero, M. A., Rivera-Dommarco, J., Popkin, B. M., & Ng, S. W. (2017). In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. *Health Affairs, 36*(3), 564-571.

Cole, S., Filomena, S., & Morland, K. (2010). Analysis of fruit and vegetable cost and quality among racially segregated neighborhoods in Brooklyn, New York. *Journal of Hunger & Environmental Nutrition, 5*(2), 202-215.

Connell, C. L., Yadrick, M. K., Simpson, P., Gossett, J., McGee, B. B., & Bogle, M. L. (2007). Food supply adequacy in the Lower Mississippi Delta. *Journal of Nutrition Education and Behavior, 39*(2), 77-83.

Conner, D. S., Montri, A. D., Montri, D. N., & Hamm, M. W. (2009). Consumer demand for local produce at extended season farmers' markets: guiding farmer marketing strategies. *Renewable Agriculture and Food Systems, 24*(04), 251-259.

Consejo Nacional de Poblacion. (2019). *Indice Absoluto de Marginacion 2000-2010*. Retrieved from

http://www.conapo.gob.mx/es/CONAPO/Indice_Absoluto_de_Marginacion_2000_2010.

Cortés, F. (2002). Consideraciones sobre la marginalidad, marginación, pobreza y desigualdad en la distribución del ingreso. *Papeles de Población, 8*(31), 9-24.

Crawford, R. (1979). Individual resposibility and health politics in the 1970s. In S. Reverby & D. Rosner (Eds.), *Health care in America: essays in social history*. Philadelphia: Temple University Press.

Creel, J. S., Sharkey, J. R., McIntosh, A., Anding, J., & Huber, J. C. (2008). Availability of healthier options in traditional and nontraditional rural fast-food outlets. *BMC Public Health, 8*(1), 395.

Cummins, S., & Macintyre, S. (2002). "Food deserts"—evidence and assumption in health policy making. *BMJ: British Medical Journal, 325*(7361), 436.

Cummins, S., & Macintyre, S. (2006). Food environments and obesity—neighbourhood or nation? *International Journal of Epidemiology, 35*(1), 100-104.

Curhan, R. C. (1972). The relationship between shelf space and unit sales in supermarkets. *Journal of Marketing Research*, 406-412.

Daily, M. N. (2020). Peso falls some more but Big Mac Index indicates it is undervalued. Retrieved from https://mexiconewsdaily.com/news/peso-falls-more-but-big-mac-index-indicates-it-is-undervalued/#:~:text=The%20price%20of%20a%20Big,hamburger%20should%20be%20111%20pesos.

Daniels, S. R. (2006). The consequences of childhood overweight and obesity. *The Future of Children, 16*(1), 47-67.

Davis, B., & Carpenter, C. (2009). Proximity of fast-food restaurants to schools and adolescent obesity. *American Journal of Public Health, 99*(3), 505-510.

Day, P. L., & Pearce, J. (2011). Obesity-promoting food environments and the spatial clustering of food outlets around schools. *American Journal of Preventive Medicine, 40*(2), 113-121.

Day, P. L., Pearce, J. R., & Pearson, A. L. (2015). A temporal analysis of the spatial clustering of food outlets around schools in Christchurch, New Zealand, 1966 to 2006. *Public Health Nutrition, 18*(01), 135-142.

de Bem Lignani, J., Sichieri, R., Burlandy, L., & Salles-Costa, R. (2011). Changes in food consumption among the Programa Bolsa Família participant families in Brazil. *Public Health Nutrition, 14*(5), 785-792.

de Jong, F., & Graf, G. (2017). Mexico City's endless commute. *CityLab.* Retrieved from https://www.bloomberg.com/news/articles/2017-02-09/mexico-city-s-endless-commute

Dean, W. R., Sharkey, J. R., & John, J. S. (2011). Pulga (flea market) contributions to the retail food environment of colonias in the South Texas border region. *Journal of the American Dietetic Association, 111*(5), 705-710.

Dean, W. R., Sharkey, J. R., Johnson, C. M., & St John, J. (2012). Cultural repertoires and food-related household technology within colonia households under conditions of material hardship. *International Journal for Equity in Health, 11*(1), 25.

Dean, W. R., Sharkey, J. R., Johnson, C. M., & Valdez, Z. (2011). Food vending and acquisition in Texas border region Pulgas (flea markets) from both sides of the counter. *Journal of Hunger & Environmental Nutrition, 6*(4), 458-476.

Deshmukh-Taskar, P., Nicklas, T., Morales, M., Yang, S., Zakeri, I., & Berenson, G. (2006). Tracking of overweight status from childhood to young adulthood: the Bogalusa Heart Study. *European Journal of Clinical Nutrition, 60*(1), 48-57.

Devine, C. M., Nelson, J. A., Chin, N., Dozier, A., & Fernandez, I. D. (2007). "Pizza Is Cheaper Than Salad": Assessing Workers' Views for an Environmental Food Intervention. *Obesity, 15*(S1), 57S-68S.

DeWeese, R. S., Todd, M., Karpyn, A., Yedidia, M. J., Kennedy, M., Bruening, M., . . . Ohri-Vachaspati, P. (2016). Short-form audit instrument for assessing corner store healthfulness. *American Journal of Health Promotion, 32*(1), 224-232.

Díaz-López, A., Cantú-Ramírez, R., Garza-González, E., Ruiz-Tolentino, L., Tellez-Luis, S., Rivera, G., & Bocanegra-Garcia, V. (2011). Prevalence of foodborne pathogens in grilled chicken from street vendors and retail outlets in Reynosa, Tamaulipas, Mexico. *Journal of Food Protection, 74*(8), 1320-1323.

Ding, D., Sallis, J. F., Norman, G. J., Saelens, B. E., Harris, S. K., Kerr, J., . . . Glanz, K. (2012). Community food environment, home food environment, and fruit and

vegetable intake of children and adolescents. *Journal of Nutrition Education and Behavior, 44*(6), 634-638.

Donovan, M. G. (2008). Informal cities and the contestation of public space: The case of Bogotá's street vendors, 1988—2003. *Urban Studies, 45*(1), 29-51.

Drabo, K., Toe, L., Savadogo, L., Tarnagda, Z., Zeba, A., Zongo, I., . . . Ouédraogo, J. (2009). Main characteristics of the street food sector in Bobo-Dioulasso, Burkina Faso. *Bulletin de la Societe de Pathologie Exotique (1990), 102*(1), 36-40.

Draper, A. (1996). *Street foods in developing countries: the potential for micronutrient fortification*: John Snow, Incorporated, OMNI PROJECT.

Drewnowski, A., Aggarwal, A., Hurvitz, P. M., Monsivais, P., & Moudon, A. V. (2012). Obesity and supermarket access: proximity or price? *American Journal of Public Health, 102*(8), e74-e80.

Dwyer, J. (1995). The school nutrition dietary assessment study. *American Journal of Clinical Nutrition, 61*(1), 173S.

Eisend, M. (2014). Shelf space elasticity: A meta-analysis. *Journal of Retailing, 90*(2), 168-181.

El-Hage Scialabba, N. (2011). *Food availability and natural resource use*. Retrieved from http://www.fao.org/fileadmin/user_upload/suistainability/Presentations/Availability.pdf

Elbel, B., Moran, A., Dixon, L. B., Kiszko, K., Cantor, J., Abrams, C., & Mijanovich, T. (2015). Assessment of a government-subsidized supermarket in a high-need area on household food availability and children's dietary intakes. *Public Health Nutrition, 18*(15), 2881-2890.

Emond, J. A., Madanat, H. N., & Ayala, G. X. (2012). Do Latino and non-Latino grocery stores differ in the availability and affordability of healthy food items in a low-income, metropolitan region? *Public Health Nutrition, 15*(2), 360-369.

Ershow, A. G. (2009). Environmental influences on development of type 2 diabetes and obesity: challenges in personalizing prevention and management: SAGE Publications.

Estrada-Garcia, T., Cerna, J., Thompson, M., & Lopez-Saucedo, C. (2002). Faecal contamination and enterotoxigenic Escherichia coli in street-vended chili sauces in Mexico and its public health relevance. *Epidemiology and Infection, 129*(1), 223-226.

Estrada-Garcia, T., Lopez-Saucedo, C., Zamarripa-Ayala, B., Thompson, M., Gutierrez-Cogco, L., Mancera-Martinez, A., & Escobar-Gutierrez, A. (2004). Prevalence of Escherichia coli and Salmonella spp. in street-vended food of open markets (tianguis) and general hygienic and trading practices in Mexico City. *Epidemiology and Infection, 132*(6), 1181-1184.

Farley, T. A., Rice, J., Bodor, J. N., Cohen, D. A., Bluthenthal, R. N., & Rose, D. (2009). Measuring the food environment: shelf space of fruits, vegetables, and snack foods in stores. *Journal of Urban Health, 86*(5), 672-682.

Federacion, D. O. d. l. (2011). *Acuerdo mediante el cual se establecen los lineamientos generales para expendio de bebidas en los establecimientos de consumo escolar de los planteles de education basica Program de Accion en el Context Escolar*. Retrieved from http://dof.gob.mx/nota_detalle.php?codigo=5156173&fecha=23/08/2010

Feng, J., Glass, T. A., Curriero, F. C., Stewart, W. F., & Schwartz, B. S. (2010). The built environment and obesity: a systematic review of the epidemiologic evidence. *Health & Place, 16*(2), 175-190.

Finkelstein, D. M., Hill, E. L., & Whitaker, R. C. (2008). School food environments and policies in US public schools. *Pediatrics, 122*(1), e251-e259.

Fleischhacker, S., Evenson, K. R., Rodriguez, D. A., & Ammerman, A. S. (2011). A systematic review of fast food access studies. *Obesity Reviews, 12*(5).

Flynn, J. (2013). The changing face of pediatric hypertension in the era of the childhood obesity epidemic. *Pediatric Nephrology, 28*(7), 1059-1066.

Food and Agriculture Organization. (1989). *Street Foods-Report of an FAO Expert Consultation Yogyakarta, Indonesia, 5-9 December 1988*.

Food and Agriculture Organization. (2018). *Food for the Cities: Street Foods*. Retrieved from http://www.fao.org/fcit/food-processing/street-foods/en

Food and Nutrition Service. (2017). School meals programs. Retrieved from https://www.fns.usda.gov/school-meals/child-nutrition-programs

Ford, P. B., & Dzewaltowski, D. A. (2008). Disparities in obesity prevalence due to variation in the retail food environment: three testable hypotheses. *Nutrition Reviews, 66*(4), 216-228.

Forsyth, A., Lytle, L., & Van Riper, D. (2010). Finding food: Issues and challenges in using Geographic Information Systems to measure food access. *Journal of Transport and Land Use, 3*(1), 43.

Forsyth, A., Wall, M., Larson, N., Story, M., & Neumark-Sztainer, D. (2012). Do adolescents who live or go to school near fast-food restaurants eat more frequently from fast-food restaurants? *Health & Place, 18*(6), 1261-1269.

Fox, M. K., Gordon, A., Nogales, R., & Wilson, A. (2009). Availability and consumption of competitive foods in US public schools. *Journal of the American Dietetic Association, 109*(2), S57-S66.

Fox, S., Meinen, A., Pesik, M., Landis, M., & Remington, P. L. (2005). Competitive food initiatives in schools and overweight in children: a review of the evidence. *WMJ-MADISON-, 104*(5), 38.

Franco, M., Diez-Roux, A. V., Nettleton, J. A., Lazo, M., Brancati, F., Caballero, B., . . . Moore, L. V. (2009). Availability of healthy foods and dietary patterns: the Multi-Ethnic Study of Atherosclerosis. *The American Journal of Clinical Nutrition, 89*(3), 897-904.

Franco, M., Roux, A. V. D., Glass, T. A., Caballero, B., & Brancati, F. L. (2008). Neighborhood characteristics and availability of healthy foods in Baltimore. *American Journal of Preventive Medicine, 35*(6), 561-567.

Frank, R. E., & Massy, W. F. (1970). Shelf position and space effects on sales. *Journal of Marketing Research*, 59-66.

Franks, P. W., Hanson, R. L., Knowler, W. C., Sievers, M. L., Bennett, P. H., & Looker, H. C. (2010). Childhood obesity, other cardiovascular risk factors, and premature death. *New England Journal of Medicine, 362*(6), 485-493.

Freedman, D. A. (2009). Local food environments: they're all stocked differently. *American Journal of Community Psychology, 44*(3-4), 382-393.

French, S. A. (2003). Pricing effects on food choices. *The Journal of Nutrition, 133*(3), 841S-843S.

French, S. A., Jeffery, R. W., Story, M., Breitlow, K. K., Baxter, J. S., Hannan, P., & Snyder, M. P. (2001). Pricing and promotion effects on low-fat vending snack purchases: the CHIPS Study. *American Journal of Public Health, 91*(1), 112.

Fulkerson, J. A., Nelson, M. C., Lytle, L., Moe, S., Heitzler, C., & Pasch, K. E. (2008). The validation of a home food inventory. *International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 55.

Fuller, D., Cummins, S., & Matthews, S. A. (2013). Does transportation mode modify associations between distance to food store, fruit and vegetable consumption, and BMI in low-income neighborhoods? *The American Journal of Clinical Nutrition, 97*(1), 167-172.

Galvez, M. P., Hong, L., Choi, E., Liao, L., Godbold, J., & Brenner, B. (2009). Childhood obesity and neighborhood food-store availability in an inner-city community. *Academic Pediatrics, 9*(5), 339-343.

Gantner, L. A., Olson, C. M., Frongillo, E. A., & Wells, N. M. (2011). Prevalence of nontraditional food stores and distance to healthy foods in a rural food environment. *Journal of Hunger & Environmental Nutrition, 6*(3), 279-293.

Garipe, L. Y., Gónzalez, V., Biasizzo, A., Soriano, J. L., Perman, G., & Giunta, D. (2014). Evaluación del ambiente construido en barrios de diferente nivel socioeconómico de la CABA. *Revista de la Facultad de Ciencias Medicas, 71*(3).

Gelormini, M., Damasceno, A., Lopes, S. A., Maló, S., Chongole, C., Muholove, P., . . . Padrão, P. (2015). Street food environment in Maputo (STOOD Map): a cross-sectional study in Mozambique. *JMIR Research Protocols, 4*(3), e98.

Ghemawat, P. (2001). Distance still matters. *Harvard Business Review, 79*(8), 137-147.

Ghirardelli, A., Quinn, V., & Sugerman, S. (2011). Reliability of a retail food store survey and development of an accompanying retail scoring system to communicate survey findings and identify vendors for healthful food and marketing initiatives. *Journal of Nutrition Education and Behavior, 43*(4), S104-S112.

Gibson, D. M. (2011). The neighborhood food environment and adult weight status: estimates from longitudinal data. *American Journal of Public Health, 101*(1), 71-78.

Gittelsohn, J. (2012). Interventions in small food stores to change the food environment, improve diet, and reduce risk of chronic disease. *Preventing Chronic Disease, 9*.

Glanz, K. (2009). Measuring food environments: a historical perspective. *American Journal of Preventive Medicine, 36*(4), S93-S98.

Glanz, K., Johnson, L., Yaroch, A. L., Phillips, M., Ayala, G. X., & Davis, E. L. (2016). Measures of retail food store environments and sales: review and implications for healthy eating initiatives. *Journal of Nutrition Education and Behavior, 48*(4), 280-288. e281.

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2005). Healthy nutrition environments: concepts and measures. *American Journal of Health Promotion, 19*(5), 330-333.

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2007). Nutrition Environment Measures Survey in stores (NEMS-S): development and evaluation. *American Journal of Preventive Medicine, 32*(4), 282-289.

Gloria, C. T., & Steinhardt, M. A. (2010). Texas nutrition environment assessment of retail food stores (TxNEA-S): development and evaluation. *Public Health Nutrition, 13*(11), 1764-1772.

Gomez Méndez, N. A. (2007). Redes sociales y comercio en vía pública en la Ciudad de México. *El Cotidiano, 22*(143), 41-47.

Gordon, C., Purciel-Hill, M., Ghai, N. R., Kaufman, L., Graham, R., & Van Wye, G. (2011). Measuring food deserts in New York City's low-income neighborhoods. *Health & Place, 17*(2), 696-700.

Griew, P., Hillsdon, M., Foster, C., Coombes, E., Jones, A., & Wilkinson, P. (2013). Developing and testing a street audit tool using Google Street View to measure environmental supportiveness for physical activity. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 103.

Grigsby-Toussaint, D. S., Zenk, S. N., Odoms-Young, A., Ruggiero, L., & Moise, I. (2010). Availability of commonly consumed and culturally specific fruits and vegetables in African-American and Latino neighborhoods. *Journal of the American Dietetic Association, 110*(5), 746-752.

Guariguata, L., Whiting, D., Hambleton, I., Beagley, J., Linnenkamp, U., & Shaw, J. (2014). Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes Research and Clinical Practice, 103*(2), 137-149.

Guiterrez, J., Rivera-Dommarco, J., Shamah-Levy, T., Villalpando-Hernandez, S., Franco, A., & Hernandez-Avila, M. (2012). *Encuesta Nacional de Salud y Nutricion 2012. Resultados Nacionales*. Instituto Nacional de Salud Publica: Cuernavaca, Mexico.

Gustafson, A., Christian, J. W., Lewis, S., Moore, K., & Jilcott, S. (2013). Food venue choice, consumer food environment, but not food venue availability within daily travel patterns are associated with dietary intake among adults, Lexington Kentucky 2011. *Nutrition Journal, 12*(1), 17.

Gustafson, A., Hankins, S., & Jilcott, S. (2012). Measures of the consumer food store environment: a systematic review of the evidence 2000–2011. *Journal of Community Health, 37*(4), 897-911.

Gutierrez, J. P., Rivera-Dommarco, J., Shamah-Levy, T., Villalpando-Hernández, S., Franco, A., Cuevas-Nasu, L., . . . Hernández-Ávila, M. (2012). Encuesta nacional de salud y nutrición 2012. *Resultados Nacionales. Cuernavaca, México: Instituto Nacional de Salud Pública, 1*(1.48).

Hanson, N. I., Neumark-Sztainer, D., Eisenberg, M. E., Story, M., & Wall, M. (2005). Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables and dairy foods. *Public Health Nutrition, 8*(01), 77-85.

Hartstein, J., Cullen, K. W., Reynolds, K. D., Harrell, J., Resnicow, K., Kennel, P., & Group, S. t. T. o. P. P. T. D. P. S. (2008). Impact of portion-size control for school a la carte items: changes in kilocalories and macronutrients purchased by middle school students. *Journal of the American Dietetic Association, 108*(1), 140-144.

Hawkes, C. (2006). Uneven dietary development: linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Globalization and Health, 2*(1), 4.

Hawley, A. H. (1950). *Human ecology: a theory of community structure*. New York: Ronald Press.

Haws, K. L., & Winterich, K. P. (2013). When value trumps health in a supersized world. *Journal of Marketing, 77*(3), 48-64.

Heinrich, K. M., Li, D., Regan, G. R., Howard, H. H., Ahluwalia, J. S., & Lee, R. E. (2012). Store and restaurant advertising and health of public housing residents. *American Journal of Health Behavior, 36*(1), 66-74.

Hernandez Barrera, L., Rothenberg, S. J., Barquera, S., & Cifuentes, E. (2016). The Toxic Food Environment Around Elementary Schools and Childhood Obesity in Mexican Cities. *American Journal of Preventive Medicine, 51*(2), 264-270.

Hill, J. O., Wyatt, H. R., Reed, G. W., & Peters, J. C. (2003). Obesity and the environment: where do we go from here? *Science, 299*(5608), 853-855.

Hillier, A., Cannuscio, C. C., Karpyn, A., McLaughlin, J., Chilton, M., & Glanz, K. (2011). How far do low-income parents travel to shop for food? Empirical evidence from two urban neighborhoods. *Urban Geography, 32*(5), 712-729.

Holsten, J. E. (2009). Obesity and the community food environment: a systematic review. *Public Health Nutrition, 12*(03), 397-405.

Hosler, A. S., & Dharssi, A. (2011). Reliability of a survey tool for measuring consumer nutrition environment in urban food stores. *Journal of Public Health Management and Practice, 17*(5), E1-E8.

House, L., Lusk, J., Jaeger, S., Traill, W. B., Moore, M., Valli, C., . . . Yee, W. M. (2005). Objective and subjective knowledge: impacts on consumer demand for genetically modified foods in the United States and the European Union. *AgBioForum, 7*(3), 113-123.

Hua, S. V., & Ickovics, J. R. (2016). Vending Machines: A Narrative Review of Factors Influencing Items Purchased. *Journal of the Academy of Nutrition and Dietetics, 116*(10), 1578-1588.

Hubert, H. B., Feinleib, M., McNamara, P. M., & Castelli, W. P. (1983). Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation, 67*(5), 968-977.

Hutchinson, P. L., Bodor, J. N., Swalm, C. M., Rice, J. C., & Rose, D. (2012). Neighbourhood food environments and obesity in southeast Louisiana. *Health & Place, 18*(4), 854-860.

Imamura, F., O'Connor, L., Ye, Z., Mursu, J., Hayashino, Y., Bhupathiraju, S. N., & Forouhi, N. G. (2015). Consumption of sugar sweetened beverages, artificially sweetened beverages, and fruit juice and incidence of type 2 diabetes: systematic

review, meta-analysis, and estimation of population attributable fraction. *BMJ, 351*, h3576.

Inagami, S., Cohen, D. A., Finch, B. K., & Asch, S. M. (2006). You are where you shop: grocery store locations, weight, and neighborhoods. *American Journal of Preventive Medicine, 31*(1), 10-17.

Isganaitis, E., & Lustig, R. H. (2005). Fast food, central nervous system insulin resistance, and obesity. *Arteriosclerosis, Thrombosis, and Vascular Biology, 25*(12), 2451-2462.

Izumi, B. T., Zenk, S. N., Schulz, A. J., Mentz, G. B., Sand, S. L., De Majo, R. F., . . . Odoms-Young, A. (2012). Inter-rater reliability of the food environment audit for diverse neighborhoods (FEAD-N). *Journal of Urban Health, 89*(3), 486-499.

Jeffery, R. W., Baxter, J., McGuire, M., & Linde, J. (2006). Are fast food restaurants an environmental risk factor for obesity? *International Journal of Behavioral Nutrition and Physical Activity, 3*(1), 2.

Jeffery, R. W., French, S. A., Raether, C., & Baxter, J. E. (1994). An environmental intervention to increase fruit and salad purchases in a cafeteria. *Preventive Medicine, 23*(6), 788-792.

Jenkins, S., & Horner, S. D. (2005). Barriers that influence eating behaviors in adolescents. *Journal of Pediatric Nursing, 20*(4), 258-267.

Jilcott, S. B., Wade, S., McGuirt, J. T., Wu, Q., Lazorick, S., & Moore, J. B. (2011). The association between the food environment and weight status among eastern North Carolina youth. *Public Health Nutrition, 14*(09), 1610-1617.

Jiménez-Cruz, A., Bacardí-Gascón, M., & Jones, E. G. (2002). Consumption of fruits, vegetables, soft drinks, and high-fat-containing snacks among Mexican children on the Mexico-US border. *Archives of Medical Research, 33*(1), 74-80.

Kahn, B. E., & Wansink, B. (2004). The influence of assortment structure on perceived variety and consumption quantities. *Journal of Consumer Research, 30*(4), 519-533.

Kahn, S. E., Hull, R. L., & Utzschneider, K. M. (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. *Nature, 444*(7121), 840-846.

Kaiser, L. L., & Dewey, K. G. (1991). Household economic strategies, food resource allocation, and intrahousehold patterns of dietary intake in rural Mexico. *Ecology of Food and Nutrition, 25*(2), 123-145.

Kang, M.-H., Lee, J.-S., Kim, H.-Y., Kwon, S., Choi, Y.-S., Chung, H. R., . . . Cho, Y.-H. (2012). Selecting items of a food behavior checklist for the development of Nutrition Quotient (NQ) for children. *Korean Journal of Nutrition, 45*(4), 372-389.

Kelly, B., Flood, V. M., & Yeatman, H. (2011). Measuring local food environments: an overview of available methods and measures. *Health & Place, 17*(6), 1284-1293.

Kendall, A., Olson, C. M., & Frongillo, E. A. (1996). Relationship of hunger and food insecurity to food availability and consumption. *Journal of the American Dietetic Association, 96*(10), 1019-1024.

Kim, H.-Y., Lim, Y.-I., & Kim, H.-J. (2007). A study on the ready-to-eat street-foods usage of customers in a college-town in northern part of Seoul. *Journal of the Korean Society of Food Culture, 22*(1), 43-57.

Kirkpatrick, S. I., Reedy, J., Butler, E. N., Dodd, K. W., Subar, A. F., Thompson, F. E., & McKinnon, R. A. (2014). Dietary assessment in food environment research: a systematic review. *American Journal of Preventive Medicine, 46*(1), 94-102.

Kirkpatrick, S. I., Reedy, J., Kahle, L. L., Harris, J. L., Ohri-Vachaspati, P., & Krebs-Smith, S. M. (2014). Fast-food menu offerings vary in dietary quality, but are consistently poor. *Public Health Nutrition, 17*(4), 924-931.

Kirkpatrick, S. I., & Tarasuk, V. (2010). Assessing the relevance of neighbourhood characteristics to the household food security of low-income Toronto families. *Public Health Nutrition, 13*(07), 1139-1148.

Korir, S. C., Imungi, J. K., & Muroki, N. M. (1998). Proximate chemical composition of street foods and their energy and protein contribution to the nutrition of manual workers in Nairobi. *Ecology of Food and Nutrition, 37*(2), 123-133.

Kurban, H., Henry-Nickie, M., Green, R. D., & Phoenix, J. A. (2008). Leveling the playing field: Enabling community-based organizations to utilize geographic information systems for effective advocacy. *Journal of the Urban and Regional Information Systems Association, 20*.

Lallukka, T., Laaksonen, M., Rahkonen, O., Roos, E., & Lahelma, E. (2007). Multiple socio-economic circumstances and healthy food habits. *European Journal of Clinical Nutrition, 61*(6), 701.

Langellier, B. A. (2015). Consumption and expenditure on food prepared away from home among Mexican adults in 2006. *Salud Publica de México, 57*(1), 4-13.

Laraia, B. A., Siega-Riz, A. M., Kaufman, J. S., & Jones, S. J. (2004). Proximity of supermarkets is positively associated with diet quality index for pregnancy. *Preventive Medicine, 39*(5), 869-875.

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments: disparities in access to healthy foods in the US. *American Journal of Preventive Medicine, 36*(1), 74-81. e10.

Lassen, A., Hansen, K., & Trolle, E. (2007). Comparison of buffet and a la carte serving at worksite canteens on nutrient intake and fruit and vegetable consumption. *Public Health Nutrition, 10*(3), 292-297.

Leatherman, T. L., & Goodman, A. (2005). Coca-colonization of diets in the Yucatan. *Social Science and Medicine, 61*(4), 833-846.

Lechner, L., Brug, J., & De Vries, H. (1997). Misconceptions of fruit and vegetable consumption: differences between objective and subjective estimation of intake. *Journal of Nutrition Education, 29*(6), 313-320.

Ledoux, T., Hingle, M., & Baranowski, T. (2011). Relationship of fruit and vegetable intake with adiposity: a systematic review. *Obesity Reviews, 12*(5).

Ledoux, T. A., Mama, S. K., O'Connor, D. P., Adamus, H., Fraser, M. L., & Lee, R. E. (2012). Home availability and the impact of weekly stressful events are associated with fruit and vegetable intake among African American and Hispanic/Latina women. *Journal of Obesity, 2012*.

Lee, R. E., Heinrich, K. M., Medina, A. V., Regan, G. R., Reese-Smith, J. Y., Jokura, Y., & Maddock, J. E. (2010). A picture of the healthful food environment in two diverse urban cities. *Environmental Health Insights, 4*, 49.

Lee, R. E., Heinrich, K. M., Reese-Smith, J. Y., Regan, G. R., & Adamus-Leach, H. J. (2014). Obesogenic and youth oriented restaurant marketing in public housing neighborhoods. *American Journal of Health Behavior, 38*(2), 218-224.

Lee, R. E., Mama, S. K., Medina, A. V., Ho, A., & Adamus, H. J. (2012). Neighborhood factors influence physical activity among African American and Hispanic or Latina women. *Health & Place, 18*(1), 63-70.

Leone, A. F., Lee, J. S., Rigby, S., Kurtz, H., Johnson, M. A., Betterley, C., & Park, S. (2011). Store Type and Demographic Influence on the Availability and Price of Healthful Foods, Leon County, Florida, 2008. *Preventing Chronic Disease, 8*(6).

Lewin, K., & Cartwright, D. (1951). *Field theory in social science*. New York: Harper.

Lewis, L. B., Sloane, D. C., Nascimento, L. M., Diamant, A. L., Guinyard, J. J., Yancey, A. K., & Flynn, G. (2011). African Americans' access to healthy food options in South Los Angeles restaurants. *American Journal of Public Health, 95*(4), 668-673.

Liese, A. D., Weis, K. E., Pluto, D., Smith, E., & Lawson, A. (2007). Food store types, availability, and cost of foods in a rural environment. *Journal of the American Dietetic Association, 107*(11), 1916-1923.

Lin, J. S., O'connor, E., Whitlock, E. P., & Beil, T. L. (2010). Behavioral counseling to promote physical activity and a healthful diet to prevent cardiovascular disease in adults: a systematic review for the US Preventive Services Task Force. *Annals of Internal Medicine, 153*(11), 736-750.

Liu, Z., Zhang, G., & Zhang, X. (2014). Urban street foods in Shijiazhuang city, China: Current status, safety practices and risk mitigating strategies. *Food Control, 41*, 212-218.

Long-Solís, J. (2007). A survey of street foods in Mexico City. *Food and Foodways, 15*(3-4), 213-236.

López-Barrón, R. G., Jiménez-Cruz, A., & Bacardí-Gascón, M. (2015). Modifiable environmental obesity risk factors among elementary school children in a Mexico-US Border City. *Nutricion Hospitalaria, 31*(5), 2047-2053.

Lucan, S. C., Karpyn, A., & Sherman, S. (2010). Storing empty calories and chronic disease risk: snack-food products, nutritive content, and manufacturers in Philadelphia corner stores. *Journal of Urban Health, 87*(3), 394-409.

Lucan, S. C., Maroko, A., Shanker, R., & Jordan, W. B. (2011). Green Carts (Mobile Produce Vendors) in the Bronx—Optimally Positioned to Meet Neighborhood Fruit-and-Vegetable Needs? *Journal of Urban Health, 88*(5), 977.

Lucan, S. C., Maroko, A. R., Bumol, J., Varona, M., Torrens, L., & Schechter, C. B. (2014). Mobile food vendors in urban neighborhoods—Implications for diet and diet-related health by weather and season. *Health & Place, 27*, 171-175.

Lucan, S. C., Varona, M., Maroko, A. R., Bumol, J., Torrens, L., & Wylie-Rosett, J. (2013). Assessing mobile food vendors (aka street food vendors)—methods, challenges, and lessons learned for future food-environment research. *Public Health, 127*(8), 766-776.

Lytle, L. A. (2009). Measuring the food environment: state of the science. *American Journal of Preventive Medicine, 36*(4), S134-S144.

Macintyre, S. (2007). Deprivation amplification revisited; or, is it always true that poorer places have poorer access to resources for healthy diets and physical activity? *International Journal of Behavioral Nutrition and Physical Activity, 4*(1), 32.

Mahon, B., Sobel, J., Townes, J., Mendoza, C., Lemus, M. G., Cano, F., & Tauxe, R. (1999). Surveying vendors of street-vended food: a new methodology applied in two Guatemalan cities. *Epidemiology and Infection, 122*(03), 409-416.

Malik, V. S., Popkin, B. M., Bray, G. A., Després, J.-P., Willett, W. C., & Hu, F. B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes a meta-analysis. *Diabetes Care, 33*(11), 2477-2483.

Martinez, L. M., & Estrada, D. (2017). Street vending and informal economy: Survey data from Cali, Colombia. *Data in brief, 14*, 132-137.

Matsuzaki, M., Sánchez, B. N., Acosta, M. E., Botkin, J., & Sanchez-Vaznaugh, E. V. (2020). Food environment near schools and body weight—A systematic review of associations by race/ethnicity, gender, grade, and socio-economic factors. *Obesity Reviews*.

McAlexander, K. M., Banda, J. A., McAlexander, J. W., & Lee, R. E. (2009). Physical activity resource attributes and obesity in low-income African Americans. *Journal of Urban Health, 86*(5), 696-707.

McKinlay, J., & McKinlay, S. (1977). Medical Measures and the decline of mortality. *Milbank Memorial Fund Quarterly/Health and Society*, 405-428.

McKinnon, R. A., Reedy, J., Morrissette, M. A., Lytle, L. A., & Yaroch, A. L. (2009). Measures of the food environment: a compilation of the literature, 1990–2007. *American Journal of Preventive Medicine, 36*(4), S124-S133.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education and Behavior, 15*(4), 351-377.

McMillan, T. E., Cubbin, C., Parmenter, B., Medina, A. V., & Lee, R. E. (2010). Neighborhood sampling: how many streets must an auditor walk? *International Journal of Behavioral Nutrition and Physical Activity, 7*(1), 20.

Mendes Gorgulho, B., Nogueira Previdelli, A., & Lobo Marchioni, D. M. (2012). Effects of an intervention in the workplace food environment. *Nutrition & Food Science, 42*(3), 156-163.

Mensah, J. O., Aidoo, R., & Teye, A. N. (2013). Analysis of street food consumption across various income groups in the Kumasi metropolis of Ghana. *International Review of Management and Business Research, 2*(4), 951.

Mensah, P., Yeboah-Manu, D., Owusu-Darko, K., & Ablordey, A. (2002). Street foods in Accra, Ghana: how safe are they? *Bulletin of the World Health Organization, 80*(7), 546-554.

Mente, A., de Koning, L., Shannon, H. S., & Anand, S. S. (2009). A systematic review of the evidence supporting a causal link between dietary factors and coronary heart disease. *Archives of Internal Medicine, 169*(7), 659-669.

Mirmiran, P., Bahadoran, Z., Delshad, H., & Azizi, F. (2014). Effects of energy-dense nutrient-poor snacks on the incidence of metabolic syndrome: a prospective approach in Tehran Lipid and Glucose Study. *Nutrition, 30*(5), 538-543.

Moore, L. V., Diez Roux, A. V., Nettleton, J. A., & Jacobs Jr, D. R. (2008). Associations of the local food environment with diet quality—a comparison of assessments based on surveys and geographic information systems: the multi-ethnic study of atherosclerosis. *American Journal of Epidemiology, 167*(8), 917-924.

Morland, K., & Evenson, K. (2009). Obesity prevalence and the local food environment. *Health & Place, 15*(2), 491-495.

Morland, K., & Filomena, S. (2007). Disparities in the availability of fruits and vegetables between racially segregated urban neighbourhoods. *Public Health Nutrition, 10*(12), 1481-1489.

Morland, K., Roux, A. V. D., & Wing, S. (2006). Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. *American Journal of Preventive Medicine, 30*(4), 333-339.

Morland, K., Wing, S., & Roux, A. D. (2002). The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. *American Journal of Public Health, 92*(11), 1761-1768.

Moy, G., Hazzard, A., & Käferstein, F. (1996). Improving the safety of street-vended food. *World Health Statistics Quarterly. Rapport Trimestriel de Statistiques Sanitaires Mondiales, 50*(1-2), 124-131.

Munoz de Chavez, M., Chávez Villasana, A., Chávez Muñoz, M., & Vuskovic, I. (2000). Sale of Street Foods in Latin America *Street Foods* (Vol. 86, pp. 138-154): Karger Publishers.

Mwangi, A. M., den Hartog, A. P., Foeken, D. W., van't Riet, H., Mwadime, R. K., & Van Staveren, W. A. (2001). The ecology of street foods in Nairobi. *Ecology of Food and Nutrition, 40*(5), 497-523.

Mwangi, A. M., den Hartog, A. P., Mwadime, R. K., Van Staveren, W. A., & Foeken, D. W. (2002). Do street food vendors sell a sufficient variety of foods for a healthful diet? The case of Nairobi. *Food and Nutrition Bulletin, 23*(1), 48-56.

Nago, E. S., Lachat, C. K., Huybregts, L., Roberfroid, D., Dossa, R. A., & Kolsteren, P. W. (2010). Food, energy and macronutrient contribution of out-of-home foods in school-going adolescents in Cotonou, Benin. *British Journal of Nutrition, 103*(02), 281-288.

Namugumya, B. S., & Muyanja, C. (2012). Contribution of street foods to the dietary needs of street food vendors in Kampala, Jinja and Masaka districts, Uganda. *Public Health Nutrition, 15*(8), 1503-1511.

Neumark-Sztainer, D., French, S. A., Hannan, P. J., Story, M., & Fulkerson, J. A. (2005). School lunch and snacking patterns among high school students: associations with school food environment and policies. *International Journal of Behavioral Nutrition and Physical Activity, 2*(1), 14.

Ni Mhurchu, C., Aston, L. M., & Jebb, S. A. (2010). Effects of worksite health promotion interventions on employee diets: a systematic review. *BMC Public Health, 10*(1), 62. doi:10.1186/1471-2458-10-62

Nørnberg, T. R., Houlby, L., Jørgensen, L. N., He, C., & Pérez-Cueto, F. (2014). Do we know how much we put on the plate? Assessment of the accuracy of self-estimated versus weighed vegetables and whole grain portions using an Intelligent Buffet at the FoodScape Lab. *Appetite, 81*, 162-167.

Numbeo. (2020). Cost of living in Mexico. Retrieved from https://www.numbeo.com/cost-of-living/country_result.jsp?country=Mexico

OEDC. (2011). *Health at a Glance 2011: OEDC Inidcators*. Retrieved from Available at http://www.patients-rights.org/uploadimages/FULL_REPORT.pdf:

Oguntona, C., & Tella, T. (1999). Street foods and dietary intakes of Nigerian urban market women. *International Journal of Food Sciences and Nutrition, 50*(6), 383-390.

Oguntona, C. R., & Kanye, O. (1995). Contribution of street foods to nutrient intakes by Nigerian adolescents. *Nutrition and Health, 10*(2), 165-171.

Ohri-Vachaspati, P., & Leviton, L. C. (2010). Measuring food environments: a guide to available instruments. *American Journal of Health Promotion, 24*(6), 410-426.

Oldenburg, B., Sallis, J. F., Harris, D., & Owen, N. (2002). Checklist of Health Promotion Environments at Worksites (CHEW): development and measurement characteristics. *American Journal of Health Promotion, 16*(5), 288-299.

Ortiz-Bautista, R., Freyre, S., Zamora-Ortiz, G., & Sanchez-Salas, J. (2009). Microbiological quality of street food in Puebla City, Mexico. *Giornale Italiano di Medicina Tropicale, 14*(1/4), 17-19.

Patterson, R. E., Kristal, A. R., Shannon, J., Hunt, J. R., & White, E. (1997). Using a brief household food inventory as an environmental indicator of individual dietary practices. *American Journal of Public Health, 87*(2), 272-275.

Pereira, M. A., Kartashov, A. I., Ebbeling, C. B., Van Horn, L., Slattery, M. L., Jacobs, D. R., & Ludwig, D. S. (2005). Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *The Lancet, 365*(9453), 36-42.

Poti, J. M., Braga, B., & Qin, B. (2017). Ultra-processed food intake and obesity: what really matters for health—processing or nutrient content? *Current Obesity Reports, 6*(4), 420-431.

Powell, L. M., Slater, S., Mirtcheva, D., Bao, Y., & Chaloupka, F. J. (2007). Food store availability and neighborhood characteristics in the United States. *Preventive Medicine, 44*(3), 189-195.

Pratt, C. A., Lemon, S. C., Fernandez, I. D., Goetzel, R., Beresford, S. A., French, S. A., . . . Webber, L. S. (2007). Design characteristics of worksite environmental interventions for obesity prevention. *Obesity, 15*(9), 2171-2180.

QGIS Development Team. (2009). QGIS Geographic Information System: Open Source Geospatial Foundation. Retrieved from http://qgis.org

Quiñones-Ramírez, E. I., Vázquez-Salinas, C., Rodas-Suárez, O. R., Ramos-Flores, M. O., & Rodríguez-Montaño, R. (2000). Frequency of isolation of Campylobacter from roasted chicken samples from Mexico City. *Journal of Food Protection, 63*(1), 117-119.

Raja, S., Ma, C., & Yadav, P. (2008). Beyond food deserts: measuring and mapping racial disparities in neighborhood food environments. *Journal of Planning Education and Research, 27*(4), 469-482.

Reiley, L. (2020). Mexico moves to ban junk food sales to children, citing obesity as coronavirus risk factor. *The Washinton Post*. Retrieved from https://www.washingtonpost.com/business/2020/08/19/mexico-kids-junk-food-ban/

Rheinländer, T., Olsen, M., Bakang, J. A., Takyi, H., Konradsen, F., & Samuelsen, H. (2008). Keeping up appearances: Perceptions of street food safety in urban Kumasi, Ghana. *Journal of Urban Health, 85*(6), 952-964.

Rivera, J. A., Barquera, S., Campirano, F., Campos, I., Safdie, M., & Tovar, V. (2002). Epidemiological and nutritional transition in Mexico: rapid increase of non-communicable chronic diseases and obesity. *Public Health Nutrition, 5*(1a), 113-122.

Rivera, J. A., Barquera, S., Gonzalez-Cossio, T., Olaiz, G., & Sepulveda, J. (2004). Nutrition transition in Mexico and in other Latin American countries. *Nutrition Reviews, 62*(suppl 2), S149-S157.

Rodríguez-Ramírez, S., Mundo-Rosas, V., García-Guerra, A., & Shamah-Levy, T. (2011). Dietary patterns are associated with overweight and obesity in Mexican school-age children. *Archivos Latinoamericanos de Nutrición, 61*(3), 270.

Rolls, B. J., Rowe, E. A., Rolls, E. T., Kingston, B., Megson, A., & Gunary, R. (1981). Variety in a meal enhances food intake in man. *Physiology and Behavior, 26*(2), 215-221.

Rosales Chavez, J. B., Garcia, L. M., Jehn, M., Pereira, M. A., & Bruening, M. (2020). Relationship between different levels of the Mexican food environment and dietary intake: A qualitative systematic review. *Public Health Nutrition*, 1-12.

Rose, D., Bodor, J. N., Hutchinson, P. L., & Swalm, C. M. (2010). The importance of a multi-dimensional approach for studying the links between food access and consumption. *The Journal of Nutrition, 140*(6), 1170-1174.

Rose, D., Bodor, J. N., Swalm, C. M., Rice, J. C., Farley, T. A., & Hutchinson, P. L. (2009). Deserts in New Orleans? Illustrations of urban food access and implications for policy. *Ann Arbor, MI: University of Michigan National Poverty Center/USDA Economic Research Service Research*.

Rose, D., & Richards, R. (2004). Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. *Public Health Nutrition, 7*(08), 1081-1088.

Rosi, A., Zerbini, C., Pellegrini, N., Scazzina, F., Brighenti, F., & Lugli, G. (2017). How to improve food choices through vending machines: the importance of healthy food availability and consumers' awareness. *Food Quality and Preference*.

Rueff, A., & Logomarsino, J. (2016). Increasing fruit and vegetable intake among manufacturing workers. *International Journal of Workplace Health Management, 9*(1), 32-45.

Saelens, B. E., & Glanz, K. (2009). Work group I: Measures of the food and physical activity environment: instruments. *American Journal of Preventive Medicine, 36*(4), S166-S170.

Saelens, B. E., Glanz, K., Sallis, J. F., & Frank, L. D. (2007). Nutrition Environment Measures Study in restaurants (NEMS-R): development and evaluation. *American Journal of Preventive Medicine, 32*(4), 273-281.

Sahota, A. (2009). The global market for organic food and drink. *The world of organic agriculture. Statistics and emerging trends, 2009*, 59-64.

Sallis, J. F., & Glanz, K. (2006). The role of built environments in physical activity, eating, and obesity in childhood. *The Future of Children*, 89-108.

Sallis, J. F., Nader, P. R., Rupp, J. W., Atkins, C. J., & Wilson, W. C. (1986). San Diego surveyed for heart-healthy foods and exercise facilities. *Public Health Reports (1974-)*, 216-219.

Saltijeral, J. A., Alvarez, V. B., & Garcia, B. (1999). Presence of Listeria in Mexican cheeses. *Journal of Food Safety, 19*(4), 241-247.

Salud, S. d. (2018). Guias alimentarias y de actividad fisica para poblacion mexicana. Retrieved from http://guiasalimentacionyactividadfisica.org.mx/ps/inicio-2

Saydah, S., Bullard, K. M., Cheng, Y., Ali, M. K., Gregg, E. W., Geiss, L., & Imperatore, G. (2014). Trends in cardiovascular disease risk factors by obesity level in adults in the United States, NHANES 1999-2010. *Obesity, 22*(8), 1888-1895.

Schulze, M. B., Manson, J. E., Ludwig, D. S., Colditz, G. A., Stampfer, M. J., Willett, W. C., & Hu, F. B. (2004). Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA, 292*(8), 927-934.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*(2), 167-177.

Sharkey, J. R., Dean, W. R., & Johnson, C. M. (2012). Use of vendedores (mobile food vendors), pulgas (flea markets), and vecinos o amigos (neighbors or friends) as alternative sources of food for purchase among Mexican-origin households in Texas border colonias. *Journal of the Academy of Nutrition and Dietetics, 112*(5), 705-710.

Sharkey, J. R., Dean, W. R., Nalty, C. C., & Xu, J. (2013). Convenience stores are the key food environment influence on nutrients available from household food supplies in Texas Border Colonias. *BMC Public Health, 13*(1), 45.

Sharkey, J. R., Dean, W. R., St John, J. A., & Huber, J. C. (2010). Using direct observations on multiple occasions to measure household food availability among low-income Mexicano residents in Texas colonias. *BMC Public Health, 10*(1), 445.

Sharkey, J. R., Horel, S., Han, D., & Huber, J. C. (2009). Association between neighborhood need and spatial access to food stores and fast food restaurants in neighborhoods of colonias. *International Journal of Health Geographics, 8*(1), 9.

Sharkey, J. R., Johnson, C. M., & Dean, W. R. (2010). Food access and perceptions of the community and household food environment as correlates of fruit and vegetable intake among rural seniors. *BMC Geriatrics, 10*(1), 32.

Sharkey, J. R., Johnson, C. M., Dean, W. R., & Horel, S. A. (2011). Association between proximity to and coverage of traditional fast-food restaurants and non-traditional fast-food outlets and fast-food consumption among rural adults. *International Journal of Health Geographics, 10*(1), 37.

Singh, A. S., Mulder, C., Twisk, J. W., Van Mechelen, W., & Chinapaw, M. J. (2008). Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obesity Reviews, 9*(5), 474-488.

Singleton, C. R., Affuso, O., & Sen, B. (2016). Decomposing racial disparities in obesity prevalence: variations in retail food environment. *American Journal of Preventive Medicine, 50*(3), 365-372.

Slavin, J. L., & Lloyd, B. (2012). Health benefits of fruits and vegetables. *Advances in Nutrition, 3*(4), 506-516.

Smith, K. W., Hoelscher, D. M., Lytle, L. A., T DWYER, J., Nicklas, T. A., Zive, M. M., . . . Stone, E. J. (2001). Reliability and validity of the child and adolescent trial for cardiovascular health (CATCH) food checklist: a self-report instrument to measure fat and sodium intake by middle school students. *Journal of the American Dietetic Association, 101*(6), 635-647.

Soltero, E. G., Ortiz Hernández, L., Jauregui, E., Lévesque, L., Lopez Y Taylor, J., Barquera, S., & Lee, R. E. (2017). Characterization of the School Neighborhood Food Environment in Three Mexican Cities. *Ecology of Food and Nutrition, 56*(2), 139-151.

Sorensen, G., Linnan, L., & Hunt, M. K. (2004). Worksite-based research and initiatives to increase fruit and vegetable consumption. *Preventive Medicine, 39*, 94-100.

Sorof, J. M., Lai, D., Turner, J., Poffenbarger, T., & Portman, R. J. (2004). Overweight, ethnicity, and the prevalence of hypertension in school-aged children. *Pediatrics, 113*(3), 475-482.

Spence, J. C., Cutumisu, N., Edwards, J., Raine, K. D., & Smoyer-Tomic, K. (2009). Relation between local food environments and obesity among adults. *BMC Public Health, 9*(1), 192.

StataCorp. (2017). Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC.

Steyn, N. P., & Labadarios, D. (2011). Street foods and fast foods: how much do South Africans of different ethnic groups consume? *Ethnicity and Disease, 21*(4), 462.

Steyn, N. P., Mchiza, Z., Hill, J., Davids, Y. D., Venter, I., Hinrichsen, E., . . . Jacobs, P. (2014). Nutritional contribution of street foods to the diet of people in developing countries: a systematic review. *Public Health Nutrition, 17*(6), 1363-1374.

Story, M., Nanney, M. S., & Schwartz, M. B. (2009). Schools and obesity prevention: creating school environments and policies to promote healthy eating and physical activity. *The Milbank Quarterly, 87*(1), 71-100.

Sturm, R. (2008). Disparities in the food environment surrounding US middle and high schools. *Public Health, 122*(7), 681-690.

Sujatha, T., Shatrugna, V., Rao, G. N., Reddy, G. C. K., Padmavathi, K., & Vidyasagar, P. (1997). Street food: an important source of energy for the urban worker. *Food and Nutrition Bulletin, 18*(4), 1-5.

Taber, D. R., Chriqui, J. F., Powell, L. M., & Chaloupka, F. J. (2012). Banning all sugar-sweetened beverages in middle schools: reduction of in-school access and purchasing but not overall consumption. *Archives of Pediatrics and Adolescent Medicine, 166*(3), 256-262.

Taillie, L. S., Afeiche, M. C., Eldridge, A. L., & Popkin, B. M. (2017). The contribution of at-home and away-from-home food to dietary intake among 2–13-year-old Mexican children. *Public Health Nutrition, 20*(14), 2559-2568.

Tester, J. M., Yen, I. H., & Laraia, B. (2010). Mobile food vending and the after-school food environment. *American Journal of Preventive Medicine, 38*(1), 70-73.

Timperio, A., Ball, K., Roberts, R., Campbell, K., Andrianopoulos, N., & Crawford, D. (2008). Children's fruit and vegetable intake: associations with the neighbourhood food environment. *Preventive Medicine, 46*(4), 331-335.

Tinker, I. (1999). Street foods into the 21st century. *Agriculture and Human Values, 16*(3), 327-333.

Tinker, I. (2003). Street foods: Traditional microenterprise in a modernizing world. *International Journal of Politics, Culture, and Society, 16*(3), 331-349.

Torres-Vitela, M. R., Castillo, A., Finne, G., Rodriguez-Garcia, M. O., Martinez-Gonzales, N. E., & Navarro-Hidalgo, V. (1997). Incidence of Vibrio cholerae in

fresh fish and ceviche in Guadalajara, Mexico. *Journal of Food Protection, 60*(3), 237-241.

Tu, W., Eckert, G. J., DiMeglio, L. A., Yu, Z., Jung, J., & Pratt, J. H. (2011). Intensified effect of adiposity on blood pressure in overweight and obese children. *Hypertension, 58*(5), 818-824.

U.S. Department of Health and Human Services. (2015). *US Department of Agriculture. Dietary guidelines for Americans, 2015-2020.* Washington DC.

US Congress. (2010). *Healthy, Hunger-Free Kids Act of 2010*. US Government Printing Office: 111th Congress Retrieved from https://www.gpo.gov/fdsys/pkg/PLAW-111publ296/html/PLAW-111publ296.htm.

Valdez, Z., Dean, W. R., & Sharkey, J. R. (2012). Mobile and home-based vendors' contributions to the retail food environment in rural South Texas Mexican-origin settlements. *Appetite, 59*(2), 212-217.

Van Hook, J., & Altman, C. E. (2012). Competitive food sales in schools and childhood obesity: a longitudinal study. *Sociology of Education, 85*(1), 23-39.

Vargas, L., Jiménez-Cruz, A., & Bacardí-Gascón, M. (2013). Unhealthy and healthy food consumption inside and outside of the school by pre-school and elementary school Mexican children in Tijuana, Mexico. *Journal of Community Health, 38*(6), 1166-1174.

Walker, R. E., Keane, C. R., & Burke, J. G. (2010). Disparities and access to healthy food in the United States: A review of food deserts literature. *Health & Place, 16*(5), 876-884.

Wansink, B. (1996). Can package size accelerate usage volume? *The Journal of Marketing*, 1-14.

Ward, M. H., & López-Carrillo, L. (1999). Dietary factors and the risk of gastric cancer in Mexico City. *American Journal of Epidemiology, 149*(10), 925-932.

Waterlander, W. E., de Boer, M. R., Schuit, A. J., Seidell, J. C., & Steenhuis, I. H. (2013). Price discounts significantly enhance fruit and vegetable purchases when combined with nutrition education: a randomized controlled supermarket trial. *The American Journal of Clinical Nutrition, 97*(4), 886-895.

Wechsler, H., Devereaux, R. S., Davis, M., & Collins, J. (2000). Using the school environment to promote physical activity and healthy eating. *Preventive Medicine, 31*(2), S121-S137.

Widener, M. J., Metcalf, S. S., & Bar-Yam, Y. (2012). Developing a mobile produce distribution system for low-income urban residents in food deserts. *Journal of Urban Health, 89*(5), 733-745.

Williams, J., Scarborough, P., Matthews, A., Cowburn, G., Foster, C., Roberts, N., & Rayner, M. (2014). A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. *Obesity Reviews, 15*(5), 359-374.

Winarno, F., & Allain, A. (1991). Street foods in developing countries: lessons from Asia. *Alimentation, Nutrition et Agriculture (FAO); Alimentacion, Nutricion y Agricultura (FAO).*

Wojcicki, J. M., Jimenez-Cruz, A., Bacardi-Gascon, M., Schwartz, N., & Heyman, M. B. (2012). Bimodal distribution of risk for childhood obesity in urban Baja California, Mexico. *Journal of Urban Health, 89*(4), 628-638.

Wolf, M. M., Spittler, A., & Ahern, J. (2005). A Profile of Farmers' Market Consumers and the Perceived Advantages of Produce Sold at Farmers' Markets. *Journal of Food Distribution Research, 36*(1).

World Health Organization. (1996). *Essential safety requirements for street-vended foods*. Retrieved from https://www.who.int/foodsafety/publications/street-vended-food/en/

Wyse, R., Campbell, E., Nathan, N., & Wolfenden, L. (2011). Associations between characteristics of the home food environment and fruit and vegetable intake in preschool children: a cross-sectional study. *BMC Public Health, 11*(1), 938.

Young, L. R., & Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health, 92*(2), 246-249.

Young, L. R., & Nestle, M. (2003). Expanding portion sizes in the US marketplace: implications for nutrition counseling. *Journal of the American Dietetic Association, 103*(2), 231-240.

Zenk, S. N., Lachance, L. L., Schulz, A. J., Mentz, G., Kannan, S., & Ridella, W. (2009). Neighborhood retail food environment and fruit and vegetable intake in a

multiethnic urban population. *American Journal of Health Promotion, 23*(4), 255-264.

Zenk, S. N., Schulz, A. J., Israel, B. A., James, S. A., Bao, S., & Wilson, M. L. (2005). Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. *American Journal of Public Health, 95*(4), 660-667.