WIC Community Spill-Over:

Access to WIC-authorized Stores and Child Consumption Behaviors

by

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ABSTRACT

Background: Stores authorized by the Supplemental Nutrition Program for Women, Infants, and Children (WIC) have been shown to improve the community food environments of lower-income areas by stocking healthy food items in accordance with the program's food package guidelines. Whether greater access to WIC-authorized stores is associated with improvements in diet among children from WIC and non-WIC households is not well understood.

Methods: Secondary analysis of cross-sectional data collected in 2009-2010 and 2014 for the New Jersey Child Health Study (NJCHS). Surveys from 2,211 urban households with 3-18-year-old children. Counts of WIC stores near children's homes determined through geo-coding of store and household addresses using roadway network distances of 0.5 and 1.0 mile. Children's consumption was categorized in age-specific deciles of quantities consumed for each food category examined: fruits, vegetables, sugar from sugar-sweetened beverages, total added sugars. Associations between counts of WIC stores and children's consumption were examined, first for the full sample, then by household WIC participation.

Results: No significant associations between WIC store counts near children's homes and consumption were observed in the overall sample at any distance. A small, but significant inverse relationship was seen in total added sugar consumption among children residing in WIC households only, with each additional WIC store within a 0.5 mile roadway network associated with a 0.24-decile lower consumption ($p = .047$). In age-stratified

exploratory analysis, higher vegetable ($p = .024$) and combined fruits and vegetables ($p = .006$) consumption were seen in the under 5 age group only.

Conclusions: Living close to more WIC-authorized stores was associated with healthier consumption, but only for a subset of children and only for a few food categories examined. Lack of a consistent pattern of healthier consumption among children suggests that access to WIC stores may have a positive, albeit limited impact on children's diets.

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CHAPTER 1

INTRODUCTION

The community food environments in low-income areas often fail to provide the types of foods necessary to support healthy food choices among community members (Hosler et al., 2008; Larson et al., 2009; Richardson et al., 2012). In densely populated urban settings, smaller grocery and convenience stores tend to dominate the landscape, and access to supermarkets, along with the healthier foods they offer, can vary widely (Larson et al., 2009; Ohri-Vachaspati et al., 2013). In order to maximize their limited shelf space, smaller stores are often carry fewer fresh and perishable foods, such as fruits and vegetables, relying instead on packaged, shelf-stable, and consequently more energy dense foods, such as soda and candy. When available, healthier options are often more expensive in smaller stores compared to larger stores, especially in low income neighborhoods (Gosliner et al., 2018). Lack of access to healthy food options may contribute to the dietary patterns of children from lower-income households, who have been found to consume greater amounts of unhealthy foods, such as chips, candy, and sugar-sweetened beverages, and fewer fruits and vegetables than their higher-income peers (Borradaile et al., 2009; Hanson & Chen, 2007; Paes et al., 2015).

Poor dietary patterns, including excess sugar intake and reduced fruit and vegetable consumption, have also been linked to overweight and obesity in children, which can put children at greater risk of developing harmful chronic conditions, such as metabolic syndrome, Type II Diabetes, and cardiovascular disease, as they move into adulthood (Biro & Wien, 2010; Due et al., 2011; Evensen et al., 2017; Shrewsbury &

Wardle, 2008). According to the latest Dietary Guidelines for Americans, children ages 2-8 should be consuming a minimum of 1 to 1.5 cups of both fruits and vegetables in a day and children ages 9-18 should be consuming at least 1.5 to 2 cups of fruit and 2 to 3 cups of vegetables (USDA, 2015). However, over 50% of children ages 1-8 and more than 90% of children ages 9-18 fail to consume the recommended daily servings of fruits and vegetables (National Cancer Institute, 2019). The American Heart Association suggests that children's daily intake of added sugars be limited to fewer than 10% of total daily calories, yet added sugars, particularly those from sugar-sweetened beverages like juice and soda, account for far more than 10% of the calories most children receive in a day (Bailey et al., 2018; National Cancer Institute, 2019).

A key federal program for improving young children's access to healthy foods is the Special Supplemental Nutrition Assistance Program for Women, Infants and Children (WIC). WIC's primary purpose is to ensure that pregnant and breastfeeding mothers, infants, and children up to the age of 5 residing in low-income households can obtain nutritionally adequate diets. As a result of the types of foods provided through its unique food packages, children and mothers participating in WIC have been shown to consume higher quality diets than non-participants (Gu & Tucker, 2017). A recent study by Guthrie et al. (2018) found that WIC infants consume more vegetables and infant cereals, and WIC children consume greater amounts of milk and 100% juice, than nonparticipants. WIC is also the only federal food assistance program which has effectively improved weight outcomes among children participating in the program. Pan et al. (2019) found that obesity prevalence among 2- to 4-year-olds participating in the

program had decreased significantly between 2010 and 2016. In a similar study, Daepp et al. (2019) found that obesity prevalence among WIC child participants has been steadily declining since the last major food package revisions in 2009.

To ensure availability of healthy foods for the program's recipients, WIC-authorized food stores are required to stock a minimum number of healthy food items in accordance with the program's unique food package guidelines. These items typically include whole grain-rich foods, low-fat milk, 100% fruit juice, dried beans or peanut butter, cheese, fruits, vegetables, and eggs, in addition to baby food and infant formula (Pelletier et al., 2017).

While superstores and supermarkets make up nearly 60% of WIC retail vendors nationally, smaller grocery and convenience stores, prominent in urban settings, make up a substantial portion of all WIC-authorized retail vendors at approximately 22% and 13%, respectively (Tiehen & Frazão, 2016). A recent study analyzing the healthfulness of small stores in urban settings found that healthy food options were largely absent from small stores that were not WIC-authorized (DeWeese et al., 2016). This scenario appears to persist even when municipalities mandate minimum healthy food stocking requirements for food outlets, as was recently attempted in Minneapolis, MN beginning in 2015 (Laska et al., 2019). Through its influence on the foods that are available in WIC authorized stores, WIC has been shown to measurably improve the community food environments in low-income areas (Andreyeva et al., 2012; DeWeese et al., 2016; Rose et al., 2014).

Although WIC's primary reach is limited to infants, young children, and pregnant and nursing mothers from low-income households, emerging evidence suggests that WIC's presence may benefit non-eligible members of the household. For example, older children residing in WIC-participating households who are not eligible for WIC benefits, but likely share access to WIC compliant foods in the home, also exhibit healthier consumption behaviors and improved health outcomes (Robinson, 2013; Steeves et al., 2019).

What remains to be examined empirically is whether similar spill-over effects resulting from improved access to stores carrying WIC-compliant foods exist in the larger community setting, particularly among low-income households not participating in WIC.

Study Purpose

The current study seeks to examine the associations between child food consumption and the number of WIC-authorized stores near children's homes, as well as examine how this association might differ by household WIC participation status. It is hypothesized that children living close to a greater number of WIC stores will consume a greater quantity of healthy foods and a lower quantity of unhealthy foods, and that this association will be stronger among children from WIC-participating households.

Research Question and Hypothesis

Based upon the research question:

Is household proximity to WIC-authorized stores associated with the consumption of select dietary components (fruits, vegetables, sugar-sweetened beverages, and total

added sugars) among 3- to 18-year-old children residing in lower-income, urban neighborhoods, and do such associations differ by

(a) household WIC participation status

(b) store size

It is hypothesized that:

A. Children from households at or below 200% of the Federal Poverty Level (FPL) living in an area with a greater number of WIC-authorized stores will have higher consumption of fruits and vegetables, and lower consumption of sugar-sweetened beverages and total added sugars, compared to similar children in areas with fewer WIC-authorized stores, after adjusting for child and family demographics, household WIC participation status, and the community food environment.

B. In low-income (at or below 200% FPL), non-WIC households, children living in an area with a greater number of WIC-authorized stores will have higher consumption of fruits and vegetables, and lower consumption of sugar-sweetened beverages and total added sugars compared to their peers residing in areas with fewer WIC-authorized stores.

C. In WIC participating households, children living in an area with a greater number of WIC-authorized stores will have higher consumption of fruits and vegetables, and lower consumption of sugar-sweetened beverages and total added sugars compared to their peers residing in areas with fewer WIC-authorized stores.

D. The associations observed in A, B, and C above will differ by the size of WIC authorized stores (small vs large).

Definition of Terms

- WIC-authorized Store: A food store authorized by the state health department to accept WIC food program benefits
- Large Store: Supermarkets, supercenters, and chain grocery stores having $2M or more in annual sales, at least 4 checkout stands, and stocking a broad range of healthy food items.
- Small Store: Small grocery stores, meat markets, fruit and vegetable markets, and convenience stores generally having sales below $2M, fewer than 4 checkouts, and stocking 3 or fewer out of 4 healthy food categories: 1) 5 or more types of fresh fruits, 2) 5 or more types of fresh vegetables, 3) fresh or frozen meats, and 4) low-fat or fat-free milk.
- Store Count: The number of WIC-authorized stores located within a specified roadway network distance of each child's home.
- Consumption: Frequency of consumption of foods from specific food categories by index child in each household. Food categories include both healthy (fruits, vegetables) and unhealthy (sugar sweetened beverages, total added sugars) items.
- Sugar-Sweetened Beverages (SSBs): Beverages which contain added sugars, including non-diet sodas, sweet teas, energy drinks, non-100% juice drinks, and sport drinks.
- WIC Participation: At least one parent and/or child (age 0-4) in the household had received benefits from the WIC program during the year preceding the date data was collected.

Limitations and Delimitations

- Data for this study were obtained from two separate, cross-sectional survey panels at baseline (time 1), undertaken as part of the New Jersey Child Health Study in 2009-2010 and 2014. Due to the nature of cross-sectional data, causal relationships cannot be established.
- Survey respondents were adults over the age of 18 who were considered to make the majority of food purchasing decisions for the household, and who were related to the index child randomly selected for analysis in each household.
- Surveys were offered in English and Spanish.
- Adult respondents were responsible for reporting consumption frequencies on behalf of the index child in each household after considering the index child's typical intake over the past 30 days. These frequencies were then transformed into daily frequency estimates and further converted into quantity measurements before being placed into deciles by age group for analysis. Each of these conversions introduces a potential for error.
- Only select dietary components were chosen for screening, so survey data may not capture every aspect of each child's diet.
- Survey responses may be subject to recall and/or social desirability bias (i.e. the act of under- or over-reporting certain dietary components to fit perceived expectations of the survey administrator or social norms). As such, reported values at baseline may not accurately reflect actual child intakes.

CHAPTER 2

REVIEW OF LITERATURE

The Ecological Approach

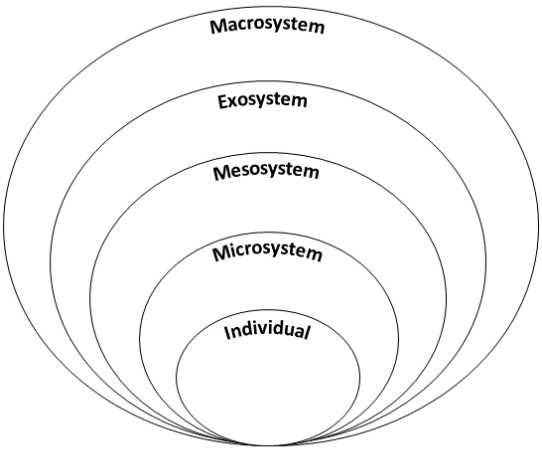
Overview of Behavior Ecology

Understanding the drivers of health-related behaviors in humans has challenged researchers, behavioral scientists, and public health professionals for decades. In order to comprehend the complex nature of interactions between individual characteristics and a seemingly limitless number of external influences, constructs have evolved which frame behaviors and choices within an ecological or environmental setting (Richard et al., 2011). Whereas historical models of behavior often placed primary emphasis on personal responsibility for determining behavior and health outcomes (Minkler, 1999), the ecological perspective provides an enhanced platform for understanding how the various personal, cultural, policy, and environmental factors that exist in everyday life serve to influence health behaviors at the individual level.

The Social Ecological Model

Famed American psychologist Urie Bronfenbrenner was one of the first researchers to propose an ecological style framework for explaining the relationship of various systems of influence on human development (Bronfenbrenner, 1977). Bronfrenbrenner's groundbreaking ecological approach featured 4 primary levels of external influence, which he referred to as "systems". These included the Macro-, Exo-, Meso-, and Micro-systems. Beginning with the Microsystem and working outward

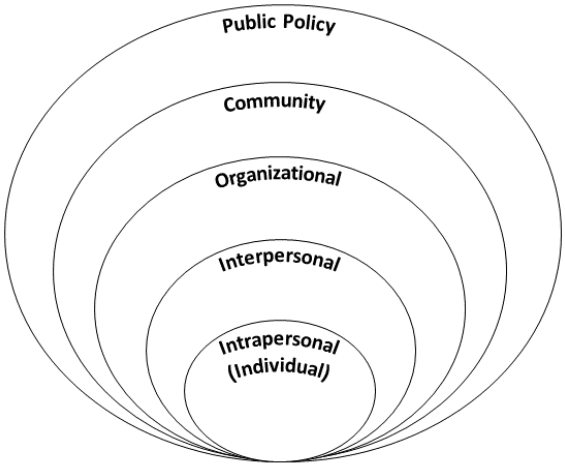
toward the Macrosystem, each layer is viewed as being nested within the next, creating an overarching sphere of influence which collectively affects the developing individual found at the center of the model.



Bronfenbrenner Ecological Model

In Bronfenbrenner's construct, the Microsystem represents the developing individual's most immediate environment, made up of parents, siblings, teachers and both the home and school settings. The Mesosystem represents the slightly less direct social and structural settings in which a person may interact, such as churches, camps, extended family, and formal peer groups. The Exosystem comprises structures which are not immediate to the individual, but which can impact or control characteristics of the lower systems, such as the neighborhood environment, government agencies, transportation and distribution systems, and the media. The larger Macrosystem is viewed as encompassing the non-concrete "blueprints" of society, such as laws and regulations, economic systems, political systems, educational systems, popular culture, subcultures, and social systems under which the other layers exist (Bronfenbrenner, 1977).

While revolutionary in concept, application of Bronfenbrenner's framework remained somewhat limited within the public health arena due to its strong basis in the psychological sciences and emphasis on child development. With a more explicit focus on health promotion among the general public, McLeroy et al. (1988) introduced the Social Ecological Model (SEM), which effectively reframed Bronfenbrenner's core ecological factors into five primary levels of influence: Intrapersonal, Interpersonal, Organizational, Community, and Public Policy.



Social Ecological Model

The intrapersonal layer of the SEM consists of individual characteristics, including the beliefs, attitudes, and knowledge that act as a basis for health decisions and behaviors. The interpersonal level contains factors of influence stemming from an individual's various social support systems, including relationships within the family, peer networks, and work groups. The organizational layer consists of influence from organizational structures, such as the school and workplace, and considers things like worksite health initiatives and institutional food environments. Community factors

include relationships between the individual and organizations and entities to which that individual belongs, such as church and clubs. The community level also includes characteristics of the local neighborhood, including access to resources and opportunities for engaging in specific behaviors. In the outermost layer, public policy encompasses all of the regulatory, procedural, and legal factors that guide and control many of the elements within the other layers (McLeroy et al., 1988).

In the application of these ecological models, it is important to understand that a change in one layer can both directly and indirectly affect the layers above and below it. This perspective of environmental interaction reveals many possibilities for public health interventions to begin to initiate changes at the individual level by modifying higher level environmental factors.

The Life Course Perspective

Building on McLeroy's work, some researchers have proposed expanding the SEM to provide greater consideration for historical factors which might influence future behaviors, as well as the larger socio-cultural and temporal contexts in which health decisions and behaviors occur (Devine, 2005). This framework, called the Life Course Perspective (LCP), is considered as a logical evolution of the current ecological approach.

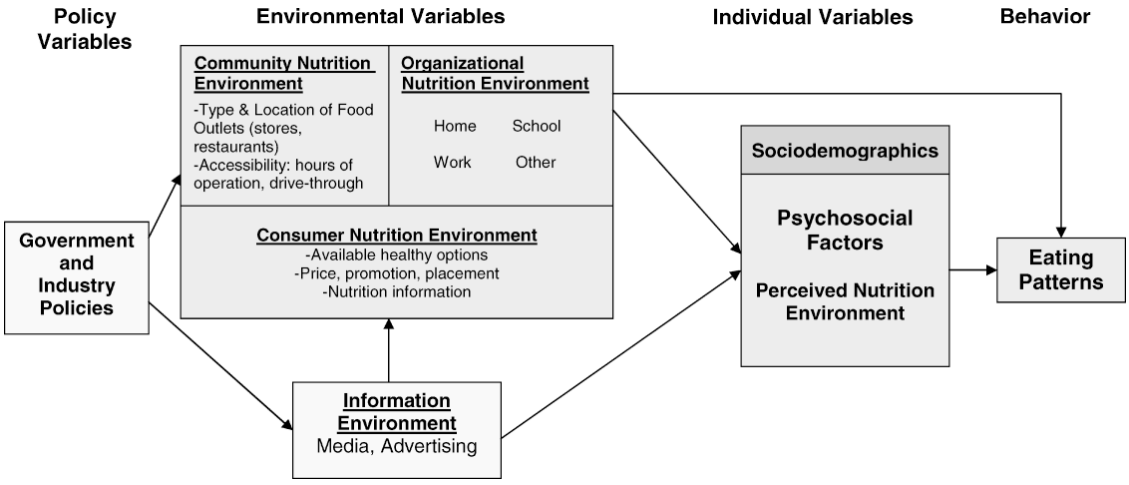
As Devine (2005) highlights, the LCP takes into account the impact of environmental and social exposures over time and across generations, in addition to the contemporary elements of the ecological framework. Herman et al. (2014) goes on to

explain that consideration of the LCP is necessary to address concerns of equity and timing of interventions, and to better understand health trajectories across the lifespan. Indeed, the LCP framework may be particularly useful when interventions surround minority and socio-economically depressed populations requiring a greater recognition of historical influences and cultural implications in order to understand what drives certain behaviors among these unique groups beyond immediate environmental factors alone. However, because historical and socio-cultural contexts are complex and generally not able to be changed, they are most useful in informing the design of interventions, rather than being ideal targets for the interventions themselves.

Food Environments

Many public health interventions at both the national and local levels focus on making environmental improvements to support change toward healthier behaviors. Perhaps the most important environment in terms of nutrition and food consumption behavior is that of the food environment, which spans multiple layers of the ecological model. In its broadest sense, the food environment encompasses all of the ways in which foods are produced, distributed, marketed, priced, and accessed. However, while it is important to consider the ways in which foods are produced, transported, and regulated at the highest levels, finer elements of the food environment may have a more direct impact on individual behaviors. To better understand the crucial roles that these more specific components of the food environment play in directing and supporting individual behaviors, Glanz et al. (2005) proposed a conceptual model of what they term the "nutrition environment", which is also based upon the ecological perspective.

Through their model, the authors demonstrate the flow of influence across three primary variable domains (policy, environmental, and individual), with behavior as the final output. Policy variables include government and industry policies and regulations that affect the flow and distribution of foods and food-related messaging. Environmental variables comprise factors from both the underlying information environment, which includes advertising and media, and the nutrition environment, which is further broken down into community, organization, and consumer environments. Individual variables include sociodemographic factors, individual perceptions about the food environment, and psychosocial factors through which the previous influences are ultimately filtered to result in observed behaviors, such as eating patterns (Glanz et al., 2005).



Model of Nutrition Environments (Glanz et al., 2005)

In Glanz et al.'s' model, the community level of the nutrition environment corresponds to the type and location of food outlets, particularly stores and restaurants, found in the local area. The community level also considers elements of accessibility to these food outlets, such as hours of operation, distance from home or work, and characteristics of the surrounding built environment. The organizational level takes into account the various family and institutional structures in which an individual may have access to food or be exposed to food-related messaging, such as at work, home, and school. Lastly, the consumer level of the nutrition environment entails deeper attributes of the retail setting, such as availability of healthy options on shelves and on menus, product pricing, promotion, and placement of foods within stores, as well as the presence of consumer-oriented nutrition information, if applicable (Glanz et al., 2005).

Glanz et al.'s environmental variables collectively encompass what researchers refer to as the "community food environment". In other words, community food environments consist of the more localized elements of the overall food environment with which individuals are likely to interact on a regular basis. Because of this more direct interaction, the community food environment plays a crucial role in providing access to healthy foods and enabling healthy eating behaviors at the individual level. It is also this ability of the community food environment to affect individual choices and behaviors that makes it an ideal target of ecology-based interventions.

Community Food Environments

While research surrounding community food environments and their impacts on both behavior and health outcomes has grown considerably over the past two decades,

results from a number of literature reviews have been somewhat mixed. Inconsistencies appear to stem from the broad range of community types analyzed and rather poor homogeneity among the measures used to assess various aspects of the community food environment (Black et al., 2014; Pitt et al., 2017). Nonetheless, several prominent themes have emerged from the literature.

In their review of the evidence surrounding inequalities in neighborhood food environments and the effects of these environments on the dietary intakes of adults between the ages of 18 and 60, Black et al. (2014) summarized the findings of 56 research articles and 12 prior review articles from the U.S. and abroad. Using research questions based on Glanz' model of the nutrition environment, the authors concluded that a trend existed in the literature toward an association between greater access to stores likely to have more healthy foods available, such as supermarkets and grocery stores, and better dietary outcomes. A very similar trend was observed in associations between access to stores and restaurants with fewer healthy foods and poorer dietary outcomes. However, while studies from the U.S. yielded the greatest number of significant associations between the community nutrition environment and dietary outcomes among all regions studied, when considering results from only the U.S.-based studies, associations between the community nutrition environment and the dietary intakes of adults in the U.S. was considered weak overall. Of the 24 U.S.-based studies, only 10 found an association in the expected direction and approximately half of the studies failed to find any association at all. Only 2 studies reported an inverse relationship, limited to grocery stores and fast-food restaurants, respectively. Despite these discrepancies,

greater density of fast-food outlets and closer proximity of convenience stores were found to be related to poorer dietary outcomes in a number of U.S.-based studies with relatively few studies reporting an inverse relationship. Looking deeper at only the studies which performed in-store audits to assess healthy food availability directly, the review concluded that moderate evidence did exist to support associations between healthy/less healthy food access and better/poorer dietary outcomes, respectively (Black et al., 2014).

A 2017 systematic review of literature produced between 2001 and 2015 by Pitt and colleagues sought to explore the impact of community food environments on food behaviors in urban settings. Out of 2744 articles identified, 30 met the inclusion criteria for review, including 19 from the U.S., 7 from the U.K. and one article each from Australia, Canada, and Mexico. No participant age range was specified for inclusion. Although the authors found the quality of studies mixed, the reviewers concluded several themes based on Glanz et al's model of the nutrition environment, primarily surrounding issues of healthy and unhealthy food accessibility, availability, and affordability. Sixteen studies identified the comparative availability of healthy and unhealthy food options in the community food environment as key drivers of food purchasing behaviors, with a number of articles highlighting disparities in healthy food availability in socioeconomically disadvantaged or high ethnic minority areas. Furthermore, foods in smaller stores were reported to be less healthy than at larger stores and 12 primarily U.S.-based studies found that foods in corner stores and meat markets were significantly more expensive than in larger chain grocery stores and supermarkets. However, an issue of limited access to these larger grocery stores and supermarkets was cited in 18 studies. A

theme of neighborhood walkability further affecting healthy food access was seen in studies examining lower income populations. Cost of healthy foods, such as fruits and vegetables, was also reported as a barrier in 6 of the studies reviewed. (Pitt et al., 2017).

A review by Cobb et al. (2015) looked at 71 studies examining the impacts of community food environments on weight outcomes, which are often indicative of dietary patterns. Of the 71 articles reviewed, 22 studied children, 47 were limited to adults, one more did not specify its sample population, but was assumed to be adults, and one included both adults and children with separate analyses provided for each. Sixty four of the studies were conducted in the U.S. with the remaining 7 studies hailing from Canada. Studies were rarely limited to either rural or urban areas and typically included areas of varying population densities. As with the above reviews looking at food-related behaviors, study quality was found to vary widely. However, a strong trend toward increased obesity in adults who had reduced access to supermarkets was concluded based on 22 associations in 10 studies, while only 4 positive associations between supermarket access and obesity were found in 2 studies. Nonetheless, 72% of the 93 total associations analyzed among all of the studies looking at these variables were null. Grocery store availability was more likely to be associated with obesity in adults, with 14 associations in 5 studies reporting a positive relationship and only 2 associations from a single study reporting an inverse relationship. Even so, 83% of the associations examined were null. Based on 29 positive associations in 11 studies compared to 6 inverse associations in 3 studies, the authors summarized that there was a notable positive trend in the association between fast-food restaurant availability and obesity in adults. Among children, 50% of

the 14 studies looking at associations between convenience store availability and obesity found at least one positive association. No negative associations were observed, but 82% of all associations examined were null. Associations between fast-food access and childhood obesity were reportedly mixed due to just 4 studies examining these relationships. However, 12 of the 19 associations examined in these studies found positive associations among children from lower-income households and those residing in lower-income areas (Cobb et al., 2015).

Low Income and Urban Areas

The community food environments of urban and low income communities have been key areas of research and a growing body of evidence suggests that these areas often lack the types of foods necessary to support healthy food choices. Furthermore, urban settings can post unique challenges due to their elevated population densities, complex built environments, and tendency toward geographical stratification by both socio-economic status (SES) and ethnicity (Hosler et al., 2008; Richardson et al., 2012).

To assess differences in healthy food access in underserved communities in both urban and rural settings, Hosler et al (2008) surveyed fruit and vegetable availability in 263 retail food stores and farmers markets in Albany, New York, as well as two neighboring counties located on the outskirts of the Albany metro area that were home to predominantly rural communities. The team found that the urban minority areas of downtown Albany, where 1 in 3 residents were reported to be living below the federal poverty level, experienced the greatest barriers to access of fruits and vegetables, even when compared to the nearby rural communities. The number of stores carrying at least 2

types of fresh fruits and at least 3 types of fresh vegetables had a density of just 4.6 stores per 10,000 residents in the urban minority areas, compared with Albany's predominantly white mixed race areas with a density of 11.4 stores and 9.8 stores in the more rural communities (Hosler et al., 2008).

Looking more closely at the distribution of food resources across the urban spectrum, Richardson et al. (2012) examined cross-sectional data from a nationally representative sample of 13,995 U.S. adults between 18 and 28 years old who had participated in the third wave of the National Longitudinal Study of Adolescent Health in 2001-2002. Participant addresses were geo-coded and merged with national census block data and community-level information from the Add Health Obesity and Neighbourhood Environment database (ONEdata). Food resource availability was determined by the number of fast-food restaurants, grocery stores/supermarkets, and convenience stores per 100 km of roadway within a 3 km "neighborhood" buffer of each participant's residence, which was designed to capture areas readily accessible by walking or driving. Census-defined urban areas were further categorized as either low density or high density based on the percentage of developed land coverage reported by the U.S. Geological Survey National Landcover Data. The study found that food stores were more equitably distributed in non-urban areas, regardless of neighborhood poverty level or ethnic minority composition. In low density urban areas, availability of grocery stores/supermarkets and convenience stores did not differ by neighborhood poverty level, but was found to be significantly lower in areas with higher minority populations. Greater access to fast-food restaurants was seen in all urban settings compared to non-

urban areas. Furthermore, urban areas with both high poverty and high minority composition were found to experience the greatest disparities in terms of reduced access to both grocery stores/supermarkets and convenience stores (Richardson et al., 2012).

Other studies have examined the retail food composition of urban environments and found similar outcomes. Lee et al. (2010) outlined 2 separate, but similar studies looking at urban food sources in Kansas City (Missouri and Kansas) and Honolulu, HI. In the Kansas study, which is more representative of urban environments located in the mainland U.S., 17 urban neighborhoods were identified, matched with demographic data from the 2000 U.S. Census, and categorized as either HD (low income, higher ethnic diversity, having a public housing development, n=13) or comparison (higher income, lower ethnic diversity, no public housing, n=4) neighborhoods. Following store classification by type, a 10% sample of stores in each neighborhood was randomly selected for direct analysis of store cleanliness, food quality, price, and availability using a survey tool developed by the team. In total, 51 stores were surveyed in HD neighborhoods and 26 stores were assessed in the comparison neighborhoods. In terms of retail composition, the researchers found that supermarkets and small grocery stores were largely absent from both the HD and comparison neighborhoods. Only 25% of both types of neighborhoods had a supermarket. Furthermore, HD neighborhoods typically had at least one liquor store selling groceries, whereas the comparison neighborhoods did not. While all but one of the HD neighborhoods had stores selling fresh fruits, only half of the HD neighborhoods had stores which sold fresh vegetables, typically limited to only a single store in each neighborhood. Similarly, only half of the 4 comparison

neighborhoods had a store that sold fruit and only one comparison neighborhood had a store which sold vegetables. Healthier foods like low-fat milk and eggs were found to be more expensive in HD neighborhoods, while sugary cereals were less expensive. When available, fruits and vegetables tended to be less expensive in HD neighborhoods, but the quality of these foods was seen to be lower, as well. Food prices were also higher in convenience stores, which were common across both neighborhood types (Lee et al., 2010).

Gosliner et al. (2018) also examined the quality and price of produce in food stores located in 225 low-income neighborhoods in California. In-store surveys were completed for 231 large grocery stores (≥ 4 cash registers), 621 small markets (fewer than 4 cash registers, but still offering a wide selection of foods, including fresh meat), and 622 convenience stores (stores selling food and snacks, but not a complete range of foods). The team found that small markets had less variety and generally lower quality of fresh fruits and vegetables compared to larger grocery stores. Convenience stores offered the least variety of fruits and vegetables of all store types and quality of these items was rated less than high in 75% of the stores. Store participation in WIC and/or SNAP was associated with better quality and variety of produce in stores, including convenience stores. However, few small markets or convenience stores carried items like tomatoes, broccoli, or cabbage. Additionally, food prices in convenience stores were higher than the other store types and all 3 types of stores were found to have higher lowest average prices for the food items studied than average prices in supermarket chains in the same counties.

The lack of large supermarkets and greater number of smaller stores offering fewer, more expensive, and lower quality healthy foods and a greater number of less expensive, less healthy foods may help to explain why many children who live in lower-income, urban environments appear to consume greater amounts of these less healthy foods. Borradaile et al. (2009), conducted 833 intercept surveys of children's food purchases outside of 24 urban corner stores in Pennsylvania, PA before and after school. The study, which focused on the purchases of 4th through 6th grade students from 10 different schools, found that 53.3% of students made purchases from corner stores on a daily basis, with 42% saying they shopped 2 or more times per day on average. The large majority of students purchased chips, candy, frozen treats, and/or a beverage during each trip with the average number of calories purchased per trip being 357 kcal. Beverages accounted for less than 20% of all purchases, but more than 80% of beverages purchased were of the sugar-sweetened variety. No purchases of fruits or vegetables were noted in the study due to the fact that virtually no corner stores studies offered these items for sale (Borradaile et al., 2009).

In their literature review focused on the health behaviors of children and adolescents between the age of 10 and 21 years-old, Hanson & Chen (2007) reviewed 31 studies examining elements of SES and diet quality. The reviewers concluded from the results of 25 out of the 31 studies that adolescents from low SES backgrounds experienced poorer quality diets, including reduced consumption of fruits and vegetables, and greater intake of fats and refined sugars. The associations were even stronger when

considering only the 16 highest quality studies, with 88% reporting associations in at least one sub-sample (Hanson & Chen, 2007).

Diets of U.S. Children

Guidelines and Recommendations

The latest Dietary Guidelines for Americans (DGA) published in 2015 recommend that children from ages 2 through 8 consume 1 to 1.5 cups each of both fruits and vegetables per day. Older children between the ages of 9 and 18 are recommended to consume 1.5 cups of fruit and 2 cups of vegetables, at minimum, per day (USDA, 2015).

The DGA also recommend that intake of added sugars be kept below 10% of total calories for all Americans and emphasis be put on choosing beverages that do not contain added sugars (USDA, 2015). The American Heart Association has offered a slightly more conservative recommendation for sugar, suggesting that intake of added sugars among children and adolescents be kept below half of available discretionary calories, or approximately 4% to 7% of total calories, depending on age, to ensure cardiovascular health (Johnson et al., 2009). Added sugars are those sugars which do not occur naturally in a product's ingredients and are often used to enhance the sweetness and appeal of many foods and beverages.

Current Dietary Trends

The diets of children in the U.S. vary widely, but largely fall short of official recommendations according to recent research. For example, nationally representative data from the most recent surveys conducted by the National Cancer Institute indicate

that fewer than 50% of children ages 1 to 8 and fewer than 10% of children ages 9 to 18 are consuming the recommended daily servings of fruits and vegetables (National Cancer Institute, 2019).

A study by Moore et al. (2017) sought to measure the likelihood of high school aged youth meeting dietary recommendations based on a model created from the 24-hour dietary recalls of 14- to 18-year olds (n = 1,535) collected through the 2007-10 NHANES. The probability model was then applied to a nationally representative, cross-sectional sample of children ages 14-18 who provided dietary information through the Youth Risk Behavior Surveillance System in 2013 (n= 12,829) along with individual state-level samples from 33 states in the same year (n= 141,006). As a result of their analysis, the authors estimated that only 8.5% of high school students met fruit consumption recommendations nationally. Furthermore, only 2.1% of high school students met the daily recommendations for vegetables (Moore et al., 2017).

Dunford & Popkin (2018) examined snacking trends of U.S. youth using data from 8 nationally representative surveys performed between 1977 and 2014. The 8 studies included the 1977-1978 Nationwide Food Consumption Survey (NFCS), the 1989-1991, 1994-1996, and 1997-1998 cohorts of the Continuing Survey of Food Intake by Individuals (CSFII), and 4 NHANES surveys (2003-2004, 2005-2006, 2011-2012, and 2013-2014). The total sample included 57,762 children between the ages of 2 and 18 year old. Analysis revealed that energy intake from snacks increased significantly in all groups from 1977 to 2014. However, those in the lowest poverty level groups experienced a greater than 100% increase over the period. In the overall sample,

consumption of salty snacks doubled from 1977 to 2014. While the authors observed a decrease in sugar-sweetened beverage (SSB) consumption across the study period, intake increased among non-Hispanic Blacks, who also demonstrated the highest levels of snack consumption overall (Dunford & Popkin, 2018).

A recent CDC report on SSB consumption among U.S. youth between 2011 and 2014 indicates that nearly two-thirds of children consumed at least one SSB on a given day with daily calories from SSB increasing with age. Overall, youth in the U.S. were found to consume an average of 7.3% of their total daily calories from SSB alone (Rosinger et al., 2017).

Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

WIC Program Overview

The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) is key federal program meant to ensure that children and pregnant or breastfeeding mothers from lower-income households receive a high quality diet. WIC became a formal federal program in 1974, following a successful pilot that began in 1972. WIC's primary mission is to protect the health of nutritionally at-risk, low-income mothers, infants, and children up to the age of 5. As of 2016, WIC provided services to more than 1.8 million mothers, delivering nutrition education, breastfeeding assistance, and access to specialized social and health care services in addition to food assistance. More than 3.9 million children were also covered by the program in 2016 and the USDA estimates that

WIC services around one half of all infants born in the United States each year (USDA, 2019; USDA-FNS, 2016).

To qualify for benefits, participants must have incomes at or below 185% of the U.S. poverty level guidelines. This equates to an annual income of approximately $23,107 for a single individual and $47,638 for a family of 4 (USDA-FNS, 2018). Applicants must also demonstrate a degree of nutritional risk to be eligible. What constitutes nutritional risk is somewhat broad and can include conditions of under- or over-weight, high maternal age, and undesirable dietary patterns, among other factors.

Hispanics are the largest users of WIC, with nearly 3.2 million Hispanic infants and children participating in WIC in 2016. Participation was noticeably lower for Whites at around 2.3 million and much lower for Blacks at 1.5 million. All other races combined accounted for less than 700,000 infant and child participants (USDA-FNS, 2016). WIC is also the only government food assistance program which requires that participants receive nutrition education in order to qualify for financial benefits.

WIC Food Packages

A unique feature of the WIC program is that financial assistance for food is only provided for foods included in the program's unique food package guidelines, which differ by child age and by whether a mother is pregnant or breastfeeding. In 2009, the food packages offered through WIC received significant revisions for the first time since 1980 in order to better align the food packages with the 2005 Dietary Guidelines for Americans, with final revisions completed in 2014. The updates included a more than

30% increase in the purchasing power of fruits and vegetables, increased options for whole grain foods, and greater flexibility for states in tailoring food packages to their own populations. The changes also called for a reduction in the amount of fruit juice offered through the program and a reduction in the total amount of dairy and eggs provided. Milk was limited to lower-fat varieties and alternatives of some food items were permitted to address concerns over cultural suitability for certain groups (USDA-FNS, 2014).

Benefits of the WIC Program

Because of its national reach and focus on lower-income populations, WIC has become a popular target of public health research and the body of evidence highlighting the program's impacts on both participant health outcomes and changes to the community food environment has grown substantially in just the past few years.

Dietary Patterns of WIC Participants

Gu & Tucker (2017) looked at trends in dietary quality among child and adolescent populations in the U.S. and their associations with socioeconomic status and the use of federal nutrition assistance programs. The study used NHANES survey data collected from 1999 to 2012, yielding a nationally representative sample of 38,487 children and adolescents between the ages of 2 and 18 years old. Dietary quality was measured using the Healthy Eating Index 2010 (HEI-2010), which assesses adherence to the 2010 Dietary Guidelines for Americans. Among the total sample, mean HEI-2010 scores improved steadily across the study period, but diet quality among children and

adolescents was considered to be poor overall. Despite this, when all 7 study periods between 1999-2000 and 2011-2012 were combined, participants in the WIC program (mean HEI-2010: 46.1 in 1999-00 and 55.8 in 2011-12) were shown to have significantly better quality diets than nonparticipants (mean HEI-2010: 44.5 in 1999-00 and 51.3 in 2011-12). Though not always statistically significant, WIC participants also maintained higher mean HEI-2010 scores compared to the total sample (42.5 in 1999-00 and 50.9 in 2011-12) in each of the 7 study periods (Gu & Tucker, 2017).

A study by Guthrie et al. (2018) examined differences in the food consumption patterns of WIC participants and nonparticipants using data from the 2016 Feeding Infants and Toddlers Study (FITS). The study collected data about children ages 4 and under, yielding a nationally representative sample of 3,235 children for analysis. Study participants were categorized as WIC-participating, lower-income nonparticipating (i.e. likely WIC-eligible, but not enrolled), and higher-income nonparticipating groups. In their analysis, the researchers found that older infants (6 to 11.9 months old) participating in the WIC program were more likely to consume infant cereals and vegetables than nonparticipating infants from similar low-income households and more likely to consume 100% juice than all other nonparticipants. While fewer than 9% of all infants between 6 and 11.9 months of age consumed sugar-sweetened beverages (SSB), WIC children were more likely to do so than nonparticipants. Among older WIC children, participants between 12 and 23.9 months old were more likely to consume whole milk than nonparticipants and those between 24 and 47.9 months old were more likely to consume low- or non-fat milk than nonparticipants. Older WIC participants were found to

consume fewer fruits compared to non-participants, but also consumed more 100% juice, a feature of the WIC food packages. Among 12 to 23.9 month-olds, WIC participants were found to consume more SSB than higher-income nonparticipants. However, among the oldest WIC group, fewer participants consumed SSB than low-income non-participants (Guthrie et al., 2018).

An earlier study by Whaley et al. (2012) examining dietary changes of WIC recipients following the last food package revisions in 2009 surveyed approximately 3,000 pregnant or postpartum women and/or caregivers of children enrolled in WIC in California immediately before and 6 months after the food package changes. Following the revisions, there was a significant increase (18%) in the number of families eating more vegetables than was reported before the revisions. The proportion of families who reported eating more fruit did not change significantly over the study period. However, whole milk consumption among caregivers and children decreased by 60% and 63%, respectively, while the number of caregivers and children consuming lower-fat milk options increased by 20% and 29%, respectively, over baseline. Furthermore, the proportion of families who reported eating more whole-grain foods increased by 51% over baseline (Whaley et al., 2012).

WIC and Child Weight Status

A recent CDC report revealed that the prevalence of obesity and overweight among children aged 2-19 in the U.S. rose nearly 33% in a little over 15 years, from a previous landmark of 13.9% in the year 2000 to 18.5% in 2016 (Hales, 2017). In contrast, the historical prevalence of overweight and obesity among children in the U.S. remained

fairly steady throughout the 1970s and early 1980s at right around 5% (Fryar et al., 2014). Newer data published by the Robert Wood Johnson Foundation (2018) summarizing findings from the 2016-17 National Survey of Children's Health (NSCH) reveals that childhood obesity prevalence in the U.S. has decreased slightly among 10- to 17-year-olds. However, the magnitude of the change was not found to be significant overall. The same analysis also highlights the disproportionate burden of obesity among Black and Hispanic children compared to White children with rates at 22.5%, 20.6% and 12.5%, respectively (Robert Wood Johnson Foundation, 2018).

Among the critical age group that WIC services, the WIC-participating child population has experienced a trend in the opposite direction, with participants seeing improvements in weight status over the past decade. Analyzing trends in obesity among 2- to 4-year-olds who were enrolled in WIC between 2010-2016, Pan et al. (2019) found that the prevalence of obesity among this group decreased significantly from 15.9% in 2010 to 13.9% in 2016. Daepp et al. (2019), examining the effects of the 2009 food package change on obesity prevalence among child participants, found that obesity prevalence among 2- to 4-year-olds enrolled in WIC had been steadily increasing prior 2009, but then experienced a significant reversal in the years following the food package revisions**.** These results were further supported in a study by Chaparro et al. (2019), who found that WIC children in the Los Angeles area who were exposed to the 2009 food package revisions for all years from 0-4 years of age had significantly healthier growth trajectories and reduced risk of being obese at age 4. Even partial (2 years) exposure to

the updated food package standards was associated with lower obesity risk at age 4 in boys (Chaparro et al., 2019).

WIC, Diet, and Cognitive Function

With a specific interest in WIC populations, Jackson (2015) examined the associations between early childhood participation in WIC and outcomes of cognitive development and academic achievement. The study utilized data from 2 complementary, nationally representative longitudinal studies from the U.S. The first source of data was from the birth cohort of the Early Childhood Longitudinal Study (ECLS-B), which followed approximately 11,000 children from age 9 months through kindergarten, and provided WIC participation information beginning with the mother during the prenatal period. The second data source was the Child Development Supplement (CDS) of the Panel Study of Income Dynamics, an ongoing study which follows families over time. A sibling sub-sample of 263 children between 0 and 12 years of age was used for analysis in order to control for household variables, mother effects, and unobserved differences between families. Approximately 40% of the ECLS-B children were exposed to WIC in utero and, of this group, 97% also participated in the program prior to the age of 3. In the CDS sibling sub-sample, nearly half of the siblings were enrolled prenatally. The study found that, among the ECLS-B group, early WIC exposure was significantly associated with stronger cognitive development at age 2 compared to similar (matched) non-participants, based on Bayley Mental Development assessment scores. According to the author, the strength of this association was on par with that of breastfeeding on cognitive development and approximately a quarter of the strength of the associations related to

race/ethnicity and socioeconomic status. In within-family analysis of the CDS sibling subsample, children who received prenatal or early life exposure to WIC scored significantly better on reading assessments at around age 11 than their siblings who did not (Jackson, 2015).

The association between diet and cognitive performance in children is well documented. In a study of 107 predominately Hispanic (91%) fourth grade students across 5 schools in Los Angeles, California, Riggs et al. (2010) examined baseline survey data from an obesity intervention pilot program called Pathways, which assessed students' typical food intakes alongside measures of executive cognitive function (ECF). The researchers found that increased snack food consumption, a risk factor related to obesity, was associated with lower ECF, while fruits and vegetables did not share this association (Riggs et al., 2010).

A formal literature review by Adolphus et al. (2013) examined the impacts of breakfast on academic performance in children and adolescents under the age of 18. The research team identified and analyzed 36 studies in the U.S. and abroad and concluded that skipping breakfast or consuming breakfasts of low nutritional quality was found to reduce academic performance in both children and adolescents. Skipping breakfast or consuming breakfasts of low nutritional quality was also seen to increase the likelihood of disruptive classroom behavior in both children and adolescents (Adolphus et al., 2013).

A Canadian study of 5,200 fifth grade students by Florence et al. (2008) also examined the associations between diet quality and academic performance. The

researchers, using the U.S. Dietary Guidelines as the reference for ideal diet quality, found that students who had low diet quality relative to the U.S. Dietary Guidelines performed significantly worse on academic assessments. Furthermore, those in higher socioeconomic tiers tended to perform significantly better than those of lower socioeconomic status (Florence et al., 2008).

WIC's Impact on In-Store and Community Food Environments

WIC has also been shown to increase healthy food access in communities by improving healthy food availability in smaller stores. Andreyeva et al. (2012) performed pre and post store inventories of 252 convenience and non-chain grocery stores in Connecticut 4-7 months prior to and 6-7 months following the last major WIC food package revisions in 2009. The store sample included 33 WIC authorized stores and 219 non-WIC stores. Approximately 80% of stores were small stores with only a single cash register. Data were collected on healthy food availability, variety, quality, and pricing in each store, which were then used to calculate a healthy food supply score (maximum score of 31 points) for each outlet. Prior to the food package revisions, non-WIC convenience and grocery stores scored an average of 8.16 points, while WIC authorized stores scored slightly higher at 9.97 points ($p<0.05$). However, following the revisions, non-WIC stores remained statistically the same at 8.65 points, while the healthy food supply score of WIC scores increased significantly to 14.03 points (Andreyeva et al., 2012).

Cobb et al. (2015) performed a similar pre-post study of store inventory healthfulness before and after the 2009 food package revisions by looking at store audits

of 118 food stores in Baltimore, MD conducted in 2006 and 2012. At baseline, the mean healthy food availability score for all stores was 7.06 (out of 18), ranging from approximately 5 points for all smaller stores to more than 16 points for supermarkets. Between 2006 and 2012, there was a significant increase of 1.25 points observed in the total sample, with the greatest increases seen in corner stores. When the scores were recalculated using an 11-point scale accounting for only WIC-relevant foods, the 102 smaller stores in the study saw their scores increase significantly from 3.60 at baseline in 2006 to 4.61 in 2012, regardless of WIC status. However, stores which were not WIC authorized in either period increased by an average of 0.49 points, while stores which were WIC authorized in both time periods increased by 1.22 points. Furthermore, stores which were authorized by WIC in 2012, but not in 2006, increased their scores by an additional 1.00 point compared to pre-existing WIC authorized stores (Cobb et al., 2015).

Rose et al. (2014) also performed in-store inventories of 27 WIC authorized stores and 66 non-WIC stores in 2009 and again in 2010, following the food package revisions. The store sample covered 77% of all small stores (<$1 million in annual sales) located in New Orleans, LA. WIC authorized stores were generally located in lower-income areas than non-WIC stores. From baseline to follow-up, the percentage of non-WIC stores carrying fresh fruits increased significantly from 50% to 68%. Meanwhile, the proportion of WIC authorized stores carrying fresh fruit remained high at 82% and 93%, respectively. The percentage of WIC authorized stores carrying the WIC-specified brand of whole wheat bread increased from 4% to 70% across the period. A similar change was observed in the proportion of WIC authorized stores carrying the WIC-specified brand of

brown rice, which increased from 4% to 93%. The median number of fresh fruits in WIC authorized stores increased from 3.0 to 4.0, but did not increase in non-WIC stores. Furthermore, the odds of improving the availability of low-fat milk options (skim, 1%, or 2%) were approximately 5 times greater for WIC authorized stores than non-WIC stores across the study period (Rose et al., 2014).

WIC Spill-Over Effects and Gaps in the Literature

Few studies have examined so-called "spill-over" effects surrounding the WIC program. However, emerging evidence suggests that access to WIC foods may yield improved dietary and health outcomes among nonparticipants.

Basiotis & Kramer-LeBlanc (1998) were among the first to touch on this phenomenon by looking at aggregate Healthy Eating Index (HEI) scores for a national sample of households participating in WIC and the Food Stamp Program (FSP, now SNAP), between 1989 and 1991. The mean HEI for all low-income households was 62.18. Households participating in the FSP had a significantly lower mean HEI of 60.70. However, households with at least one person participating in WIC had a mean aggregate household HEI score 23.45 points higher than the overall mean, suggesting that other household members, likely to be nonparticipants, may benefit from exposure to the WIC program (Basiotis & Kramer-LeBlanc, 1998).

Ver Ploeg (2009) was among the first to examine spillover effects more directly by comparing the HEI scores of age-ineligible children (i.e 5- to 17-year olds) residing in WIC households with similar children living in non-WIC households. Data were obtained

from the third wave of the NHANES conducted between 1988 and 1994. The study found that children residing in WIC households had significantly higher HEI scores than those who did not. Robinson (2013) performed a similar examination of data from the third wave of the NHANES to assess ties between household WIC participation and the health outcomes of age-eligible siblings residing in the home. The author found that doctor-reported measures of health were significantly better among older siblings living in WIC-participating homes compared to those residing in non-WIC households.

More recently, Steeves et al. (2019) examined the dietary behaviors of 570 low-income, age-ineligible children (ages 5-11 years and 12-18 years) residing in four densely populated New Jersey cities using cross-sectional data collected as part of the New Jersey Child Health Study (NJCHS) in 2009-10 and 2014. The study found a strong trend toward higher frequency of vegetable consumption among 12- to 18-year old children residing in WIC-participating homes compared to those in non-WIC homes, with a significant difference seen among older males exclusively. While fruit consumption did not vary between WIC and non-WIC households, younger females from WIC households were found to consume 100% juice approximately 44% more frequently than similar females in non-WIC households (Steeves et al., 2019).

The need to examine whether similar "spill-over" effects exist in the broader community as a result of improved access to WIC stores, and the healthier foods they provide, is a primary motivation of the current study and an area in which very little research currently exists. Data from the NJCHS provides a unique opportunity to begin to

explore these relationships at the community level and the following analysis has been performed in the hope that future studies might build upon its findings and approach.

CHAPTER 3

METHODS

Study Design

This study was conducted as a secondary analysis of household survey data collected as part of the New Jersey Child Health Study (NJCHS). The NJCHS is a longitudinal study examining how food and physical activity environments impact child health behaviors and weight status among the populations of four high-density, predominantly lower-income cities in New Jersey: Camden, Newark, New Brunswick and Trenton.

The NJCHS was approved by the Institutional Review Boards (IRB) of Rutgers University and Arizona State University (Appendix C).

Data Collection

For this study, data were derived from the baseline interviews of two independent cross-sectional panels from the NJCHS. Panel 1, which occurred between June 2009 and April 2010, consisted of 1,408 households. Panel 2, conducted between April and August 2014, consisted of 803 households. In total, data were collected from 2,211 households. The primary method of data collection was through household surveys administered using random-digit-dial sampling of landline phone numbers. Randomly generated cell phone sampling was added during Panel 2 due to declining use of landlines in homes. For Panel 1 and Panel 2, up to 22 and 23 call efforts were made to each geographically qualifying household, respectively.

Surveys were offered in both English and Spanish. All respondents provided verbal consent prior to beginning the survey. Respondents were asked to complete the survey on behalf of themselves and the index child in each household. Respondents who successfully completed the survey were compensated $10 in Panel 1 and $25 in Panel 2. Response rate was 49% and 36%, respectively. Average time to complete the survey was 36 minutes in Panel 1 and 30 minutes in Panel 2.

In total, data were collected from 2,211 households. Panel 1 consisted of 1,408 households, while Panel 2 consisted of 803 households. The number of households by city, for each panel, is shown in Appendix A.

Participants

In order to participate, respondents were required to be: 1) 18 years or older with at least one child age 3-to-18 years old residing in the home with whom they were related, 2) able to speak either English or Spanish, and 3) responsible for making most of the household's food shopping decisions. In instances where a household contained more than 1 child between the ages of 3 and 18, computer randomization was used to select a child from the household to be the "index child" for analysis. For Panel 2, inclusion criteria were the same as Panel 1 except that the age range for the index child was 5 to 15 years old. In 94% cases, the respondent was a parent or grandparent of the index child.

In order to restrict the study sample (n = 2,211) to lower-income households, individuals were excluded if their household income exceeded 200% of the Federal Poverty Level (n = 711). Additional exclusion criteria included unknown WIC

participation status (n = 12), index child age above 18 (n = 3), non-geo-codable household location (n = 48), biologically implausible measurements (n = 151), unknown maternal education level (n = 35), and individuals for which a localized measure of the retail food environment could not be calculated (n = 4). The final analytical sample consisted of 1,247 individuals.

Outcome Variable

Child food consumption was determined by asking respondents frequency-based questions about the index child's consumption of items from key food categories. Survey questions were adapted from similar questions used by the Behavioral Risk Factor Surveillance System (BRFSS) and the National Health Examination Survey (NHANES) (CDC, 2005; CDC, 2014). Key food categories included fruits, vegetables, sugar-sweetened beverages, and certain sweet snack foods.

Respondents were asked to recall the "different kinds of foods [the index child] ate or drank during the past month" and to estimate consumption frequency in terms of "times per day, per week, or per month". Respondents could also choose to answer "Never", "Don't Know", or "Refuse" for any frequency-related question.

Fruit consumption frequency was measured by asking respondents "Not counting juice, how often did (index child) eat fruit? Count fresh, frozen, or canned fruit".

Vegetable consumption frequency was measured using responses from 4 independent questions regarding food frequencies for salads, potatoes, beans, and "other vegetables". For salads, respondents were asked "How often did (index child) eat a green

leafy or lettuce salad, with or without other vegetables?". For potatoes, respondents were asked "Not including French fries or other fried potatoes, how often did (index child) eat any other kind of potatoes such as baked, boiled, mashed potatoes, or potato salad?". For beans, respondents were asked "How often did (index child) eat cooked or canned dried beans, such as refried beans, baked beans, bean soup, tofu, or lentils?". For other vegetables, respondents were asked "Not including what you just told me about, how often did (index child) eat other vegetables such as tomatoes, green beans, carrots, corn, cooked greens, sweet potatoes, broccoli, or any other kinds of vegetables?".

Sugar-sweetened beverages (SSB) included any non-diet beverages containing added sugar and was evaluated as a composite of 2 separate questions, one regarding soda specifically and the second regarding all other sweetened beverages. For soda, respondents were asked "How often did (index child) drink regular carbonated soda or soft drinks that are sweetened such as Coke, Pepsi, or 7-up? Do not include diet drinks." For other SSBs, respondents were asked "How often did (index child) drink fruit flavored drinks such as lemonade, Sunny Delight, Kool-Aid, Gatorade, or sweet iced teas? Do not include 100% fruit juice".

Frequencies of sweet food consumption were combined with frequencies of SSBs to assess a measure of total added sugar intake. To determine sweet food frequencies, respondents were asked "How often did (index child) eat sweet items like cookies, cakes, candy, or pies?".

Per-day frequencies were calculated from weekly and monthly ranges reported by the parents. Daily frequencies were then converted to estimated daily consumption

quantity values using sex-age specific portion size conversion algorithms developed by NCI for processing of 2009-2010 NHANES Dietary Screener Questionnaire data (National Cancer Institute, 2020). Quantities were specified as cups-per-day for fruits and vegetables, and teaspoons-per-day for sugar from sugar-sweetened beverages and for total added sugars. Estimated daily consumption values for each of the key food categories were then placed into age group specific deciles (under 5, 5-11, 12-18) for analysis. This effectively divided the distribution of consumption quantities for children in each age group into 10 equal subsections, with each subsection corresponding to a range of 10 percentage points. Thus, children found in the lowest decile rank (i.e. 10^{th} percentile) were among the lowest 10% of their respective age group in terms of consumption. Similarly, children found in the highest decile rank (i.e. 90^{th} percentile) were among the highest 10% of their respective age group in terms of consumption.

Retail Food Stores

Lists of retail food establishments located within each study city, containing address, contact, and sales volume information for each establishment, were acquired from the national business databases of InfoUSA and Nielsen in each of the study years and classified using the Food Store and Restaurant Classification Protocol shown in Appendix D. Information from commercial databases can be prone to incomplete or out-of-date data, which was minimized by comparing information from multiple databases and verifying individual entries on multiple levels, as outlined below.

Stores were first sorted by annual sales volume (under $1M, $1M to $2M, over $2M). Keyword searches were performed for common non-food outlet types (e.g.

"liquor", "bar", etc.) and corresponding entries were withheld from analysis. All other outlets with sales volumes below $1M were classified as convenience stores. For outlets with sales volumes of $1M to $2M, and over $2M, name recognition scans were performed for known outlets, including popular supercenter, supermarket, chain grocery, and convenience store names (e.g. WalMart, Aldi, Wawa, ShopRite, etc). For stores in the $1M to $2M category which could not be identified through name recognition, calls were made to individual stores to assess store type and healthy food availability. For stores with sales volumes over $2M which could not be identified through name recognition, internet searches were first performed to identify the store type. If the store type was unidentifiable by internet search, or if found not to be a supermarket or chain grocery store, telephone calls were made to individual stores. The specific phone script used when contacting stores by telephone can be found in the Food Store and Restaurant Classification Protocol shown in Appendix D. Up to 6 call attempts were made for each store. Calls were completed on different days and at different times to ensure the best chance of contact.

Upon successful contact, stores were categorized by store type based on the number of specific healthy foods available and the number of checkouts in each store, as well as manager-reported perceptions of store type. To assess healthy food availability, stores were asked if they carried: 1) five or more different kinds of fresh fruits, 2) five or more different kinds of fresh vegetables, 3) any fresh or frozen meats, and 4) either skim or low-fat (1%) milk. Following phone verification, stores with annual sales volumes of at least $2M, having 4 or more checkouts, and a manager's perception of the store being

similar to either commonly known supermarkets (e.g. Pathmark, ShopRite, or Stop-and-Shop) or chain grocery stores (e.g. Aldi or Save-A-Lot) and selling many healthy foods were classified as supermarkets or chain grocery stores, respectively. Food stores having sales volumes of at least $1M, fewer than 4 checkouts, but carrying at least 3 of the 4 healthy food categories, were classified as small grocery stores. Stores with sales volumes of at least $1M, but carrying fewer than 3 of the 4 healthy food categories, were classified as convenience stores. For the purpose of the current study, stores were further categorized into a binary variable of store size as either large stores (chain grocery stores, supermarkets, supercenters) or small stores (small grocery, convenience, etc.).

Key Exposure

A complete list of WIC authorized vendors for the State of New Jersey was obtained from the New Jersey Department of Health for each of the study years. These state lists were cross-referenced with the retail food store database for each study city in order to identify the store type classification of each WIC authorized store in the corresponding study year. WIC authorized store counts for each household were determined through geo-coded analysis of roadway networks between household and retail food store addresses at 0.25, 0.5, and 1.0 mile road network distances from each child's home using ArcGIS software. Household addresses were collected through the preceding household surveys.

Covariates

Age, sex, and race/ethnicity of the index child was determined through corresponding survey questions and reported by the survey respondent. For this analysis, child age was further categorized into 3 age groups: 1) Under 5 years old, 2) 5- to 10-years old, and 3) 11- to 18-years old. Race/ethnicity of the index child was categorized as either “Non-Hispanic White”, “Non-Hispanic Black”, “Hispanic” or “Other”.

Household WIC participation was assessed by asking respondents “Did anyone in your family living there receive WIC in [previous year]?”. Response options were “Yes”, “No”, “Don’t Know”, or “Refused”. When necessary, WIC was clarified to mean the “Special Supplemental Nutrition Program for Women, Infants and Children”. Participants were also asked if they received food stamps or Supplemental Nutrition Assistance Program (SNAP) benefits in the prior year.

Parental educational attainment was also assessed. If respondent was not the mother of the index child, the respondent was asked to report “the highest grade or level of school” that the index child’s mother had completed. The mother’s education level was then categorized as either “less than high school”, “high school or equivalent”, “some college”, “4-year degree (Bachelors)”, or “advanced degree (MS, MA, PhD)”.

Respondents were asked to report total household income from all sources, before taxes and other deductions. These responses were later converted to a relative percentage of the Federal Poverty Level (FPL) in each study year.

Statistical Analyses

As this study was a secondary analysis of existing data, the research questions and hypotheses were developed prior to data analysis, but subsequent to data collection. Following distribution analyses to assess variable normality, bivariate testing was applied to examine associations between individual factors and assess collinearity prior to creating models for multivariate regression analysis. Multivariate regression analyses were then performed to assess relationships between WIC store counts and child food consumption measures. Survey weights were applied to all models to produce a more representative sample of the geographical areas used in the study. Interaction terms based upon WIC participation were employed in analyses examining differences between WIC-participating and non-participating households.

All models controlled for socio-economic and demographic characteristics, such as household income, maternal education level, age, sex, and race/ethnicity of the index child. To control for factors related to the community food environment, the CDC's modified Retail Food Environment Index (mRFEI) formula was adapted to calculate a measure of local food environment healthfulness for each household. The CDC formula is mRFEI = 100 x [H/(H + L)], where H is the number of healthy food retailers (supermarkets, supercenters, large grocery stores, F&V markets, warehouse clubs), and L is the number of less healthy food retailers (fast food restaurants, convenience stores, small grocery stores), located within a given census tract (CDC, 2011). The current analysis refined that measure and used counts for each outlet type within a 1-mile radius

of a child's home, rather than by census tract, allowing for improved representation of local neighborhood characteristics. Significance was achieved at $p \leq 0.05$.

All analyses were performed using Stata 15.1 (StataCorp LLC; College Station, TX, 2017).

CHAPTER 4

MANUSCRIPT

Introduction

The community food environments in low-income areas often fail to provide the types of foods necessary to support healthy food choices (Hosler et al., 2008; Larson et al., 2009; Richardson et al., 2012). In densely populated urban settings, smaller grocery and convenience stores tend to dominate the landscape, and access to supermarkets, along with the healthier foods they offer, can vary widely (Larson et al., 2009; Ohri-Vachaspati et al., 2013). When available, healthier options are often more expensive in smaller stores compared to larger stores, especially in low income neighborhoods (Gosliner et al., 2018). Lack of access to healthy food options may contribute to the dietary patterns of children from lower-income households, who have been found to consume greater amounts of unhealthy foods, such as chips, candy, and sugar-sweetened beverages, and fewer fruits and vegetables than their higher-income peers (Borradaile et al., 2009; Hanson & Chen, 2007; Paes et al., 2015).

According to the latest Dietary Guidelines for Americans, children ages 2-8 should be consuming a minimum of 1 to 1.5 cups of both fruits and vegetables in a day and children ages 9-18 should be consuming at least 1.5 to 2 cups of fruit and 2 to 3 cups of vegetables (USDA, 2015). However, over 50% of children ages 1-8 and more than 90% of children ages 9-18 fail to consume the recommended daily servings of fruits and vegetables (National Cancer Institute, 2019). The American Heart Association suggests

that children's daily intake of added sugars be limited to fewer than 10% of total daily calories, but added sugars, particularly those from sugar-sweetened beverages like juice and soda, account for far more than 10% of the calories most children receive in a day (Bailey et al., 2018; National Cancer Institute, 2019).

A key federal program for improving young children's access to healthy foods is the Special Supplemental Nutrition Assistance Program for Women, Infants and Children (WIC). WIC's primary purpose is to ensure that pregnant and breastfeeding mothers, infants, and children up to the age of 5 residing in low-income households can obtain nutritionally adequate diets. To ensure availability of healthy foods for the program's recipients, WIC-authorized food stores are required to stock a minimum number of healthy food items in accordance with the program's unique food package guidelines. These items typically include whole grain-rich foods, low-fat milk, 100% fruit juice, dried beans or peanut butter, cheese, fruits, vegetables, and eggs, in addition to baby food and infant formula (Pelletier et al., 2017).

While superstores and supermarkets make up nearly 60% of WIC retail vendors nationally, smaller grocery and convenience stores, prominent in urban settings, make up a substantial portion of all WIC-authorized retail vendors at approximately 22% and 13%, respectively (Tiehen & Frazão, 2016). A recent study analyzing the healthfulness of small stores in urban settings found that healthy food options were largely absent from small stores that were not WIC-authorized (DeWeese et al., 2016). Through its influence on the foods that are available in WIC authorized stores, WIC has been shown to

measurably improve the community food environments in low-income areas (Andreyeva et al., 2012; DeWeese et al., 2016; Rose et al., 2014).

Although WIC's primary reach is limited to young children and pregnant and nursing mothers from low-income households, emerging evidence suggests that WIC's presence may benefit non-eligible members of the household (Robinson, 2013; Steeves et al., 2019). What remains to be examined empirically is whether similar spill-over effects resulting from improved access to WIC-authorized stores, and the healthier foods they offer, exist in the larger community setting, particularly among low-income households not participating in WIC.

The current study seeks to examine the associations between child food consumption and the number of WIC-authorized stores found near children's homes, as well as examine how this association might differ by household WIC participation status. It is hypothesized that children living close to a greater number of WIC stores will consume a greater quantity of healthy foods and lower quantity of unhealthy foods, and that this association will be stronger among children from WIC households.

Methods

Participant Data

This study was conducted as a secondary analysis of household survey data collected as part of the New Jersey Child Health Study (NJCHS). The NJCHS is a longitudinal study examining how food and physical activity environments impact child health behaviors and weight status among the populations of four high-density,

predominantly lower-income cities in New Jersey: Camden, Newark, New Brunswick and Trenton. The NJCHS was approved by the Institutional Review Boards (IRB) of Rutgers University and Arizona State University.

For this study, data were derived from the baseline interviews of two independent cross-sectional panels from the NJCHS. Panel 1, which occurred between June 2009 and April 2010, consisted of 1,408 households. Panel 2, conducted between April and August 2014, consisted of 803 households. In total, data were collected from 2,211 households. The primary method of data collection was through household surveys administered using random-digit-dial sampling of landline phone numbers. Randomly generated cell phone sampling was added during Panel 2 due to declining use of landlines in homes.

Respondents were required to be: 1) 18 years old or older with at least one child age 3-to-18 years old residing in the home with whom they were related, 2) able to speak either English or Spanish, and 3) responsible for making most of the household's food shopping decisions. In instances where a household contained more than 1 child between the ages of 3 and 18, computer randomization was used to select a child from the household to be the "index child" for analysis. For Panel 2, inclusion criteria were the same as Panel 1 except that the age range for the index child was 5 to 15 years old.

Surveys were offered in both English and Spanish. All respondents provided verbal consent prior to beginning the survey. Respondents were asked to complete the survey on behalf of themselves and the index child in each household. Respondents who successfully completed the survey were compensated $10 in Panel 1 and $25 in Panel 2.

Response rate was 49% and 36%, respectively. Average time to complete the survey was 36 minutes in Panel 1 and 30 minutes in Panel 2.

Study Sample

In order to restrict the study sample (n = 2,211) to lower-income households, individuals were excluded if their household income exceeded 200% of the Federal Poverty Level (n = 711). Additional exclusion criteria included unknown WIC participation status (n = 12), index child age above 18 (n = 3), non-geo-codable household location (n = 48), biologically implausible measurements (n = 151), unknown maternal education level (n = 35), and individuals for which a localized measure of the retail food environment could not be calculated (n = 4). The final analytical sample consisted of 1,247 individuals.

Outcome Variable

Child food consumption was determined by asking respondents frequency-based questions about the index child's consumption of items from key food categories. These categories included fruits, vegetables, sugar-sweetened beverages, and certain sweet snack foods. Fruits did not include fruit juice and vegetables included legumes, but not French fries. Sugar-sweetened beverages included all sweetened drinks and sodas, but not diet drinks or 100% fruit juice. In the analysis, total added sugars included sugar from SSBs, as well as sweet foods, such as cookies, cake, candy, and pies, but not from ice cream, donuts/danishes, or breakfast cereals.

Respondents were asked to recall the "different kinds of foods [the index child] ate or drank during the past month" and to estimate consumption frequency for each food category in terms of "times per day, per week, or per month". Respondents could also choose to answer "Never", "Don't Know", or "Refuse". Per-day frequencies were recorded as a range of 1-10 with "10" equating to 10 times per day or more. Per-week and per-month frequencies were recorded as a range of 1-7 and 1-30, respectively. Estimated daily frequencies were calculated from weekly and monthly ranges, then all daily frequencies were converted to estimated daily consumption quantity values using sex-age specific portion size conversion algorithms developed by the National Cancer Institute for processing of 2009-2010 NHANES Dietary Screener Questionnaire data (National Cancer Institute, 2020). Quantities were specified as cups-per-day for fruits and vegetables, and teaspoons-per-day for sugar from sugar-sweetened beverages and total added sugars. Estimated daily consumption values for each of the key food categories were then placed into age group specific deciles (under 5, 5-11, 12-18) for analysis.

Key Exposure – WIC Food Outlets

Stores were first sorted by annual sales volume (under $1M, $1M to $2M, over $2M). Keyword searches were performed to remove common non-food outlet such as liquor stores and bars. All outlets with sales volumes below $1M were classified as convenience stores. For outlets with sales volumes of over $2M, name recognition scans were performed for known outlets, including popular supercenter, supermarket, chain grocery, and convenience store names (e.g. WalMart, Aldi, Wawa, ShopRite, etc). If stores were not identified through name recognition, internet searches and phone calls

were and stores having 4 or more checkouts, and a manager's perception of the store being similar to either commonly known supermarkets (e.g. Pathmark, ShopRite, or Stop-and-Shop) or chain grocery stores (e.g. Aldi or Save-A-Lot) and selling a range of healthy foods were classified as supermarkets. For stores in the $1M to $2M category which could not be identified through name recognition, calls were made to individual stores to assess store type and healthy food availability. To assess healthy food availability, stores were asked if they carried: 1) five or more different kinds of fresh fruits, 2) five or more different kinds of fresh vegetables, 3) any fresh or frozen meats, and 4) either skim or low-fat (1%) milk. Stores carrying at least 3 of the 4 healthy food categories, were classified as small grocery stores and those carrying fewer than 3 of the 4 healthy food categories, were classified as convenience stores. For the purpose of the current study, stores were further categorized into a binary variable of store size as either large stores (chain grocery stores, supermarkets, supercenters) or small stores (small grocery stores, convenience stores.). Up to 6 call attempts were made for each store. Calls were completed on different days and at different times to ensure the best chance of contact.

A complete list of WIC authorized vendors for the State of New Jersey was obtained from the New Jersey Department of Health for each of the study years. These state lists were cross-referenced with the retail food store database for each study city in order to identify the store type classification of each WIC authorized store in the corresponding study year. WIC authorized store counts for each household were determined through geo-coded analysis of roadway networks between household and

retail food store addresses at 0.25, 0.5, and 1.0 mile road network distances from each child's home using ArcGIS software. Household addresses were collected through the preceding household surveys.

Statistical Analyses

Following distribution analyses to assess variable normality, bivariate testing was applied to examine associations between individual factors and assess collinearity prior to creating models for multivariate regression analysis. Multivariate regression analyses were then performed to assess relationships between WIC store counts and child food consumption measures. Survey weights were applied to all models to produce a more representative sample of the geographical areas used in the study. Interaction terms based upon WIC participation were employed in analyses examining differences between WIC-participating and non-participating households. All models controlled for potentially confounding socio-economic and demographic characteristics, including household income, maternal education level, age, sex, and race/ethnicity of the index child.

To control for factors related to the community food environment, the CDC's modified Retail Food Environment Index (mRFEI) formula was adapted to calculate a measure of local food environment healthfulness for each household. The CDC formula is mRFEI = 100 x [H/(H + L)], where H is the number of healthy food retailers (supermarkets, supercenters, large grocery stores, F&V markets, warehouse clubs), and L is the number of less healthy food retailers (fast food restaurants, convenience stores, small grocery stores), located within a given census tract (CDC, 2011). The current analysis refined that measure and used counts for each outlet type within a 1-mile radius

of a child's home, rather than by census tract, allowing for improved representation of local neighborhood characteristics.

All analyses were performed using Stata 15.1 (StataCorp LLC; College Station, TX, 2017). Significance was achieved at $p \leq 0.05$.

Results

Demographic characteristics of the analytical sample (N = 1247) are described in Table 1. Of the total, 311 (24.9%) children resided in WIC households and 936 (75.1%) in non-WIC households. Slightly more than half (51.0%) of the children in the overall sample were Non-Hispanic Black and 43.2% were Hispanic. Non-Hispanic Whites and those identifying as "other" accounted for 3.1% and 2.6% of the study sample, respectively. Almost three-quarters (73.6%) of the children had a mother who received at least a high school education and 5.9% had a college degree. A higher proportion of children in WIC-participating households were under 5 years of age (21.7%) compared to the proportion in non-WIC households (3.8%). Similarly, although the analytical sample was restricted to children in households with incomes at or below 200% of the FPL, WIC-participating households on average had significantly lower incomes relative to the FPL (88%) than non-participating households (99%). No significant differences were observed for race/ethnicity, mother's education, city of residence, or child's sex between WIC and non-WIC households.

Table 1. Characteristics of sample by household WIC participation status (n=1,247)[a]

Characteristic	Total Analytical Sample (n=1,247)	*Children in Non-WIC Households (n=936) %*	*Children in WIC Households (n=311) %*	*p-value*[b]
Sex				0.06
Male	637	50.1	60.4	
Female	610	49.9	39.6	
Age				0.00*
Under 5 years old	85	3.9	21.7	
5-11 years old	587	50.5	52.0	
12-18 years old	575	45.6	26.3	
Race/Ethnicity				0.29
Non-Hispanic White	39	5.1	2.7	
Non-Hispanic Black	636	50.9	43.1	
Hispanic	539	38.7	49.3	
Other	33	5.3	4.9	
Mother's Education				0.50
Less than High School	329	24.6	32.4	
High School	572	46.4	42.6	
Some College	273	20.6	18.3	
College Degree or Higher	73	8.4	6.7	
Residence				0.36
Camden	387	20.6	21.9	
Newark	435	55.5	51.0	
New Brunswick	152	7.8	12.2	
Trenton	273	16.0	14.9	
Household Income				
Income to Federal Poverty Level Ratio, mean (SD)		0.99 (0.51)	0.88 (0.47)	0.03*

[a] All n values unweighted; Percentage values weighted and adjusted for clustering by city

[b] For difference between WIC and non-WIC participating households

*$p<0.05$

Mean daily estimated consumption quantities for key food categories are shown in Table 2, stratified by age group, and shown by household WIC participation status. Children in the 12-18 age range residing in WIC-participating households were found to consume a significantly ($p = 0.03$) higher amount of vegetables (1.51 cup-equivalents per day) compared to non-WIC households (1.32 cup-equivalents per day). No other

significant differences in mean daily consumption quantities were found between WIC-participating and non-participating households.

Table 2: Daily food consumption characteristics by age group and household WIC participation status (n=1,247)

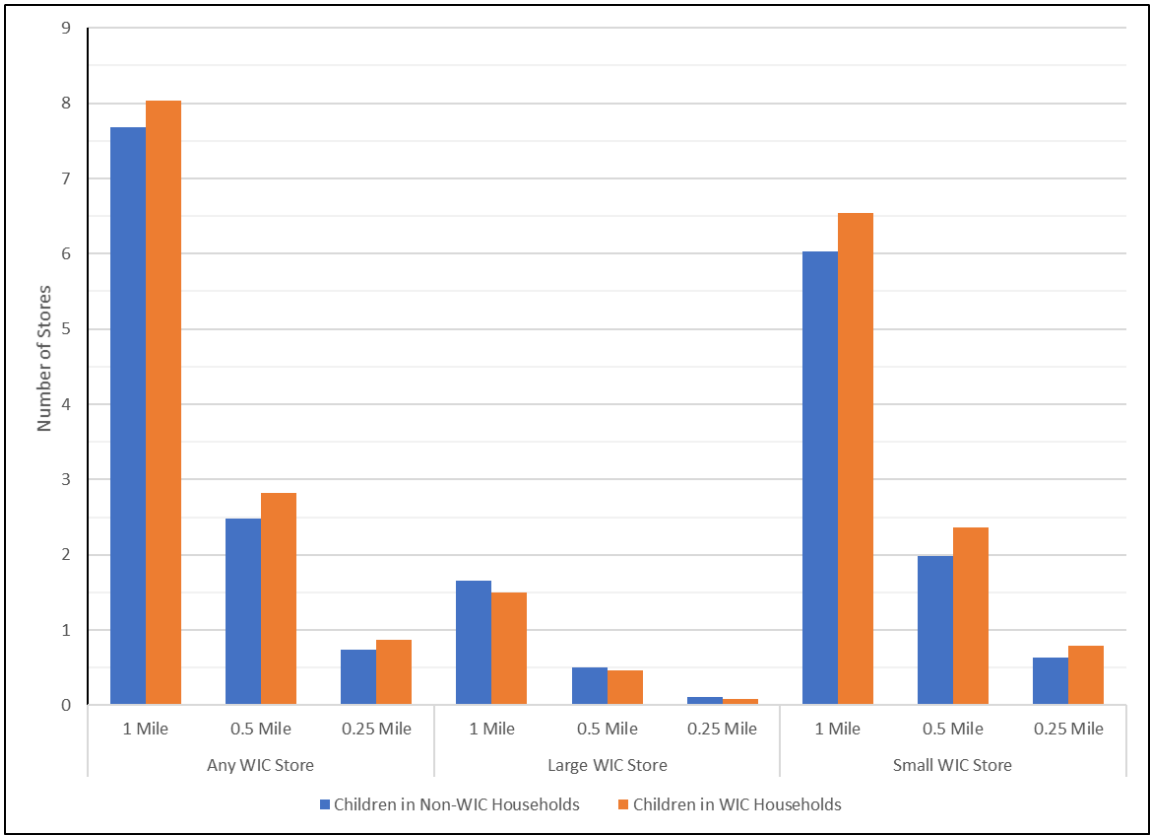
Age Group and Food Categories	*Non-WIC mean (SD) (n=936)*	*WIC mean (SD) (n=311)*	*p-value*[a]
Children under age 5	***n=31***	***n=54***	
Vegetables (cup equivalents/day)	0.99 (0.24)	0.85 (0.23)	0.08
Fruits (cup equivalents/day)	1.33 (0.50)	1.21 (0.42)	0.34
Sugar From Sweetened Beverages (tsp/day)	5.70 (1.42)	5.70 (2.55)	1.00
Total Added Sugars (tsp/day)	13.20 (1.31)	13.66 (3.16)	0.56
Children ages 5-11	***n=430***	***n=157***	
Vegetables (cup equivalents/day)	0.97 (0.34)	0.96 (0.33)	0.75
Fruits (cup equivalents/day)	1.36 (0.75)	1.35 (0.63)	0.87
Sugar From Sweetened Beverages (tsp/day)	6.86 (4.02)	6.13 (2.96)	0.10
Total Added Sugars (tsp/day)	14.89 (4.72)	14.19 (3.69)	0.21
Children ages 12-18	***n=475***	***n=100***	
Vegetables (cup equivalents/day)	1.32 (0.44)	1.51 (0.62)	0.03*
Fruits (cup equivalents/day)	1.02 (0.70)	1.12 (0.86)	0.46
Sugar From Sweetened Beverages (tsp/day)	10.78 (8.16)	10.28 (5.37)	0.63
Total Added Sugars (tsp/day)	18.30 (8.83)	17.84 (6.23)	0.70

[a] For differences between WIC-participating and non-participating households
*$p<0.5$

Figure 1 shows the count of WIC stores by store size at 0.25, 0.5, and 1 mile road networks from children's homes for WIC-participating and non-participating households. On average, within a 1 mile road network around their home, children living in WIC households had 8 total WIC stores, 1.5 large WIC stores, and 6.5 small WIC stores. As expected, there were fewer stores at smaller road network distances (0.25 mile and 0.5

mile) and this was especially true for large WIC stores. No significant differences were observed in store counts between WIC-participating and non-participating households for any distance or store size.

Figure 1: Count of WIC-authorized stores by store size and distance from children's homes[a]



[a] No differences were found to be significant at $p<0.05$

Given the small number of WIC stores within 0.25 mile road networks, and the fact that 80% of all WIC stores were small stores, resulting in a very low frequency of large stores in the overall sample, multivariable analyses were limited to 0.5 mile and 1 mile road networks and conducted only for small WIC stores and total WIC stores. Results from ordinary least square regression models examining the association between

estimated quantities of consumption, grouped in deciles, and counts of total and small WIC stores located within immediate 0.5-mile and 1.0-mile road networks around each child's home are shown in Table 3. Beta coefficients represent the estimated decile change in a child's consumption level for each additional WIC store located within the specified road network distance. Using fruits and vegetables consumption as an example, each additional WIC store within a 0.5 mile road network of children's homes was associated with a 0.03-decile (95% CI = -0.08, 0.15) higher fruit and vegetable consumption. However, no associations were found to be statistically significant for any relationship examined.

Table 3: Association between estimated consumption quantities of key foods, in deciles, by children residing in households with incomes below 200% of the Federal Poverty Line and the number of WIC-authorized stores located within 0.5-mile and 1-mile of their homes by store size[a]

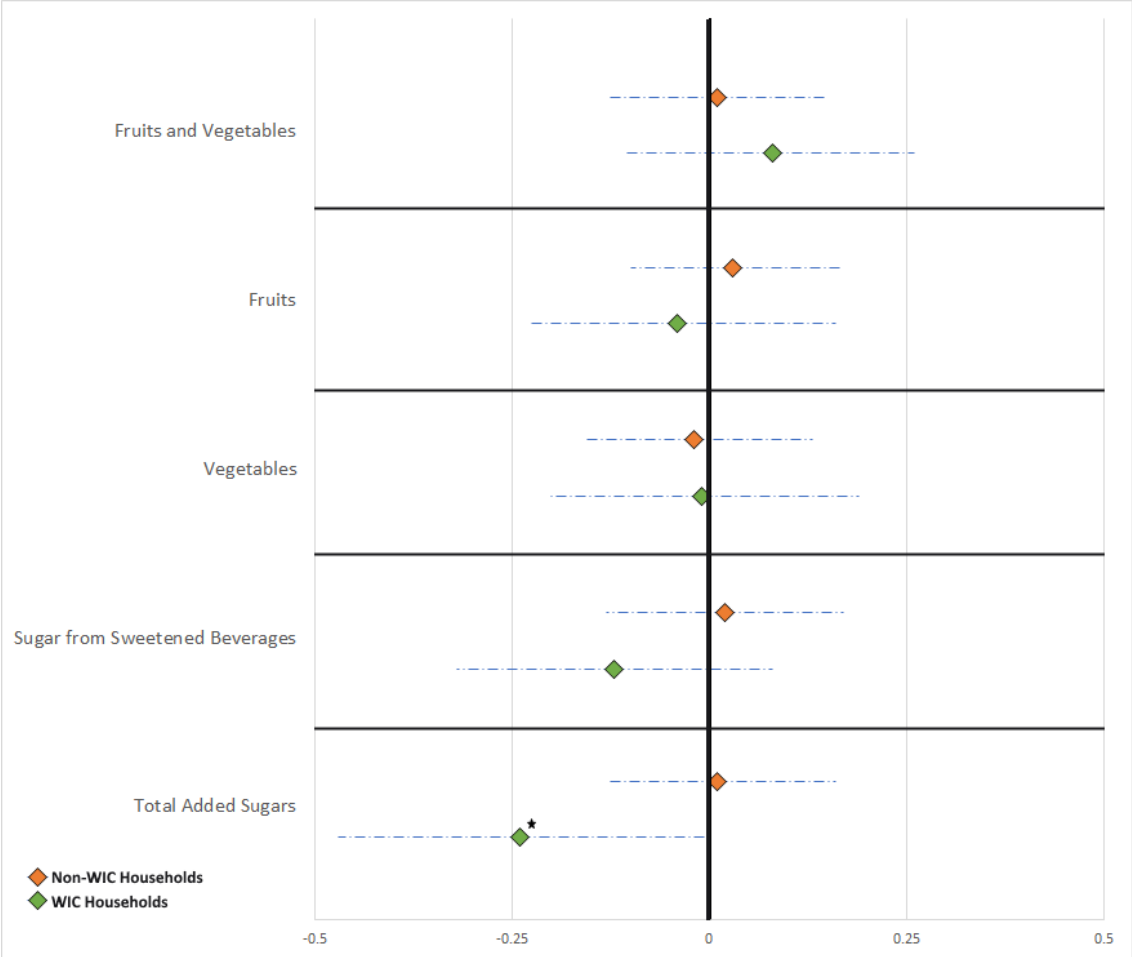
	All WIC Stores				Small WIC Stores Only			
	Number of WIC Stores within 0.5-mile		Number of WIC Stores within 1-mile		Number of WIC Stores within 0.5-mile		Number of WIC Stores within 1-mile	
Food Category	β-Coefficient	95% CI	β-Coefficient	95% CI	β-Coefficient	95% CI	β-Coefficient	95% CI
Fruits and Vegetables	0.03	(-0.08, 0.15)	0.01	(-0.05, 0.07)	-0.01	(-0.13, 0.11)	0.02	(-0.05, 0.08)
Fruits	0.01	(-0.11, 0.12)	-0.01	(-0.07, 0.05)	-0.04	(-0.17, 0.08)	-0.01	(-0.08, 0.05)
Vegetables	-0.01	(-0.13, 0.10)	-0.004	(-0.07, 0.06)	-0.04	(-0.16, 0.08)	-0.01	(-0.07, 0.06)
Sugar from Sweetened Beverages	-0.03	(-0.16, 0.09)	-0.004	(-0.06, 0.05)	-0.02	(-0.15, 0.11)	0.0003	(-0.06, 0.06)
Total Added Sugars	-0.08	(-0.21, 0.06)	-0.04	(-0.10, 0.03)	-0.05	(-0.19, 0.09)	-0.03	(-0.09, 0.04)

[a] No associations were found to be statistically significant at $p<0.05$.
Based upon ordinary least square regression models examining the association between estimated quantities of consumption, in deciles, and total count of WIC stores located within immediate 0.5-mile and 1-mile roadway networks around each child's home, adjusting for child gender, parental education level, household income, poverty level, race and ethnicity, participation in federal nutrition assistance programs (SNAP and WIC), and differences in consumption deciles by age group.

In order to examine how the relationships described in Table 3 might differ by household WIC participation status, and to see if differences exist in the magnitude of these associations when comparing WIC-participating and non-participating households, interaction terms (count of WIC stores * WIC participation status) were added to the models for total WIC stores presented in Table 3. Analyses were conducted separately for 0.5 and 1 mile road networks from children's homes and the results at each distance are presented in Figures 2 and 3, respectively. Each additional WIC store within a 0.5 mile road network was associated with a 0.24-decile lower (95% CI = -0.47, -0.003)

consumption quantity for total added sugars in WIC-participating households. While the difference in magnitude of this association was marginally significant ($p = 0.07$) when WIC and non-WIC households were compared, no between-group differences for any food category were found to be statistically significant. Furthermore, no other associations between household WIC participation status, decile consumption quantity, and the number of WIC-authorized stores were found to be significant at either the 0.5 mile or 1.0 mile road network distance.

Figure 2: β-coefficients and 95% CI from multivariate regression examining association between estimated daily food consumption quantity deciles & the number of WIC stores within 0.5-mile road network of children's homes[a]

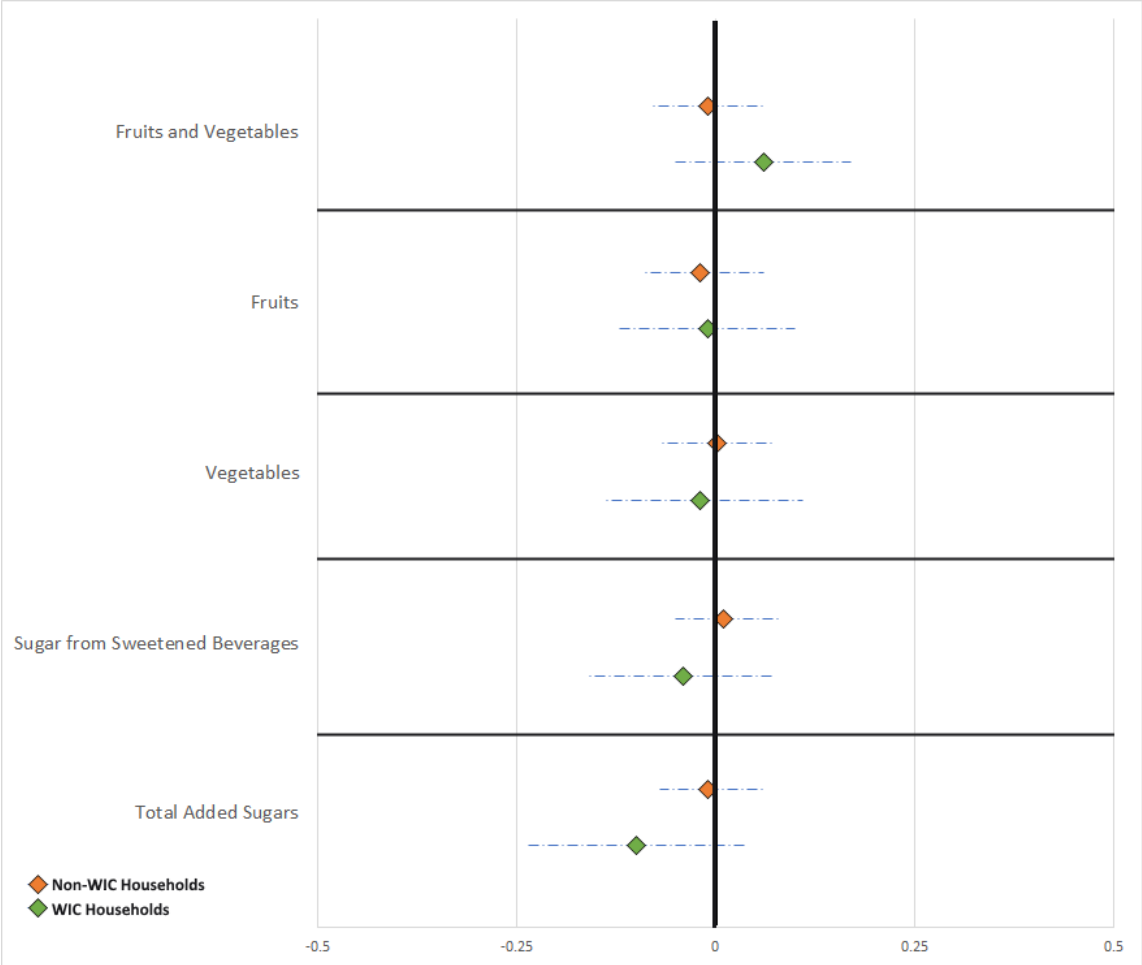


[a] No significant differences were found in associations between WIC and non-WIC participating households

*p<0.05 for association between WIC store count and change in consumption quantity deciles for total added sugars among WIC-participating households only.

Based upon ordinary least square regression models examining the association between estimated quantities of consumption, in deciles, and total count of WIC stores located within 0.5-mile roadway networks of children's homes by household WIC participation status, adjusting for child gender, parental education level, household income, poverty level, race and ethnicity, participation in federal nutrition assistance programs (SNAP and WIC), and differences in consumption deciles by age group.

Figure 3: β-coefficients and 95% CI from multivariate regression examining association between estimated daily food consumption quantity deciles & the number of WIC stores within 1-mile road network of children's homes[a]



[a] No within-group or between-group results were found to be significant at $p<0.05$
Based upon ordinary least square regression models examining the association between estimated quantities of consumption, in deciles, and total count of WIC stores located within 1.0-mile roadway networks of children's homes by household WIC participation status, adjusting for child gender, parental education level, household income, poverty level, race and ethnicity, participation in federal nutrition assistance programs (SNAP and WIC), and differences in consumption deciles by age group.

Appendix B extends the analysis presented in Table 3 by stratifying the sample into specific age groups (under 5, 5-11 and 12-18) and examines associations between decile consumption quantities and counts of all WIC stores within the 0.5 mile and 1 mile roadway networks. In these stratified models, significant associations were observed for

decile consumption quantities of both vegetables and combined fruits and vegetables with the total number of WIC stores at the 1 mile distance, but only for children in the under 5 age group. Each additional WIC store within 1 mile was associated with a 0.21-decile higher consumption quantity of vegetables (95% CI = 0.03, 0.40) and a 0.22-decile higher consumption quantity of fruits and vegetables combined (95% CI = 0.06, 0.37) for children under 5. Associations between consumption and the number of WIC stores at each distance were not significant for any other age group.

Discussion

Building on previous studies that have shed light on potential spillover effects related to the WIC program (Robinson, 2013; Steeves et al., 2019), this study is the first to examine associations between the number of WIC-authorized stores near children's homes and child food consumption using a diverse sample of children from 4 low-income, urban environments in New Jersey.

In the overall sample, there was no evidence of significant association between the number of WIC stores near children's homes and consumption of any food category. Previous studies have also failed to find associations between greater healthy food access and improved dietary habits, though none have examined WIC stores exclusively. A longitudinal study of residents from 2 low-income neighborhoods in Philadelphia, PA found that when a new supermarket was built in the neighborhood, perceptions of food access improved, but diets did not (Cummins et al., 2014). Similarly, a report by the USDA on food store access, food choice, and diet quality concluded that access to food

stores had a limited impact on food choices in a nationally representative sample (Ver Ploeg & Rahkovsky, 2016). In their systematic review of articles evaluating community food environments and children's diets, Engler-Stringer et al. (2014) concluded that, while a moderate body of evidence suggests an association between the community and consumer food environments and the dietary intakes of children and adolescents, those studies which used GIS-based measures, as the current study does, were much less consistent, often failing to find significance or finding results in unexpected directions (Engler-Stringer et al., 2014). Because dietary choices are driven by more than just environmental characteristics, often yielding to individual perceptions and preferences, as well as socio-cultural norms and traditions, the impact of WIC stores on the general population may be too nuanced to be adequately captured by the current approach.

Further examining the association between WIC store count and child food consumption by household WIC participation status also revealed limited associations. Previous research has shown that child WIC participants generally have better diets than similar non-participants (Gu & Tucker, 2017; Guthrie et al., 2018). In the current analysis, only total added sugars, which includes sugars from sugar-sweetened beverages, as well as sugars from common sweet food items, was found to have an inverse association with WIC store count at the 0.5 mile road network distance among WIC-participating households. No similar association was observed among non-WIC households. Similarly, in a separate exploratory analysis, wherein the sample was stratified by age group (under 5, 5-11, 12-18), associations were seen between WIC store count and decile consumption quantities for vegetables and combined fruits and

vegetables at the 1 mile road network distance, but only for children in the under 5 age group, which is the age group WIC benefits directly.

Studies have shown that WIC-authorized stores can be a reliable source of healthy food options, even when similar stores in the same area, which are not WIC-authorized, fail to carry many healthy items (DeWeese et al., 2016; Gosliner et al., 2018). Furthermore, WIC-approved foods are not reserved for WIC participants exclusively; both WIC-participating and non-participating households shopping at WIC-authorized stores are able to purchase these items. However, WIC households are likely to be at a greater advantage for accessing these healthier foods due to the financial benefits they receive through the WIC program. These benefits effectively incentivize the purchase of healthy foods by restricting the use of benefits to certain, pre-approved foods. Furthermore, WIC's financial benefits may help to offset the higher prices of healthy foods often encountered in smaller stores, which tend to be more prominent in low-income urban settings (Gosliner et al., 2018; Ohri-Vachaspati et al., 2013).

There are several potential reasons for the lack of associations between exposure of WIC stores and consumption that was observed in the current study. Majority of households in the sample had access to supermarkets, 80% lived within a mile of one (Ohri-Vachaspati et al., 2013) and households on an average had 1.6 supermarkets within 1 mile, resulting in little variability in exposure to stores where bulk of grocery purchases are likely made. According to a national study by the USDA, 89% of households do their

primary food shopping at supermarkets and supercenters, with WIC households shopping almost exclusively at supercenters (Ver Ploeg et al., 2015).

Alternatively, the 0.5 and 1-mile road network distances used in this analysis may not fully capture the stores frequented most by shoppers in the current sample. The same national study by the USDA reveals that shoppers at all income levels regularly travel more than 1 mile to purchase groceries, even if closer options exist. In fact, low-income households were found to do their primary shopping at stores 3.8 miles away from home, on average, even though the nearest supermarket or supercenter was only 2.1 miles away. This trend for bypassing stores nearest to home was consistent for both SNAP- and WIC-participating households (Ver Ploeg et al., 2015).

Thus, it is likely that many households in the current sample are shopping at WIC-authorized stores that are not among those nearest their homes and/or not shopping regularly at smaller stores. Future studies should examine these relationships at road network distances greater than 1 mile or looking more closely at trends among those urban households which are known to make primary food purchases closer to home or at smaller stores. The impact of WIC store access may also become more apparent in less dense settings, such as in suburban and rural environments, where fewer households have access to a large store at close distances.

A major strength of this study is the large sample of diverse urban households, making the findings generalizable to similar populations in the US. However, there are several limitations that potentially impact the current findings. First and foremost, the

cross-sectional nature of this research cannot describe causal relationships. Furthermore, the particular foods captured by the household survey and/or chosen for subsequent analysis may not adequately capture the diets of the children in the study sample. For instance, certain questions, such as those for sweet foods used to develop the total added sugars measure, may not have included all of the unhealthy food items children are likely to consume, and certain food items, such as 100% fruit juice and French fries, were intentionally excluded from analysis for the categories of fruits and vegetables, respectively. Another possible limitation relates to the potential for error in parent report, wherein the survey respondent may report higher consumption of foods they believe the researcher might consider "good" or "healthy" and underreport foods that they perceive might be considered "bad" or "unhealthy" (Börnhorst et al., 2013; Hebert et al., 1995). However, these biases are likely to all respondents in the sample and may not result in systematic bias.

In the household surveys used for this analysis, parents provided their best approximation of child food consumption frequencies on behalf of the index child during the previous month. While reporting over longer periods may be subject to recall bias, multiple studies have found that parental reports of child and adolescent food intake is similar to intakes reported by the children and adolescents themselves (Lamb et al., 2007; Persson Osowski et al., 2012). Additionally, although validated processes were used to convert reported weekly and monthly frequencies into daily frequencies and then daily frequencies into estimated consumption quantities, there is a potential for calculated values to overestimate or underestimate actual consumption quantities.

Conclusion and Policy Implications

Living close to more WIC authorized stores was associated with healthier consumption, but only for a subset of children and only for a few food categories examined. Lack of a consistent pattern of healthier consumption among children suggests that access to WIC stores may have a positive, albeit limited impact on children's diets.

While few associations were uncovered in the current study, there are promising signs that increased access to WIC stores, and the healthier foods they provide, may be associated with reduced total added sugar consumption in some groups and increased fruit and vegetable consumption in others. Among WIC households, the results do suggest potential benefits for WIC's intended target population in the under 5 age group, as well as a potential for so-called "spillover effects" to exist in the broader community. Future studies will be critical to understand the role that WIC store presence plays in children's diets, particularly among non-participating households, and in different community settings.

Policies should continue to support the WIC program, which has consistently demonstrated the ability to ensure healthy food access for its participants, improve child health outcomes, and strengthen community food environments at the local level. Efforts should also be made to increase healthy food availability in smaller stores that are non-WIC-authorized and to make healthier options more affordable for families, particularly in lower-income areas.

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APPENDIX A

NUMBER OF HOUSEHOLDS PER CITY BY DATA COLLECTION PANEL

Appendix A. Number of households per city by data collection panel

Panel 1: June 2009 to April 2010

City	Number of Households
Camden	400
Newark	400
Trenton	400
New Brunswick	280

Panel 2: April 2014 to August 2014

City	Number of Households
Camden	199
Newark	382
Trenton	160
New Brunswick	62

APPENDIX B

EXPLORATORY ANALYSIS: KEY OUTCOME STRATIFIED BY AGE

Appendix B: Association between estimated consumption quantities of key foods (in deciles) by children residing in households with incomes below 200% of the Federal Poverty Line and the total number of WIC-authorized stores located within 0.5-mile and 1-mile of their homes, stratified by age groups

		Number of WIC stores within 0.5-mile		Number of WIC stores within 1-mile	
Food Category	**Age Group**	β-Coefficient	95% CI	β-Coefficient	95% CI
Fruits and Vegetables	Under 5	-0.07	(-0.38, 0.24)	0.22*	(0.06, 0.37)
	5-11	0.11	(-0.08, 0.31)	0.02	(-0.09, 0.13)
	12-18	0.01	(-0.14, 0.16)	-0.01	(-0.08, 0.06)
Fruits	Under 5	-0.03	(-0.32, 0.27)	0.14	(-0.02, 0.29)
	5-11	-0.01	(-0.21, 0.18)	-0.02	(-0.13, 0.09)
	12-18	0.11	(-0.03, 0.25)	0.00	(-0.07, 0.07)
Vegetables	Under 5	-0.08	(-0.43, 0.27)	0.21*	(0.03, 0.40)
	5-11	0.09	(-0.09, 0.27)	0.00	(-0.10, 0.10)
	12-18	-0.07	(-0.23, 0.09)	-0.02	(-0.10, 0.06)
Sugar from Sweetened Beverages	Under 5	0.06	(-0.23, 0.34)	0.02	(-0.13, 0.16)
	5-11	0.03	(-0.18, 0.23)	0.02	(-0.07, 0.12)
	12-18	-0.06	(-0.19, 0.07)	-0.03	(-0.10, 0.04)
Total Added Sugars	Under 5	0.20	(-0.11, 0.52)	0.03	(-0.14, 0.20)
	5-11	-0.03	(-0.24, 0.19)	0.00	(-0.11, 0.10)
	12-18	-0.09	(-0.23, 0.05)	-0.06	(-0.13, 0.01)

*$p<0.05$

Based upon ordinary least square regression models examining the association between estimated quantities of consumption (in deciles) and total count of WIC stores located within immediate 0.5-mile and 1-mile roadway networks around each child's home using independent consumption deciles for each age group, and adjusting for child gender, parental education level, household income, poverty level, race and ethnicity, and participation in federal nutrition assistance programs (SNAP and WIC).

APPENDIX C

IRB APPROVAL FOR NJCHS

APPROVAL:CONTINUATION

Punam Ohri-Vachaspati
Nutrition
602/827-2270

Punam.Ohri-Vachaspati@asu.edu

Dear Punam Ohri-Vachaspati:

On 6/15/2020 the ASU IRB reviewed the following protocol:

Type of Review:	Continuing Review
Title:	Impact of Environmental Changes on Children's BMI and Behaviors: A Panel Study
Investigator:	Punam Ohri-Vachaspati
IRB ID:	1107006669
Category of review:	
Funding:	Name: Robert Wood Johnson Foundation; Name: HHS: National Institutes of Health (NIH), Funding Source ID: HHS-NIH-National Institutes of Health
Grant Title:	None
Grant ID:	None
Documents Reviewed:	None

The IRB approved the protocol from 6/15/2020 to 6/14/2021 inclusive. Three weeks before 6/14/2021 you are to submit a completed Continuing Review application and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 6/14/2021 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely, IRB Administrator

APPENDIX D

FOOD STORE CLASSIFICATION PROTOCOL

New Jersey Child Health Study
FOOD STORE AND RESTAURANT CLASSIFICATION PROTOCOL

Check NAICS codes

Before starting with the classification process, on the master list of outlets for that year (for example, Export_Food_and_PhysAct_9_2012) make sure there's something in each NAICS code so we know we received all the codes we requested. Those codes for food outlets are:

445110: Supermarkets and grocery stores
445120: Convenience stores
447110: Convenience stores with gas stations
445210: Meat markets
445220: Fish and seafood markets
445230: Fruit and vegetable markets
445292: Confectionary and nut stores
445291: Baked goods stores
445299: Other specialty stores
452910: Superstores
446110: Pharmacies and drug stores
722511: Full service restaurants
722513: Limited service restaurants
722515: Snack and nonalcoholic beverage bars

Preparing worksheets for classification

1. Separate master list into 10 different excel sheets according to city and retail (codes in green) or restaurant (codes in red) (e.g. Newark retail, Newark restaurants, etc. for the other 4 cities)

2. Put copies of the master list and all ten spreadsheets on the z-drive.

3. On the dropbox versions of the 10 spreadsheets, do the following:

    - On retail sheets insert 3 columns at the beginning: #, Category, Healthy/Unhealthy. Add a Notes column at the end.
    - On restaurant sheets add 3 columns at the beginning: #, Category, Limited/Full Service. Add a Notes column at the end.

Classifying Retail Outlets

For classifying retail outlets use the following codes:

Retail Type	Code
supermarket	1
chain grocery store (Aldi, Save A Lot, etc.)	11
small grocery store	2
convenience store	3
meat market	4
meat market + small grocery store	24
fruit and vegetable market	5
pharmacy	16
convenience store with gas station	17
supercenter	10
membership supercenter	101

Description of retail types:

- Supermarket: very large supermarket, such as a Fry's, Safeway or Bashas'. Look for Pathmark, Shoprite, Key Foods or Stop and Shop. Sales over $2 million, 4 or more checkouts.
- Chain grocery store: a smaller store that is a chain (more than one location), similar to a Fresh N' Easy. Look for Aldi or Save a Lot.
- Small grocery store: a smaller store that sells at least 3 of the 4 healthy food categories (below). May look like a convenience store from the outside. Will have sales less than $2.5 million.
- Convenience store: small store that sells less than 3 of the 4 healthy food categories.
- Meat market: store that primarily sells meat
- Fruit and vegetable market: store that primarily sells fruits and vegetables

Follow the classification system described below to code each outlet. Once a category has been determined for a store, put the correct code number in the 'Category' column, and color the store name cell according to category (e.g., if you categorize a store as a supermarket, put '1' in the 'Category' column, and color the store name cell yellow).

Classification System for Supermarkets, Grocery Stores, Convenience stores (as designated by NAICS codes)

Sort stores by NAICS codes and organize each NAICS code according to annual sales volume

Sales volume over $2 million

1. Start with a name recognition scan
    a. If identifiable as part of a local or national supermarket chain, (this can be determined from past years to see which stores are east coast chain supermarkets) classify as supermarket (code = 1). If identified as local or national smaller grocery store chain (e.g., Aldi, Save a Lot), classify as chain grocery store (code = 11)
    b. If identified as local or national convenience store chain (e.g., Wawa, 7-11, Circle K), classify as convenience store (code = 3)
2. If unidentifiable by name, do an Internet search
    1. Use website or online description to determine if store is a supermarket/chain grocery store. For example, store ads may indicate that it sells many healthy foods like a full service supermarket. (Check dates on ads to ensure they are current.) If store is found to be a supermarket or chain grocery store, use appropriate code to classify.
3. If unidentifiable by Internet search, or if found not to be a supermarket/chain grocery store, call the store using the Retail Food Script. Classify according to answers obtained from call:
    a. If someone answers and you go through the script:
        - Manager's perception of the store similar to Pathmark or Shoprite or Stop and Shop; has more than 4 checkouts; classify as supermarket (code = 1) (chain grocery store with smaller selection of food items such as Aldi or Save A Lot code = 11)
        - If above does not apply but they sell at least 3 of 4 food groupings asked about, classify as small grocery store (code = 2)
        - If they sell fewer than 3 of the food groupings asked about, classify as convenience store (code = 3)
        - If through the conversation it appears they are a meat market or fruit and vegetable market, see information in next section(s)
    b. If number listed is out of service or there is no answer, search Internet for alternate number(s).
        - If all numbers you can find for the store (from InfoUSA and online) are out of service, shade the store name gray
        - If you get a store answering machine, you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's Daylight Savings Time, and time (AZ time) of the call. Also note what the result was (e.g., hung up on me, store answering machine, etc.).
            - Call on different days of the week and different times of the day until you get responses to the script questions below or

until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*

- If no one answers, record in "Notes" the day, date (important for knowing if it's DST), time (AZ time) of the call and the results (e.g., no answer, generic vm).
    - Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

Retail Food Script

Hello, this is _____ and I am calling for Rutgers University and ASU School of Nutrition and Health Promotion. We are doing a study to learn about the types of stores in your community and would like to ask you a few questions about foods available at your store.

IF THEY ANSWER "NO," SAY: Is there a manager or someone else I could talk to, or
is there a better time to call back?
(Write down the day and time if there is a better time)

IF THEY ANSWER "YES," SAY: Thank you. This is a confidential survey and your
responses will only be used to group stores of similar types.

1. How would you describe your store? Is it a supermarket (like Stop and Shop or Pathmark or Shop Rite), a smaller grocery store, or a convenience store (like 7-11 or Wawa)?
2. How many checkouts does your store have?
3. Does your store sell five or more different kinds of fresh fruits?
4. Does your store sell five or more different kinds of fresh vegetables?
5. Does your store sell fresh or frozen meats?
6. Does your store sell skim or low-fat (1%) milk?

Closing: Thank you for your help and answering our questions.

Sales volume $1-2 million

1. Start with a name recognition scan.
    a. If identifiable as part of a local or national supermarket chain, (this can be determined from past years to see which stores are east coast chain supermarkets) classify as supermarket (code = 1). If identified as local or

national smaller grocery store chain (e.g., Aldi), classify as chain grocery store (code = 11)
    2. If identified as local or national convenience store chain, classify as convenience store (code = 3)
2. If unidentifiable by name, call the store using the Retail Food Script. Classify according to answers obtained from call.
    a. If someone answers and you go through the script:
        - Manager's perception of the store similar to Pathmark or Shoprite or Stop and Shop; has more than 4 checkouts; classify as supermarket (code = 1) (chain grocery store with smaller selection of food items such as Aldi or Save A Lot code = 11)
        - If above does not apply but they sell at least 3 of 4 food groupings asked about, classify as small grocery store (code = 2)
        - If they sell fewer than 3 of the food groupings asked about, classify as convenience store (code = 3)
        - If through the conversation it appears they are a meat market or fruit and vegetable market, see information in next section(s)
    b. If number listed is out of service or there is no answer, search Internet for alternate number(s).
        - If all numbers you can find for the store (from InfoUSA and online) are out of service, shade the store name gray
        - If you get a store answering machine, you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's Daylight Savings Time, and time (AZ time) of the call. Also note what the result was (e.g., hung up on me, store answering machine, etc.).
            - Call on different days of the week and different times of the day until you get responses to the script questions below or until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*
        - If no one answers, record in "Notes" the day, date (important for knowing if it's DST), time (AZ time) of the call and the results (e.g., no answer, generic vm).
            - Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

Sales volume less than $1 million

1. Search for terms *liquor, bar*, and *auto repair* in the store name. Shade these gray.
2. Search for term *pharmacy, Walgreens, CVS, drug*. If pharmacy, classify it as pharmacy (code = 16)
3. Classify anything else in this category as a convenience store (code = 3).

Classification System for Other Stores (specialty stores like farmers' markets, meat markets etc., as designated by NAICS codes)

I. Sort by NAICS codes.

II. Search the store name for words such as *gifts, florist, distributor*, and others that do not sell food and that are nonfood businesses. When these are found in any category, color the store name cell gray.

III. For the following NAICS descriptions:

1. Meat markets
    a. Call the store using the Retail Food Script. If number listed is out of service or there is no answer, search Internet for alternate number(s).
    b. Classify according to answers obtained from call:
        i. Sells fewer than 3 of the food groupings asked about, and primarily sells meat (dead or alive), classify as meat market (code = 4)
        ii. Manager's perception of the store similar to Pathmark or Shoprite or Stop and Shop; has more than 4 checkouts; sells many healthy foods (like a full service supermarket) classify as supermarket (code = 1) (This almost never happens) (chain grocery store with smaller selection of food items such as Aldi or Save A Lot code = 11)
        iii. If above does not apply, and does not primarily sell meat but sells at least 3 of 4 food groupings asked about, classify as small grocery store (code = 2)
        iv. Primarily a meat market but also sells at least 3 of 4 food groupings asked about, classify as small meat market grocery store (code = 24)
        v. Sell fewer than 3 of the food groupings asked about and is not primarily a meat market, classify as convenience store (code = 3)
        vi. If all numbers found (through InfoUSA and online) are out of service, shade the store name gray
        vii. If you get a store answering machine, or you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's DST), and time (AZ time) of the call. Also note what the result was (e.g., hung up on me).
            1. Call on different days of the week and different times of the day until you get responses to the script questions above or until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*
        viii. If no answer, record in "Notes" the day, date (important for knowing if it's DST), time (AZ time) of the call and results.

1. Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

2. Fruit and vegetable markets
    a. Call the store using the Retail Food Script. If number listed is out of service or there is no answer, search Internet for alternate number(s).
    b. Classify according to answers obtained from call.
        i. Primarily sell fruits and vegetables, classify as fruit and vegetable market (code = 5)
        ii. Manager's perception of the store similar to Pathmark or Shoprite or Stop and Shop; has more than 4 checkouts; sells many healthy foods (like a full service supermarket) classify as supermarket (code = 1) (chain grocery store with smaller selection of food items such as Aldi or Save A Lot code = 11)
        iii. If above does not apply, and does not primarily sell vegetables, but sells at least 3 of 4 food groupings asked about, classify as small grocery store (code = 2)
        iv. Sell fewer than 3 of the food groupings asked about and does not primarily sell fruit and vegetables, classify as convenience store (code = 3)
        v. If all numbers found (InfoUSA and online) are out of service, shade the store name gray
        vi. If you get a store answering machine, or you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's DST), and time (AZ time) of the call. Also note what the result was (e.g., hung up on me).
            1. Call on different days of the week and different times of the day until you get responses to the script questions above or until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*
        vii. If no answer, record in "Notes" the day, date (important for knowing if it's DST), time (AZ time) of the call, and the result.
            1. Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

3. Pharmacies
    a. Name recognition scan
        i. If identified as part of local or national pharmacy chain, or has *pharmacy* (not *pharmaceuticals* – that may not be retail) in the name, classify as pharmacy (code = 16)

ii. If identified as a pharmacy that may be part of a supermarket (e.g., Shop Rite pharmacy), check to see if the supermarket is listed separately. If it is, shade the pharmacy name gray.

b. If unidentifiable by name, do an Internet search
   i. Websites clearly designating store as a pharmacy
c. If unidentifiable by Internet search, call the store using the Retail Food Script. You will probably be able to stop after asking, "How would you describe your store?" If number listed is out of service or there is no answer, search Internet for alternate number(s).
d. Classify according to answers obtained from call.
   i. Describe themselves as a pharmacy, classify as pharmacy (code = 16)
   ii. Manager's perception of the store similar to Pathmark or Shoprite or Stop and Shop; has more than 4 checkouts; sells many healthy foods (like a full service supermarket) classify as supermarket (code = 1) (chain grocery store with smaller selection of food items such as Aldi or Save A Lot code = 11)
   iii. If above does not apply, but sell at least 3 of 4 food groupings asked about, classify as small grocery store (code = 2)
   iv. Sell fewer than 3 of the food groupings asked about and is not a pharmacy, classify as convenience store (code = 3)
   v. If number out of service, shade the store name gray
   vi. If you get a store answering machine, or you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's DST), and time (AZ time) of the call. Also note what the result was (e.g., hung up on me).
      1. Call on different days of the week and different times of the day until you get responses to the script questions above or until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*
   vii. If no answer, record in "Notes" the day, date (important for knowing if it's DST), time (AZ time) of the call and result of the call.
      1. Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

4. Convenience store with gas station – ONLY FOR NAICS CODES 447110. If it's a gas station only with a different NAICS code, gray it out (most – probably all – will be grayed out)
   a. Name recognition scan

i. If identified as part of local or national convenience store with gas station chain, classify as convenience store with gas station (code = 17)

b. If unidentifiable by name, do an Internet search
   i. Websites, internet, Google maps street view (this works well for gas stations)

c. If unidentifiable by Internet search, call the store using the script above. You will probably be able to stop after asking, "How would you describe your store?" If number listed is out of service or there is no answer, search Internet for alternate number(s).

d. Classify according to answers obtained from call.
   i. Describe themselves as a gas station, classify as convenience store with gas station (code = 17)
   ii. Manager's perception of the store similar to Pathmark or Shoprite or Stop and Shop; has more than 4 checkouts; sells many healthy foods (like a full service supermarket) classify as supermarket (code = 1) (chain grocery store with smaller selection of food items such as Aldi or Save A Lot code = 11)
   iii. If ii (above) does not apply, but sell at least 3 of 4 food groupings asked about, classify as small grocery store (code = 2)
   iv. Sell fewer than 3 of the food groupings asked about, classify as convenience store (code = 3)
   v. If number out of service, shade the store name gray
   vi. If you get a store answering machine, or you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's DST), and time (AZ time) of the call. Also note what the result was (e.g., hung up on me).
      1. Call on different days of the week and different times of the day until you get responses to the script questions above or until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*
   vii. If no answer, record in "Notes" the day, date (important for knowing if it's DST), time (AZ time) of the call, and result.
      1. Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

5. Supercenters and membership supercenters
   a. Name recognition scan
      i. If identified as part of national non-membership supercenter (e.g., Walmart, Target, Kmart), classify as supercenter (code = 10)
      ii. If identified as part of membership supercenter (e.g., Sam's Club, Costco), classify as membership supercenter (code = 101)

For everything above:

- If any stores are inside places like airports, ballparks, arenas, movie theaters, etc., do not classify them. Gray them out.
- If found through any of the search processes that the store is actually a restaurant, color the store name cell light blue and record in "Notes" that it should be moved to restaurants.
- If found through any of the search processes to not be any type of food store or pharmacy, shade the store name cell gray. Record in "Notes" what type of store it is
- *Conduct Internet searches (websites and google street view) for all stores shaded maroon to determine their classifications.

Classifying Restaurants

For classifying restaurant outlets use the following codes:

Restaurant Type	Code
snack specialty	6
other specialty	18
deli	70
chicken/fish	71
pizza	72
burger/hotdog	73
subs/hoagie	74
Chinese takeout	75
Chinese restaurant	751
Fast food chain [national]	76
other fast food	77
burritos/taco/Mexican	78
full service	79
limited service as per NAICS	7
cafeteria	61

Description of Restaurants:

- Snack specialty: primarily sells food items that are ready-to-eat and can be eaten in store, such as bagels, coffee, donuts, ice cream.
- Other specialty: primarily sells food items intended to be taken with the customer to eat, rather than eaten in the store (e.g., stores that sell nuts, candy etc.).
- Full service: sit-down restaurant with wait staff. You eat and then pay your bill.
- Limited service (in general): you always pay before you receive your food. It can be to-go (like a McDonalds) or sit-down (like a Pei Wei), and there is no wait service.
- Fast food chain [national]: any national fast food chain, regardless of type of food sold (e.g., McDonalds, Taco Bell, Panda Express, Dominos Pizza)
- Limited service as per NAICS: for restaurants where additional information cannot be gathered, but has a limited service NAICS code

Follow the classification system described below to code each outlet. Once a category has been determined for a restaurant, put the correct code number in the 'Category' column, and color the restaurant name cell according to category (e.g., if you categorize a restaurant as a pizza place, put '72' in the 'Category' column, and color the store name cell blue).

Classification System for Restaurants

1. Sort stores by NAICS codes.

2. Name-recognition scan to identify and classify chain full-service restaurants (code = 79).

3. Name-recognition scan to identify and classify national chain fast food restaurants (code=76).

4. Other specialty stores
    a. Name recognition scan
        i. If identified as part of local or national specialty store (e.g., Rocky Mountain Chocolate Factory), classify as other specialty store (code = 18)
        ii. If unidentifiable by name, do an Internet search: Websites, internet, Google maps street view
        iii. If unidentifiable by Internet search, call the store using the Retail Food Script. You will probably be able to stop after asking, "How would you describe your store?" Classify according to answers obtained from call.

1. Primarily sell food items intended to be taken with the customer to eat, rather than eaten in the store (e.g., stores that sell nuts, candy, etc.), classify the store as other specialty, code=18.
2. Primarily sell food items that are ready-to-eat and can be eaten in store, such as bagels, coffee, donuts, ice cream, classify the store as snack specialty, code=6.
3. Manager's perception of the store similar to Pathmark or Shoprite or Stop and Shop; has more than 4 checkouts; sells many healthy foods (like a full service supermarket) classify as supermarket (code = 1) (chain grocery store with smaller selection of food items such as Aldi or Save A Lot code = 11)
4. If above does not apply, but sell at least 3 of 4 food groupings asked about, classify as small grocery store (code = 2)
5. If is not a snack or specialty store, and sells fewer than 3 of the food groupings asked about, classify as convenience store (code = 3)
6. If number out of service, shade the store name gray
7. If you get a store answering machine, or you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's DST), and time (AZ time) of the call. Also note what the result was (e.g., hung up on me).
    a. Call on different days of the week and different times of the day until you get responses to the script questions above or until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*
8. If no answer, record in "Notes" the day, date (important for knowing if it's DST), time (AZ time) of the call and result.
    a. Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

5. Classify restaurants with the following words in the name – fried chicken, chicken, pizza, hot dog, burger, hoagie, Chinese/China, taco, burrito, deli, sandwich – as limited service. Put them in the correct category on the classified restaurants sheet.

6. Internet check/Google maps street view for restaurants in question
    a. check menus and restaurant descriptions
    b. restaurants primarily selling hamburgers, fried chicken, pizza, hot dogs, Chinese, classify as a limited service restaurant and choose the correct category

c. restaurants described as fine dining experiences or with table service – classify as full service restaurant, code=79

7. Phone calls using script below for restaurants still in question. If number listed is out of service or there is no answer, search Internet for alternate number(s).
    a. If customers do not pay for their order before they eat, classify as full service.
    b. If customers always pay for their order before they eat, classify as limited service in the correct category according to type of food (when calling, you may need to ask what type of food they serve)
    c. If all numbers you try (from InfoUSA and online) are out of service, shade the store name gray
    d. If you get a store answering machine, or you can't understand them, or they hang up on you, record in "Notes" the day, date (important for knowing if it's DST), and time (AZ time) of the call. Also note what the result was (e.g., hung up on me).
        i. Call on different days of the week and different times of the day until you get responses to the script questions above or until you reach 6 calls. If you reach 6 calls without responses, shade the store name maroon.*
    e. If no answer, record in "Notes" the day, date (important for knowing if it's DST), and time (AZ time) of the call.
        i. Call on different days of the week and different times of the day until someone answers, or until you reach 6 calls. If you reach 6 calls with no answer ever, shade the store name gray.

8. If found through any of the search processes that the store is actually a retail store, color the store name cell light blue and record in "Notes" that it needs to be moved to retail.

9. If any restaurants are inside places like airports, ballparks, arenas, movie theaters, etc., do not classify them. Gray them out.

10. If found through any of the search processes that the business is not any type of food store or a gas station (e.g., flower shop, hair salon), shade the store name cell gray. Record in "Notes" what type of store it is.

*Conduct Internet searches (websites and google street view) for all stores shaded maroon to determine their classifications.

Restaurant Script

Hello, this is _____ and I am calling for Rutgers University and ASU School of Nutrition and Health Promotion. We are doing a study to learn about the types of restaurants in your community and would like to ask you a question about your restaurant.

IF THEY ANSWER "NO," SAY: Is there a manager or someone else I could talk to, or
is there a better time to call back?
(Write down the day and time if there is a better time)

IF THEY ANSWER "YES," SAY: Thank you. This is a confidential survey and your
responses will only be used to group stores of similar types.

Do your customers always pay for their order before they can eat?

Closing: Thank you for your help and answering our question.