The Relationship between the Neighborhood Food Environment, Health Behaviors and Health Outcomes among Urban Hispanics in New York City

Manuel C. Co Jr.

Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
under the Executive Committee
of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2017

ABSTRACT

The Relationship between the Neighborhood Food Environment, Health Behaviors and Health Outcomes among Urban Hispanics in New York City

Manuel C. Co Jr.

Background: Hispanics account for more than half of the total United States (US) population growth between 2000 and 2010. To gain a comprehensive understanding of a predominantly Hispanic urban community in Northern Manhattan, the aims of this cross-sectional observational study were: (1) to characterize the actual and perceived neighborhood food environment in Northern Manhattan, (2) to understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of consuming five or more servings of fruits and vegetables per day, and (3) to describe the contribution of participants' sociodemographic characteristics and health behavior to their health outcomes.

Methods: This cross-sectional observational study was undertaken as part of the larger Washington Heights/Inwood Informatics Infrastructure for Comparative Effectiveness Research (WICER) project. English or Spanish-speaking Hispanic participants (n=4,019) 18 years and older living in Northern Manhattan's five ZIP codes were recruited and interviewed by English-Spanish bilingual community health workers. Food outlets selling fruits and vegetables were identified using the North American Industry Classification System (NAICS) definitions obtained from the ReferenceUSA's national business database. The neighborhood food environment was characterized by integrating the geocoded addresses of WICER study participants with external geographic-level data on food outlets present in the participants' respective 0.25-mile and 0.5-mile residential radii. Data were analyzed using bivariate and multivariate binary logistic regressions.

Results: The food outlet types that sell fruit and vegetable in Northern Manhattan include small and medium/large size Supermarket/Grocery store, Meat Market, and Fruit and Vegetable Market. The majority of these food outlets (91.5%) are single location stores that have a smaller store space. The presence of Fruit and Vegetable Markets (2+ Stores in 0.25-mile: OR=1.59, p = 0.003; 1 Store in 0.5-mile: OR=2.28, p = 0.008; 2+ Stores in 0.5-mile: OR=3.10, p = 0.00) significantly increase the odds of participant's perception that a large selection of fresh fruits and vegetables is available in their

neighborhood. The presence of Fruit and Vegetable Markets (2+ Stores in 0.25-mile: OR=1.51, p = 0.003; 1 Store in 0.5-mile: OR=2.25, p = 0.004; 2+ Stores in 0.5-mile: OR=3.31, p = 0.00) as well as the presence of medium/large size Supermarket/Grocery in 0.25-mile (OR=1.05, p = 0.013) significantly increase the odds of participant's perception that the fresh fruits and vegetables in their neighborhood are of high quality whereas the presence of Meat Market in the participant's 0.25-mile (OR=0.74, p = 0.002) significantly lower the odds. The presence of Fruit and Vegetable Markets (1 Store in 0.25-mile: OR=1.23, p = 0.047; 2+ Stores in 0.25-mile: OR=1.37, p = 0.020; 2+ Stores in 0.5-mile: OR=1.94, p = 0.018) as well as the presence of medium/large size Supermarket/Grocery (0.25-mile: OR=1.05, p = 0.020; 0.5-mile: OR=1.05, p = 0.018) significantly increase the odds of participant's perception that a large selection of low-fat products is available in their neighborhood whereas the presence of Meat Market in the participant's 0.25-mile (OR=0.83, p = 0.042) significantly lowers the odds.

Variables that significantly increase the participants' odds of consuming five or more servings of fruits and vegetables per day include having more than a high school education (0.25-mile and 0.5-mile models: OR=1.62, p = 0.004) and being foreign-born (0.25-mile model: Foreign-born in Dominican Republic: OR=1.77, p = 0.032; Foreign-born outside of the United States or the Dominican Republic: OR=2.44, p = 0.007; 0.5-mile model: Foreign-born in the Dominican Republic: OR=1.73, p = 0.040; Foreign-born outside of the United States or the Dominican Republic: OR=2.48, p = 0.006). In contrast, the participants' perception that a large selection of fresh fruits and vegetables is available in their neighborhood (0.25-mile model: OR=0.63, p = 0.011; 0.5-mile model: OR=0.64, p = 0.016) and the presence of Fruit and Vegetable Market in their 0.5-mile radius (1 Store: OR=0.32, p = 0.006; 2+ Stores: OR=0.38, p = 0.009) significantly lower the odds.

Variables that significantly increase the odds of body mass index (BMI) in the overweight range were age (OR=1.02, p = 0.00*),* being foreign-born outside of the United States or the Dominican Republic (OR=1.76, p = 0.006), self-reported diabetes (OR=1.37, p = 0.026), and perceived weight as overweight (OR=4.46, p = 0.00) whereas being female (OR=0.67, p = 0.00) significantly lowers the odds. Variables that significantly increase the odds of BMI in the obese range were age (OR=1.02, p = 0.00), self-reported diabetes (OR=1.78, p = 0.00), and perceived weight as overweight (OR=19.39, p = 0.00) whereas having more than a high school education (OR=0.72, p = 0.021) significantly lowers the odds.

Variables that significantly increase the odds of hypertension were age (OR = 1.04, p = 0.00) and self-reported diabetes (OR = 1.57, p = 0.00) whereas being female (OR = 0.72, p = 0.00) significantly lowers the odds. Education (>High School) significantly increases the odds (OR=1.43, p = 0.00) of self-report of good health. In contrast, variables that significantly lower the odds were age (OR=0.98, p = 0.00), being female (OR=0.60, p = 0.00), higher fruit and vegetable consumption (OR=0.66, p = 0.007), self-reported diabetes (OR=0.51, p = 0.00), and obesity (OR=0.64, p = 0.00).

Variable that significantly increase the odds of self-report of good health include having more than a high school education (OR = 1.43, p = 0.00) whereas age (OR = 0.98, p = 0.00), female gender (OR = 0.60, p = 0.00), higher fruit and vegetable consumption (OR = 0.66, p = 0.007), self-reported diabetes (OR = 0.51, p = 0.00), and obesity (OR = 0.64, p = 0.00) significantly lower the odds.

Conclusion: This study contributed to our understanding of the relationships among neighborhood food environment, health behaviors, and health outcomes in a predominantly Hispanic underserved urban community in New York City. While most findings were similar to those reported in the literature, our findings related to the relationship between participants' perceived neighborhood food environment and actual healthy food access and fruit and vegetable consumption were in contrast to other studies in that increased perceived availability and actual availability lowered the odds of consuming five or more servings of fruits and vegetables per day. This surprising finding merits additional qualitative and quantitative research to examine the complex relationships among perceived access, availability, and consumption of healthy foods as well as improved measures of fruit and vegetable consumption.

Table of Contents

List of Tables

List of Figures

ACKNOWLEDGMENT

My PhD journey would not have been possible without the support and encouragement of many. My deepest gratitude to my mentor Dr. Suzanne Bakken for giving me an appreciation of the science and for helping me to think with greater clarity about the science. I am especially grateful to my Dissertation Committee Dr. Suzanne Bakken, Dr. Arlene Smaldone and Dr. Andrew Rundle for their expertise, guidance, thoughtful feedback, mentorship and ongoing support. I also very much appreciate the statistical insights of Dr. Rundle.

The opportunity to be part of the WICER Project Team at the School of Nursing and the Built Environment and Health Research Group at the Mailman School of Public Health has been most positive. Dr. Suzanne Bakken and Dr. Andrew Rundle are exceptional role models and it is inspiring to see them advance the science and extend the methods to support population health.

I would like to thank the Columbia University faculty for their teaching and research: Dr. Suzanne Bakken, Dr. Mary Bryne, Dr. Joan Kearney, Dr. Elaine Larson, Dr. Nancy Reame, Dr. Arlene Smaldone, Dr. Patricia Stone, Dr. Shuang Wang, and others. I also appreciate the support of the School of Nursing administrative staff. Thanks to Jeremiah Trinidad-Christensen, Eric Glass and Daniel Sheehan for their assistance with ArcGIS.

Thanks to Dr. Carolyn Herzig, Dr. Sarah Iribarren, Dr. Alsacia Pacsi, Dr. Sunmoo Yoon and WICER's Niurka Suero-Tejeda for being very supportive. Special thanks to many pre-doctoral and post-doctoral fellows at the School of Nursing and at the Mailman School of Public Health who have provided intellectual encouragement and friendship during my time at Columbia University.

I am most grateful to my parents and family for their love, encouragement and unwavering support, especially following the medical event that occurred during my doctoral studies.

My dissertation study was made possible by funding for WICER (R01HS019853) and WICER 4 U (R01HS022961). My doctoral study was generously supported by a pre-doctoral fellowship from the National Institute of Nursing Research (T32NR007969, PI: Bakken) and by the Jonas Nurse Leader Scholarship from the Jonas Center for Nursing and Veterans Healthcare.

To each one of you, I extend my sincere appreciation and value your being part of this journey.

CHAPTER I: INTRODUCTION

Overview

Studying "place" has an important role in public health research. The design of the city, its commercial and residential land use, and related man-made infrastructures such as roads, buildings, and sidewalks constitute what is collectively referred to as the built environment (Booth, Pinkston, & Poston, 2005). Studying the environmental characteristics of cities and their neighborhoods designed and created to support human activities can enhance our understanding of the positive and negative ways the food environment can affect the health of its residents.

A built environment that fosters poor eating habits and discourages physical activity can lead to an increase in body weight when one's energy intake exceeds one's energy expenditure (Hill & Peters, 1998; Kim, Subramanian, Gortmaker, & Kawachi, 2006). Similarly, the lack of access to healthy foods can contribute to the development of obesity and other diet-related diseases such as hypertension, high cholesterol, type II diabetes, and cardiovascular disease (Auchincloss et al., 2009; Black & Macinko, 2008; Bodor, Rice, Farley, Swalm, & Rose, 2010; Brug, 2008; Diez-Roux et al., 1997; Hill & Peters, 1998; Mokdad et al., 2003; Nordstrom, Diez Roux, Jackson, & Gardin, 2004; Roux et al., 2001; U.S. Department of Agriculture and U.S Department of Health and Human Services, 2010). Recent studies that examined locational food access found that the use of car as a mode of transportation to access healthy foods did not increase one's fruit and vegetable consumption (Fuller, Cummins, & Matthews, 2013) and that the nearest distance to full-service supermarket had no significant relationship to one's food access and food purchasing (Dubowitz et al., 2015).

Obesity and the Food Environment

Overweight and obesity affect lower-income communities of color with higher rates of obesity noted in areas having higher than average access to fast food restaurants and having limited access to healthy foods at reasonable cost such as those offered in supermarkets or other similar retail food outlets (Kumanyika, 2008; Taylor, Poston, Jones, & Kraft, 2006). Having limited access to healthy food outlets can narrow the choices residents of low-income neighborhoods can make when buying foods in their community. The 2008 Farm Bill defined "food desert" as areas in the United States whereby low-income communities of color do not have ready access to fresh, healthy, and affordable food or that the area is

served primarily by fast food restaurants and convenience stores offering less healthy food options (U.S. Department of Agriculture, 2013).

Actual Food Environment and Food Access in Low-Income Communities of Color

Higher-income and predominantly Caucasian neighborhoods have more grocery stores and fewer convenience stores and fast food restaurants when compared to lower-income neighborhoods and communities of color (Kimberly Morland, Wing, Diez Roux, & Poole, 2002; Shannon N Zenk et al., 2005). Disparities in the quality and variety of foods available for purchase in retail food stores were also noted in urban neighborhoods with different racial/ethnic composition (Horowitz, Colson, Hebert, & Lancaster, 2004). However, the concept of deprivation amplification, first described in the 1990s for the observed pattern of deprived community resources that amplifies household poverty, is being revisited given the lack of consistent pattern with which available resources such as food stores are located to the disadvantage of households in poorer communities (Macintyre, 2007). In particular, the commonly observed pattern of deprived community resources that amplifies household poverty may not always apply to low-income neighborhoods given the social meaning and local perceptions of accessibility and relevance (Macintyre, 2007).

Studies have found that access to supermarkets vary in neighborhoods with poor neighborhoods in South Texas and in New Zealand having better access to a variety of food stores when compared to their more affluent neighborhoods (Pearce, Day, & Witten, 2008; Sharkey & Horel, 2008). These findings were echoed in another study that found low-income Hispanic neighborhoods in the United States, drawn from Census bureau measures and food store outlet measures, have greater number of non-chain supermarkets and grocery stores when compared to non-Hispanic neighborhoods (L. M. Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007). Chain supermarkets are of particular interest in that study because higher quality food products are offered in this type of food store at lower prices. The chain supermarkets' minimal presence in Hispanic neighborhoods may limit not only the variety of higher quality food products available to residents, but at prices that low-income neighborhoods could better afford. It is worth noting that the association between non-chain supermarkets and Hispanic neighborhoods was not statistically significant in the high- versus middle-income urban areas (L. M. Powell et al., 2007).

Perceived Food Environment and Food Choices

The perceived food environment can influence one's eating habits. Differences in the perceived food environment were noted in a qualitative study conducted with low- and moderate-income, midlife women participants in North Carolina who described having more control over food choices in their home environment and having little control over food choices in the community and work food environments (Jilcott, 2009).

Sociodemographic Characteristics, Health Behaviors and Health Outcomes

Lower socioeconomic status (SES), as measured by fewer years of education, lower income, lower employment status or unemployment has been documented to contribute to poorer health (Feinstein, 1993). The relationship between self-reported health and an individual's demographic characteristics and socioeconomic factors characteristics has been examined. The self-reported poor health status by those residing in socially disadvantaged residential areas in Sweden was found to be associated with low educational level, obesity, physical inactivity, and increasing social deprivation (Malmström, Sundquist, & Johansson, 1999). In a longitudinal Multi-Ethnic Study of Atherosclerosis conducted in Baltimore, MD; Forsyth County, NC; and New York City, NY, the prevalence of hypertension for adult participants was noted to decrease with increasing income and education, better neighborhood walkability and greater safety, availability of healthy foods, and greater social cohesion (Mujahid et al., 2008).

Nativity, Health Behaviors and Health Outcomes

Research has examined obesity-related behaviors among US-born and foreign-born Hispanic adolescent immigrants by generation and ethnicity. First generation adolescents were reported to have lower income and maternal education and live in higher crime urban areas with higher linguistic isolation, higher ethnic dispersion, and higher minority population (Gordon-Larsen, Harris, Ward, & Popkin, 2003). The study also noted non-statistically significant higher overweight prevalence among US-born Hispanics, with the exception of Mexicans who shared similar weight prevalence across generations. In addition, first generation Mexicans reported greater intake of rice, beans, fruits, and vegetables as compared to foreign-born Puerto Ricans' significantly greater intake of fruits and Cubans' greater intake of vegetables.

Dietary patterns among Mexican Americans in Washington State was examined and highly

acculturated Hispanics were noted to eat fewer daily servings of fruit and vegetable and had slightly higher scores on fat-related dietary habits when compared to low-acculturated Hispanics (Neuhouser, Thompson, Coronado, & Solomon, 2004). Similarly, Hispanic immigrants who have lived ≥ 15 years in the US were noted to have four-fold greater risk of obesity (BMI score > 30 kg/m^2 based on self-reported weight and height) when compared to recent immigrants who have been in the US < 5 years (Kaplan, Huguet, Newsom, & McFarland, 2004).

The relationship between the neighborhood food environment, body mass index (BMI), and blood pressure (BP) has been studied using data from the Women's Health Initiative Clinical Trial. Greater availability of grocery stores and supermarkets within a short distance from participant's residence were noted to be associated with lower rates of obesity, lower BMI, and lower diastolic BP (Dubowitz et al., 2012). Differences in self-reported hypertension by race/ethnicity and by nativity were also examined using the National Health Interview Survey data for the period 1997-2005. The study found that the probability of reporting hypertension was higher among Puerto Ricans, Dominicans, and Blacks than non-Hispanic Whites, though the self-reported hypertension varies by nativity status/length of stay in the US with greater probability of reporting hypertension noted to be higher among foreign-born Cubans having lived <10 years in the US, and among foreign-born Puerto Ricans and foreign-born Dominicans having both lived ≥10 years in the US (Borrell, Menendez, & Joseph, 2011). Another study examined the Community Health Survey's data, which is representative of the New York City's adult population, to estimate the self-reported hypertension prevalence stratified by both acculturation-related factors (nativity, language spoken at home, and length of time in the US) and race/ethnicity (Yi, Elfassy, Gupta, Myers, & Kerker, 2014). The study noted a higher prevalence of self-reported hypertension in foreign-born Whites than US-born Whites and in US-born Blacks than foreign-born Blacks as well as in those speaking Russian or Spanish at home compared to speaking English at home.

Study Context

The 2010 Census Report presented data on the changing ethnic diversity in the United States (US), with the Hispanic population accounting for over half of the growth of the total US population between 2000 and 2010 (U.S. Census Bureau, 2010). The terms "Hispanic" or "Latino" encompassed Mexican, Puerto Rican, Central American, South American, Caribbean, and Spanish peoples who share

some common cultural values (U.S. Census Bureau) and the terms will be used interchangeably in this study consistent with the Pew Research Center's Hispanic Trends Project (Brown & Lopez, 2013). In the state of New York, about two thirds or 68 percent of Hispanics live in the five boroughs that make up New York City (U.S. Census Bureau, 2010). Differences in the Hispanic distribution were noted with Dominicans being the predominant subgroup in Northern Manhattan compared to Mexicans being the predominant subgroup in the United States (U.S. Census Bureau; Yi et al., 2014).

Northern Manhattan is a particularly relevant study setting given that half of the community residents are foreign-born and three quarters are of Hispanic origin (Olson, Van Wye, Kerker, Thorpe, & Frieden, 2006). A third of its residents live below the poverty level and residents aged 25 and older have completed fewer years of education when compared to their counterparts in Manhattan and with the rest of New York City. In addition, one in three adults is uninsured and a third of its residents (32 percent) consider themselves to be in fair or poor health compared to 18 percent in Manhattan and 21 percent in New York City overall (Olson et al., 2006). Studying this population will support public health intervention, urban planning, and community development with the goal of enhancing the overall health of low-income Hispanic urban community.

Study Aims

This study will enhance our understanding of aspects of the built food environment, both community and consumer, on patterns of healthy food consumption. The study examined relationships between actual healthy food availability, self-reported healthy food availability, and self-reported fruit and vegetable consumption and the outcomes of BMI, hypertension and self-reported health status of a low-income urban Hispanic community located in Northern Manhattan.

AIM 1. The first aim is to characterize the actual and perceived neighborhood food environment in Northern Manhattan.

- **Research Question 1.1:** What is the actual neighborhood food environment (food outlet types) and does it vary in the participants' 0.25-mile and 0.5-mile residential radius buffers?
- **Research Question 1.2:** What is the relationship between perceived neighborhood food environment and actual neighborhood food environment in the participants' respective 0.25-mile and 0.5-mile residential radius buffers?

AIM 2. The second aim is to understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of consuming five or more servings of fruits and vegetables per day.

- **Research Question 2.1:** Which factors are associated with increasing the participants' likelihood of consuming five or more servings of fruits and vegetables per day?

AIM 3. The third aim is to describe the contribution of participants' sociodemographic characteristics and health behaviors to their health outcomes.

- **Research Question 3.1:** Which factors are associated with higher BMI?
- **Research Question 3.2:** Which factors are associated with hypertension?
- **Research Question 3.3:** Which factors are associated with self-report of good health?

Operational Definition of Neighborhood Food Environment and Healthy Eating

The overarching nationwide health improvement priorities of Healthy People 2020 included measures to assess progress in nutrition, physical activity, and obesity to support one of their overarching goals of creating social and physical environments that can promote good health for all (U.S. Department of Health and Human Services). Where one lives can have an influence on one's health. The environment of interest in this study is the neighborhood food environment and is operationalized as any healthy food outlets where one can obtain food. It includes a variety of food stores such as supermarkets, grocery stores, farmers' markets, and produce stores located in and around one's place of residence.

As a cornerstone of Federal nutrition policy and nutrition education activities, the Dietary Guidelines for Americans is jointly published every five years by the U.S. Department of Health and Human Services and U.S. Department of Agriculture. The Dietary Guidelines for Americans provides evidence-based nutrition guidance to promote good health, maintain a healthy weight, and reduce preventable chronic diseases through improved nutrition and physical activity for Americans ages two years and older (U.S. Department of Agriculture, 2011). The 2010 Dietary Guidelines for Americans recommendations include balancing calories with physical activity to manage weight as well as consuming more healthy foods such as fruits, vegetables, whole grains, fat-free and low-fat dairy products (U.S. Department of Agriculture and U.S Department of Health and Human Services, 2010). As

a member of the 5-a-day public-private partnership, the U.S. Department of Agriculture's Food Guide Pyramid recommends 2-4 servings of fruits and 3-5 servings of vegetables per day (Guthrie, 2004), for a combined 5-a-day total servings of fruits and vegetables.

To provide context to the neighborhood food environment, food outlets will be identified based on the availability of healthy foods or presence of healthy food outlets in the community (Jack et al., 2013; Larson, Story, & Nelson, 2009; Rundle et al., 2009; Stark et al., 2013; Walker, Keane, & Burke, 2010). Consistent with these studies that examined food environment measures, this study will identify food outlet types that sell fruit and vegetable such as supermarkets and grocery stores (excluding convenience stores), produce stores, and fruit and vegetable stores. Conceptualization, operationalization, and measurement of the study variables are described in Table 1.

Table 1: Conceptualization, Operationalization, and Measurement of Study Variables

Concept	Variables	Definition	Measures
Physical Environment	Actual Neighborhood food environment	Objective neighborhood food environment created by identifying, aggregating, describing and quantifying healthy food outlet types that sell fruit and vegetable in the participants' 0.25-mile and 0.5-mile residential radius buffers.	Food outlet types that sell fruit and vegetable in the five Northern Manhattan ZIP codes
	Perceived food environment: Availability, selection, and quality of healthy foods in my neighborhood	Person-level self-report of the availability and selection of fresh fruit and vegetable in my neighborhood: Agree (Strongly Agree, Agree) Disagree (Disagree, Strongly Disagree)	A large selection of fresh fruit and vegetable is available in my neighborhood
		Person-level self-report of the high quality of fresh fruit and vegetable in my neighborhood Agree (Strongly Agree, Agree) Disagree (Disagree, Strongly Disagree)	The fresh fruits and vegetables in my neighborhood are of high quality.
		Perceived food environment: Person-level self-report of the availability and selection of low-fat products in my neighborhood: Agree (Strongly Agree, Agree) Disagree (Disagree, Strongly Disagree)	A large selection of low-fat products is available in my neighborhood

Concept	Variables	Definition	Measures
	Participants' Response ID, Street Address and ZIP Code	Individual 0.25-mile and 0.5-mile person-level neighborhood radius buffers created around the participants' geocoded residential addresses given that residents can travel outside of their home to buy fruit and vegetable.	0.25-mile and 0.5-mile radius buffers from participants' home addresses where they can travel to buy fruit and vegetable
Demographic Characteristics	Age	Age in years	Computer calculated age
	Gender	Male, Female	What is your gender?
	Self-reported Diabetes	Self-reported Diabetes: Yes, No	Have you ever been told by a doctor, nurse, or other health professional that you had diabetes, high blood sugar, or sugar in the urine only when you were not pregnant?
	Hispanic, Latino or Spanish origin	Hispanic: Yes, No	Are you of Hispanic, Latino or Spanish origin?
	Nativity	US-born (Born in the United States) Foreign-born: DR (Born in the Dominican Republic) Foreign-born: Other (Born outside of the United States or Dominican Republic)	Where were you born?
	Survey Language	Survey language preference: Spanish, English	Survey language preference
Social and Economic Factors	Social Relations	Partnered (Married, Partnered) Not Partnered (Single, Never Married, Divorced, Separated, Widowed)	Which best describes your marital status?
	Education	Less than high school (Never went to school, Eight grade or less, Some high school, not a high school graduate) High school graduate (High school graduate or GED) More than High School (Some college or technical, trade or vocational school, Associates or Bachelors or Masters or Doctoral degrees)	What is the highest level of education you completed?
	Health Insurance	Insured (Medicare, Medicaid, Veteran's Affairs, Private) Uninsured (No insurance) Health Insurance Type (Medicare/Medicaid, Veteran's Affairs, Private)	What type of health insurance do you currently have?

Concept	Variables	Definition	Measures
	Employment Status	Based on survey responses, any full-time or part-time employment was categorized as employed and all other responses was categorized as unemployed. Employed (any type of employment) Unemployed (all other responses)	What is your current occupation?
Heath Behaviors	Fruit and vegetable consumption	Responses were standardized to the "per day" unit of reference and recoded as categorical variables based on the participant's consuming the federal minimum recommendation of two servings of fruits per day and three servings of vegetables per day • Fruit Consumption per day: <2 or ≥2 servings per day • Vegetable Consumption per day: <3 or ≥3 servings per day The daily fruit consumption and the daily vegetable consumption variables were then combined and recoded as categorical variable based on the participant's consuming the federal minimum recommendation of five servings of fruits and vegetables per day • Fruit and Vegetable Consumption per day: <5 or ≥5 servings per day	During the past 30 days, not counting juice, how many times per day, week, or month did you eat fruit?
			During the past 30 days, about how many times per day, week, or month did you eat dark vegetables? Not counting what you just told me, during the past 30 days, about how many times per day, week or month did you eat other vegetables?
Health Outcomes	BMI	Objectively measured weight	Calculated BMI
		Perceived weight (body size): Overweight, Not Overweight	Do you consider yourself to be overweight, underweight, or just about right?
	BP	Hypertension: No or Yes (≥140/90 mmHg)	Database average of 2nd and 3rd BP readings
	Self-reported health	Self-reported health: ≥ Good (Excellent, Very Good, Good), < Good (Fair, Poor)	Would you say that in general your health is _____?

Theoretical Framework

This study is guided by the County Health Rankings model (Figure 1), which is based on the population health improvement model. The County Health Rankings model describes the relationship

between policies and programs, health factors, and health outcomes. The Rankings model is presented in Figure 1 and health factors included in this study are highlighted in yellow.

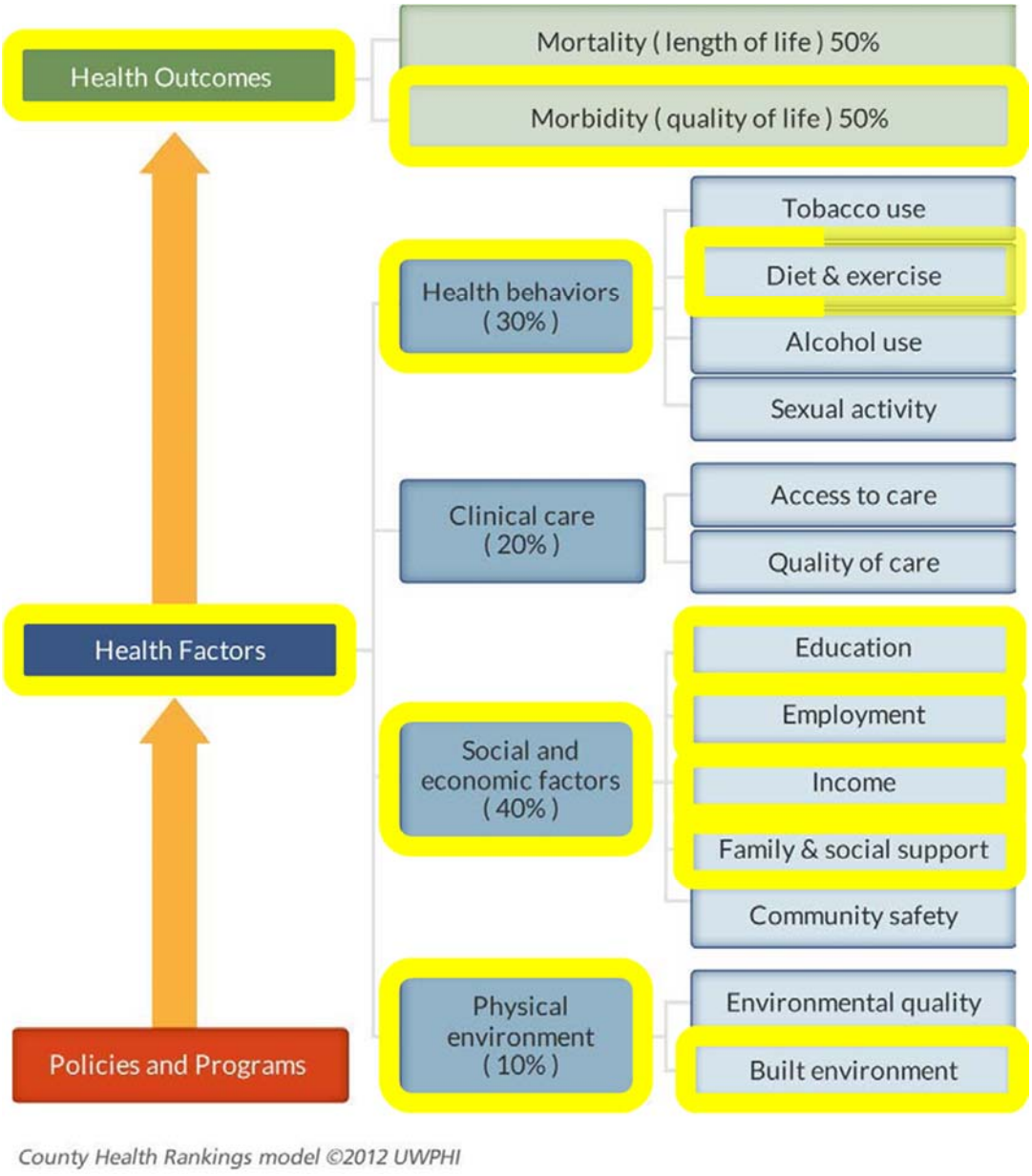


Figure 1: County Health Rankings Model

The health factors and health outcomes are two sets of messages used by the County Health Rankings model to convey the health of a community. The health outcomes, a picture of today's health, address how healthy a community currently is, whereas the health factors, a picture of tomorrow's health, address how healthy a community might be based on the health factors that can influence health (Russell, 2013).

The County Health Rankings model includes components that work together to create healthy communities and the model is designed to help communities understand what makes them sick or makes them healthy. The summary health factors rankings are based on weighted scores of four types of health factors with expert's input and their review of the literature confirming the critical role of the physical environment, social and economic factors, clinical care, and health behaviors in making people healthy or sick (Uwphi, 2012). Permission to use the County Health Rankings model was obtained from the University of Wisconsin Population Health Institute.

Significance

This study adds to our body of knowledge on aspects of the actual and perceived neighborhood food environment that can have an influence on patterns of healthy eating in a predominantly Hispanic underserved urban population. The neighborhood food environment was characterized through a comprehensive community-based survey approach using standardized measures to assess residents' perception of the availability of healthy foods and then comparing it with the objective measures of healthy food outlets in the neighborhood food environment. Although it is possible that the resident's subjective reports of their perceived healthy food availability may differ from the actual food environment, there is value to using the residents' self-reported healthy food availability measures and self-reported fruit and vegetable consumption as it can help identify variation in the availability and quality of healthy foods in their neighborhood food stores that may affect their healthy eating and health outcomes. Enhancing our knowledge of place supports the overall health of the community, which is consistent with National Institute of Nursing Research's strategic plan to promote and improve the health of individuals, families, communities and populations (National Institute of Nursing Research, 2011).

CHAPTER II: REVIEW OF THE LITERATURE

This chapter presents a summary and synthesis of the literature on the built food environment and health. The literature review was conducted by searching the PubMed, BioMed Central, Scopus, ScienceDirect and Read by QxMD electronic research databases for relevant studies on the built environment, food environment, neighborhood and health. Of the 53 articles reviewed, 12 were excluded because they did not report on the relationship between the food environment, health behaviors and/or health outcomes. The review of the literature is organized using the County Health Rankings model described in Chapter I. The Rankings model includes components that work together to create healthy communities and the model describes health outcomes as being influenced by a set of health factors. This review will focus on the influence of health factors such as the neighborhood food environment, social and economic factors, and health behavior on one's health outcomes.

Study Designs and Model Components

Forty-one studies that met the inclusion criteria were included in the review. Cross-sectional study design accounted for 84% of the literature reviewed and Table 2 highlights the study characteristics, including their health factors and health outcomes components. Aspects of the neighborhood food environment were assessed. Specifically, 80% of the studies examined the presence of certain types of food outlets such as grocery stores, supermarkets, convenience stores, delicatessens, fruit and vegetable markets, and fast food restaurants, and 16% of the studies examined access, distance and/or walkability to the neighborhood food outlets. In addition, education was assessed in 61% of the studies reviewed, followed by income (50%), employment (32%), social relations (30%), and neighborhood SES (9%). Health behaviors related to dietary intake such as fast food intake, and fruits, and vegetable consumption were examined in 45% of the studies reviewed as well as food choices, food shopping and eating behaviors (10%) and physical activity and neighborhood walking (27%). Health outcomes examined included BMI (45%), BP (2%), and self-reported health (16%).

Influence of the Neighborhood Food Environment on Food Access and Health

Distance to food stores and the number of food stores in one's ZIP codes has been studied. Lower number of supermarkets and higher numbers of convenience stores within census tracts in the Maryland, Minnesota, Mississippi, and North Carolina communities were observed in neighborhoods

where Black Americans reside as compared to neighborhoods where White Americans reside (Kimberly Morland et al., 2002). The researchers also noted that Black Americans living in the communities being studied have less access to private transportation than White American study participants, which may have limited their ability to more easily access food beyond their immediate neighborhood. Of note is that the same study found that the presence of at least one supermarket in one's census tract as compared to no supermarket in the census tract was positively associated with higher proportion of Black Americans meeting the fruit and vegetable dietary guidelines.

Another study used data from the New York City Community Healthy Survey and conducted multiple food environment measures such as density, relative concentration and diversity of the food outlets in each ZIP code (Stark et al., 2013). The study found that BMI was positively associated with the proportion of BMI-unhealthy food outlets as well as strongly associated in lower poverty ZIP codes. Findings from another study conducted in Philadelphia reported that the distance to primary food store did not predict one's fruit and vegetable consumption and that respondents taking public transportation as primary transportation mode to access their primary food stores had lower BMI compared to those using multimodal mode of car and public transportation (Fuller, Cummins, & Matthews, 2013). The food store's shelf space allocated to energy-dense snacks, particularly within one kilometer of respondents' households, was noted to be positively associated with BMI after controlling for individual socioeconomic characteristics (Rose, Bodor, Hutchinson, & Swalm, 2010). In a longitudinal study of the Framingham Heart Study Offspring Cohort with repeated measures of BMI over a 30-year period, inconsistent association was noted between an individual's BMI and their access to fast food restaurants as measured by the driving distance between the subject's residence and nearby food establishments (Block, Christakis, O'Malley, & Subramanian, 2011).

Studies have described in-store observations to assess food available for purchase. The availability and variety of fresh, frozen, and canned produce in food stores can differ depending on the racial composition of the urban neighborhoods. Findings from a study that randomly sampled and surveyed half of the food stores (20 delicatessens, 10 fruit and vegetable markets, 125 small grocery stores, and 11 supermarkets) in two racially and economically diverse neighborhoods in Brooklyn, NY, noted that although supermarkets carry the largest variety of produce types, there were no supermarkets

located in the predominantly Black area of the neighborhoods surveyed (K. Morland & Filomena, 2007). The same study also reported that frozen and canned produce were available in most of the food stores surveyed, though the availability of freshly prepared produce in racially mixed areas of the neighborhood was low and that fewer varieties were available. In addition, the study found that organic produce was available only in the predominantly White area food stores.

Access to and availability of food can be further complicated by the cost of food itself. A study conducted in rural South Carolina surveyed the availability and cost of a limited number of staple foods selected from the five main food groups and observed that food prices differ by store types with foods costing more in convenience stores than those sold in grocery stores and supermarkets (Liese, Weis, Pluto, Smith, & Lawson, 2007). The quality, variety, and cost of food items that are readily available in urban retail food stores can also differ based on the neighborhood characteristics.

A study that surveyed food stores in the racial/ethnic minority East Harlem and in the largely White and affluent Upper East Side neighborhoods of New York City reported that East Harlem has more than twice the number of food stores with significantly more small stores or bodegas when compared to the Upper East Side (Horowitz et al., 2004). Despite having more food stores, the same study also noted disparities in food availability in that less than a fifth of East Harlem's food stores surveyed carry all of the five clinician-recommended diabetes-healthy food items compared to 58% of stores surveyed in the Upper East Side, thus making it more difficult for African American and Latino residents with diabetes and living in East Harlem to maintain a healthy diet. Although the food items surveyed in the study cost less in East Harlem than in the Upper East Side, it is worth noting that the East Harlem's median household income is only a quarter of their more affluent Upper East Side neighbors' income and this can be a financial barrier when shopping for food. A challenge noted in several of the geographic information system (GIS) based studies that measure food access is the inconsistencies with how retail food stores are categorized to account for the variety and quality of food items available for purchase. Studies have grouped supermarkets and groceries together or did not differentiate between chain supermarkets from independent grocery stores (Laraia, Siega-Riz, Kaufman, & Jones, 2004; K. Morland, Wing, & Diez-Roux, 2002; Spence, Cutumisu, Edwards, Raine, & Smoyer-Tomic, 2009).

Influence of Social and Economic Factors on Healthy Eating and Health

Having easy access to inexpensive, energy-dense foods from bodegas or small convenient stores near school and having higher density of fast food outlets in low socioeconomic neighborhoods or near schools in low-income neighborhoods can influence an individual's food intake and adolescents' food choices over the years (Bauer, Larson, Nelson, Story, & Neumark-Sztainer, 2009; Casey et al., 2008; Fox, Dodd, Wilson, & Gleason, 2009; Neckerman et al., 2010). Of note is that foods available for purchase at convenience stores are of lower nutritional value (K. Morland, Diez-Roux, & Wing, 2006) and the abundance of less healthy food outlets such as convenience stores and fast food restaurants presents a significant risk for residents living in lower-income neighborhoods and communities of color for developing obesity and type II diabetes (Kimberly Morland et al., 2002; Shannon N Zenk et al., 2005).

Higher concentrations of fast food restaurants were noted in lower-income and ethnic minority neighborhoods when compared to middle- to higher-income areas, which may explain racial differences relating to higher obesity prevalence in these neighborhoods (Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011; Lisa M. Powell, Chaloupka, & Bao, 2007) with the density of fast food restaurants accounting for six percent of the variance in the state obesity rates (Maddock, 2004). Another study reported that the neighborhood SES has a positive and statistically significant association with one's fruit and vegetable intake, even after controlling for individual characteristics such as gender, nativity, educational attainment, and family income (Dubowitz et al., 2008). Of interest is that their study found the neighborhood SES mattered more for Whites than for Blacks and Mexican Americans, which suggests that the neighborhood SES may influence race/ethnic groups' dietary intake differently.

The association between one's level of education and food choices has been examined. A survey of adults living in rural communities in Missouri, Arkansas and Tennessee noted that those having more than a high school education reported greater access to a large selection of fruit and vegetable and were more likely to shop in supermarkets and bakeries, and to eat at sit down restaurants (restaurant with waiter or waitress service) (Casey et al., 2008). One's occupation can provide helpful context when studying the association between education level and food choices. Findings from a study using the New York City Community Health Survey showed increased odds of eating five or more servings of fruit and vegetable a day in men and women with higher education (Jack et al., 2013). Similarly, a German

National Health Interview and Examination Survey that reported adults having less education consumed more energy-dense foods and fewer fruit and vegetable, which may be partially explained by the greater energy demand related to the participant's higher levels of physical work activity (Finger, Tylleskar, Lampert, & Mensink, 2013).

Qualitative studies have been conducted to more fully understand the experience and interactions of food shopping in disadvantaged neighborhoods. The experience of fruit and vegetable grocery shopping by low-income households in upstate New York's underserved rural and inner city settings was examined using a grounded theory approach. The principal food shopper was selected, independent of any shopping destination, and interviewed in their homes. Themes that emerged from the interviews included weighing location versus convenience, navigating the store environment, determining product quality, evaluating product price, and differing social relationships that takes place between the participant consumers with stores and store personnel (Webber, Sobal, & Dollahite, 2010). The themes that emerged from this qualitative study provided helpful insights into the attitude, motivation, and behavior of produce shoppers and their choice of shopping location.

The consumption-related behavior of community participants from poor neighborhoods in the United Kingdom was examined using an ethnography research method. Findings from this study provided insights into four routines-of-practice, each representing participants' approaches to food shopping: The "restricted and budgeted" food shopping style was least influenced by the supermarket environment and has more to do with the participants' planned purchases; (2) The "item by item" food shopping style was not greatly influenced by in-store marketing and relied on planning; (3) The "working around the store" food shopping style relied on participants' familiarity with the in-store food environment layout and their repetitive food purchases; and (4) The "chaotic and reactive" food shopping style is most influenced by the supermarket environment and is characterized by unplanned purchases (Thompson, Cummins, Brown, & Kyle, 2012).

The sociocultural root of low-income Latino community in the Bushwick neighborhood of Brooklyn, NY was studied using an ethnographic approach to understand circumstances of childhood obesity in families interviewed and observed. Families who participated were Puerto Rican, Ecuadorian, Columbian, Cuban, Dominican, and Mexican in origin. Overweight in children was positively viewed by some of the

families as being safer and less fragile than thinner children given that overweight was not out of their family norm. Of note is that many of the families interviewed relied heavily on government benefit programs and their food coping strategies included food sharing with family members, "taking credit" and paying back over time when food shopping at local bodegas (small neighborhood food stores) in order to save travel time and transportation costs, and eating at community resource centers such as church food pantries (Kaufman & Karpati, 2007). Community leaders suggested that food shopping at bodegas conveniently located in one's densely populated inner-city neighborhood provides residents with a comfortable place to go to and one that offers informal credit that they or other family members can pay back over time (Horowitz et al., 2004).

Influence of Health Behavior on Health Outcomes

The activity-friendliness of the neighborhood can have an impact on the resident's weight status as noted in studies that found an association between higher rates of obesity and the residents' perception of their community as being unpleasant or not supportive of physical activity (Casey et al., 2008; Li et al., 2008). The presence of facilities such as post office, banks, and drugstores in areas with a higher commercial/residential land use mix was noted to be correlated with higher frequencies and duration of resident's neighborhood walking (Adams et al., 2011; Li et al., 2008). The aesthetic of the neighborhood, street trees, parks, and the neighborhood landscaping was reported to have an influence on one's interest in walking as does the sidewalk condition, street lighting, pedestrian safety, police presence, neighborhood surveillance, street connectivity, and access to subway and transit stops in increasing physical activity in the various age groups studied ranging from adolescents to older adults (Adams et al., 2011; Li et al., 2008; Lovasi et al., 2011; Mota, Almeida, Santos, & Ribeiro, 2005; Wang & Lee, 2010). One's living space also has an effect on an individual's motivation for physical activity. In particular, living in a corner lot, having a good window view, adequate indoor daylight or the presence of landscaped yards as well as having a variety of walking routes were noted to have contributed to higher levels of physical activity and neighborhood walking among older adults (Wang & Lee, 2010). Moreover, the combination characteristics of the urban walking environment, the availability of healthy foods in the neighborhood, and other formal fitness amenities was significantly associated with lower BMI (Black, Macinko, Dixon, & Fryer, 2010).

Studies have found that people living near grocery stores or supermarkets are more likely to eat fruit and vegetable, whereas people living near convenience stores or fast food restaurants are more likely to purchase potentially unhealthy foods thus contributing to their becoming obese and increasing their risk for obesity-related disease (Auchincloss, Roux, Brown, Erdmann, & Bertoni, 2008; Babey et al., 2008; Bauer et al., 2009; Brug, 2008; K. Morland et al., 2006; K. Morland et al., 2002; K. B. Morland & Evenson, 2009; Spence et al., 2009; Thornton, Pearce, Macdonald, Lamb, & Ellaway, 2012; Shannon N. Zenk et al., 2009). Greater availability of fresh vegetables in the neighborhood, regardless of the type of food store, was noted to be associated with increased vegetable intake (Bodor, Rose, Farley, Swalm, & Scott, 2008). However, no association was found to support the access to healthier food choices in supermarkets and the actual consumption of fruit and vegetable in adults; those having less than a high school education were noted to have less access to large selection of fruit and vegetable as well as having a higher rate of eating at buffet-style restaurants (Casey et al., 2008; Pearce, Blakely, Witten, & Bartie, 2007).

The 2010 Dietary Guidelines for Americans highlighted the connection between the food and physical activity environment and recommended that healthy eating complement regular physical activity in order to support growth and development and to reduce the risk for chronic disease (U.S. Department of Agriculture and U.S Department of Health and Human Services, 2010). Compared to other types of food stores, supermarkets tend to provide a greater variety of healthier food choices and at lower prices (Chung & Myers, 1999; Glanz, Sallis, Saelens, & Frank, 2007). The effects of healthy eating have been examined and differences were noted in metropolitan and nonmetropolitan areas. Fruit and vegetable consumption were higher and obesity was lower in the metropolitan areas (Michimi & Wimberly, 2010). Of note is that increasing distance to supermarkets was positively associated with increased prevalence of obesity only in the metropolitan area model, which supported the association between higher supermarket accessibility with higher availability and consumption of fruit and vegetable (Michimi & Wimberly, 2010).

In a study of the neighborhood food environment and obesity in New York City, a positive association was noted for those surrounded by increased density of healthy food outlets with having lower BMI and lower prevalence of overweight and obesity (Rundle et al., 2009). The food environment

examined in the study was categorized as BMI-healthy, BMI-intermediate, and BMI-unhealthy food outlets based on existing literature such that supermarkets, fruit and vegetable stores, and natural/health food stores are grouped under BMI-healthy food outlets. However, the same study also noted the lack of significant association between the density of unhealthy food and BMI or obesity, which the researchers reflected as the presence of additional unhealthy food outlets reaching a saturation point such that there may not be any corresponding increase in fast food intake among residents in these neighborhoods. Similarly, another study that examined the association between individual and neighborhood-level characteristics with obesity in a large representative sample from New York City reported that mixed land use and improved walkability was significantly associated with an individual's BMI (Black et al., 2010).

Summary

The review of the literature highlighted the important role that place can have on health. Specifically, the review provided insights into the influence of the neighborhood food environment on food access and health, the influence of social and economic factors on healthy eating and health, and the influence of health behaviors such as fruit and vegetable consumption on health outcomes. Additional study is needed to better understand the relationship between the neighborhood food environment, health behaviors, and health outcomes in a predominantly low-income urban community in New York City that has significant health disparities.

Table 2: Characteristics of the Studies highlighting Study Designs and Model Components

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Adams, Sallis, Kerr, Conway, Saelens, Frank, Norman & Cain, 2011	Epidemiological Study; Seattle-King County, Washington (n=1,287), and Baltimore, Maryland and Washington, DC regions (n=912)	Neighborhood walkability	Education, Income, Social support	Physical activity	BMI

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Auchincloss, Diez Roux, Brown, Erdmann & Bertoni, 2009	Cross-sectional Study; Baltimore City and County, (Maryland), Forsyth County, (North Carolina), and New York and Bronx counties, (New York) (n=2,226)	Healthy food environment	Education, Income	Physical activity, Dietary low-fat and dietary fiber intake	BMI, Insulin resistance
Babey, Diamant, Hastert, Goldstein, Harvey, Banthia, Flournoy, Rubin & Treuhaft, 2008	Cross-sectional Study; California (n=40,000)	Neighborhood food environment (fast food restaurants, convenience stores, produce vendors)	Community income		BMI, Diabetes
Bauer, Larson, Nelson, Story & Neumark-Sztainer, 2009	Correlational Study to examine secular and longitudinal changes in fast food intake among adolescents in Minnesota (n=2,516)	Neighborhood food environment	SES	Fast food intake	
Black, Macinko, Dixon & Fryer, 2008	Cross-sectional Study; New York City (n=9,916)	Neighborhood food environment, Physical activity environment	Education, Income, Employment, Family/social support	Smoking status	BMI
Block, Christakis, O'Malley & Subramanian, 2011	Cross-sectional Study; Framingham, Natick, Ashland, and Holliston, Massachusetts (n=3,113)	Neighborhood food environment, Neighborhood walkability, Driving distance between each subject's residential address and the nearest restaurant or food store	Education, Income	Smoking status, Alcohol use	BMI

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Bodor, Rose, Farley, Swalm & Scott, 2008	Cross-sectional Study of 4 contiguous census tracts in central-city New Orleans, Louisiana (n=102)	Food store access and in-store fruit and vegetable availability	Poverty index ratio, Food assistance, Car ownership	Fruit and vegetable intake	
Brug, 2008	Narrative review informed by a series of six systematic reviews	Neighborhood food environment		Physical activity, Food choices and eating behavior	
Casey, Elliott, Glanz, Haire-Joshu, Lovegreen, Saelens, Sallis & Brownson, 2008	Cross-sectional Study of 12 rural communities in Missouri (6), Arkansas (2) and Tennessee (4) (n=1,258)	Perceived food environment and shopping pattern	Education, Income	Physical activity	BMI, General health status
Chung & Myers, 1999	Cross-sectional Study; Inner-city (n=226 stores) and suburban (n=300 stores) communities within the Twin Cities-metropolitan area	Neighborhood food environment (store availability, food prices across inner-city and suburban communities)			
Dubowitz, Heron, Bird, Lurie, Finch, Basurto-Dávila, Hale & Escarce, 2008	Cross-sectional Study; 3rd National Health and Nutrition Examination Survey (NHANES III) (n=13,310 for the analyses of fruit intake, n=13,296 for the analyses of vegetable intake, and n=13,281 for the analyses of combined fruit and vegetable intake)		Neighborhood SES, Education, Employment status, Family income	Fruit and vegetable intake, General health status	

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Finger, Tylleskär, Lampert & Mensink, 2013	Cross-sectional Study of 1998 German National Health Interview and Examination Survey (GNHIES98) (n=7,124)		Education, Occupational status, Income	Physical activity, Dietary intake, Smoking status	BMI, Self-perceived health
Fleischhacker, Evenson, Rodriguez & Ammerman, 2011	Systematic Review; Urban and rural settings (n=40 studies) across the USA, Australia, Canada, United Kingdom, and New Zealand	Fast food access	SES	Dietary intake	BMI
Fox, Dodd, Wilson & Gleason, 2009	Cross-sectional Study of schools (n=287) and children in grades 1 through 12 (n=2,228) using the 3rd School Nutrition Dietary Assessment Study's national sample of public school districts, schools, and children in the 2004-2005 school year	School food environment and practices	Parents education, Income, Household food security, School characteristics	Child's food intake, Family's usual dining habits, Child's physical activity, Child's screen time	BMI
Fuller, Cummins & Matthews, 2013	Cross-sectional Study of Philadelphia neighborhoods (n=1,440)	Distance to primary food store, Transportation mode	Education, Employment status, Income	Fruit and vegetable intake	BMI

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Glanz, Sallis, Saelens & Frank, 2007	Cross-sectional Study of 4 neighborhoods in the Atlanta, Georgia metropolitan area (n=85 retail food stores) to assess test-retest reliability of a food store environment measurement tool related to availability of healthy options, price, and quality	Neighborhood food environment (evaluated 10 food categories or indicator food items in grocery and convenience stores)	Neighborhood SES		
Horowitz, Colson, Hebert & Lancaster, 2004	Cross-sectional Study of New York City food stores (n=173 East Harlem and n=152 Upper East Side grocery stores)	Neighborhood food environment (availability of 5 recommended foods)	Household income		
Jack, Neckerman, Schwartz-Soicher, Lovasi, Quinn, Richards, Bader, Weiss, Konty, Arno, Viola, Kerker & Rundle, 2013	Cross-sectional Study of data from 2002 and 2004 New York City Community Health Survey linked by residential ZIP code to neighborhood data (n=15,634 adult survey respondents)	Neighborhood food environment (ZIP code- level access to retail outlets selling healthful foods)	Neighborhood poverty status, Income to Poverty Ratio, Employment, Race/Ethnicity, Education, Nativity, Marital status	Fruit and vegetable consumption	
Kaufman & Karpati, 2007	Ethnography; Bushwick, Brooklyn, New York (n=60 residents)		Education, Household food security, Economic resources and food practices, Sociocultural roots of childhood obesity	Neighborhood food shopping	

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Laraia, Siega-Riz, Kaufman & Jones, 2004	Cross-sectional Study; Wake County, North Carolina (n = 973)	Pregnant woman's food environment, as measured by distance to supermarkets, grocery stores, and convenience stores.	Education, Family income	Dietary intake	
Li, Harmer, Cardinal, Bosworth, Acock, Johnson-Shelton & Moore, 2008	Cross-sectional Study; 120 neighborhoods in Portland, Oregon (n=1221 residents; aged 50-75)	Built environment features (land-use mix, distribution of fast-food outlets, street connectivity, access to public transportation, and green and open spaces)	Education, Employment status, Household income, Home ownership	Physical activity, Walking activities, Alcohol use, Tobacco use	BMI, General health status
Liese, Weis, Pluto, Smith & Lawson, 2007	Cross-sectional Study; Orangeburg County, South Carolina, a rural county with a total population of 91,582 (n=75 food stores)	Neighborhood food environment: food availability, store amenities, price comparison of food	Education, Family income		
Lovasi, Jacobson, Quinn, Neckerman, Ashby-Thompson & Rundle, 2011	Cross-sectional Study; New York City (n=41 Head Start centers)	Neighborhood walkability		Physical activity	BMI
Maddock, 2007	Cross-sectional Study; State-level data, with Alaska excluded as an outlier (n=50)	Neighborhood food environment		Fruit and vegetable intake, Physical activity	BMI

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Michimi & Wimberly, 2010	Cross-sectional Study; BRFSS secondary data analysis of metropolitan and non-metropolitan areas (n=1,477,828 sample size for obesity and n=836,281 sample size for fruit/vegetable consumption variables)	Neighborhood food environment (supermarkets)	Education, Income	Fruit and vegetable intake, Physical activity	BMI
Morland & Evenson, 2009	Cross-sectional Study; n=1,295 adults living in the southern region of the United States	Neighborhood food environment (food stores & food service places)	Education, Employment status		BMI
Morland & Filomena, 2007	Cross-sectional Study; 2 Brooklyn, NY Community Districts (BCD6 and BCD9) selected based on diversity of racial demographics among area residents (n=166 food stores)	Neighborhood food environment (supermarkets, small grocery stores, delicatessens, fruit and vegetable markets)	Neighborhood racial segregation		
Morland, Diez-Roux, & Wing, 2006	Cross-sectional Study; Jackson City (Mississippi), Forsyth County (North Carolina), Washington County (Maryland), and selected suburbs of Minneapolis (Minnesota) (n=10,763 individuals)	Neighborhood food environment	Education, Income	Physical activity	Cardiovascular disease risk factors (Obesity, Overweight, Diabetes, High cholesterol, Hypertension)

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Morland, Wing & Diez-Roux, 2002	Cross-sectional Study; 208 census tracts used for analysis (Maryland=28, North Carolina=78, Mississippi=48, Minnesota=54)	Neighborhood food environment	Education, Family income	Dietary intake	
Morland, Wing, Diez Roux & Poole, 2002	Cross-sectional Study; 216 census tracts (Mississippi=56, North Carolina=78, Maryland=28, Minnesota=54)	Neighborhood food environment (food stores & food service places)	Neighborhood SES, Neighborhood racial segregation		
Neckerman, Bader, Richards, Purciel, Quinn, Thomas, Warbelow, Weiss, Lovasi & Rundle, 2010	Cross-sectional Study; New York City (n=1,135 school locations)	School neighborhood food environment	Income		
Pearce, Blakely, Witten & Bartie, 2007	Cross-sectional Study; 74 local Territorial Authorities across New Zealand	Fast food outlets and travel distance from each school across the country	Education, Occupation, Household income, Household overcrowding, Income support in households with children		
Rose, Bodor, Hutchinson & Swalm, 2010	Narrative review informed by a series of cross-sectional studies	Neighborhood food environment		Dietary intake	BMI
Rundle, Neckerman, Freeman, Lovasi, Purciel, Quinn, Richards, Sircar & Weiss, 2009	Cross-sectional Study; New York City, n=13,102 adult residents	Neighborhood food environment, Neighborhood walkability	Education, Income		BMI

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Spence, Cutumisu, Edwards, Raine & Smoyer-Tomic, 2009	Cross-sectional Study; Telephone-administered survey conducted in the Capital Health region of Alberta, Canada (n=2,900)	Neighborhood food environment	Education, Neighborhood SES		BMI
Stark, Neckerman, Lovasi, Konty, Quinn, Arno, Viola, Harris, Weiss, Bader & Rundle, 2013	Cross-sectional Study; data from the 2002–2006 Community Health Survey in New York City and linked to residential ZIP code-level characteristics (n=48,482 adult survey respondents)	Neighborhood food environment, Walkability	Neighborhood poverty status, Income, Employment, Education, Nativity, Marital status		BMI, Self-reported health
Thompson, Cummins, Brown & Kyle, 2012	Symbolic Interactionist Ethnography Approach; n=26 participants from deprived neighborhoods (10 men, 16 women, aged 18–70) in the United Kingdom	Supermarket environment	Employment	Food shopping behaviors	
Thornton, Pearce, Macdonald, Lamb & Ellaway, 2012	Cross-sectional Study; Supermarket location data from Glasgow, United Kingdom (n = 119), and fruit and vegetable intake data from the 'Health and Well-Being' Survey (n = 1041)	Neighborhood supermarket access	Education, Vehicle ownership	Fruit and vegetable consumption	
Wang & Lee, 2010	Cross-sectional Study; n=114 older adults from 5 assisted-living facilities in Houston, Texas	Neighborhood environment		Neighborhood walking	

		Health Factors			
Author(s) and Year	Study Design, Setting, and Sample Size	Built Environment	Social and Economic Factors	Health Behaviors	Health Outcomes
Webber, Sobal & Dollahite, 2010	Grounded Theory Approach; n=28 low-income rural (n=10), village/small town (n=8), and inner city (n=10) heads of households in upstate New York			Fruit and vegetable food shopping behavior	
Zenk, Lachance, Schulz, Mentz, Kannan & Ridella, 2009	Cross-sectional Study; n=146 neighborhoods within three large geographic communities of Detroit, Michigan	Neighborhood food environment	Education, Household income, Employment status, Car ownership	Fruit and vegetable consumption	
Zenk, Schulz, Israel, James, Bao & Wilson, 2005	Cross-sectional Study; n=869 neighborhoods (census tracts) in metropolitan Detroit	Neighborhood food environment (distance to nearest large "chain" supermarkets)	Neighborhood poverty		

CHAPTER III: METHODOLOGY

This cross-sectional observational study was undertaken as part of a larger initiative, the Washington Heights/Inwood Informatics Infrastructure for Comparative Effectiveness Research (WICER) Project, and supports WICER's overall goal of gaining a comprehensive understanding of community residents living in Northern Manhattan by contributing to our understanding of the influence of place on health in a predominantly Hispanic underserved urban population.

This study is guided by three aims:

AIM 1. The first aim is to characterize the actual and perceived neighborhood food environment in Northern Manhattan.

- **Research Question 1.1:** What is the actual neighborhood food environment (food outlet types) and does it vary in the participants' 0.25-mile and 0.5-mile residential radius buffers?
- **Research Question 1.2:** What is the relationship between perceived neighborhood food environment and actual neighborhood food environment in the participants' respective 0.25-mile and 0.5-mile residential radius buffers?

AIM 2. The second aim is to understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of consuming five or more servings of fruits and vegetables per day.

- **Research Question 2.1:** Which factors are associated with increasing the participants' likelihood of consuming five or more servings of fruits and vegetables per day?

AIM 3. The third aim is to describe the contribution of participants' sociodemographic characteristics and health behaviors to their health outcomes.

- **Research Question 3.1:** Which factors are associated with higher BMI?
- **Research Question 3.2:** Which factors are associated with hypertension?
- **Research Question 3.3:** Which factors are associated with self-report of good health?

Study Setting and Participant Recruitment

The study was conducted in ZIP codes 10031, 10032, 10033, 10034, and 10040 that comprise the Hamilton Heights, Washington Heights and Inwood sections of Northern Manhattan, a low-income and minority urban community with significant issues in healthcare disparities. Study participants who

were 18 years or older and spoke either English or Spanish were primarily recruited for the WICER Study through convenience and snowball sampling in the Columbia Community Partnership for Health (CCPH), in the New York-Presbyterian Hospital's Ambulatory Care Network (ACN) clinics, and in Northern Manhattan's residential households (HH) and other community locations such as schools and businesses. For participants in residential households, sampling was initiated through a randomized household sampling approach, but evolved as planned to convenience and snowball sampling over time (Lee et al, 2014).

The CCPH, an initiative of the Irving Institute for Clinical and Translational Research at Columbia University Medical Center, is the community outreach arm of Columbia University, which aims to improve the health of the community-at-large. A dedicated community resource center, CCPH offers communal space to support the health-related research interests of investigators, community-based organizations, and community residents. An average of 25 community residents visit CCPH on most days to attend workshops on a variety of health topics offered at the center, participate in a clinical trial, or use the center's computers to search health information online (Columbia University Medical Center). Free blood pressure screening is offered once a week. The ACN is the ambulatory clinics network of New York-Presbyterian Hospital and consists of in-hospital or stand-alone community health center practices for New York City residents. The ACN primarily serves patients with Medicaid/Medicare insurance.

Human Subjects Protection

Participant recruitment and data collection began in 2011 by the English-Spanish bilingual community health workers. All study participants provided informed consent in their language of choice (English or Spanish). A unique Response ID was assigned for each of the WICER study participants to protect their identity and to ensure their privacy. This study supports the National Institutes of Health's mandate by law (NIH Revitalization Act of 1993, PL103-43) to include women and minority groups in research in a manner that is appropriate to the scientific question under study. The study population included Hispanic participants of both genders 18 years of age and older living in a low income and minority underserved urban community. The Institutional Review Board at Columbia University Medical Center approved all WICER study procedures, including the present study.

Inclusion and Exclusion Criteria

Inclusion criteria for this study included Hispanic males and females aged 18 years or older, speak English or Spanish, have valid measures for key variables of interest, and reside in one of the five Northern Manhattan postal ZIP codes: 10031, 10032, 10033, 10034, and 10040. The Hamilton Heights community includes the ZIP code 10031, the Washington Heights community encompasses the ZIP codes 10032, 10033 and 10040, and the Inwood community covers the ZIP code 10034. The exclusion criteria included non-Hispanics, those younger than 18 years old, those who do not speak English or Spanish, have missing or invalid measures on key variables of interest, or reside outside of the five Northern Manhattan ZIP codes.

Study Variables

The variables for this study are based on the integration of relevant external data on healthy food outlets to provide an objective assessment of the neighborhood food environment in Northern Manhattan with the comprehensive community-based WICER survey data. The external neighborhood food environment data and the WICER survey are described below.

Neighborhood Food Environment

Data for the neighborhood food environment were derived using the ReferenceUSA (Infogroup, Papillion, Nebraska) verified national business database on U.S. businesses for 2012. The detailed business information in the ReferenceUSA database include company name, address and geocoded location (latitude, longitude), location type (single location or branch), franchise description, location employee size, location square footage, Standard Industrial Classification (SIC) and North American Industry Classification System (NAICS) codes and descriptions. SIC is a system that classifies companies based on their industry areas whereas NAICS is the standard used by the Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy (U.S. Census Bureau, 2013).

Consistent with other studies that examined the availability of healthy foods or presence of healthy food outlets in the local community being studied (Jack et al., 2013; Larson et al., 2009; Rundle et al., 2009; Stark et al., 2013; Walker et al., 2010), relevant healthy food outlets were identified and extracted from the 2012 ReferenceUSA's verified national business database based on their NAICS

codes and descriptions for this study. Three types of food outlets that sell fruits and vegetables were identified and their NAICS codes are: 445110 for Supermarkets/Other Grocery (exclude Convenience) Stores, 445230 for Fruit and Vegetable Markets, and 445210 for Meat Markets.

WICER Survey

The WICER survey employs primary data collection by English-Spanish bilingual community health workers through face-to-face interview with study participants. To obtain a comprehensive understanding of the health of residents living in Northern Manhattan, participants' self-reported variables were collected using a comprehensive community-based survey that was developed from standardized patient assessment instruments representing health measures of interest to the WICER Study. The WICER survey includes discrete response questions with branching logic and takes approximately 45 minutes to one hour for participants to complete.

The WICER survey is administered using the iPad tablet computer in the clinical setting and on paper outside of the clinical study setting. The WICER survey collected participants' demographic characteristics and socioeconomic factors data, anthropometric measurements (objectively measured BP, height, weight, and waist circumference), and participants' self-reported information such as self-reported health, health and illness perceptions, quality of life, social relations, and health behaviors such as physical activity and diet.

Operationalization, Measures and Data Types

The variables of interest in this study are the actual and perceived neighborhood food environment, residents' demographic and socioeconomic characteristics (study participant's address and ZIP codes, age, gender, self-reported diabetes, Hispanic or Latino or Spanish origin, nativity, marital status, education, health insurance, and employment status), health behavior (fruit and vegetable consumption), and health outcomes (BMI, hypertension, self-reported health). Table 3 describes the study aim, research question and variables of interest organized using the County Health Rankings Model and Table 4 provides operationalization and measurement of the study variables.

Table 3: Study Aim, Research Question and Study Variables

Study Aim	Research Question	Study Variables
Neighborhood Food Environment		

Study Aim	Research Question	Study Variables
1. To characterize the actual and perceived neighborhood food environment in Northern Manhattan.	1.1: What is the actual neighborhood food environment (food outlet types) and does it vary in the participants' 0.25-mile and 0.5-mile residential radius buffers? 1.2: What is the relationship between perceived neighborhood food environment and actual neighborhood food environment in the participants' respective 0.25-mile and 0.5-mile residential radius buffers?	Actual Neighborhood Food Environment's food outlets that sell fruit and vegetable Perceived Food Environment: A large selection of fresh fruit and vegetable is available in my neighborhood, fresh fruit and vegetable in my neighborhood are of high quality, and a large selection of low-fat products is available in my neighborhood Participant's geocoded residential address
Health Behavior		
2. To understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of consuming five or more servings of fruits and vegetables per day.	2.1 Which factors are associated with increasing the participants' likelihood of consuming five or more servings of fruits and vegetables per day?	Actual and Perceived Neighborhood Food Environment Sociodemographic Characteristics Health Behavior (Fruit and Vegetable Consumption)
Health Outcomes		
3. To describe the contribution of participants' sociodemographic characteristics and health behavior to their health outcomes.	3.1: Which factors are associated with higher BMI? 3.2: Which factors are associated with hypertension? 3.3: Which factors are associated with self-report of good health?	Sociodemographic Characteristics Health Behaviors (Fruit and Vegetable Consumption) Health Outcomes (BMI, Hypertension, Self-reported health)

Table 4: Study Variables, Definition, Measures, and Data Types

Study Variables	Definition	Measures	Data Type
Physical Environment			
Actual neighborhood food environment	Objective neighborhood food environment created by identifying, aggregating, describing and quantifying healthy food outlet types that sell fruit and vegetable in the	Food outlet types in the five Northern Manhattan ZIP codes	Continuous Categorical

Study Variables	Definition	Measures	Data Type
	participants' 0.25-mile and 0.5-mile residential radii.		
Perceived food environment: Availability, selection, and quality of healthy foods in my neighborhood	Person-level self-report of the availability and selection of fresh fruit and vegetable in my neighborhood: Disagree (Disagree, Strongly Disagree) Agree (Strongly Agree, Agree)	A large selection of fresh fruits and vegetables are available in my neighborhood.	Categorical
	Person-level self-report of the quality of fresh fruit and vegetable in my neighborhood Disagree (Disagree, Strongly Disagree) Agree (Strongly Agree, Agree)	The fresh fruits and vegetables in my neighborhood are of high quality.	Categorical
	Person-level self-report of the availability and selection of low fat products in my neighborhood: Disagree (Disagree, Strongly Disagree) Agree (Strongly Agree, Agree)	A large selection of low fat products is available in my neighborhood	Categorical
Participants' Response ID, Street Address and ZIP Code	Individual 0.25-mile and 0.5-mile person-level neighborhood radius buffers created around the participants' geocoded residential addresses given that residents can travel outside of their home to buy fruit and vegetable.	0.25-mile and 0.5-mile radii from study participants' home addresses where they can travel to buy fruit and vegetable	Continuous
Demographic Characteristics			
Age	Age in years	Computer calculated age	Continuous
Gender	Male, Female	What is your gender?	Categorical
Self-reported Diabetes	Self-reported Diabetes: No or Yes	Have you ever been told by a doctor, nurse, or other health professional that you had... Diabetes, high blood sugar, or sugar in the urine only when you were not pregnant?	Categorical
Hispanic, Latino or Spanish origin	Hispanic: No or Yes (study inclusion criteria: Hispanic=Yes)	Are you of Hispanic, Latino or Spanish origin?	Categorical
Nativity	US-born (Born in the United States)	Where were you born?	Categorical

Study Variables	Definition	Measures	Data Type
	Foreign-born: DR (Born in the Dominican Republic) Foreign-born: Other (Born outside of the United States or the Dominican Republic)		
Survey Language	Survey language preference: Spanish or English	Survey language preference	Categorical
Social and Economic Factors			
Social Relations	Not Partnered (Single, Never Married, Divorced, Separated, Widowed) Partnered (Married, Partnered)	Which best describes your marital status?	Categorical
Education	< High School (Never went to school, Eight grade or less, Some high school, not a high school graduate) High School graduate (High school graduate or GED) > High School (Some college or technical, trade or vocational school, Associates or Bachelors or Masters or Doctoral degrees)	What is the highest level of education you completed?	Categorical
Health Insurance	Uninsured (No insurance) Insured (Medicare, Medicaid, Veteran's Affairs, Private) Health Insurance Type (Medicare/Medicaid, Veteran's Affairs, Private)	What type of health insurance do you currently have?	Categorical
Employment	Based on survey responses, any full-time or part-time employment was categorized as employed and all other responses was categorized as unemployed. Unemployed (all other responses) Employed (any type of employment)	What is your current occupation?	Categorical
Heath Behaviors			
Fruit and vegetable consumption	Responses were standardized to the "per day" unit of reference and recoded as dichotomous variable based on participant's consuming the federal minimum recommendation of two servings of fruits per day and	During the past 30 days, not counting juice, how many times per day, week, or month did you eat fruit? __ per day, __ per week, or __ per month	Categorical

Study Variables	Definition	Measures	Data Type
	three servings of vegetables per day • Fruit Consumption per day: <2 or ≥2 servings per day • Vegetable Consumption per day: <3 or ≥3 servings per day The daily fruit consumption and the daily vegetable consumption (continuous) variables were then combined and recoded as dichotomous variable based on the participant's consuming the federal minimum recommendation of five servings of fruits and vegetables per day • Fruit and Vegetable Consumption per day: <5 or ≥5 servings per day	During the past 30 days, about how many times per day, week, or month did you eat dark green vegetables? __ per day, __ per week, or __ per month Not counting what you just told me, during the past 30 days, about how many times per day, week or month did you eat other vegetables? __ per day, __ per week, or __ per month	Categorical Categorical
Health Outcomes			
BMI	BMI: Normal Weight (18.5 - 24.9), Overweight (25.0 – 29.9), Obese (≥30.0)	Objectively measured BMI (kg/m^2)	Continuous Categorical
	Perceived weight (body size): Not Overweight (underweight, just about right), Overweight	Do you consider yourself to be overweight, underweight or just about right?	Categorical
BP	Hypertension: No or Yes (≥140/90 mmHg)	Database average of the 2nd and 3rd BP readings	Categorical
Self-reported health	< Good (Fair, Poor) ≥ Good (Excellent, Very Good, Good),	Would you say that in general your health is _____?	Categorical

Physical Environment

The Northern Manhattan food environment was characterized through the actual and perceived neighborhood food environment. The actual neighborhood food environment is defined as the objective availability of food outlets that sells fruit and vegetable, and was created by aggregating external data on food stores. Data to support the actual neighborhood food environment was obtained by identifying food outlets using commercial business data and public data sources. The actual neighborhood food environment's food outlets in Northern Manhattan were geocoded using geographic information system (GIS) software ArcGIS 10.1 (ESRI, Redlands, California) and integrated with the geocoded study

participant's street addresses. In addition to using the NAICS codes to identify food outlets obtained from the ReferenceUSA business dataset, differentiation was made on the actual neighborhood food environment using the ReferenceUSA business data on square footage and location type (single location or branch). Retail food outlets with larger square footage are of particular interest in this study given that these types of food outlets may offer higher quality and greater variety of healthy food products at affordable prices (Chung & Myers, 1999; Glanz, Sallis, Saelens, & Frank, 2007).

The perceived neighborhood food environment is defined as the person-level self-report of the availability, selection and quality of healthy foods in their neighborhood. Data on the perceived availability of healthy foods were measured using the three WICER community survey items: 1) "A large selection of fresh fruit and vegetable is available in my neighborhood", 2) "The fresh fruit and vegetable in my neighborhood are of high quality", and 3) "A large selection of low fat products is available in my neighborhood." Participants' responses to these questions were dichotomized and coded as either Disagree or Agree. Data on participants' residence are based on the WICER survey data's response IDs, geocoded residential addresses and ZIP Codes.

Proxy for Neighborhood

The definition of neighborhood can vary from one person to another. One's context of their neighborhood may depend on where they work or shop in the neighborhood or how much they are exposed to the neighborhood where they live (Sastry, Pebley, & Zonta, 2002). Potential proxies for neighborhood such as the Zone Improvement Plan (ZIP) codes' geographical boundary and resident-level neighborhood will be explored and discussed. ZIP codes are familiar geographical distinction that is representative of the U.S. Postal Service's mail delivery service areas. The primary use for ZIP code is to improve the mail delivery service and the postal ZIP code boundaries may undergo realignment to reflect changes in city name, area growth and/or changes in finance number (U.S. Postal Service).

For this study, the person-level neighborhood will serve as proxy for neighborhood. Food outlet types present in the participants' 0.25-mile and 0.5-mile radius buffers was identified and spatially modeled to create a person-level neighborhood food environment where community residents can travel outside of their home to buy fruits and vegetables. The 0.25-mile radius starts from where participants live up through the edge of their 0.25-mile residential radius border and the 0.5-mile radius starts from

where participants live up through the edge of their 0.5-mile residential radius border. Half-mile is considered a walkable distance (Agrawal, Schlossberg, & Irvin, 2008) and covers places that a person can reach along their connected street networks (Rundle et al., 2009). The geocoded addresses of Northern Manhattan's food outlet types were integrated and mapped into our WICER study participants' respective 0.25-mile and 0.5-mile residential radii as illustrated in Figure 2.

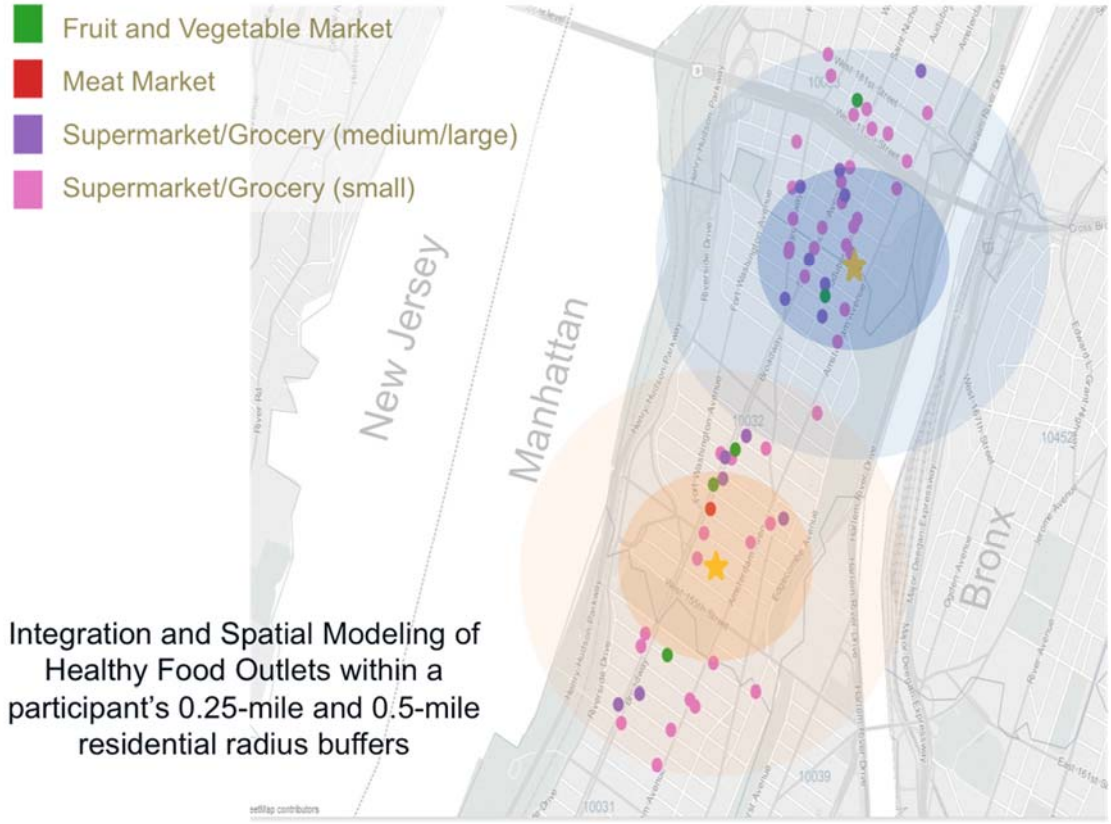


Figure 2: Illustration of Neighborhood Food Environment present in the Participants' 0.25-mile and 0.5-mile Residential Radius Buffers

Food Environment Measures

The actual neighborhood food environment was measured by describing how many of the different food outlet types are present in each of the five Northern Manhattan ZIP codes. Figure 3 illustrates how the WICER survey data maintained in the REDCap database were integrated with the Northern Manhattan's neighborhood food environment data through ArcGIS and spatial models were created to identify food outlet types that are present in the participants' respective 0.25-mile and 0.5-mile radius buffers. Data were analyzed using SPSS Statistics version 23 (IBM SPSS Inc., Chicago, Illinois).

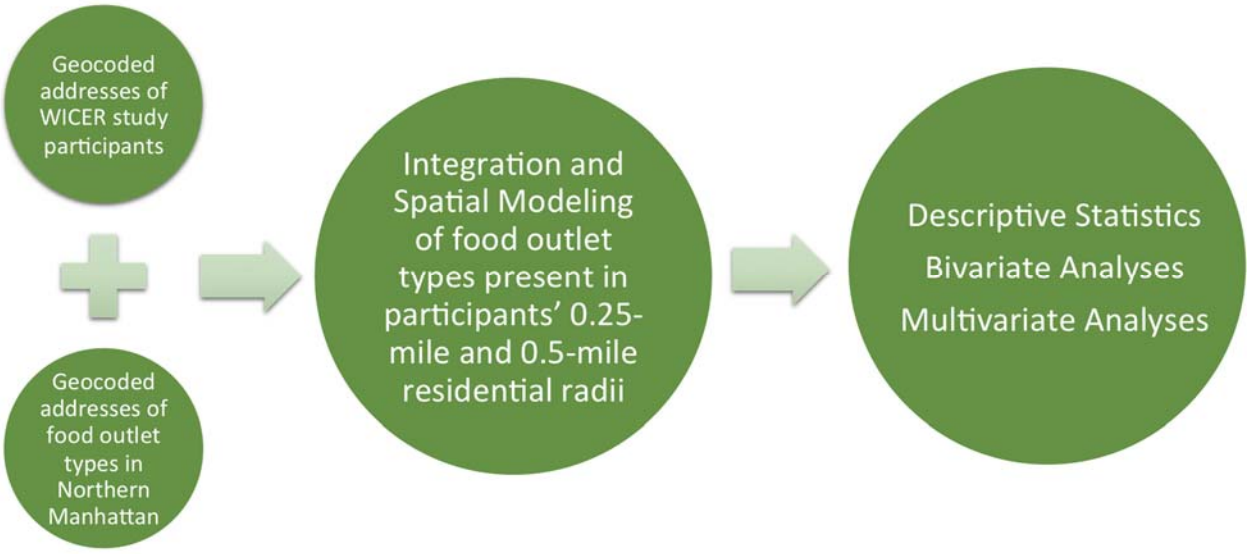


Figure 3: Diagram of Data Integration, Spatial Modeling and Data Analyses

Demographic Characteristics

Participants' demographic characteristics were measured using the WICER survey data such as age, gender, home address and ZIP code, self-reported diabetes, and nativity. Age of the study participants was measured using the computer-calculated age. Gender was measured as Male or Female. Self-reported diabetes was measured using the question: "Have you ever been told by a doctor, nurse, or other health professional that you had... Diabetes, high blood sugar, or sugar in the urine only when you were not pregnant?" The survey responses were dichotomized as Self-reported diabetes: Yes or No. Hispanic, Latino or Spanish Origin was measured with the survey question "Are you of Hispanic, Latino or Spanish Origin?" and only the Yes response was included in this study. Nativity was measured with the question "Where were you born?" and responses for this birthplace question was grouped into three categories: (1) US-born, (2) Foreign-born: DR for participants born in the Dominican Republic, and (3) Foreign-born: Other for participants born outside of the United States or the Dominican Republic.

Social and Economic Factors

Data on the social and economic factors were measured using the WICER community survey data on social relations, education, health insurance, and employment status. Social relation related to marital status was assessed and coded as either Not Partnered or Partnered. Education was measured using the question "What is the highest level of education?" and the nine response options were

collapsed into Less than High School, High School, and More than High School. The six response options to the survey question "What type of health insurance do you currently have?" were assessed, dichotomized, and coded as either Uninsured or Insured. Employment status was assessed using the question "What is your current occupation?". Responses related to any type of full-time or part-time employment (i.e., Teacher, Teacher Assistant, Cook, Baker, Deli Worker, Street Vendor, Travel Agent, Bus Driver, Cashier, Night Clerk, Messenger, Forklift Operator, Construction Worker, Sales Person, Factory Worker, Computer Technician, Babysitter, Home Attendant, Housekeeper, Security Officer, Pharmacy Technician, Postal Worker, Pastor, Industrial Engineer, Actress, Legal Secretary, Social Worker, Counselor, Supervisor, Manager) were coded as Employed and all other responses (i.e., Student, Homemaker, Disabled, Retired) were coded as Unemployed.

Health Behavior

Health behavior was measured using the WICER survey questions on fruit and vegetable consumption. Fruit and vegetable consumption were measured separately using the WICER survey questions: 1) "During the past 30 days, not counting juice, how many times per day, week, or month did you eat fruit? Count fresh, frozen, or canned fruit.", 2) "During the past 30 days, how many times per day, week, or month did you eat dark green vegetables?", and 3) "Not counting what you just told me, during the past 30 days, about how many times per day, week or month did you eat other vegetables?"

The three fruit and vegetable consumption survey questions allowed participants to respond with the actual number of fruits and of vegetables they consume either per day, per week, or per month. Responses were standardized to the "per day" unit of reference. The daily Fruit Consumption and the daily Vegetable Consumption continuous variables were initially assessed separately and recoded as categorical variables based on the participant's consuming the federal minimum recommendation of two servings of fruits per day and three servings of vegetables per day. The daily Fruit Consumption and the daily Vegetable Consumption continuous variables were then combined and recoded as a Fruit and Vegetable Consumption dichotomous variable based on the participant's consuming the federal minimum recommendation of five servings of fruits and vegetables per day (Centers for Disease Control and Prevention, 2005; Guthrie, 2004).

Health Outcomes

Health outcomes were measured using the WICER survey data on BMI, hypertension, and self-reported health. English-Spanish bilingual community health workers interviewed the study participants and took their height and weight, waist circumference and BP anthropometric measurements. BMI was derived from the objectively measured participant's height and weight and calculated using the standard equation of weight (kilograms) divided by the square root of height (square meters). The mean and SD were used to describe the calculated BMI, a continuous variable. The perceived weight (body size) was measured using the question "Do you consider yourself to be overweight, underweight or just about right?" to assess participant's perceived weight and their responses was dichotomized as Overweight or Obese, and Not Overweight.

Average of the second and third blood pressure readings was coded as Hypertension: Yes or No based on the current national guideline and the Eight Joint National Committee's panel recommendation for BP goals of <140/90 mm Hg for managing hypertension in adults and in persons 18 years and over with diabetes (American Heart Association, 2013; James et al., 2014). The self-rated health status was assessed using the question "Would you say that in general your health is _____?" and the five Likert-type response options ranging from Poor, Fair, Good, Very Good, and Excellent was collapsed into ≥Good and <Good. Participants who responded that their health status was Fair or Poor were considered to have less than good self-reported health.

Data Management and Data Quality

Each of the ReferenceUSA's commercial database records was examined by hand for quality and completeness by one of their more than 700 database specialists. The ReferenceUSA's business and residential databases are also continuously verified and updated from more than 5,000 public sources, including millions of phone calls placed annually to verify and collect additional information on businesses (ReferenceUSA).

Approaches undertaken to further ensure the validity of ReferenceUSA's commercial database for the Northern Manhattan's healthy food outlets included a review of all the data contained in the business listing. The store's physical addresses was also examined given that the address listed in the business listing may have reflected the store's headquarters or that the store share the same physical co-

location address with another store. To ensure that food outlets derived from the ReferenceUSA commercial database are represented accurately and that their identity, address and food outlet classification are validated, an onsite ground-truth field assessment was undertaken by the Investigator. In addition, the Investigator conducted an online virtual assessment using Google Maps with Street View to complement the onsite ground-truth field assessment. Studies have noted the agreement between on-site field assessments and virtual neighborhood assessments conducted using Google Earth, Google Maps, and Google Maps with Street View (Ben-Joseph, Lee, Cromley, Laden, & Troped, 2013; Clarke, Ailshire, Melendez, Bader, & Morenoff, 2010; Rundle, Bader, Richards, Neckerman, & Teitler, 2011a, 2011b) and findings from these studies support the innovative use of web-based GIS tools as an efficient, cost-effective and reliable approach to complement neighborhood field assessments.

The WICER survey data management process is proactive and ongoing to identify and clean invalid, duplicate or missing WICER community survey response data. The WICER survey database has also been transitioned into REDCap, a secure, web-based application for building and managing online surveys and databases, to provide real-time data validation, integrity checks and other mechanisms for ensuring data quality. Data was assessed for errors and/or missing values and participants were excluded from the analysis if they had missing data on one or more of the key study variables. Participants with extreme outlying BMI data (objectively measured BMI >70) were excluded from the analysis.

Linkage of WICER Survey Data with Neighborhood Food Environment Data

The neighborhood food environment data on healthy food outlets was integrated with the WICER survey data. Food outlets were identified using the NAICS codes and definitions obtained from the ReferenceUSA commercial database given that the NAICS codes offer more detailed food outlet classification information when compared to SIC codes. The geocoded addresses of the neighborhood food environment data and the WICER survey participant's residential addresses provided the longitude and latitude coordinates to allow overlaying of the healthy food outlet locations around the participant's 0.25-mile and 0.5-mile radius buffers from their home using ArcGIS.

Data Analysis

Statistical analyses were conducted using the IBM SPSS Statistics version 23 (IBM SPSS Inc., Chicago, Illinois). Descriptive statistics were used to summarize the sample characteristics and to assess the frequency and distribution of study variables. The distribution of predictor variables were individually assessed and decision to treat predictor variables as continuous variables were based upon their normal distribution. The binary outcome variables included the study participants' perceived neighborhood food environment, fruit and vegetable consumption, BMI, hypertension, and self-reported health. All variables having an alpha level of significance at $p<0.20$ in the bivariate analyses were included in the multivariate regression models using the Backward elimination model building method to avoid excluding relevant variables for the final model (Hosmer & Lemeshow, 2000; Mickey & Greenland, 1989). Results of the final step in the multivariate regression models are presented.

AIM 1. The first aim is to characterize the actual and perceived neighborhood food environment in Northern Manhattan.

A spatial model approach was used to identify food outlet types present in the study participants' 0.25-mile and 0.5-mile residential radius buffers. The spatially modeled person-level neighborhood provided geographical context on where participants can buy fruit and vegetable in the neighborhood. Histograms and detailed descriptive statistics of food outlet types present in the participants' respective 0.25-mile and 0.5-mile residential radii described the neighborhood food environment landscape in the Northern Manhattan's five ZIP codes study setting. To provide additional context, the descriptive statistics also included the number and percentage of residents who have access to Fruit and Vegetable Market and Meat Market given the lower counts of these two food outlet types present in the participants' respective 0.25-mile and 0.5-mile residential radii. The number of medium and large size Supermarket/Grocery was also combined into one variable given their smaller count data.

Three perceived neighborhood food environment outcome variables were examined: a large selection of fresh fruit and vegetable is available in my neighborhood, fresh fruit and vegetable in my neighborhood are of high quality, and a large selection of low-fat products is available in my neighborhood. Bivariate (single predictor) binary logistic regressions were initially performed to examine factors predicting the participants' perception of their neighborhood food environment. Statistically

significant predictor variables (p<0.20) noted during the bivariate analyses were entered into the full multivariate binary logistic regression models to examine factors predicting the participants' perception of their neighborhood food environment. In particular, two multivariate regression analyses were performed to account for food outlet types present in the participants' respective 0.25-mile and 0.5-mile residential radii. The Hosmer-Lemeshow tests were used to determine goodness of fit of the model with the data.

AIM 2. The second aim is to understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of consuming five or more servings of fruits and vegetables per day.

Bivariate (single predictor) binary logistic regressions were initially performed to examine factors predicting factors predicting the participants' likelihood of consuming five or more servings of fruits and vegetables per day. Variables with p<0.20 in bivariate analyses were entered in our multivariate models. The models were run using the three perceived neighborhood food environment as continuous predictor variables based on their normal distribution. Two multivariate binary logistic regression analyses were conducted to separately account for food outlet types present in the participant's 0.25-mile and in their 0.5-mile residential radii, while controlling for other factors included in the model. The Hosmer-Lemeshow tests were used to determine goodness of fit of the model with the data.

AIM 3. The third aim is to describe the contribution of participant's sociodemographic characteristics and health behaviors (fruit and vegetable consumption) to their health outcomes (BMI, hypertension, self-reported good health).

Three outcome variables were examined: BMI, hypertension, and self-reported health. Bivariate (single predictor) binary logistic regressions were initially performed to examine factors predicting the outcome variables. Variables with p<0.20 in bivariate analyses were entered in our multivariate models. For the BMI outcome variable, separate bivariate and multivariate logistic regression analyses were performed to examine the contribution of factors to higher BMI in the overweight and in the obese range, while controlling for other factors included in the model. The fruit and vegetable consumption variable was included in the binary logistic regression analyses that examined factors predicting their association with higher BMI, hypertension, self-reported health. In addition, BMI and hypertension were also included in the binary logistic regression analyses that examined factors predicting their association with self-report

of good health. The Hosmer-Lemeshow tests were used to determine goodness of fit of the model with the data. The statistical techniques are highlighted in Table 5.

Table 5: Aim, Research Question, Variables, and Data Analysis

Aim	Research Question	Study Variables	Statistical Techniques
Neighborhood Food Environment			
1. To characterize the actual and perceived neighborhood food environment in Northern Manhattan.	1.1: What is the actual neighborhood food environment (healthy food outlet types) and does it vary in the participants' 0.25-mile and 0.5-mile residential radius buffers? 1.2: What is the relationship between perceived neighborhood food environment and actual neighborhood food environment in the participants' respective 0.25-mile and 0.5-mile residential radius buffers?	Actual neighborhood food environment Perceived neighborhood food environment	Descriptive Statistics
Health Behavior			
2. To understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of consuming five or more servings of fruits and vegetables per day.	2.1 Which factors are associated with increasing the participants' likelihood of consuming five or more servings of fruits and vegetables per day?	Actual neighborhood food environment Perceived neighborhood food environment Sociodemographic characteristics Health Behaviors (Fruit and Vegetable Consumption)	Bivariate and Multivariate Logistic Regression
Health Outcomes			
3. To describe the contribution of participants' sociodemographic characteristics and health behaviors to their health outcomes.	3.1: Which factors are associated with higher BMI? 3.2: Which factors are associated with hypertension? 3.3: Which factors are associated with self-report of good health?	Sociodemographic characteristics Health Behaviors (Fruit and Vegetable Consumption) Health Outcomes (BMI, Hypertension, Self-reported health)	Bivariate and Multivariate Logistic Regression

CHAPTER IV: RESULTS

Demographic Characteristics of the Study Population

The demographic characteristics of the Hispanic study sample are shown in Table 6. Data on our 4,023 WICER study participants were assessed for missing data regarding variables of interest or those with outlier BMIs (objectively measured BMI >70), resulting in a final sample of 4,019 participants included in this study. The age of the study participants ranged from 18 to 100 years old. The mean age for male participants is 49 years old and the mean age for female participants is 50 years old. Female participants accounted for 74% of the study population. About one in five of the study participants (18%) self-reported having diabetes. Of the 87% of the study sample who are foreign-born, Dominicans accounted for 78%. Three quarters of the surveys (76%) were administered in Spanish based on the participants' survey language preference.

Table 6: Demographic Characteristics of the Study Population

Demographic Variables	Total (n=4,019)
Demographic Characteristics: Mean (SD)	
Age	49.8 (16.8)
Mean age of Male	49.2 (17.7)
Mean age of Female	50 (16.4)
Demographic Characteristics: n (%)	
Gender	
Male	1,049 (26.1%)
Female	2,950 (73.4%)
Not answered	20 (0.5%)
Self-reported diabetes: Yes	711 (17.8%)
Nativity	
US-born	514 (12.8%)
Foreign-born: DR	3,130 (77.9%)
Foreign-born: Other	368 (9.2%)
Not answered	7 (0.2%)
Survey language preference	
Spanish	3,066 (76.3%)
English	953 (23.7%)

Descriptive Statistics for the Study Variables

The descriptive statistics for the study variables are organized using the County Health Rankings model and shown in Tables 7 and 8. The County Health Rankings model includes components that work together to create healthy communities.

Neighborhood Food Environment

The food outlet types that sell fruit and vegetable in Northern Manhattan's five ZIP codes include Fruit and Vegetable Market, Meat Market, and small and medium/large size Supermarket/Grocery stores. The food outlet types that form the neighborhood food environment landscape for this study are shown in Figure 4.

Figure 4: Map of Food Outlet Types that sell Fruit and vegetable in Northern Manhattan

The food outlets that sell fruit and vegetable in Northern Manhattan's five ZIP codes ranged from 28 to 45 stores per ZIP code (Table 7). The majority of the food outlets (91.5%) are single location stores, which have smaller square footage when compared to food outlets that are a branch of another store. Approximately six in seven single location stores are small size food outlets with up to 2,499 square feet of store space and the remaining one in seven single location stores are medium size food outlets with 2,500 to 9,999 square feet of store space.

Food outlets that are a branch of another store accounted for 8.5% of the total food outlets and have a larger square footage when compared to single location stores. About six in seven of these stores are medium size food outlets with 2,500 to 9,999 square feet of store space. The remaining one in seven of these stores are large size food outlet with over 40,000 square feet of store space.

Table 7: Food Outlet Types that sell Fruit and vegetable by ZIP Codes

	Northern Manhattan ZIP Codes					
NAICS Code and Food Outlet Description	10031	10032	10033	10034	10040	Grand Total
445230 Fruit and Vegetable Market	5	3	1	1	1	**11**
445210 Meat Market		1	1		1	**3**
445110 medium/large Supermarket/Grocery*	6	8	9	5	6	**34**
445110 small Supermarket/Grocery*	23	16	34	23	21	**117**
Grand Total	34	28	45	29	29	**165**

* excludes Convenience Stores

Social and Economic Factors

The descriptive statistics of the study variables are presented in Table 8. Three in five of the study participants are not partnered (64%). Almost half of the study participants (48%) have a high school or higher education. Over half of the participants (58%) are employed. The majority of the study participants are insured (97%), primarily Medicare and/or Medicaid.

Health Behavior

Four in five of the study participants (>80%) agreed that a large selection of fresh fruit and vegetable is available and of high quality and that a large selection of low-fat products is available in their neighborhood. Only 9.4% of the study participants met the federal minimum recommendation of two servings of fruits per day and 5.9% of the participants met the federal minimum recommendation of three

servings of vegetables per day. Overall, 5.4% of the participants met the federal minimum recommendation of five servings of fruits and vegetables per day.

Health Outcomes

The objectively measured weight (BMI) places 39% of study participants in the overweight category and 36% in the obese category. The participants' mean BMI is 29 with BMI ranging from 14.9 to 53.9 for male participants and 13.5 to 62.8 for female participants. The average of study participants' second and third systolic and diastolic blood pressure readings showed that 28% have hypertension. About three in four of the study participants (73%) reported their overall health as being greater than good.

Table 8: Descriptive Statistics of Variables organized using the County Health Rankings Model Components

Model Components	Total (n=4,019)
Perceived Neighborhood Food Environment: n (%)	
Availability and selection of fresh fruit and vegetable	
Agree	3,429 (86%)
Disagree	559 (14%)
High quality of fresh fruit and vegetable	
Agree	3,297 (82.7%)
Disagree	690 (17.3%)
Availability and selection of low-fat products	
Agree	3,274 (82%)
Disagree	717 (18%)
Social and Economic Factors: n (%)	
Education	
More than High School	1,081 (26.9%)
High School Graduate	860 (21.4%)
Less than High School	2,078 (51.7%)
Employment: Employed	2,314 (57.6%)
Health insurance: Insured	3,916 (97.4%)
Insurance Type: Medicare/Medicaid	3,095 (77%)
Marital Status	
Partnered	1,443 (36%)
Not partnered	2,560 (64%)
Health Behavior: n (%)	
Fruit consumption	
≥2 servings per day	376 (9.4%)
Vegetable consumption	
≥3 servings per day	239 (5.9%)
Fruit and vegetable consumption	
≥5 servings per day	216 (5.4%)

Health Outcomes: n (%)	
BMI: Mean (SD)	29 (5.8)
Obese (≥30)	1,447 (36%)
Overweight (25-29.9)	1,581 (39.3%)
Hypertension	
Yes (≥140/90 mmHg)	1,118 (27.8%)
Self-reported health	
≥ Good	2,872 (72.5%)
< Good	1,090 (27.5%)

Bivariate and Multivariate Analyses

Bivariate and multivariate analyses were performed for each of the outcome variables and the results are presented under their respective study aims.

Neighborhood Food Environment: Actual and Perceived

AIM 1. The first aim is to characterize the actual and perceived neighborhood food environment in Northern Manhattan.

Research Question 1.1: What is the actual neighborhood food environment (food outlet types) and does it vary in the participants' 0.25-mile and 0.5-mile residential radius buffers?

A spatial model approach was used to identify food outlet types that sell fruit and vegetable in the participants' 0.25-mile and 0.5-mile residential radii. The descriptive statistics and histograms of food outlet types present in the participants' residential radii are presented in Table 9 and Figure 5.

The shape of the distribution for the small and medium/large size Supermarket/Grocery is normally distributed. Given the distribution and their smaller count data, the Fruit and Vegetable Market variable and the Meat Market variable were each recoded as categorical and dichotomous variables. In particular, the Fruit and Vegetable Market variable was recoded as a variable with three categories to indicate none, one store, and two or more stores in the participants' respective 0.25-mile and 0.5-mile radii whereas the Meat Market was recoded as dichotomous variable to indicate their absence or presence in the participants' 0.25-mile and 0.5-mile radii.

Table 9: Descriptive Statistics of Food Outlet Types that sell Fruit and vegetable in the Participants' 0.25-mile and 0.5-mile Residential Radius Buffers

Radii	Food Outlet Types present in the Participant's Residential Radius Buffers	Mean (SD)	Median	Interquartile Range	Minimum	Maximum
0.25-mile	Fruit and Vegetable Market[1]	0.95 (0.724)	1	0	0	5
	Meat Market[2]	0.38 (0.557)	0	1	0	2
	Supermarket/Grocery (medium/large size)	4.23 (2.142)	4	3	0	8
	Supermarket/Grocery (small size)	12.91 (5.774)	14	9	0	24
0.5-mile	Fruit and Vegetable Market[3]	2.2 (1.079)	2	1	0	7
	Meat Market[4]	0.83 (0.715)	1	1	0	2
	Supermarket/Grocery (medium/large size)	9.34 (2.989)	10	4	2	15
	Supermarket/Grocery (small size)	29.42 (9.5)	31	16	8	43

n (%) of Participants who have access to these Food Outlet Types in their 0.25-mile and 0.5-mile radii:

[1]Fruit and Vegetable Market present in 0.25-mile: None = 945 (23.5%), 1 Store = 2,470 (61.5%), 2+ Stores = 604 (15%)

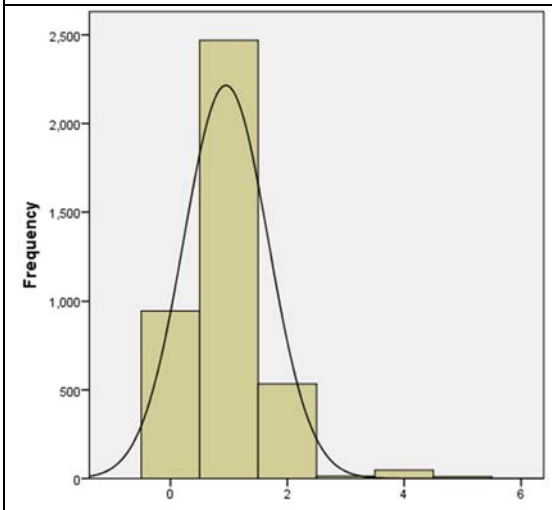
[2]Meat Market present in 0.25-mile: No = 2,645 (65.8%), Yes = 1,374 (34.2%)

[3]Fruit and Vegetable Market present in 0.5-mile: None = 67 (1.7%), 1 Store = 900 (22.4%), 2+ Stores = 3,052 (75.9%)

[4]Meat Market present in 0.5-mile: No = 2,602 (64.7%), Yes = 1,417 (35.3%)

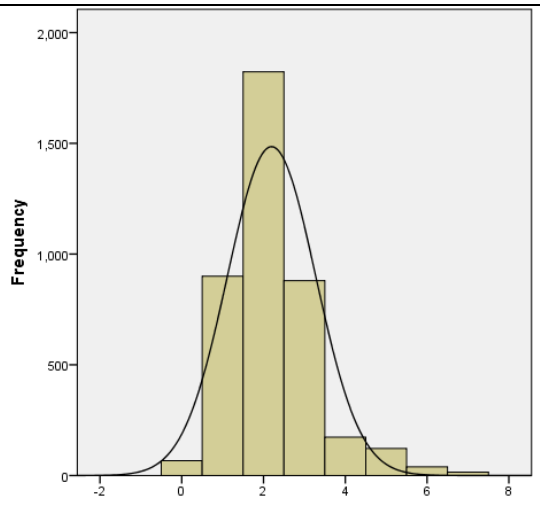
Figure 5: Histograms of the Food Outlet Types present in the Participants' 0.25-mile and 0.5-mile Residential Radius Buffers

Food Outlet Types present in 0.25-mile Radius

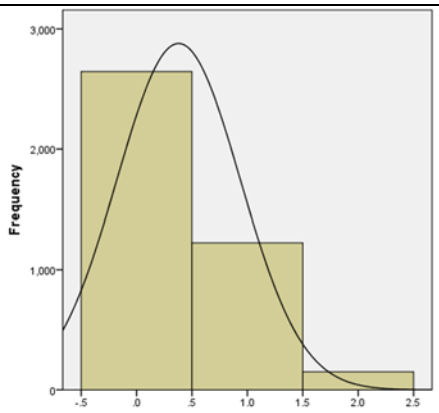
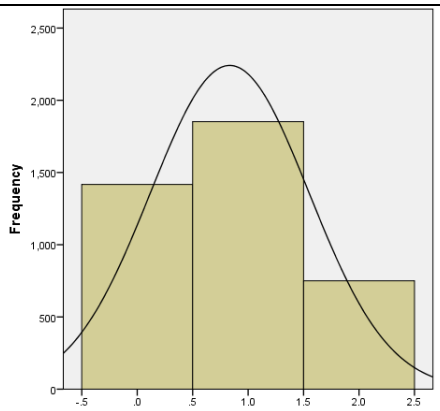
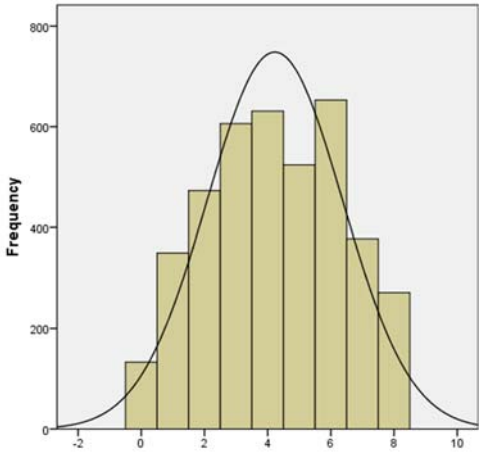
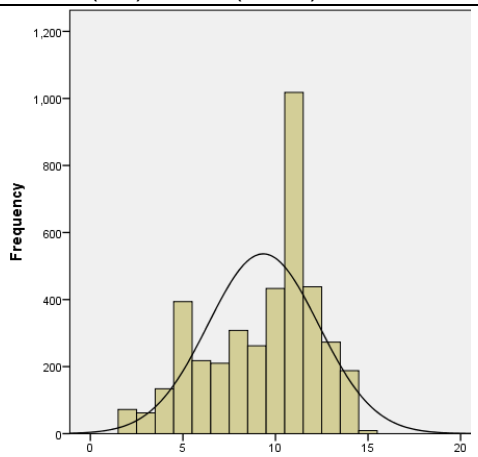
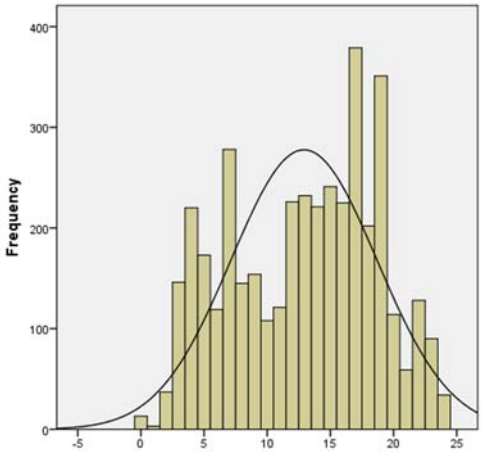
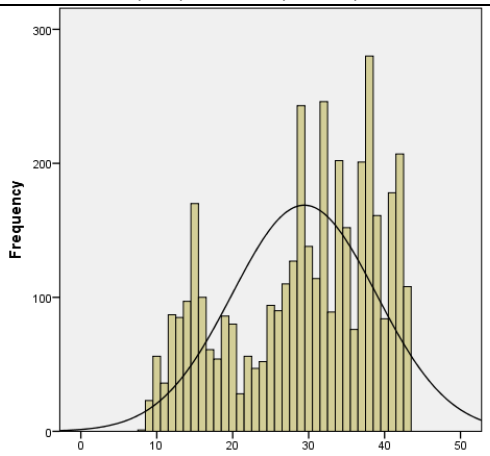


Fruit and Vegetable Market
Mean (SD) = 0.95 (0.723), Median = 1

Food Outlet Types present in 0.5-mile Radius



Fruit and Vegetable Market
Mean (SD) = 2.2 (1.079), Median = 2

Food Outlet Types present in 0.25-mile Radius	Food Outlet Types present in 0.5-mile Radius
 **Meat Market** Mean (SD) = 0.38 (0.557), Median = 0	 **Meat Market** Mean (SD) = 0.83 (0.715), Median = 1
 **Medium/Large Size Supermarket/Grocery** Mean (SD) = 4.23 (2.142), Median = 4	 **Medium/Large Size Supermarket/Grocery** Mean (SD) = 9.34 (2.989), Median = 10
 **Small Size Supermarket/Grocery** Mean (SD) = 12.91 (5.774), Median = 14	 **Small Size Supermarket/Grocery** Mean (SD) = 29.42 (9.5), Median = 31

Research Question 1.2: What is the relationship between perceived neighborhood food environment and actual neighborhood food environment in the participants' respective 0.25-mile and 0.5-mile residential radius buffers?

To answer this research question, bivariate and multivariate analyses for the three perceived neighborhood food environment variables accounting for the participant's 0.25-mile and 0.5-mile radii are presented below.

Perceived Availability and Selection of Fresh Fruits and Vegetables in the Neighborhood

Single predictor and multivariate binary logistic regression analyses that examined food outlet types that predicted the perceived availability and selection of fresh fruit and vegetable in the neighborhood are presented in Table 10. Only variables with $p<0.20$ in bivariate analyses were entered in our multivariate models. Predictors that met the criterion for the 0.25-mile radius were Fruit and Vegetable Market and Meat Market. These variables along with small size Supermarket/Grocery met the criterion for the 0.5-mile radius.

In the multivariate analyses, the presence of two or more Fruit and Vegetable Markets in the 0.25-mile radius and the presence of one or more Fruit and Vegetable Markets in the 0.5-mile radius significantly increase the participant's odds of perceiving that a large selection of fresh fruits and vegetables is available in their neighborhood. The Hosmer-Lemeshow Tests indicated that the overall model fit is good (0.25-mile model: Chi-square 2.484, $p=0.647$; 0.5-mile model: Chi-square 13.287, $p=0.102$).

Table 10: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regressions of Predictors of Participants' Perceived Availability and Selection of Fresh Fruit and vegetable in the Neighborhood

	Perceived availability and selection of fresh fruits and vegetables in the neighborhood					
	Disagree n (%)	Agree n (%)	Bivariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Fruit and Vegetable Market in 0.25-mile						
None	155 (16.5%)	782 (83.5%)	1.00		1.00	
1 store	324 (13.3%)	2118 (86.7%)	1.30 (1.05-1.60)	**0.015**	1.21 (0.97-1.51)	0.097
2+ stores	67 (11.2%)	529 (88.8%)	1.57 (1.15-2.13)	**0.004**	1.59 (1.17-2.16)	**0.003**
Meat Market in 0.25-mile						
No	339 (13%)	2278 (87%)	1.00		1.00	
Yes	207 (15.2%)	1151 (84.8%)	0.83 (0.69-1.00)	**0.047**	0.82 (0.67-1.01)	0.063
Medium/large size Supermarket/Grocery in 0.25-mile			1.03 (0.98-1.07)	0.250		
Small size Supermarket/Grocery in 0.25-mile			1.00 (0.98-1.01)	0.500		
Fruit and Vegetable Market in 0.5-mile						
None	18 (27.3%)	48 (72.7%)	1.00		1.00	
1 store	151 (16.9%)	740 (83.1%)	1.84 (1.04-3.25)	**0.036**	2.28 (1.24-4.22)	**0.008**
2+ stores	377 (12.5%)	2641 (87.5%)	2.63 (1.51-4.56)	**0.001**	3.10 (1.74-5.55)	**0.000**
Meat Market in 0.5-mile						
No	176 (12.5%)	1230 (87.5%)	1.00			
Yes	370 (14.4%)	2199 (85.6%)	0.85 (0.70-1.03)	0.099		
Medium/large size Supermarket/Grocery in 0.5-mile			1.00 (0.97-1.03)	0.874		
Small size Supermarket/Grocery in 0.5-mile			0.99 (0.98-1.00)	0.087	0.99 (0.98-1.00)	0.065

Note: Variables that had *p* value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented. Variable not in the final step of the multivariate model: Meat Market in 0.5-mile.

Perceived High Quality of Fresh Fruits and Vegetables in the Neighborhood

Single predictor and multivariate binary logistic regression analysis that examined types of food outlets predicting the perceived high quality of fresh fruits and vegetables in the neighborhood are presented in Table 11. Based on the bivariate analysis, three food outlet types (Fruit and Vegetable Market, Meat Market, and medium/large size Supermarket/Grocery) met the criterion for entry into the multivariate analysis for the 0.25-mile radius and two food outlet types (Fruit and Vegetable Market and Meat Market) met the criterion for entry into the multivariate analysis for the 0.5-mile radius. In the multivariate analyses, the presence of two or more Fruit and Vegetable Markets in the 0.25-mile radius, the presence of one or more Fruit and Vegetable Markets in the 0.5-mile radius, and the presence of medium/large size Supermarket/Grocery in the 0.25-mile radius significantly increase the participant's

odds of perceiving that the fresh fruits and vegetables in their neighborhood are of high quality. The presence of Meat Market in the participant's 0.25-mile radius significantly lowers the odds. The Hosmer-Lemeshow Tests indicated that the overall model fit is good (0.25-mile model: Chi-square 11.709, *p*=0.165; 0.5-mile model: Chi-square 0.076, *p*=0.995).

Table 11: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regressions of Predictors of Participants' Perceived High Quality of Fresh Fruit and vegetable in the Neighborhood

	Perceived high quality of fresh fruits and vegetables in the neighborhood					
	Disagree n (%)	Agree n (%)	Bivariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Fruit and Vegetable Market in 0.25-mile						
None	194 (20.8%)	739 (79.2%)	1.00		1.00	
1 store	386 (15.8%)	2056 (84.2%)	1.40 (1.15-1.69)	**0.001**	1.18 (0.96-1.45)	0.123
2+ stores	92 (15.5%)	502 (84.5%)	1.43 (1.09-1.88)	**0.010**	1.51 (1.15-1.99)	**0.003**
Meat Market in 0.25-mile						
No	403 (15.4%)	2212 (84.6%)	1.00		1.00	
Yes	269 (19.9%)	1085 (80.1%)	0.74 (0.62-0.87)	**0.000**	0.74 (0.61-0.89)	**0.002**
Medium/large size Supermarket/Grocery in 0.25-mile			1.06 (1.02-1.10)	**0.007**	1.05 (1.01-1.10)	**0.013**
Small size Supermarket/Grocery in 0.25-mile			1.01 (1.00-1.02)	0.219		
Fruit and Vegetable Market in 0.5-mile						
None	23 (34.8%)	43 (65.2%)	1.00		1.00	
1 store	195 (22%)	693 (78%)	1.90 (1.12-3.23)	**0.018**	2.25 (1.29-3.92)	**0.004**
2+ stores	454 (15.1%)	2561 (84.9%)	3.02 (1.80-5.06)	**0.000**	3.31 (1.96-5.60)	**0.000**
Meat Market in 0.5-mile						
No	206 (14.7%)	1199 (85.3%)	1.00		1.00	
Yes	466 (18.2%)	2098 (81.8%)	0.77 (0.65-0.93)	**0.005**	0.82 (0.68-1.00)	0.052
Medium/large size Supermarket/Grocery in 0.5-mile			1.01 (0.98-1.04)	0.460		
Small size Supermarket/Grocery in 0.5-mile			1.00 (0.99 1.01)	0.362		

Note: Variables that had p value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented

Perceived Availability and Selection of Low-Fat Products in the Neighborhood

Single predictor and multivariate binary logistic regression analysis that examined food outlet types predicting the perceived availability and selection of low-fat products in the neighborhood are presented in Table 12. Based on the bivariate analyses, three food outlet types (Fruit and Vegetable Market, Meat Market, and medium/large size Supermarket/Grocery) met the criterion for entry into the multivariate analysis for both the 0.25-mile or 0.5-mile radii. In the multivariate analyses, the presence of one or more Fruit and Vegetable Markets in the 0.25-mile radius, the presence of two or more Fruit and

Vegetable Markets in the 0.5-mile radius, and the presence of medium/large size Supermarket/Grocery in both radii significantly increase the participant's odds of perceiving that a large selection of low-fat products is available in their neighborhood. The presence of Meat Market in the 0.25-mile significantly lowers the odds. The Hosmer-Lemeshow Tests indicated that the overall model fit is good (0.25-mile model: Chi-square 11.430, p=0.178; 0.5-mile model: Chi-square 13.061, p=0.110).

Table 12: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regressions of Predictors of Participants' Perceived Availability and Selection of Low-Fat Products in the Neighborhood

	Perceived availability and selection of low-fat products in the neighborhood					
	Disagree n (%)	Agree n (%)	Bivariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Fruit and Vegetable Market in 0.25-mile						
None	200 (21.3%)	738 (78.7%)	1.00		1.00	
1 store	395 (16.2%)	2046 (83.8%)	1.40 (1.16-1.70)	**0.000**	1.23 (1.00-1.52)	**0.047**
2+ stores	101 (17.1%)	490 (82.9%)	1.32 (1.01-1.71)	**0.043**	1.37 (1.05-1.79)	**0.020**
Meat Market in 0.25-mile						
No	427 (16.3%)	2185 (83.7%)	1.00		1.00	
Yes	269 (19.8%)	1089 (80.2%)	0.79 (0.67-0.94)	**0.007**	0.83 (0.69-0.99)	**0.042**
Medium/large size Supermarket/Grocery in 0.25-mile			1.06 (1.02-1.10)	**0.005**	1.05 (1.01-1.09)	**0.020**
Small size Supermarket/Grocery in 0.25-mile			1.00 (0.99-1.02)	0.653		
Fruit and Vegetable Market in 0.5-mile						
None	20 (29.9%)	47 (70.1%)	1.00		1.00	
1 store	195 (21.8%)	699 (78.2%)	1.53 (0.88-2.64)	0.130	1.32 (0.76-2.31)	0.328
2+ stores	481 (16%)	2528 (84%)	2.24 (1.31-3.81)	**0.003**	1.94 (1.12-3.34)	**0.018**
Meat Market in 0.5-mile						
No	228 (16.3%)	1175 (83.7%)	1.00			
Yes	468 (18.2%)	2099 (81.8%)	0.87 (0.73-1.04)	0.117		
Medium/large size Supermarket/Grocery in 0.5-mile			1.02 (1.00-1.05)	0.115	1.05 (1.01-1.09)	**0.018**
Small size Supermarket/Grocery in 0.5-mile			1.00 (0.99-1.00)	0.250		

Note: Variables that had p value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented. Variable not in the final step of the multivariate model: Meat Market in 0.5-mile.

Health Behavior: Fruit and Vegetable Consumption

AIM 2. The second aim is to understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of participant's consuming five or more servings of fruits and vegetables per day.

Daily Fruit and Vegetable Consumption

Research Question 2.1: Which factors are associated with increasing the participant's likelihood of consuming five or more servings of fruits and vegetables per day?

Single predictor binary logistic regression analyses and multivariate binary logistic regression analyses that examined factors predicting the participants' likelihood of consuming five or more servings of fruits and vegetables per day are presented in Table 13. In the bivariate analyses, the participant's perception that a large selection of fresh fruits and vegetables is available in their neighborhood, perception that the fresh fruits and vegetables in their neighborhood are of high quality, Fruit and Vegetable Market in their 0.25-mile or 0.5-mile radii, small and medium/large size Supermarket/Grocery in their 0.25-mile or 0.5-mile radii, education, nativity, and perceived weight met the criterion for inclusion in the multivariate models.

The two multivariate binary logistic regression analyses accounted for factors and food outlet types present in the participants' respective 0.25-mile and 0.5-mile residential radii in predicting their likelihood of consuming five or more servings of fruits and vegetables per day. Having more than a high school education and being foreign-born in other country significantly increase the odds. In contrast, the participant's perception that a large selection of fresh fruits and vegetables is available in their neighborhood and the presence of Fruit and Vegetable Markets in their 0.5-mile radius lowers the odds. The Hosmer-Lemeshow Tests indicated that the overall model fit is good (0.25-mile model: Chi-square 5.288, p=0.726; 0.5-mile model: Chi-square 7.778, p=0.455).

Table 13: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regressions of Predictors of Participants' Fruit and Vegetable Consumption

	Fruit and Vegetable Consumption							
	<5 servings/day	≥5 servings/day	Bivariate		Multivariate OR (95% CI)			
	n (%)	n (%)	OR (95% CI)	*p*	0.25-mile Radius	*p*	0.5-mile Radius	*p*
Perceived availability and selection of fresh fruits and vegetables in the neighborhood								
Disagree	504 (92.3%)	42 (7.7%)	1.00		1.00		1.00	
Agree	3263 (95.2%)	166 (4.8%)	0.61 (0.43-0.87)	**0.006**	0.63 (0.44-0.90)	**0.011**	0.64 (0.44-0.92)	**0.016**
Perceived high quality of fresh fruits and vegetables in the neighborhood								
Disagree	629 (93.6%)	43 (6.4%)	1.00					
Agree	3134 (95.1%)	163 (4.9%)	0.76 (0.54-1.08)	0.122				
Perceived availability and selection of low-fat products in the neighborhood								
Disagree	655 (94.1%)	41 (5.9%)	1.00					
Agree	3109 (95%)	165 (5%)	0.85 (0.60-1.21)	0.358				
Fruit and Vegetable Market in 0.25-mile								
None	886 (93.8%)	59 (6.2%)	1.00					
1 store	2346 (95%)	124 (5%)	0.79 (0.58-1.09)	0.156				
2+ stores	576 (95.4%)	28 (4.6%)	0.73 (0.46-1.16)	0.182				
Meat Market in 0.25-mile								
No	2503 (94.6%)	142 (5.4%)	1.00					
Yes	1305 (95%)	69 (5%)	0.93 (0.69-1.25)	0.640				
Medium/large size Supermarket/Grocery in 0.25-mile			0.95 (0.89-1.02)	0.147				
Small size Supermarket/Grocery in 0.25-mile			0.98 (0.95-1.00)	0.054	0.98 (0.95-1.00)	0.051		
Fruit and Vegetable Market in 0.5-mile								
None	55 (82.1%)	12 (17.9%)	1.00				1.00	
1 store	863 (95.9%)	37 (4.1%)	0.20 (0.10-0.40)	**0.000**			0.32 (0.14-0.72)	**0.006**
2+ stores	2890 (94.7%)	162 (5.3%)	0.26 (0.14-0.49)	**0.000**			0.38 (0.18-0.79)	**0.009**
Meat Market in 0.5-mile								
No	1337 (94.4%)	80 (5.6%)	1.00					
Yes	2471 (95%)	131 (5%)	0.89 (0.67-1.18)	0.407				
Medium/large size Supermarket/Grocery in 0.5-mile			0.93 (0.89-0.98)	**0.003**				
Small size Supermarket/Grocery in 0.5-mile			0.98 (0.97-0.99)	**0.003**			0.99 (0.97-1.00)	0.075
Age: Mean (SD)	49.80 (16.77)	49.87 (16.86)	1.00 (0.99-1.01)	0.954				
Gender								
Male	998 (95.1%)	51 (4.9%)	1.00					
Female	2791 (94.6%)	159 (6.4%)	1.12 (0.81-1.54)	0.510				
Education					**Education**			
< High School	1976 (95.1%)	102 (4.9%)	1.00		1.00		1.00	
High School	821 (95.5%)	39 (4.5%)	0.92 (0.63-1.34)	0.666	0.99 (0.67-1.47)	0.965	0.98 (0.66-1.46)	0.923
> High School	1011 (93.5%)	70 (6.5%)	1.34 (0.98-1.84)	0.066	1.62 (1.17-2.25)	**0.004**	1.62 (1.17-2.26)	**0.004**
Nativity								
US-born	497 (96.7%)	17 (3.3%)	1.00		1.00		1.00	
Foreign-born: DR	2963 (94.7%)	167 (5.3%)	1.65 (0.99-2.74)	0.054	1.77 (1.05-2.99)	**0.032**	1.73 (1.02-2.92)	**0.040**
Foreign-born: Other	342 (92.9%)	26 (7.1%)	2.22 (1.19-4.16)	**0.012**	2.44 (1.28-4.65)	**0.007**	2.48 (1.30-4.74)	**0.006**
Employment								
No	1619 (95%)	86 (5%)	1.00					
Yes	2189 (94.6%)	125 (5.4%)	1.08 (0.81-1.43)	0.615				
Perceived Weight								
Not Overweight	1821 (93.9%)	118 (6.1%)	1.00		1.00		1.00	
Overweight	1901 (94.7%)	88 (4.4%)	0.71 (0.54-0.95)	**0.020**	0.75 (0.56-1.01)	0.056	0.78 (0.58-1.04)	0.089

Note: Variables that had p value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented. (1) Variables not in the final step of the multivariate model for 0.25-mile radius: Perceived high quality of fresh fruits and vegetables in the neighborhood, Fruit and Vegetable Market in 0.25-mile, Medium/large size Supermarket/Grocery in 0.25-mile. (2) Variables not in the final step of the multivariate model for 0.5-mile radius: Perceived high quality of fresh fruits and vegetables in the neighborhood, Medium/large size Supermarket/Grocery in 0.5-mile.

AIM 3. The third aim is to describe the contribution of participants' sociodemographic characteristics and health behaviors to their health outcomes.

Bivariate and multivariate analyses for the three health outcomes variables BMI, hypertension and self-reported health are presented and described below.

Health Outcome: BMI

Research Question 3.1: Which factors are associated with higher BMI?

To answer this research question, separate bivariate and multivariate logistic regression analyses were performed to examine the contribution of factors to BMI in the overweight and obese range.

BMI: Normal Weight and Overweight

Single predictor binary logistic regression analyses and multivariate binary logistic regression analyses that examined factors predicting the participants' higher BMI in the overweight range are presented in Table 14. Bivariate analyses indicated that all variables with the exception of employment and fruit and vegetable consumption met the criterion for entry into the multivariate models. In the multivariate analyses, variables that significantly increase the odds of BMI in the overweight range were age, being foreign-born in other countries, self-reported diabetes, and perceived weight as overweight. In contrast, female gender significantly lowers the odds. The Hosmer-Lemeshow test indicated that the model does not fit the data well (Chi-square 23.08, p=0.003).

Table 14: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regressions of Predictors of Overweight

BMI (Normal Weight and Overweight)						
	Normal Weight	Overweight	Bivariate		Multivariate	
	n (%)	n (%)	OR (95% CI)	*p*	OR (95% CI)	*p*
Age: Mean (SD)	45.10 (18.14)	51.25 (16.52)	1.02 (1.01-1.03)	**0.000**	1.02 (1.01-1.02)	**0.000**
Gender						
Male	248 (34.4%)	473 (65.6%)	1.00		1.00	
Female	714 (39.8%)	1080 (60.2%)	0.79 (0.66-0.95)	**0.012**	0.67 (0.55-0.81)	**0.000**
Education						
< High School	409 (32.9%)	836 (67.1%)	1.00			
High School	228 (40.6%)	334 (59.4%)	0.72 (0.58-0.88)	**0.002**		
> High School	331 (46%)	389 (54%)	0.58 (0.48-0.69)	**0.000**		
Nativity						
US-born	171 (52.5%)	155 (47.5%)	1.00		1.00	
Foreign-born: DR	722 (36.6%)	1248 (63.4%)	1.91 (1.51-2.41)	**0.000**	1.28 (0.96-1.70)	0.097
Foreign-born: Other	72 (32%)	153 (68%)	2.34 (1.65-3.34)	**0.000**	1.76 (1.18-2.61)	**0.006**
Employment						
No	388 (36.9%)	664 (63.1%)	1.00			
Yes	580 (39.3%)	895 (60.7%)	0.90 (0.77-1.06)	0.214		
Fruit and Vegetable Consumption						
<5 servings/day	912 (38.1%)	1482 (61.9%)	1.00			
≥5 servings/day	56 (42.1%)	77 (57.9%)	0.85 (0.59-1.21)	0.355		
Self-reported Diabetes						
No	868 (40.5%)	1274 (59.5%)	1.00		1.00	
Yes	96 (26.2%)	271 (73.8%)	1.92 (1.50-2.47)	**0.000**	1.37 (1.04-1.81)	**0.026**
Perceived Weight						
Not Overweight	798 (48.9%)	835 (51.1%)	1.00		1.00	
Overweight	149 (17.8%)	689 (82.2%)	4.42 (3.61-5.41)	**0.000**	4.46 (3.63-5.49)	**0.000**

Note: Variables that had p value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented. Variables not in the final step of the multivariate model: Education.

BMI: Normal Weight and Obese

Single predictor binary logistic regression analyses and multivariate binary logistic regression analyses that examined factors predicting the participants' BMI in the obese range are presented in Table 15. Bivariate analyses indicated that the variables that met the criterion for entry into the multivariate model were the same as for overweight. In the multivariate analyses, age, self-reported diabetes, and perceived weight as overweight significantly increase the odds of BMI in the obese range whereas having more than a high school education significantly lowers the odds. The Hosmer-Lemeshow test indicated that the overall model fit is good (Chi-square 6.390, p=0.604).

Table 15: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regression of Predictors of Obesity

	BMI (Normal Weight and Obese)					
	Normal Weight n (%)	Obese n (%)	Bivariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Age: Mean (SD)	45.10 (18.14)	51.34 (15.50)	1.02 (1.02-1.03)	**0.000**	1.02 (1.01-1.02)	**0.000**
Gender						
Male	248 (43.1%)	328 (56.9%)	1.00			
Female	714 (38.2%)	1156 (61.8%)	1.02 (1.01-1.03)	**0.000**		
Education						
< High School	409 (32.9%)	833 (67.1%)	1.00		1.00	
High School	228 (43.3%)	298 (56.7%)	0.64 (0.52-0.79)	**0.000**	0.93 (0.69-1.24)	0.601
> High School	331 (47.8%)	361 (52.2%)	0.54 (0.44-0.65)	**0.000**	0.72 (0.55-0.95)	**0.021**
Nativity						
US-born	171 (47.6%)	188 (52.4%)	1.00			
Foreign-born: DR	722 (38.4%)	1160 (61.6%)	1.46 (1.17-1.83)	**0.001**		
Foreign-born: Other	72 (33.5%)	143 (66.5%)	1.81 (1.27-2.57)	**0.001**		
Employment						
No	388 (37.3%)	653 (62.7%)	1.00			
Yes	580 (40.9%)	839 (59.1%)	0.86 (0.73-1.01)	0.260		
Fruit and Vegetable Consumption						
<5 servings/day	912 (39.2%)	1414 (60.8%)	1.00			
≥5 servings/day	56 (41.8%)	78 (58.2%)	0.90 (0.63-1.28)	0.552		
Self-reported Diabetes						
No	868 (43.3%)	1136 (56.7%)	1.00		1.00	
Yes	96 (21.8%)	344 (78.2%)	2.74 (2.15-3.49)	**0.000**	1.78 (1.30-2.44)	**0.000**
Perceived Weight						
Not Overweight	798 (72.3%)	306 (27.7%)	1.00		1.00	
Overweight	149 (11.5%)	1151 (88.5%)	20.15 (16.24-24.99)	**0.000**	19.39 (15.55-24.18)	**0.000**

Note: Variables that had p value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented. Variables not in the final step of the multivariate model: Gender, Nativity.

Health Outcome: Hypertension

Research Question 3.2: Which factors are associated with hypertension?

Single predictor and multivariate binary logistic regression analyses that examined factors predicting the participants' hypertension are presented in Table 16. Based on the bivariate analyses, only fruit and vegetable consumption did not meet the criterion for entry into the multivariate analysis. Variables that significantly increase the odds of hypertension were age and self-reported diabetes. In contrast, being female significantly lowers the odds. The Hosmer-Lemeshow test indicated that the model does not fit the data well (Chi-square 29.376, p=0.000).

Table 16: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regression of Predictors of Hypertension

	Hypertension					
	No	Yes	Bivariate		Multivariate	
	n (%)	n (%)	OR (95% CI)	*p*	OR (95% CI)	*p*
Age: Mean (SD)	47.06 (16.94	56.92 (14)	1.04 (1.03-1.04)	**0.000**	1.04 (1.03-1.04)	**0.000**
Gender						
Male	715 (68.2%)	334 (31.8%)	1.00		1.00	
Female	2174 (73.7%)	776 (26.3%)	0.76 (0.66-0.89)	**0.001**	0.72 (0.61-0.85)	**0.000**
Education						
< High School	1380 (66.4%)	698 (33.6%)	1.00			
High School	672 (78.1%)	188 (21.9%)	0.55 (0.46-0.67)	**0.000**		
> High School	849 (78.5%)	232 (21.5%)	0.54 (0.46-0.64)	**0.000**		
Nativity						
US-born	440 (85.6%)	74 (14.4%)	1.00		1.00	
Foreign-born: DR	2174 (69.5%)	956 (30.5%)	1.98 (1.65-2.39)	**0.000**	1.18 (0.86-1.58)	0.259
Foreign-born: Other	282 (76.6%)	86 (23.4%)	0.77 (0.60-0.99)	**0.046**	0.84 (0.58-1.22)	0.361
Employment						
No	1170 (68.6%)	535 (31.4%)	1.00			
Yes	1731 (74.8%)	538 (25.2%)	0.74 (0.64-0.85)	**0.000**		
Fruit and Vegetable Consumption						
<5 servings/day	2752 (72.3%)	1056 (27.7%)	1.00			
≥5 servings/day	149 (70.6%)	62 (29.4%)	1.08 (0.80-1.47)	0.602		
Self-reported Diabetes						
No	2475 (75.5%)	803 (24.5%)	1.00		1.00	
Yes	400 (56.3%)	311 (43.7%)	2.40 (2.03-2.84)	**0.000**	1.57 (1.31-1.88)	**0.000**

Note: Variables that had p value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented. Variables not in the final step of the multivariate model: Education, Employment.

Health Outcome: Self-reported Health

Research Question 3.3: Which factors are associated with self-report of good health?

Single predictor and multivariate binary logistic regression analyses that examined factors predicting the participants' self-report of good health are presented in Table 17. In the bivariate analyses, all variables except for being foreign-born in other countries met the criterion for entry into the multivariate analysis. Having more than a high school education significantly increases the odds of self-report of good health whereas age, female gender, higher fruit and vegetable consumption, self-reported diabetes, and obesity significantly lower the odds. The Hosmer-Lemeshow test indicated that the overall model fit does not fit the data well (Chi-square 16.376, p=0.037).

Table 17: Bivariate (Single Predictor) Binary Logistic Regressions and Multivariate Binary Logistic Regression of Predictors of Self-reported Good Health

	Self-reported Health					
	<Good n (%)	≥Good n (%)	Bivariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Age: Mean (SD)	55.16 (14.76)	47.76 (17.04)	0.97 (0.97-0.98)	**0.000**	0.98 (0.98-0.99)	**0.000**
Gender						
Male	208 (20.3%)	819 (79.7%)	1.00		1.00	
Female	877 (30.1%)	2039 (69.9%)	0.59 (0.50-0.70)	**0.000**	0.60 (0.50-0.71)	**0.000**
Education						
< High School	677 (33.1%)	1368 (66.9%)	1.00		1.00	
High School	209 (24.7%)	638 (75.3%)	1.20 (1.01-1.43)	**0.037**	1.05 (0.86-1.28)	0.614
> High School	204 (19.1%)	866 (80.9%)	1.88 (1.58-2.23)	**0.000**	1.43 (1.17-1.75)	**0.000**
Nativity						
US-born	91 (18%)	415 (82%)	1.00			
Foreign-born: DR	887 (28.7%)	2199 (71.3%)	0.74 (0.62-0.88)	**0.001**		
Foreign-born: Other	109 (30%)	254 (70%)	0.87 (0.69-1.10)	0.255		
Employment						
No	517 (30.8%)	1159 (69.2%)	1.00			
Yes	573 (25.1%)	1713 (74.9%)	1.33 (1.16-1.53)	**0.000**		
Fruit and Vegetable Consumption						
<5 servings/day	1017 (27.1%)	2738 (72.9%)	1.00		1.00	
≥5 servings/day	73 (35.3%)	134 (64.7%)	0.68 (0.51-0.92)	**0.011**	0.66 (0.48-0.90)	**0.007**
Self-reported Diabetes						
No	763 (23.6%)	2473 (76.4%)	1.00		1.00	
Yes	319 (45.7%)	379 (54.3%)	0.37 (0.31-0.43)	**0.000**	0.51 (0.43-0.62)	**0.000**
BMI						
Normal Weight	191 (20%)	763 (80%)	1.00		1.00	
Overweight	386 (25.1%)	1152 (74.9%)	0.82 (0.71-0.95)	**0.007**	0.86 (0.70-1.05)	0.135
Obese	513 (34.9%)	957 (65.1%)	0.56 (0.49-0.65)	**0.000**	0.64 (0.55-0.74)	**0.000**
Hypertension						
No	730 (25.5%)	2135 (74.5%)	1.00			
Yes	360 (32.8%)	737 (67.2%)	0.70 (0.60-0.81)	**0.000**		

Note: Variables that had p value of 0.2 or less in the bivariate were entered into the multivariate model; only variables that were in the last step of the multivariate model are presented. Variables not in the final step of the multivariate model: Nativity, Employment, Hypertension.

CHAPTER V: DISCUSSION

The three aims of this study were: (1) to characterize the actual and perceived neighborhood food environment in Northern Manhattan, (2) to understand the relationship between the actual and perceived neighborhood food environment, sociodemographic characteristics and the likelihood of consuming five or more servings of fruits and vegetables per day, and (3) to describe the contribution of participants' sociodemographic characteristics and health behavior to their health outcomes. This chapter summarizes the study results in light of current body of evidence, followed by a discussion of the study limitations and strengths, implications for public health and policy, and concludes with recommendations for future research.

Neighborhood Food Environment

The food outlet types that sell fruit and vegetable in Northern Manhattan include small and medium/large size Supermarket/Grocery store, Meat Market, and Fruit and Vegetable Market. The majority of these food outlets (91.5%) are single location stores that have a smaller store space when compared to bigger food outlet that is a branch of another store. The food outlets in our predominantly Hispanic low-income urban community in Northern Manhattan echoed findings from a national study that examined the association between food store availability and neighborhood characteristics that low-income Hispanic neighborhoods in the US have greater number of non-chain supermarkets and grocery stores when compared to non-Hispanic neighborhoods (Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007).

We identified food outlet types present in the participant's 0.25-mile and 0.5-mile residential radii to create a person-level neighborhood food environment. We found that the presence of two or more Fruit and Vegetable Markets in 0.25-mile and the presence of one or more Fruit and Vegetable Markets in 0.5-mile increase the participants' odds of perceiving the availability, selection, and high quality of fresh fruits and vegetables in their neighborhood. In addition, the presence of medium/large size Supermarket/Grocery in 0.25-mile increases the odds of perceiving that the fresh fruits and vegetables in their neighborhood are of high quality whereas the presence of Meat Market in 0.25-mile lowers the odds. We also found that the presence of one or more Fruit and Vegetable Markets in 0.25-mile, the presence of two or more Fruit and Vegetable Markets in 0.5-mile, and the presence of medium/large size

Supermarket/Grocery in both radii increase the odds of perceiving that a large selection of low-fat products is available in their neighborhood whereas the presence of Meat Market in 0.25-mile lowers the odds.

Although the Meat Markets assessed in our study sell fruits and vegetables, our study participants were consistently less likely to associate fresh fruits and vegetables and low-fat products with this particular food outlet type. It is possible that the participants' perception of their neighborhood food environment may have less to do with the physical distance of the food outlet from their home, but more to do with their preference on where they shop for healthy foods in their neighborhood. Small size Supermarket/Grocery accounted for 71% of the actual neighborhood food environment assessed in our study. However, their presence has no statistical significance in predicting the participants' perception of the fresh fruits and vegetables and low-fat products in their neighborhood. A possible explanation for this finding is that the medium/large size Supermarket/Grocery, which accounted for 21% of the actual neighborhood food environment assessed in this study, may offer higher quality and greater variety of healthier food products at lower prices for our study participants than those offered in small size Supermarket/Grocery. This observation has been reported in a mixed method study of urban adults in Philadelphia who chose to shop at large chain supermarkets because of the greater variety of healthful foods and sometimes lower prices, including opting for more distant stores from home given the variety of healthful foods offered (Cannuscio et al., 2013).

Health Behavior: Fruit and Vegetable Consumption

Four in five of our study participants (>80%) agreed that a large selection of fresh fruits and vegetables is available and of high quality and that a large selection of low-fat products is available in their neighborhood. However, only 9.4% of our participants met the federal minimum recommendation of two servings of fruits per day and only 5.9% of our participants met the federal minimum recommendation of three servings of vegetables per day. Our findings that participants do not eat enough fruits and vegetables echoed the findings from a secondary data analysis using the 2013 state-based telephone Behavioral Risk Factor Surveillance Survey (BRFSS) that reported 13.1% met the federal fruit intake recommendation and 8.9% met the federal vegetable intake recommendation across all respondents, and that 15.5% met the federal fruit intake recommendation and 8.8% met the federal vegetable intake

recommendation for respondents from New York State (Moore & Thompson, 2015). Of note is that although Moore and Thompson (2015) acknowledged that the relatively low BRFSS response rates might have biased their sample, our collective findings were similar in that our Hispanic urban participants from New York City and their BRFSS respondents from New York State both consume more fruits than vegetables.

Our study findings related to the predictors of fruit and vegetable consumption were inconsistent with the literature. The findings related to two demographic characteristics, education and foreign born, were similar to prior studies. In particular, our findings of association that participant with more than a high school education and being foreign-born have higher odds of consuming five or more servings of fruits and vegetables are consistent with the literature. A secondary data analysis of the Third National Health and Nutrition Examination Survey found that having higher educational attainment and foreign birth were both associated with higher fruits and vegetables consumption (Dubowitz et al., 2008). Similarly, a cross-sectional multilevel analyses of the 2002 and 2004 New York City Community Health Survey data found that higher levels of education was associated with higher fruit and vegetable consumption (Jack et al., 2013).

Compared to US-born Hispanics, foreign-born Hispanics have increased odds of consuming five or more servings of fruits and vegetables per day. The results from a study conducted among Hispanic immigrants from Mexico to Washington state found that low-acculturated Hispanics consumed more fruits and vegetables compared to high-acculturated Hispanics and that this association remained statistically significant after adjusting for age, sex, income, and education (Neuhouser, Thompson, Coronado, & Solomon, 2004). Of note is that Hispanics who adopted the dominant characteristics of the mainstream society ate fewer servings of fruits and vegetables per day and this may indicate that as compared to the US-born Hispanics, the foreign-born Hispanics in our study had not adopted the dominant pattern of mainstream society (i.e., non-Hispanic) perhaps because of their living in a predominantly Hispanic community.

In contrast, our findings about the relationship between participants' perception of the availability and selection of fresh fruits and vegetables in their neighborhood, actual access to fresh produce, and daily consumption of five or more servings of fruits and vegetables were the inverse of other studies

(Blitstein, Snider, & Evans, 2012; Zenk et al., 2009); higher perceived and actual availability decreased the odds of five or more servings of fruits and vegetables per day. Several methodological explanations could be posited for this finding. First, is it possible that the manner in which information about fruit and vegetable consumption was gathered led to inaccurate self-reporting of fruit and vegetable consumption? Participants were asked to recall their recent fruit and vegetable consumption in the last 30 days, using their choice of scale, i.e., last 30 days, per week, or per day, and then the values were converted to per day for purposes of the analysis. While this could be the case, the fact that the findings related to education and foreign-born are consistent with the literature in terms of directions of the relationship suggests that the method of data collection does not completely explain the finding. Second, we did not ask participants where they shop for food or gather data about how the costs of food influence their food shopping location and food choices. These factors may influence fruit and vegetable consumption, but the lack of these factors in the analysis would not likely cause an inverse relationship – a null relationship is more likely. A third consideration is that in one ZIP code in our analysis, the presence of cliffs means that the 0.25-mile and 0.5-mile residential radii may not actually represent availability. However, the majority of participants in the study were from ZIP codes without physical obstructions such as cliffs. Consequently, given that the literature and our examination of our methods do not point to a clear explanation of the unexpected inverse association between perceived and actual availability and fruit and vegetable consumption, additional quantitative and qualitative research is needed.

Health Outcome: BMI

Seventy five percent of our study participants are overweight or obese based on their objectively measured BMI. Of note is that 82% of our participants who are overweight and 88.5% of our participants who are obese correctly perceived themselves to be overweight. This is consistent with the results of a secondary data analysis using the 2007 Health Information National Trends Survey data, a nationally representative biennial survey from the National Cancer Institute (Squiers et al., 2014). In particular, Squiers and colleagues found that 84.23% of respondents who have a BMI in the overweight or obese range accurately perceived themselves to be overweight. BMI also progressively increases with advancing age. Being female lowers the odds of being overweight whereas participants who self-reported having diabetes have higher odds of being overweight or obese.

Participants with more than a high school education have consistently lower odds of obesity. Having higher education may have enhanced the participants' ability to make healthier food choices, an association that was reported in a large population-representative Danish Twin Registry study that found adult participants with less education have greater variance in their BMI (Johnson, Kyvik, Skytthe, Deary, & Sørensen, 2011). Similarly, a recent cross-sectional telephone survey of urban adults in Brazil found that higher levels of education was associated with higher fruit and vegetable consumption (Pessoa, Mendes, Gomes, Martins, & Velasquez-Melendez, 2015). In addition, having knowledge of fruit and vegetable recommendations was associated with greater fruit and vegetable consumption among men of African descent surveyed in the New York City metropolitan area (Wolf et al., 2008). Compared to US-born Hispanics, participants who are foreign-born have higher odds of being overweight. A possible explanation for this finding is that participants may be eating more and that larger portions of foods (including fruits and vegetables) are being consumed, an association reported in a review of evidence linking portion size, energy intake and weight gain (Rolls, 2014).

Health Outcome: Hypertension

Our Hispanic study participants are relatively healthy in that only 28% have hypertension, which is comparable to findings from another study that reported hypertension prevalence of 29.5% among Dominicans living in the Bronx (Sorlie et al., 2014). Advancing age and participants who self-report having diabetes increases the odds of hypertension whereas being female lowers the odds. Our findings of association are consistent with the literature. A scientific statement summarizing current evidence on the burden of cardiovascular disease among Hispanics in the US documented age-adjusted prevalence of hypertension among Mexicans, higher prevalence of diabetes mellitus among people of Hispanic descent, and slightly lower prevalence of hypertension among female Hispanics (Rodriguez et al., 2014). Similarly, investigators in the Hispanic Community Health Study/Study of Latinos cohort study found that women had lower overall prevalence of hypertension when compared to men and that cardiovascular risk factors such as diabetes and hypertension were strongly associated (Daviglus et al., 2012; Daviglus, Pirzada, & Talavera, 2014). Daviglus and Colleagues (2014) also found that higher prevalence of cardiovascular risk factors were associated with higher degrees of acculturation, which we were unable to assess in our study.

Health Outcome: Self-reported Health

Overall, 73% of our Hispanic study population self-reported having greater than good health. Older age and being female lower the odds of self-report of good health. This finding is consistent with the results reported by another study that examined the influence of immigration and other associated factors on self-reported health (Salinero-Fort et al., 2012). Participants with more than a high school education have higher odds of self-reporting good health. Our findings were consistent with another study that found higher education level was significantly associated with improving self-assessments of health (Gorman & Sivaganesan, 2007). Participants who consumed five or more servings of fruits and vegetables have lower odds of self-report of good health. The potential influence of our method of collecting information about fruit and vegetable consumption on accuracy of report was discussed earlier. It is also possible that participants with a higher level of consumption may underreport and participants with a lower level of consumption may over report the frequency of their dietary intake (National Cancer Institute, n.d.). In addition, our sample that consumed five or more servings of fruits and vegetables was small and this may not play out in a larger sample.

Participants with self-reported diabetes and who have BMI in the obese range have lower odds of self-report of good health. Similar findings have been noted in the literature regarding lower self-reported health and diabetes (Sparring et al., 2013) and obesity (Lopez-Garcia, Guallar-Castillón, Garcia-Esquinas, & Rodríguez-Artalejo, 2016). Our findings is also consistent with results from a prospective community-based longitudinal Montreal Diabetes Health and Well Being Study that found participants with lower self-reported health have less than a secondary schooling and higher BMI in the obese range (Schmitz et al., 2013).

In our multivariate analyses, we had poor model fit for our BMI (overweight multivariate model), hypertension, and self-report of good health outcome variables. A possible explanation is that studies with large sample size make it more likely to detect a significant difference, resulting in poor model fit. (Huber-Carol, Balakrishnan, Nikulin, & Mesbah, 2012)

Study Limitations

The study has several limitations. First, the cross-sectional data and observational study design limited our ability to demonstrate causality. More than half (52%) of our study participants have less than

a high school education. It is possible that having fewer years of education may potentially affect their understanding or accurate recall of their fruit and vegetable consumption. In particular, our survey questions that measure fruit and vegetable consumption during the past 30 days can be a limitation since participants could respond to their self-reported frequency either by day, by week, or by month, and doing so can contribute to under reporting of their fruit and vegetable consumption. However, the participants' responses on fruit and vegetable consumption were consistent with other national study that reported Americans do not eat enough fruits and vegetables (Moore & Thompson, 2015).

Second, there were several aspects of our methods that present potential limitations. In regards to actual food availability, we defined the participants' actual neighborhood food environment to only include food outlets that have a physical address. In doing so, we excluded sidewalk produce vendors, Green Carts mobile vendors, and farmers markets that sell fruits and vegetables given their variable mobile locations and/or seasonal hours. In terms of the participants' 0.25 and 0.5 mile residential radii, we did not assess how the presence of some cliffs running along the north south direction on both the east west side of one of our study setting's ZIP code may present as potential barrier to healthy eating in the neighborhood. Moreover, we did not assess other aspects of availability such as how study participants travel outside of their home to buy food, where they shop for food, and how the price of food influence their food shopping and food choices. Related to measurement of fruit and vegetable consumption, the recall period of 30 days for reporting the number of fruits and vegetables per month, week, or day may have led to inaccurate reports and consumption was somewhat lower, but displayed the same consumption pattern among New York State residents as reported in a study using BRFSS data (Moore & Thompson, 2015). Moreover, the relationship between consumption and sociodemographic variables such as education and nativity was similar to other studies (Pessoa et al., 2015; Wolf et al., 2008).

Although we did include nativity as predictor variable in our analyses and were able to group our Hispanic participants into three distinct categories: (1) US-born, (2) Foreign-born: Dominicans and (3) Foreign-born: Other country of birth, we were unable to further disaggregate foreign-born Hispanic participants who are born outside of the US or the Dominican Republic because their numbers were too small for meaningful analysis. We also do not have complete data on participant's length of residency in

the US and we are therefore unable to examine the relationship between acculturation and health outcomes, which could have influenced the results. Our study population is demographically representative of the predominantly Dominican Hispanic subgroup in Northern Manhattan. However, our convenience and snowball sampling have resulted in the majority of our study participants being female Hispanics. In addition, the generalizability of our study findings to other Hispanic communities beyond New York City is limited given that Mexicans are the predominant Hispanic subgroup in the United States.

Study Strengths

Despite the study limitations, the strengths of our study include the large sample size of Hispanic participants surveyed by English-Spanish bilingual community health workers through face-to-face interview in Northern Manhattan. In addition, the comprehensive WICER community-based survey includes many participants' self-reported variables developed from standardized patient assessment instruments. The objective anthropometric measurement of height, weight and BP readings provided valid and consistent measures of BMI and BP readings.

Another strength of our study is the use of objective (actual) and self-reported (perceived) measures of the participants' neighborhood food environment, which provide different dimensions of the neighborhood food environment. The use of the NAICS codes allowed us to distinguish Supermarket/Grocery stores from Convenient Stores to provide a greater level of specificity. The Investigator also conducted onsite ground-truth field assessments to further validate the commercial business listing of food outlets in Northern Manhattan as well as conducted online virtual assessments using Google Maps with Street View to complement the onsite ground-truth field assessments.

Our use of a spatial modeling approach to integrate geographic-level neighborhood food environment data with our comprehensive WICER survey data enabled us to identify food outlets within a participant's 0.25-mile and 0.5-mile residential radii. By creating individual 0.25-mile and 0.5-mile person-level neighborhood food environments, we were able to model where study participants have the opportunity to buy fruits and vegetables within walking distance from where they live. In addition, by measuring our low-income urban Hispanic participants' self-report of their neighborhood food environment, we were able to compare how their self-reported perceptions align with the objective

measures of their neighborhood food environment and how it relate to their self-reported fruit and vegetable consumption.

Implications and Recommendations for Future Research

The use of the County Health Rankings population health model as the overarching framework for our study allowed us to examine components that work together to create healthy communities and provided a common ground to engage clinicians, public health professionals, policy makers, and community leaders in understanding issues of importance to help the community achieve better health. Our finding that four in five of our participants correctly perceive themselves to be overweight highlights the potential of tailoring population-based behavioral intervention programs to encourage and help this underserved Hispanic urban community achieve healthier weight.

We also applied geographic information system as a public health informatics approach to enhance our understanding of the relationship between health and place in an underserved urban Hispanic community. In particular, we use geographic technique to spatially model and integrate geographic-level neighborhood food environment data with our comprehensive WICER survey data to identify food outlets within a participant's 0.25-mile (about a 5-minute walking distance) and 0.5-mile (about a 10-minute walking distance) residential radii where they can potentially buy fruits and vegetables in the neighborhood. Our finding about the inverse relationship between actual and perceived food environment and fruit and vegetable consumption suggests that this relationship is complex and requires further study through a variety of qualitative and quantitative methods.

We presented descriptive and inferential statistics related to participants consuming ≥2 servings of fruits per day, ≥3 servings of vegetables per day, and the combined ≥5 servings of fruits and vegetables per day as proxy for the 2010 Dietary Guidelines for Americans. The Guidelines is jointly published every five years by the U.S. Department of Agriculture and the U.S. Department of Health and Human Services with the overall goal of promoting health and preventing chronic diseases by serving as the Nation's go-to evidence-based resources for nutrition advice (USDA, n.d.). The newer 2015-2020 Dietary Guidelines for Americans calls for increasing the respective contribution of fruits and vegetables to the diets of Americans by changing from a general 5-a-day recommendation for everyone to an

individualized fruit (USDA, 2015a) and vegetable (USDA, 2015b) consumption recommendation based on daily calorie needs that take into account one's age, sex, and physical activity level.

Given the important role healthy eating can play in health promotion and chronic disease prevention, and that the local food environment can change over time to reflect the neighborhood composition and the needs of its residents, additional quantitative and qualitative research is needed to further examine relevant individual- and household-level factors regarding fruit and vegetable consumption for this low-income Hispanic urban community. The quantitative research component should consider income, cost of food choice, acculturation, and social relations into account. The qualitative research component should include methods such as focus groups to assess knowledge of recommended fruit and vegetable servings, attitudes and beliefs towards increasing consumption, food shopping and food choices, as well as barriers and facilitators towards healthy eating.

Conclusion

In summary, this large-scale cross-sectional observational study contributed to our understanding of the relationships among neighborhood food environment, health behaviors and health outcomes in a predominantly Hispanic underserved urban community in New York City. Our particular findings regarding participants' perceived neighborhood food environment and actual healthy food access being associated with lower fruit and vegetable consumption merits additional research to examine the complex relationship between perceived access, availability, and consumption of healthy foods.

REFERENCES

Adams, Marc A., Sallis, James F., Kerr, Jacqueline, Conway, Terry L., Saelens, Brian E., Frank, Lawrence D., . . . Cain, Kelli L. (2011). Neighborhood environment profiles related to physical activity and weight status: A latent profile analysis. *Preventive Medicine, 52*(5), 326-331.

Agrawal, Asha Weinstein, Schlossberg, Marc, & Irvin, Katja. (2008). How far, by which route and why? A spatial analysis of pedestrian preference. *Journal of Urban Design*(13), 81-98.

American Heart Association. (2013). Understanding Blood Pressure Readings. Retrieved December 2, 2013, from http://bit.ly/J20Bxl

Auchincloss, Amy H, Roux, Ana V Diez, Brown, Daniel G, Erdmann, Christine A, & Bertoni, Alain G. (2008). Neighborhood resources for physical activity and healthy foods and their association with insulin resistance. *Epidemiology, 19*(1), 146-157.

Auchincloss, Amy H, Roux, Ana V Diez, Mujahid, Mahasin S, Shen, Mingwu, Bertoni, Alain G, & Carnethon, Mercedes R. (2009). Neighborhood resources for physical activity and healthy foods and incidence of type 2 diabetes mellitus: the Multi-Ethnic study of Atherosclerosis. *Archives of Internal Medicine, 169*(18), 1698.

Babey, Susan H., Diamant, Allison L., Hastert, Theresa A., Goldstein, Harold, Harvey, Stefan, Banthia, Rajni, . . . Treuhaft, Sarah. (2008). Designed for disease: The link between local food environments and obesity and diabetes. Los Angeles, CA: University of California Los Angeles: UCLA Center for Health Policy Research.

Bauer, Katherine W., Larson, Nicole I., Nelson, Melissa C., Story, Mary, & Neumark-Sztainer, Dianne. (2009). Fast food intake among adolescents: Secular and longitudinal trends from 1999 to 2004. *Preventive Medicine, 48*(3), 284-287.

Ben-Joseph, Eran, Lee, Jae Seung, Cromley, Ellen K., Laden, Francine, & Troped, Philip J. (2013). Virtual and actual: Relative accuracy of on-site and web-based instruments in auditing the environment for physical activity. *Health & Place, 19*, 138-150. doi: http://dx.doi.org/10.1016/j.healthplace.2012.11.001

Black, Jennifer L., & Macinko, James. (2008). Neighborhoods and obesity. *Nutrition Reviews, 66*(1), 2-20.

Black, Jennifer L., Macinko, James, Dixon, L. Beth, & Fryer, Jr George E. (2010). Neighborhoods and obesity in New York City. *Health & Place, 16*(3), 489-499.

Blitstein, J. L., Snider, J., & Evans, W. D. (2012). Perceptions of the food shopping environment are associated with greater consumption of fruits and vegetables. *Public Health Nutrition*, *15*(06), 1124–1129. Retrieved from href="http://dx.doi.org/10.1017/S1368980012000523

Block, Jason P., Christakis, Nicholas A, O'Malley, A. James, & Subramanian, S. V. (2011). Proximity to food establishments and body mass index in the Framingham Heart Study offspring cohort over 30 years. *American Journal of Epidemiology, 174*(10), 1108-1114.

Bodor, J. Nicholas, Rice, JanetC, Farley, ThomasA, Swalm, ChrisM, & Rose, Donald. (2010). The Association between Obesity and Urban Food Environments. *Journal of Urban Health, 87*(5), 771-781.

Bodor, J. Nicholas, Rose, Donald , Farley, Thomas A, Swalm, Christopher, & Scott, Susanne K. (2008). Neighbourhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment. *Public Health Nutrition, 11*(4), 413-420.

Booth, Katie M., Pinkston, Megan M., & Poston, Walker S. Carlos. (2005). Obesity and the Built Environment. *Journal of the American Dietetic Association, 105*(5), 110-117.

Borrell, Luisa N, Menendez, Barbara S, & Joseph, Sharon P. (2011). Racial/ethnic disparities on self-reported hypertension in New York City: examining disparities among Hispanic subgroups. *Ethnicity and Disease, 21*(4), 429-436.

Brown, Anna, & Lopez, Mark Hugo. (2013). Mapping the Latino Population, By State, County and City. Washington, DC: Pew Research Center's Hispanic Trends Project.

Brug, Johannes. (2008). Determinants of healthy eating: motivation, abilities and environmental opportunities. *Family Practice, 25*(suppl 1), i50-i55.

Cannuscio, C. C., Tappe, K., Hillier, A., Buttenheim, A., Karpyn, A., & Glanz, K. (2013). Urban food environments and residents' shopping behaviors. *American Journal of Preventive Medicine*, *45*(5), 606–614. http://dx.doi.org/10.1016/j.amepre.2013.06.021

Casey, Alicia A., Elliott, Michael, Glanz, Karen, Haire-Joshu, Debra, Lovegreen, Sarah L., Saelens, Brian E., . . . Brownson, Ross C. (2008). Impact of the food environment and physical activity environment on behaviors and weight status in rural U.S. communities. *Preventive Medicine, 47*(6), 600-604.

Centers for Disease Control and Prevention. (2005). 5 A Day Works. Atlanta: U.S.: Department of Health and Human Services.

Chung, Chanjin, & Myers, Samuel L. (1999). Do the poor pay more for food? An analysis of grocery store availability and food price disparities. *Journal of Consumer Affairs, 33*(2), 276-296.

Clarke, Philippa, Ailshire, Jennifer, Melendez, Robert, Bader, Michael, & Morenoff, Jeffrey. (2010). Using Google Earth to conduct a neighborhood audit: Reliability of a virtual audit instrument. *Health & Place, 16*, 1224-1229. doi: http://dx.doi.org/10.1016/j.healthplace.2010.08.007

Columbia University Medical Center. Irving Institute for Clinical and Translational Research helps community groups encourage healthy eating. Retrieved December 18, 2013, from http://www.cumc.columbia.edu/features/CCPH-brings-fresh-produce-washington-heights

Cortés, D. E., Millán-Ferro, A., Schneider, K., Vega, R. R., & Caballero, A. E. (2013). Food purchasing selection among low-income, Spanish-speaking latinos. *American Journal of Preventive Medicine*, *44*(3 SUPPL. 3), S267–S273.

Daviglus, M. L., Pirzada, A., & Talavera, G. A. (2014). Cardiovascular disease risk factors in the hispanic/latino population: Lessons from the hispanic community health study/study of latinos (HCHS/SOL). *Progress in Cardiovascular Diseases*, *57*(3), 230–236. http://doi.org/10.1016/j.pcad.2014.07.006

Daviglus, M. L., Talavera, G. A. G., Avilés-Santa, M. L., Allison, M., Cai, J., Criqui, M. H., … Stamler, J. (2012). Prevalence of major cardiovascular risk factors and cardiovascular diseases among Hispanic/Latino individuals of diverse backgrounds in the United States. *Jama*, *308*(17), 1775–84. http://doi.org/10.1001/jama.2012.14517

Diez-Roux, Ana V., Nieto, F. Javier, Muntaner, Carles, Tyroler, Herman A., Comstock, George W., Shahar, Eyal, . . . Szklo, Moyses. (1997). Neighborhood Environments and Coronary Heart Disease: A Multilevel Analysis. *American Journal of Epidemiology, 146*(1), 48-63.

Drewnowski, A. (2010). The cost of US foods as related to their nutritive value. *American Journal of Clinical Nutrition*, *92*(5), 1181–1188. http://doi.org/10.3945/ajcn.2010.29300

Dubowitz, T., Heron, M., Bird, C. E., Lurie, N., Finch, B. K., Basurto-Dávila, R., . . . Escarce, J. J. (2008). Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *The American Journal of Clinical Nutrition, 87*(6), 1883-1891.

Dubowitz, Tamara, Ghosh-Dastidar, Madhumita, Eibner, Christine, Slaughter, Mary E., Fernandes, Meenakshi, Whitsel, Eric A., . . . Escarce, José J. (2012). The Women's Health Initiative: The Food Environment, Neighborhood Socioeconomic Status, BMI, and Blood Pressure. *Obesity, 20*(4), 862-871.

Dubowitz, Tamara, Heron, Melonie, Bird, Chloe E., Lurie, Nicole, Finch, Brian K., Basurto-Dávila, Ricardo, . . . Escarce, José J. (2008). Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. *The American Journal of Clinical Nutrition, 87*(6), 1883-1891.

Dubowitz, T., Zenk, S. N., Ghosh-Dashtidar, B., Cohen, D. A., Beckman, R., Hunter, G., … Collins, R. L. (2015). Healthy food access for urban food desert residents: examination of the food environment, food purchasing practices, diet, and body mass index. *Public Health Nutrition*, *18*(12), 2220–2230. http://doi.org/10.1017/S1368980014002742

Feinstein, Jonathan S. (1993). The relationship between socioeconomic status and health: a review of the literature. *The Milbank Quarterly*, 279-322.

Finger, J. D., Tylleskar, T., Lampert, T., & Mensink, G. B. (2013). Dietary behaviour and socioeconomic position: the role of physical activity patterns. *PLoS One, 8*(11), e78390. doi: 10.1371/journal.pone.0078390

Fleischhacker, S. E., Evenson, K. R., Rodriguez, D. A., & Ammerman, A. S. (2011). A systematic review of fast food access studies. *Obesity Reviews, 12*, e460-471.

Fox, Mary Kay, Dodd, Allison Hedley, Wilson, Ander, & Gleason, Philip M. (2009). Association between School Food Environment and Practices and Body Mass Index of US Public School Children. *Journal of the American Dietetic Association, 109*(2, Supplement), S108-S117.

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

Glanz, Karen , Sallis, James F., Saelens, Brian E. , & Frank, Lawrence D. . (2007). Nutrition Environment Measures Survey in stores (NEMS-S): Development and evaluation. *American Journal of Preventive Medicine, 32*(4), 282-289.

Gordon-Larsen, Penny, Harris, Kathleen Mullan, Ward, Dianne S., & Popkin, Barry M. (2003). Acculturation and overweight-related behaviors among Hispanic immigrants to the US: the National Longitudinal Study of Adolescent Health. *Social Science & Medicine, 57*(11), 2023-2034.

Gorman, Bridget K., & Sivaganesan, Ahilan. (2007). The role of social support and integration for understanding socioeconomic disparities in self-rated health and hypertension. *Social Science & Medicine, 65*, 958-975. doi: http://dx.doi.org/10.1016/j.socscimed.2007.04.017

Guthrie, Joanne. (2004). Understanding Fruit and Vegetable Choices—Research Briefs. *Agriculture Information Bulletin No. (AIB-792).* from http://www.ers.usda.gov/publications/aib-agricultural-information-bulletin/aib792.aspx#.U7c-_5Q7uM4

Hill, James O, & Peters, John C. (1998). Environmental contributions to the obesity epidemic. *Science, 280*(5368), 1371-1374.

Horowitz, C. R., Colson, K. A., Hebert, P. L., & Lancaster, K. (2004). Barriers to buying healthy foods for people with diabetes: evidence of environmental disparities. *American Journal of Public Health, 94*, 1549-1554.

Hosmer, D. W. & Lemeshow, S. (2000) Assessing the Fit of the Model, in Applied Logistic Regression, Second Edition, John Wiley & Sons, Inc., Hoboken, NJ, USA. doi: 10.1002/0471722146.ch5

Huber-Carol, C., Balakrishnan, N., Nikulin, M., & Mesbah, M. (2012). *Goodness-of-fit tests and model*

validity. Springer Science & Business Media.

Jack, Darby, Neckerman, Kathryn, Schwartz-Soicher, Ofira, Lovasi, Gina S., Quinn, James, Richards, Catherine, . . . Rundle, Andrew. (2013). Socio-economic status, neighbourhood food environments and consumption of fruit and vegetable in New York City. *Public health nutrition, 16*(07), 1197-1205

James, Paul A, Oparil, Suzanne, Carter, Barry L, Cushman, William C, Dennison-Himmelfarb, Cheryl, Handler, Joel, . . . Ogedegbe, Olugbenga. (2014). 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA, 311*(5), 507-520.

Jilcott, Stephanie B. (2009). Perceptions of the community food environment and related influences on food choice among midlife women residing in rural and urban areas: a qualitative analysis. *Women & Health, 49*(2-3), 164-180 Jørgensen Jørgensen.

Johnson, W., Kyvik, K. O., Skytthe, A., Deary, I. J., & Sørensen, T. I. A. (2011). Education modifies genetic and environmental influences on BMI. *PLoS ONE*, *6*(1). http://doi.org/10.1371/journal.pone.0016290

Kaplan, Mark S., Huguet, Nathalie, Newsom, Jason T., & McFarland, Bentson H. (2004). The association between length of residence and obesity among Hispanic immigrants. *American Journal of Preventive Medicine, 27*(4), 323-326.

Kaufman, Leslie, & Karpati, Adam. (2007). Understanding the sociocultural roots of childhood obesity: food practices among Latino families of Bushwick, Brooklyn. *Social Science & Medicine, 64*(11), 2177-2188.

Kim, Daniel, Subramanian, S. V., Gortmaker, Steven L., & Kawachi, Ichiro. (2006). US state- and county-level social capital in relation to obesity and physical inactivity: A multilevel, multivariable analysis. *Social Science & Medicine, 63*(4), 1045-1059.

Kumanyika, Shiriki K. (2008). Environmental influences on childhood obesity: Ethnic and cultural influences in context. *Physiology & Behavior, 94*(1), 61-70.

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

Larson, Nicole I., Story, Mary T., & Nelson, Melissa C. (2009). Neighborhood Environments: Disparities in Access to Healthy Foods in the U.S. *American Journal of Preventive Medicine, 36*(1), 74-81.e10.

Lee, Young Ji, Boden-Albala, Bernadette, Larson, Elaine, Willcox, Adam, & Bakken, Suzanne. (2014). Online health information seeking behaviors of Hispanics in New York City: a community-based cross-sectional study. *Journal of medical Internet research, 16*(7), e176. doi: 10.2196/jmir.3499

Li, Fuzhong, Harmer, Peter A., Cardinal, Bradley J., Bosworth, Mark, Acock, Alan, Johnson-Shelton, Deborah, & Moore, Jane M. (2008). Built Environment, Adiposity, and Physical Activity in Adults Aged 50–75. *American Journal of Preventive Medicine, 35*(1), 38-46.

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

Loftfield, E., Yi, S., Curtis, C. J., Bartley, K., & Kansagra, S. M. (2013). Potassium and fruit and vegetable intakes in relation to social determinants and access to produce in New York City. *American Journal of Clinical Nutrition*, *98*(5), 1282–1288. http://doi.org/10.3945/ajcn.113.059204

Lopez-Garcia, E., Guallar-Castillón, P., Garcia-Esquinas, E., & Rodríguez-Artalejo, F. (2016). Metabolically healthy obesity and health-related quality of life: A prospective cohort study. *Clinical Nutrition (Edinburgh, Scotland)*. http://doi.org/10.1016/j.clnu.2016.04.028

Lovasi, Gina S., Jacobson, Judith, Quinn, James, Neckerman, Kathryn, Ashby-Thompson, Maxine, & Rundle, Andrew. (2011). Is the Environment Near Home and School Associated with Physical Activity and Adiposity of Urban Preschool Children? *Journal of Urban Health, 88*(6), 1143-1157.

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

Maddock, J. (2004). The relationship between obesity and the prevalence of fast food restaurants: state-level analysis. *American Journal of Health Promotion, 19*, 137-143.

Malmström, M., Sundquist, J., & Johansson, S. E. (1999). Neighborhood environment and self-reported health status: a multilevel analysis. *American Journal of Public Health, 89*(8), 1181-1186.

Michimi, Akihiko, & Wimberly, Michael C. (2010). Associations of supermarket accessibility with obesity and fruit and vegetable consumption in the conterminous United States. *International Journal of Health Geographics, 9*(49), 94-112.

Mickey, Ruth M., & Greenland, Sander. (1989). The Impact of Confounder Selection Criteria on Effect Estimation. *American Journal of Epidemiology, 129*(1), 125-137.

Mokdad, Ali H, Ford, Earl S, Bowman, Barbara A, Dietz, William H, Vinicor, Frank, Bales, Virginia S, & Marks, James S. (2003). Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA: the Journal of the American Medical Association, 289*(1), 76-79.

Moore, Latetia V., & Thompson, Frances E. (2015). Adults Meeting Fruit and Vegetable Intake Recommendations—United States, 2013. *MMWR. Morbidity and mortality weekly report, 64*(26), 709-713.

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

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

Morland, K., Wing, S., & Diez-Roux, A. V. (2002). The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. *American Journal of Public Health, 92*, 1761-1767.

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

Morland, Kimberly, Wing, Steve, Diez Roux, Ana, & Poole, Charles. (2002). Neighborhood characteristics associated with the location of food stores and food service places. *American Journal of Preventive Medicine, 22*(1), 23-29.

Mota, Jorge, Almeida, Mariana, Santos, Paula, & Ribeiro, José Carlos. (2005). Perceived Neighborhood Environments and physical activity in adolescents. *Preventive Medicine, 41*(5-6), 834-836.

Mujahid, Mahasin S, Roux, Ana V Diez, Morenoff, Jeffrey D, Raghunathan, Trivellore E, Cooper, Richard S, Ni, Hanyu, & Shea, Steven. (2008). Neighborhood characteristics and hypertension. *Epidemiology, 19*(4), 590-598.

National Cancer Institute. Food Record at a Glance | Dietary Assessment Primer. Retrieved August 10, 2016, from https://dietassessmentprimer.cancer.gov/

National Institute of Nursing Research. (2011). Bringing Science to Life: NINR Strategic Plan. Bethesda, MD: National Institutes of Health.

Neckerman, Kathryn M., Bader, Michael D. M., Richards, Catherine A., Purciel, Marnie, Quinn, James W., Thomas, Juli Simon, . . . Rundle, Andrew. (2010). Disparities in the Food Environments of New York City Public Schools. *American Journal of Preventive Medicine, 39*(3), 195-202.

Neuhouser, Marian L., Thompson, Beti, Coronado, Gloria D., & Solomon, Cam C. (2004). Higher fat intake and lower fruit and vegetable intakes are associated with greater acculturation among mexicans living in Washington State. *Journal of the American Dietetic Association, 104*(1), 51-57.

Nordstrom, Cheryl K., Diez Roux, Ana V., Jackson, Sharon A., & Gardin, Julius M. (2004). The association of personal and neighborhood socioeconomic indicators with subclinical cardiovascular disease in an elderly cohort. The cardiovascular health study. *Social Science & Medicine, 59*(10), 2139-2147.

Olson, EC, Van Wye, G, Kerker, B, Thorpe, L, & Frieden, TR. (2006). Take Care Inwood and Washington Heights. *NYC Community Health Profiles* (Second ed., Vol. 19(42), pp. 1-16). New York, NY: New York City Department of Health and Mental Hygiene.

Pearce, Jamie, Blakely, Tony, Witten, Karen, & Bartie, Phil. (2007). Neighborhood Deprivation and Access to Fast-Food Retailing: A National Study. *American Journal of Preventive Medicine, 32*(5), 375-382. doi: 10.1016/j.amepre.2007.01.009

Pearce, Jamie, Day, Peter, & Witten, Karen. (2008). Neighbourhood provision of food and alcohol retailing and social deprivation in urban New Zealand. *Urban Policy and Research, 26*(2), 213-227.

Pessoa, M. C., Mendes, L. L., Gomes, C. S., Martins, P. A., & Velasquez-Melendez, G. (2015). Food environment and fruit and vegetable intake in a urban population: A multilevel analysis. *BMC Public Health*, *15*(1), 1–8. http://doi.org/10.1186/s12889-015-2277-1

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

Powell, Lisa M., Chaloupka, Frank J., & Bao, Yanjun. (2007). The availability of fast-food and full-service restaurants in the United States: associations with neighborhood characteristics. *American Journal of Preventive Medicine, 33*(4, Supplement), S240-S245.

ReferenceUSA. Data Quality. Retrieved January 10, 2014, from http://www.referenceusa.com/Static/DataQuality

Rodriguez, C. J., Allison, M., Daviglus, M. L., Isasi, C. R., Keller, C., Leira, E. C., … Sims, M. (2014). *Status of cardiovascular disease and stroke in hispanics/latinos in the united states: A science advisory from the american heart association*. *Circulation* (Vol. 130). http://doi.org/10.1161/CIR.0000000000000071

Rolls, B. (2014). What is the role of portion control in weight management? *International Journal of Obesity*, *38*, S1–S8. http://doi.org/10.1038/ijo.2014.82

Rose, Donald, Bodor, J. Nicholas, Hutchinson, Paul L., & Swalm, Chris M. (2010). The Importance of a Multi-Dimensional Approach for Studying the Links between Food Access and Consumption. *The Journal of Nutrition, 140*(6), 1170-1174.

Roux, Ana V. Diez, Merkin, Sharon Stein, Arnett, Donna, Chambless, Lloyd, Massing, Mark, Nieto, F. Javier, . . . Watson, Robert L. (2001). Neighborhood of Residence and Incidence of Coronary Heart Disease. *New England Journal of Medicine, 345*(2), 99-106.

Rundle, Andrew G., Bader, Michael D. M., Richards, Catherine A., Neckerman, Kathryn M., & Teitler, Julien O. (2011a). Using Google Street View to Audit Neighborhood Environments. *American Journal of Preventive Medicine, 40*, 94-100. doi: http://doi.org/10.1016/j.amepre.2010.09.034

Rundle, Andrew G., Bader, Michael D. M., Richards, Catherine A., Neckerman, Kathryn M., & Teitler, Julien O. (2011b). Using Google Street View to Audit Neighborhood Environments. *American Journal of Preventive Medicine, 40*(1), 94-100.

Rundle, Andrew, Neckerman, Kathryn M., Freeman, Lance, Lovasi, Gina S., Purciel, Marnie, Quinn, James, . . . Weiss, Christopher. (2009). Neighborhood food environment and walkability predict obesity in New York City. *Environmental Health Perspectives, 117*, 442-447.

Russell, A. (Producer). (2013, February 8, 2014). County Health Rankings and Roadmaps Webinar.

Salinero-Fort, Miguel Á, Jiménez-García, Rodrigo, del Otero-Sanz, Laura, de Burgos-Lunar, Carmen, Chico-Moraleja, Rosa M., Martín-Madrazo, Carmen, & Gómez-Campelo, Paloma. (2012). Self-reported health status in primary health care: the influence of immigration and other associated factors. *PLoS One, 7*(6), e38462.

Sastry, Narayan, Pebley, Anne , & Zonta, Michela. (2002). *Neighborhood Definitions and the Spatial Dimension of Daily Life in Los Angeles*. Paper presented at the Annual Meetings of the Population Association of America, Atlanta, Georgia.

Schmitz, N., Gariepy, G., Smith, K. J., Malla, A., Boyer, R., Strychar, I., … Wang, J. (2013). Trajectories of self-rated health in people with diabetes: Associations with functioning in a prospective community sample. *PLoS ONE*, *8*(12), 1–7. http://doi.org/10.1371/journal.pone.0083088

Sharkey, Joseph R., & Horel, Scott. (2008). Neighborhood Socioeconomic Deprivation and Minority Composition Are Associated with Better Potential Spatial Access to the Ground-Truthed Food Environment in a Large Rural Area. *The Journal of Nutrition, 138*(3), 620-627.

Sorlie, Paul D., Allison, Matthew A., Avilés-Santa, M. Larissa, Cai, Jianwen, Daviglus, Martha L., Howard, Annie G., . . . Schneiderman, Neil. (2014). Prevalence of hypertension, awareness, treatment, and control in the Hispanic Community Health Study/Study of Latinos. *American journal of hypertension*, hpu003.

Sparring, V., Nystrom, L., Wahlstrom, R., Jonsson, P. M., Ostman, J., & Burstrom, K. (2013). Diabetes duration and health-related quality of life in individuals with onset of diabetes in the age group 15--34years - a Swedish population-based study using EQ-5D. *BMC Public Health*, *13*(1), 377. http://doi.org/10.1186/1471-2458-13-377

Spence, John C., Cutumisu, Nicoleta, Edwards, Joy, Raine, Kim D., & Smoyer-Tomic, Karen. (2009). Relation between local food environments and obesity among adults. *BMC Public Health, 9*(1), 192.

Squiers, Linda, Renaud, Jeanette, McCormack, Lauren, Tzeng, Janice, Bann, Carla, & Williams, Pam. (2014). How Accurate Are Americans' Perceptions of Their Own Weight? *Journal of health communication, 19*(7), 795-812.

Stark, James H., Neckerman, Kathryn, Lovasi, Gina S., Konty, Kevin, Quinn, James, Arno, Peter, . . . Rundle, Andrew. (2013). Neighbourhood food environments and body mass index among New York City adults. *Journal of Epidemiology and Community Health, 67*(9), 736-742.

Taylor, Wendell C, Poston, Walker S Carlos, Jones, Lovell, & Kraft, M Katherine. (2006). Environmental justice: obesity, physical activity, and healthy eating. *Journal of Physical Activity & Health, 3*, S30.

Teruya, Stacey A., & Bazargan-Hejazi, Shahrzad. (2013). The Immigrant and Hispanic Paradoxes: A Systematic Review of Their Predictions and Effects. *Hispanic Journal of Behavioral Sciences, 35*(4), 486-509.

Thompson, Claire, Cummins, Steven, Brown, Tim, & Kyle, Rosemary. (2012). Understanding interactions with the food environment: an exploration of supermarket food shopping routines in deprived neighbourhoods. *Health & Place, 19*, 116-123.

Thornton, L. E., Pearce, J. R., Macdonald, L., Lamb, K. E., & Ellaway, A. (2012). Does the choice of neighbourhood supermarket access measure influence associations with individual-level fruit and vegetable consumption? A case study from Glasgow. *International Journal of Health Geographics, 11*, 10.

U.S. Census Bureau.). generated by Manuel C. Co Jr. using American FactFinder. Retrieved April 4, 2014, from http://factfinder2.census.gov

U.S. Census Bureau.). Hispanic Heritage Month. from http://www.census.gov/eeo/special_emphasis_programs/hispanic_heritage.html

U.S. Census Bureau. (2010). The Hispanic Population: 2010 Census Briefs. Washington, DC: U.S. Department of Commerce.

U.S. Census Bureau. (2013). Introduction to NAICS. Retrieved November 8, 2013, from http://www.census.gov/eos/www/naics/

USDA. (n.d.). *U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015 – 2020 Dietary Guidelines for Americans. 8th Edition*. Retrieved from http://health.gov/dietaryguidelines/2015/guidelines/.

USDA. (2015a). United States Department of Agriculture. Daily Fruit Recommendation. Retrieved August 29, 2016, from https://www.choosemyplate.gov/fruit

USDA. (2015b). United States Department of Agriculture. Daily Vegetable Recommendation. Retrieved August 29, 2016, from https://www.choosemyplate.gov/vegetables

U.S. Department of Agriculture. (2011). *USDA and HHS Announce New Dietary Guidelines to Help Americans Make Healthier Food Choices and Confront Obesity Epidemic*. Washington, DC.

U.S. Department of Agriculture. (2013). Food Deserts. Retrieved December 28, 2013, from http://apps.ams.usda.gov/fooddeserts/FAQ.aspx

U.S. Department of Agriculture and U.S Department of Health and Human Services. (2010). Dietary Guidelines for Americans, 2010 (7th ed.). Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services.). Office of Disease Preventiona and Health Promotion. Healthy People 2020. Washington, DC. Retrieved January 5, 2014, from http://www.healthypeople.gov/2020/

U.S. Postal Service.). Address Information Systems Products. Retrieved January 18, 2014, from https://www.usps.com/business/address-information-systems.htm

UWPHI. (2012). County Health Rankings. Madison, WI: University of Wisconsin Population Health Institute.

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

Wang, Zhe, & Lee, Chanam. (2010). Site and neighborhood environments for walking among older adults. *Health & Place, 16*(6), 1268-1279.

Webber, Caroline B, Sobal, Jeffery, & Dollahite, Jamie S. (2010). Shopping for fruit and vegetable. Food and retail qualities of importance to low-income households at the grocery store. *Appetite, 54*(2), 297-303.

Wolf, R. L., Lepore, S. J., Vandergrift, J. L., Wetmore-Arkader, L., McGinty, E., Pietrzak, G., & Yaroch, A. L. (2008). Knowledge, barriers and stage of change as correlates of fruit and vegetable consumption among urban and mostly immigrant black men. *Journal of American Dietary Association*, *108*(8), 1315–1322. http://doi.org/10.1126/scisignal.2001449.Engineering

Yi, Stella, Elfassy, Tali, Gupta, Leena, Myers, Christa, & Kerker, Bonnie. (2014). Nativity, Language Spoken at Home, Length of Time in the United States, and Race/Ethnicity: Associations with Self-Reported Hypertension. *American Journal of Hypertension, 27*(2), 237-244.

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

Zenk, Shannon N., Lachance, Laurie L., Schulz, Amy J., Mentz, Graciela, Kannan, Srimathi, & Ridella, William. (2009). Neighborhood Retail Food Environment and Fruit and Vegetable Intake in a Multiethnic Urban Population. *American Journal of Health Promotion, 23*(4), 255-264.