African Americans' satisfaction with the neighborhood fruit and vegetable environment in Detroit, MI: Correlates, modifiers, and implications for reducing disparities in diet-related disease

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Health Behavior and Health Education)
in The University of Michigan
2012

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To my parents, John and Stephanie

Acknowledgements

I would like to acknowledge and express gratitude for the support of my Heavenly Father for His blessings of health, strength, and knowledge to complete this degree. I would like to thank my family for their unending and unwavering support during my time in the PhD program. Mom and dad, your encouragement, sacrifice, support, and unspoken pushes have carried me through my academic career and allowed me to see this to completion. Thank you for giving me the space to craft my own journey.

I would also like to express my gratitude to my 4 siblings: Jade, Kim, Jonathan, and Keilah. You guys have graciously filled in and given me much needed breaks whenever I needed them. I appreciate your love, prayers, support, friendship, and for helping me keep things in perspective. Grandmom and Uncle Ira, thank you for your unyielding confidence in my abilities. Your encouragement kept me bouncing back and ready to move forward. Accompanying the support of my immediate family is that of my godparents. I would like to thank Dr. Darrilynne Mazyck and Mr. Bernie Mazyck for their support, prayers, and guidance. Your accessibility and eagerness to help me think through these topics for the last several years while keeping me focused on the next steps of my career and life have been foundational in helping me see this degree to completion.

I would also like to thank many wonderful friends who provided and continue to provide their support through prayers, laughter, and keeping me focused on the larger picture. To Victoria, Terri, Alexis, Sancia, Stephanie, Selena, Pearl and many others - I love you and appreciate your support. I would also like to thank friends and colleagues at

the University of Michigan for their support, advice, words of wisdom, and for being my family during my time away from home. Melodie, Rebecca G., Alana, Jennifer, Rebecca C., Jasmine, Ruti, Allison, Andrea, Ebony, Darrell, Kanika, Terri D.W., Denise, Chela, Yusuf, Terika, and Women of Substance, thanks for making Ann Arbor such a special place! Additionally, to the Connections Community Church family, thank you for your support and prayers. I found you just in time!

I would like to thank the Healthy Environments Partnership for the use of their data. I would also like to thank my co-chairs, Drs. Amy Schulz and Derek Griffith. Your availability and willingness to help me think through these topics made this dissertation stronger. To Dr. Harold Neighbors and the larger CRECH family, thank you for providing so many awesome opportunities for research and training. Those experiences were foundational for my time here at Michigan. I appreciate all you do to ensure the training of successive sets of health disparities researchers.

Finally, I would also like to thank my support team in Georgia. Countless family and friends kept me encouraged during trips home. Specifically, I'd like to thank the Brown, Poteat, Mathis, Reed, Hicks, Oglesby, Sims, Edmond, Jackson, and Taylor families. You always reminded me of the larger realities and implications of my research.

With love and sincere gratitude,

Jonetta

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Abstract

African Americans are more likely to suffer from diet-related diseases than other racial and ethnic groups. Dietary intake behaviors that place many African Americans at increased risk for diet-related disease have been associated with characteristics of the neighborhood environments in which they reside. Effectively altering dietary intake behaviors with the goal of reducing disparities in diet-related disease requires understanding the factors that influence what people eat. African Americans are more likely than other racial and ethnic groups to live in urban, racially segregated neighborhoods that have lower access to healthy food and other health promoting resources. This research examines associations between observed characteristics of the neighborhood food environment (such as store type and location), the social and economic environment, self-reported satisfaction with the neighborhood fruit and vegetable environment (satisfaction), and fruit and vegetable intakes (FVI) among African Americans. Satisfaction is a perception based measure that is influenced by the observed food environment and components of the social environment. Research for this study was conducted with a sample of 522 African American adults across three neighborhoods in Detroit, Michigan. Data for this study were cross-sectional and were drawn from the Healthy Environments Partnership (HEP) wave 1 (2002) community survey. Data were analyzed using three-level hierarchical regression models (HLM 7). Results include: 1) satisfaction was associated with the observed food environment and with FVI; 2) SES was associated with satisfaction, controlling for the observed food

environment; 3) SES modified associations between the observed food environment and FVI; and 4) social engagement modified associations between the observed food environment and FVI. These findings are consistent with the hypothesis that satisfaction with the food environment reflects both observed characteristics of the food environment and social factors, and that these are jointly associated with FVI. These results emphasize the importance of multilevel approaches to addressing racial inequities in diet-related conditions that consider associations between observed characteristics of the neighborhood food environment, socioeconomic factors (e.g., car access, education) and social factors (e.g., neighborhood participation) as these jointly influence satisfaction with the neighborhood fruit and vegetable environment and dietary intakes.

Chapter 1

Social and Built Environments, Self-Reported Satisfaction with the Neighborhood Fruit and Vegetable Environment, and Fruit and Vegetable Intakes Among African Americans: A Review of the Literature

Introduction

The reduction of the prevalence of diet-related illnesses is vital to improving the health of African Americans and eliminating health disparities. Studies of factors that influence health behaviors, such as fruit and vegetable intake, are important, not only to elucidate pathways to behaviors, but also for the development of effective, targeted interventions to positively influence dietary choices. In this effort, it is important to focus not only upon individuals, but also the environments in which they reside (Yen & Syme, 1999). People live in neighborhoods and communities in which health behaviors and health outcomes are directly and indirectly influenced by aspects of the social and built environment. In this dissertation, the social environment is defined as not only families, neighborhoods, and communities to which people belong, but also the social structure and shared cultural and behavioral aspects of neighborhoods in which one lives, groups and organizations that people are a part of, and policies enacted to organize one's lives (Sorensen, et al., 2007; Yen & Syme, 1999). The social environment influences dietary intake by shaping norms, enforcing patterns of social control, providing or not providing environmental opportunities to engage in particular behaviors, reducing or producing

stress, and placing constraints on individual behaviors (Berkman & Kawachi, 2000; Committee on Assuring the Health of the Public in the 21st Century., 2002).

Following others, I refer to the built environment as being human modified spaces such as homes, neighborhoods, and workplaces, and the availability of or access to healthy neighborhood food resources (Srinivasan, O'Fallon, & Dearry, 2003). Early research suggests the importance of considering how elements of the social environment work collectively with the built environment to influence health behaviors like fruit and vegetable intakes and satisfaction with the food environment (Cummins & Macintyre, 2006).The social and built environment do not operate . of each other but are the result of continuous interactions of social processes and relationships between individuals and groups and natural and artificial components of physical and social space that work to influence disease pathways, health behaviors, and health outcomes (Yen & Syme, 1999). Understanding the individual and combined contributions of the social and built environments to dietary quality is critical to the development of interventions to reduce disparities in diet-related disease and promote overall health.

Diet quality and fruit and vegetable intakes

There is significant evidence of racial and ethnic variation in health outcomes that are associated with poor diet quality (Larson, Story, & Nelson, 2009; Moore & Diez Roux, 2006; Powell, Slater, Mirtcheva, Bao, & Chaloupka, 2007; Zenk, Schulz, Israel, et al., 2005). African Americans are more likely to suffer from diet-related diseases compared to those of other racial and ethnic groups (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). The increased tendency for African Americans to suffer from diet-related diseases suggests the need for

a more detailed look at mechanisms influencing such associations. Such mechanisms may operate at individual and environmental levels to influence dietary intakes and are often influenced by larger factors, such as race-based residential segregation and neighborhood poverty (Larson & Story, 2009). Race-based residential segregation and neighborhood poverty may structure neighborhood level access to resources that influence dietary intakes (Ford & Dzewaltowski, 2008; Kumanyika, et al., 2007; Kwate, 2008; Larson & Story, 2009; Schulz, Williams, Israel, & Lempert, 2002; Zenk, Lachance, et al., 2009). Adopting such an approach may contribute to understandings of racial disparities in diet-related health outcomes. This research examines the associations between observed characteristics of the neighborhood food environment, self-reported satisfaction with the neighborhood fruit and vegetable environment (hereafter referred to as "satisfaction with the neighborhood fruit and vegetable environment"), and fruit and vegetable intakes. Results of examination of such associations may be helpful in developing culturally, socially, and environmentally sensitive interventions for improving dietary quality and reducing disparities in diet-related disease among African Americans (Bediako & Griffith, 2007). Below, I provide detail on associations between diet quality and fruit and vegetable intakes.

Diet quality is an important predictor of health and disease. According to a large body of research, only 10% of the U.S. population and just 5% of African Americans have a healthful diet (Drewnowski & Specter, 2004; Lichtenstein, et al., 2006). Generally accepted components of a healthful diet include one that is low in sodium, saturated fatty acids, cholesterol, trans fats, refined grains and alcohol, and that balances caloric intake with caloric expenditure. Maintaining a healthful diet involves eating a variety of

vegetables, fruit, foods high in fiber, whole grains, fat free or low-fat milk products, fish (especially oily fish), and foods containing potassium, calcium, and vitamin D (Drewnowski, 1997; Drewnowski & Specter, 2004; Lichtenstein, et al., 2006; Pollard, Steptoe, & Wardle, 1998; USDA, 2010). Past research has found that high quality diets, those with plentiful amounts of micronutrient-rich fruits and vegetables, potassium, folate, zinc, calcium, and vitamins C, D, and E, are associated with having protective effects against cardiovascular disease, diabetes mellitus, metabolic syndrome, obesity and certain types of cancer (Briefel & Johnson, 2004; Joshipura, et al., 2001; Kant, 2004; Key, Schatzkin, Willett, & al., 2004; Raffensperger, et al., 2010; Reddy & Katan, 2004; Steyn, Mann, Bennett, & al., 2004; Swinburn, Caterson, Seidell, & al., 2004). Substantial research also shows that diets composed of high fat, low fiber, and low fruit and vegetable intakes are associated with increases in negative health outcomes and a host of diet-related diseases, such as breast, prostate, colon, and other cancers, obesity, type 2 diabetes, hypertension, and cardiovascular disease (Dreeben, 2001; El Bayumy, et al., 1997; Hu, et al., 2000; Meyer, et al., 2000; Satia, 2009; Schlundt, Hargreaves, & Buchowski, 2003; WHO, 2000). Exploring the mechanisms underlying trends in dietary practices may yield methods and techniques for improving dietary intake and reducing diet-related health disparities.

The correlation between diet and health status, at individual and population levels, emphasizes the importance of dietary intake behaviors as crucial predictors of disease and overall human health status (Brunner, et al., 2008; Guo, Warden, Paeratakul, & Bray, 2004; Kant, 2004; Kennedy, Bowman, Spence, Freedman, & King, 2001). Dietary intake is a process that involves the consumption of energy, in the form of fat, protein,

carbohydrates, and other nutrients that are necessary to maintain human life, promote physical growth, and sustain metabolic functioning. It is often challenging for research studies to capture accurate dietary intake information (Casagrande, Wang, Anderson, & Gary, 2007; Erinosho, Thompson, Moser, & Yaroch, 2011; Horner, et al., 2002; Johansson, Solvoll, Bjorneboe, & Drevon, 1998). Many studies use fruit and vegetable intakes as measures of dietary intakes (Boone-Heinonen, et al., 2011; Morland, Wing, & Diez Roux, 2002).

Fruit and vegetable intakes are strong predictors of health and disease and are used throughout health and social science research as predictors of and proxies for diet quality (Blanck, Gillespie, Kimmons, Seymour, & Serdula, 2008). Fruit and vegetables contain vitamins, minerals, fiber and other bioactive compounds that when consumed at recommended levels can lower risk of chronic diseases, certain cancers, cardiovascular disease and aid in weight management (Blanck, et al., 2007; Blanck, et al., 2008; Erinosho, et al., 2011; Grimm, Blanck, Scanlon, Moore, & Grummer-Strawn, 2010). Americans in general consume far less than the recommended servings of fruits and vegetables per day (Blanck, et al., 2008; Casagrande, et al., 2007; Erinosho, et al., 2011; Kimmons, Gillespie, Seymour, Serdula, & Blanck, 2009; Serdula, et al., 2004). Current dietary guidelines recommend that adults increase vegetable and fruit intakes and eat a variety of vegetables, especially dark green and red and orange vegetables and beans and peas (USDA & USDHHS, 2010). To quantify the recommendation, the 2010 dietary guidelines for Americans and the United States Department of Agriculture (USDA) food pattern suggests adults consume at least 4.5 cups of fruits and vegetables per day (2.5 cups of vegetables and 2.0 cups of fruit) (USDA & USDHHS, 2010). The total of 4.5

cups of fruits and vegetables per day is equivalent to 9 servings of fruit and vegetables daily for a 2,000 calorie diet, higher or lower depending on the total caloric level of the individual (USDHHS & USDA, 2005).

Several other studies however, use the daily fruit and vegetable cut points and guidelines recommended by the national Behavioral Risk Factor Surveillance Survey (BRFSS). The BRFSS recommends consuming 2+ fruit servings a day and 3+ vegetable servings a day. For example, data from the 2009 BRFSS reported that roughly one third (32.5%) of all American adults met the recommended amount of fruit servings per day (2+ times a day) and just over one quarter of all American adults consumed vegetables the recommended 3+ times per day. In addition, the overall prevalence of consuming 2+ fruits per day decreased slightly but significantly from 34.4% to 32.5% of the population from 2000 to 2009. There was no significant change in vegetable consumption during the same time period (Grimm, et al., 2010). Below, I highlight trends in fruit and vegetable intakes according to racial and ethnic group status.

While research examining associations between the neighborhood food environment and fruit and vegetable intakes is often conducted using nationally representative data, such studies may not include representative samples of minority racial and ethnic groups (Griffith, Neighbors, & Johnson, 2009). In addition, very few studies report racial and ethnic differences in fruit and vegetable intakes at local or regional levels (Deshmukh-Taskar, Nicklas, Yang, & Berenson, 2007; Houston, Stevens, Cai, & Haines, 2005; Savoca, et al., 2009; Zamora, Gordon-Larsen, Jacobs, & Popkin, 2010). More often studies use varying types of dietary indices, create their own "healthy food" indices, or examine fruit and vegetable intakes collectively as one variable

(Champagne, et al., 2004; Franco, et al., 2009; Moore, Diez Roux, Nettleton, & Jacobs, 2008; Steffen, et al., 2003). The above listed factors make comparing racial and ethnic group variation in fruit and vegetable intakes of across studies challenging. For purposes of comparability of the current research to previous work, studies reviewed below are from the limited amount of literature that uses fruit and vegetable intakes as indicators of diet quality.

Deshmukh-Tasker and colleagues (2007) examined racial and ethnic group differences in fruit and vegetable intakes among 1,266 adults ages 20-38 enrolled in a cross sectional Bogalusa Heart Study from 1995-1996 in semi-rural Louisiana as part of the Bogalusa Heart Study (Deshmukh-Taskar, et al., 2007). The Bogalusa Heart Study began in 1973 as a study to examine the early natural history of cardiovascular disease. Deshmukh-Tasker et al. (2007) found African Americans consumed significantly more servings of fruit or 100% fruit juice compared to Whites. Whites consumed significantly more servings of vegetables (measured with and without french fries) compared to African Americans (Deshmukh-Taskar, et al., 2007). Additionally, a cross sectional study by Savoca et al. (2009) examined dietary patterns among a sample of 635 older adults living in rural North Carolina (Savoca, et al., 2009). Savoca and colleagues (2009) found no difference in vegetable consumption among between African Americans, Whites and American Indians(Savoca, et al., 2009). African Americans, however, consumed significantly greater servings of fruit compared to Whites and American Indians (Savoca, et al., 2009).

Results from two studies examined patterns in fruit and vegetable intakes across multi-centers. Houston et al. (2005) examined racial and ethnic trends in fruit and

vegetable intakes among 9,404 African American and White adults ages 45-64 who were enrolled in the Atherosclerosis Risk in Communities Study (ARIC) (Houston, et al., 2005). The ARIC study drew sample populations from cities in North Carolina, Mississippi, Minnesota, and Maryland. Results showed White women consumed more mean daily servings of vegetables and fruit compared to African American women. White men consumed more mean daily fruit servings, but less mean daily vegetable servings than African American men (Houston, et al., 2005). When genders were combined, Whites consumed more mean daily servings of fruit than African Americans and less mean daily servings of vegetables than African Americans (Houston, et al., 2005). Finally, Zamora and colleagues (2010) examined differences in fruit and vegetable intakes among 4,913 Whites and African Americans (Zamora, et al., 2010). Zamora et al. (2010) used data from the Coronary Artery Risk Development in Young Adults (CARDIA) study, a prospective, multi-center study of determinants of cardiovascular disease in young adults ages 18-30 in cities in Minnesota, California, Alabama, and Illinois (Zamora, et al., 2010). Findings showed Whites had higher intakes of vegetables than African Americans. Alternatively, African Americans had a higher intake of fruit and 100% fruit juice than Whites (Zamora, et al., 2010).

In summarizing results of the research outlined above, many studies found African Americans had higher fruit intakes compared to Whites (Deshmukh-Taskar, et al., 2007; Savoca, et al., 2009; Zamora, et al., 2010). Patterns for vegetable intakes were less consistent showing no differences in vegetable consumption by racial and ethnic group (Savoca, et al., 2009) or that Whites consumed more vegetables compared to African Americans (Deshmukh-Taskar, et al., 2007; Zamora, et al., 2010). For reasons unknown

and beyond the focus of this dissertation, patterns of fruit and vegetable intakes from Houston et al. (2005) using the ARIC study contradicted what other studies have found for racial and ethnic differences fruit and vegetable intakes, Whites had higher consumption of fruit compared to African Americans, and African Americans had higher intakes of vegetables compared to Whites (Houston, et al., 2005). Results from the research described above that use multiethnic samples, while providing information on patterns of fruit and vegetable intakes by racial and ethnic group, tell very little about why such differences in fruit and vegetables intakes exist. For development of effective public health interventions that target improving fruit and vegetable intakes and reducing disparities in diet-related disease among African Americans, more specific information regarding variation in the factors that influence dietary intakes and the mechanisms by which they operate may be important. Examining such associations with group samples allows for more thorough examination of environmental, social, cultural and historical factors that may influence diet-related behavior among African Americans.

Gary et al. (2004) examined fruit and vegetable intakes among a sample of 2,172 African Americans adults in Raleigh, North Carolina who were enrolled in Project DIRECT (Diabetes Interventions Reaching and Educating Communities Together) (Gary, et al., 2004). Gary and colleagues found 8% of African American adults met the BRFSS recommendation of 2+ servings of fruit each day while 16% of African Americans met the BRFSS recommendation of 3+ vegetable servings per day (Gary, et al., 2004). Findings from Gary et al. (2004) of fruit and vegetable consumption, using BRFSS cut points, among a geographically specific sample of African Americans in North Carolina differ drastically from reported percentages of fruit and vegetable intakes among African

Americans in the 2009 national BRFSS (21.9% vegetable and 33.7% fruit recommendations) (Gary, et al., 2004; Grimm, et al., 2010). Potential differences in patterns of fruit and vegetable consumption for African Americans in local versus national samples highlight the need for additional research assessing potential differences in local and national patterns of fruit and vegetable intakes. Additionally, compared to the other research reviewed thus far, Gary et al. (2004) used an African American only sample. The variation in BRFSS recommended fruit and vegetable intakes (Grimm, et al., 2010) and research by Gary et al. (2004) also suggests there may be differences in information obtained from studies that focus on African Americans compared to national multiethnic samples (Gary, et al., 2004; Grimm, et al., 2010). The above review of literature highlights the need for research that examines predictors of dietary intakes and other variables that may be important for reducing diet-related disease using local samples of African Americans versus national or multiethnic samples.

This dissertation research is focused on predictors, mediators, and moderators of fruit and vegetable intakes among African Americans in Detroit, Michigan. There are several reasons to consider the examination of such associations among African Americans. Evidence for racial and ethnic variation in fruit and vegetable intakes reported by several local and national multiethnic surveys like the BRFSS (Blanck, et al., 2008; Deshmukh-Taskar, et al., 2007; Dubowitz, et al., 2008; Grimm, et al., 2010; Kant, Graubard, & Kumanyika, 2007; Kruger, Yore, Solera, & Moeti, 2007; Savoca, et al., 2009; Zamora, et al., 2010) have been useful for establishing racial and ethnic differences in dietary intakes. Such studies, however, are often comparative across racial and ethnic groups and tell us little about how to improve dietary intakes among African Americans,

a group more likely to suffer from diet-related diseases compared to other racial and ethnic groups (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). For example, comparative studies tell us how health behaviors (e.g., fruit and vegetable intakes) and health outcomes (e.g., diet-related disease) vary across racial and ethnic groups. Comparative studies also tell us what factors (e.g., satisfaction) contribute to differences in fruit and vegetable intakes and diet-related diseases across different racial and ethnic groups. For example, if satisfaction influences fruit and vegetable intakes for Whites more than Blacks- or, if Whites report higher levels of satisfaction than Blacks.

For African Americans, within group research may allow for models that account for the influence of historical, social, and cultural contexts that may shape dietary behaviors. Within group studies yield information on the unique factors that may affect a particular population or the unique way determinants of health may combine or interact to influence patterns of health within a particular group. While comparative studies help to identify potential factors that may systematically vary between groups, within group studies help to illuminate unique factors that are essential for improving the health of that population and patterns that may be illustrative of important features and relationships that contribute to their health outcomes. Thus, within group analyses are not only useful for identifying where and how to intervene within the population of interest, but these studies also help to expose important mechanisms and pathways that highlight how various determinants affect health (Bleich, Thorpe Jr, Sharif-Harris, Fesahazion, & LaVeist, 2010; LaVeist, Pollack, Thorpe Jr, Fesahazion, & Gaskin, 2011).

Few studies examine factors that influence dietary behavior among African Americans, not in comparison to other racial and ethnic groups. This is important because studies that focus on African Americans yield specific information on mechanisms and techniques useful for reducing the excess burden of diet-related disease among African Americans. Results from such types of research may better inform interventions seeking changes in dietary behavior among African Americans and ultimate reduction in diet-related health disparities (Bediako & Griffith, 2007). For example, research that examines associations between healthy neighborhood food availability, satisfaction with the neighborhood fruit and vegetable environment, and dietary intakes within African American only samples may be able to measure or indirectly conceptualize the influence of larger structural level factors like racism, discrimination, and race-based residential segregation as influencing such relationships. The next section examines satisfaction with the neighborhood fruit and vegetable environment as a pathway through which factors in the social and built environment may influence dietary intakes.

Satisfaction with the neighborhood fruit and vegetable environment

Satisfaction with the neighborhood fruit and vegetable environment is a subjective measure of the neighborhood food environment that is influenced by both individual and environmental factors (Moore, Diez Roux, & Brines, 2008; Zenk, Lachance, et al., 2009). The role of satisfaction with the neighborhood fruit and vegetable environment is beginning to emerge as a significant predictor of fruit and vegetable intakes (Moore, Diez Roux, & Brines, 2008; Zenk, Lachance, et al., 2009). Assessing a person's satisfaction with their neighborhood fruit and vegetable environment is important because one way the neighborhood food environment may influence fruit and vegetable intakes is through

an individual's perception of fruits and vegetables available to them (Kumar, Quinn, Kriska, & Thomas, 2011; Moore, Diez Roux, & Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008).

Subjective measures like satisfaction with the neighborhood fruit and vegetable environment are influenced by and subject to individual perceptions, biases, likes, and dislikes, and may complement measures of the neighborhood food environment to influence health behavior and health outcomes (Moore, Diez Roux, & Brines, 2008). A person's satisfaction with the neighborhood fruit and vegetable environment may vary across a variety of subjective and personal factors, including personal preferences, levels of awareness of food resources in one's neighborhood, car ownership, and different cultural and economic factors (Moore, Diez Roux, & Brines, 2008). As influenced by a host of individual and environmental factors, satisfaction with the neighborhood fruit and vegetable environment may be an important variable to consider for health interventions seeking to improve fruit and vegetable intakes and reduce diet-related morbidities.

It is important to consider the environments in which people live in to influence fruit and vegetable intakes and reduce the prevalence of diet-related disease and health outcomes. Much may be gained by examining individual and environmental predictors of fruit and vegetable intakes (Larson 2009 review). Factors that influence fruit and vegetable intakes are embedded in the social and built environment and include cultural perceptions of food, social support associated with food consumption, media and advertising, food availability, race-based residential segregation, biology, learning history, knowledge, nutritional benefit, economic factors, individual or group culture, and social structure (Bisogni, Connors, Devine, & Sobal, 2002; Connors, Bisogni, Sobal, & Devine,

2001; Evans, McNeil, Laufman, & Bowman, 2009; Hargreaves, Schlundt, & Buchowski, 2002; Jaeger, 2006; James, 2004; Malpede, et al., 2007; Mela, 1999; Pollard, Kirk, & Cade, 2002; Steptoe & Pollard, 1995). These factors are shaped by what some have termed "fundamental" factors, or larger, macrosocial processes that shape features of the environment (Link & Phelan, 1995, 2005; Schulz, et al., 2002). In the following section, I describe the conceptual framework linking fundamental factors to the availability of healthy foods, satisfaction with the neighborhood fruit and vegetable environment, and fruit and vegetable intakes that guides the analyses in this dissertation.

Fundamental Determinants of Dietary Intake

The need for a framework that positions fundamental processes as important predictors of health behavior and health outcomes is vital to research that seeks to reduce and eliminate health inequities (Schulz, et al., 2002) in diet-related disease. Interest in fundamental cause theory and frameworks grew out of concern for the excessive and incorrect use of risk factor epidemiology methods that often failed to consider the multilevel nature of factors that influenced health and health behavior (Link & Phelan, 2005). Components of the fundamental determinants of health disparities framework operate at fundamental, intermediate and proximate levels to help explain processes by which multilevel factors in the environment influence health behaviors and health outcomes (Schulz, et al., 2000; Schulz & Lempert, 2004; Schulz & Northridge, 2004; Schulz, Parker, Israel, & Fisher, 2001; Schulz, et al., 2002).

Fundamental factors can be defined as economic and political processes that create unequal distributions of material resources. Fundamental factors affect health by shaping access to resources that are required to maintain health; for example, economic

and political systems that influence access to education and employment. Intermediate level factors such as the built environment and social context contain resources that may directly or indirectly influence fruit and vegetable intakes such as access to healthy neighborhood food, social structure and interactions with family, neighbors, and community members in neighborhood social organizations (Larson & Story, 2009). There are reciprocal processes between intermediate and fundamental factors, and between intermediate and proximate factors, with each influencing the others. Finally, proximate factors are referred to as health behaviors, social relationships, and physical and psychosocial stressors that are detrimental to health. Proximate factors are observable at personal and interpersonal levels and are direct predictors of health outcomes (Schulz & Northridge, 2004).

This research uses the fundamental determinants of health disparities framework to explain how fundamental factors, race-based residential segregation and neighborhood poverty, directly and indirectly influence satisfaction with the neighborhood food environment and fruit and vegetable intakes of African Americans. Core features of race-based residential segregation and neighborhood poverty are that they increase the chance that individuals living in such environments will be socially isolated from larger realms of society (Small & Newman, 2001; Wilson, 2010). Such fundamental factors may shape norms and beliefs about food and food choices in the social environment and influence perceived or actual food availability in the built environment. Race-based residential segregation and neighborhood poverty are also correlated with individual socioeconomic status, fruit and vegetable intakes, and ultimately influence health outcomes such as obesity, certain cancers, cardiovascular disease, diabetes mellitus and all cause mortality

(Ford & Dzewaltowski, 2008; Kumanyika, et al., 2007; Kwate, 2008; Larson & Story, 2009; Schulz, et al., 2002; Zenk, Lachance, et al., 2009) (See Figure 1.1). For African Americans, race-based residential segregation and neighborhood poverty may be important direct and indirect fundamental determinants of perceived healthy food availability and dietary intake (Ford & Dzewaltowski, 2008; Kumanyika, et al., 2007; Kwate, 2008; Larson & Story, 2009; Schulz, et al., 2002).

Race-based residential segregation. Differences in neighborhood environments are not naturally determined, but shaped by social, cultural and economic factors and policies (Link & Phelan, 1995, 1996). Race-based residential segregation is defined as the "spatial manifestation of macrolevel social processes and racial ideologies, that keeps many African Americans from resources needed to maintain health" (Schulz, et al., 2002, p.680). The origins of race-based residential segregation in the U.S. can be traced back to efforts by Whites to remain residentially separate from African Americans because of ideological beliefs about the inferiority of African Americans (Collins & Williams, 1999; Griffith, Schulz, Johnson, & Herbert, 2010). Though the hallmark of segregation as a social policy was separation, from 1896 to 1964 Jim Crow segregation was not just the physical separation of residences by race, but a political ideology based on racism (Bell, 2004; Griffith, et al., 2010). The goal of segregation was to economically, politically, and socially subordinate African Americans to Whites (Bell, 2004; Griffith, et al., 2010).

Despite calls for the removal of legal barriers to integration, African Americans remain the most segregated racial group from other racial and ethnic groups in the United States (Acevedo- Garcia, 2000; Charles, 2001; Farley, 1993; Griffith, et al., 2010; Iceland, Weinberg, & Steinmetz, 2002; Lichter, Parisi, & Taquino, 2011; Logan & Stults, 2011;

Williams & Collins, 2001). Results from the 2010 census show that a once slow pace of decline in black-white race-based residential segregation, beginning in 1980, has become stagnant with little change from 2000 and between 2005 and 2009 (Lichter, et al., 2011; Logan & Stults, 2011). Detroit remains at the top of the lists for the most segregated cities in America despite large declines in its overall African American population resulting from fallout from the recession and home foreclosure crises (Logan & Stults, 2011). High rates of race-based residential segregation in Detroit may have implications for the quality of healthy food available.

Neighborhood Poverty. Opportunities for employment are often more limited in poverty dense neighborhoods, and the jobs that are available tend to be either low-paying and with few benefits, or high skilled white-collar jobs (Boschmann & Kwan, 2010; Farley, Danziger, & Holzer, 2000; Lewis & Hamilton, 2008; Small & Newman, 2001; Stoll, 2008; Wilson, 2010). Additionally, due to compromised educational opportunities, many residents of poverty dense communities are unable to compete for such high skilled white-collar positions (Boschmann & Kwan, 2010; Farley, et al., 2000; Lewis & Hamilton, 2008; Small & Newman, 2001; Stoll, 2008; Wilson, 2010). The effect of high concentrations of poverty in racially segregated areas not only limits employment and yields increased crime rates but also produces stress resulting from the cultural and social isolation of residents, high crime rates, and limited employment opportunities (Chang, 2006; Griffith, et al., 2010; Williams & Collins, 2001). The result of the above listed factors often restricts infrastructure that would promote healthy behaviors (Chang, 2006; Griffith, et al., 2010; Williams & Collins, 2001), like increases in fruit and vegetable intakes.

Neighborhood poverty is also heavily influenced by the effects of race-based residential segregation (See Figure 1.1). The effects of race-based residential segregation on neighborhood poverty are widespread. Race-based residential segregation limits access to social and economic capital, social mobility, and increases the social isolation of residents (Collins & Williams, 1999; Massey, 2004). For example, roughly a quarter of African Americans live below the poverty line, compared to approximately nine percent of Whites. Additionally, African Americans are more likely to reside in urban neighborhoods that are low income and racially segregated compared to Whites (Kumanyika, et al., 2007). In large part, lower levels of education and income, factors highly associated with neighborhood poverty for African Americans, are also associated with decreased diet quality (Casagrande, Wang, Anderson, & Gary, 2007; CDC, 2009; Darmon & Drewnowski, 2008; Schlundt, et al., 2003). The above review discusses race-based residential segregation and neighborhood poverty within the context of the fundamental determinants of health disparities framework. Below I expand upon the details of how the built and social environments, as influenced and informed by processes of race-based residential segregation and associated concentrations of poverty and wealth, work through to directly and indirectly influence African Americans' satisfaction with healthy food availability and fruit and vegetable intakes.

Influence of the race-based residential segregation and neighborhood poverty on the built and social environment

The built and social environments are intermediate level factors in the fundamental determinants of health disparities framework. Components of the built and social environments are influenced by fundamental factors (race-based residential segregation and neighborhood poverty) and influence satisfaction with neighborhood

fruit and vegetable environment and fruit and vegetable intakes (See Figure 1.1) (Ford & Dzewaltowski, 2008; Kumanyika, et al., 2007; Kwate, 2008; Larson & Story, 2009; Schulz, et al., 2002; Zenk, Lachance, et al., 2009). Below, I describe mechanisms by which race-based residential segregation and concentrations of poverty influence the built and social environments, and how those environments, in turn, influence fruit and vegetable intakes.

The Built Environment. This research conceptualizes neighborhood food availability as a component of the built environment. A substantial body of literature has examined race-based residential segregation and neighborhood poverty and their associations with neighborhood food availability (Powell, et al., 2007). Previous research shows supermarkets are located further away from African American versus White neighborhoods (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005) and that grocery stores in African American neighborhoods are less likely to have healthy food items or healthy food substitutions, such as low fat or low sodium options (Cummins & Macintyre, 2006; Morland, Wing, Diez Roux, & Poole, 2002). Availability of grocery stores is associated with lower obesity rates, increased fruit and vegetable intake, and more healthful diets (Powell, et al., 2007). Most studies measure neighborhood food availability by direct observation of food environments using market based analysis techniques, geographic information systems (GIS) for spatial analysis of neighborhood access to food outlets, or observer-measured counts of food store types as proxies for access to healthy foods (Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Hollis-Neely, et al., 2005). Recent studies have begun to examine the actual foods available within neighborhood stores (Glanz &

Hoelscher, 2004; Izumi, Zenk, Schulz, Mentz, & Wilson, 2011; Zenk, Schulz, et al., 2009), their quality and their prices in order to more accurately capture these dimensions of the food environment. Together, these studies have begun to establish differences in the availability of healthy foods by neighborhood racial composition and neighborhood socioeconomic status, offering empirical support for the thesis that many African Americans, particularly those living in more segregated and more impoverished neighborhoods, have reduced access to healthy foods and greater access to unhealthy foods. These differences in observed characteristics of neighborhood food environments may contribute to differences in dietary quality. In the remainder of this dissertation, I use the term "observed characteristics of the neighborhood food environment" to capture these dimensions of the food environment.

The Social Environment. Behaviors that influence fruit and vegetable intakes are also embedded within dynamic social environments that are continuously formed, supported, or rejected (Quandt, 1999). Social roles, networks, and relationships are influenced by fundamental factors that may heavily shape and structure neighborhood level access to healthy food. For example, for African Americans, neighborhood conditions that may be present as a result of residing in residentially segregated and lower income neighborhoods may influence social roles, networks or relationships, in addition to the availability of healthy foods. Involvement in neighborhood social groups, roles and networks may shape opportunities for discussion of neighborhood food resources, and be positively or negatively associated with one's perceptions of local food environments as well as fruit and vegetable intakes (Cohen, 2004; Lindstrom, Hanson, Wirfalt, &

Ostergren, 2001; Litt, et al., 2011). These associations are examined in greater detail in the following section.

Associations between the built and social environments, satisfaction with the neighborhood fruit and vegetable environment, and with fruit and vegetable intakes

Satisfaction with the neighborhood fruit and vegetable environment, fruit and vegetable intakes, and observed characteristics of the neighborhood food environment. In addition to their direct effects on dietary intakes, observed characteristics of the neighborhood food environment, as a component of the built environment, may also indirectly influence fruit and vegetable intakes by influencing how satisfied people are with their neighborhood fruit and vegetable environment. For example, the presence or absence of healthy food in one's neighborhood has the potential to positively or negatively shape their satisfaction with their neighborhood fruit and vegetable environment. Additionally, potential associations between observed characteristics of the neighborhood food environment and fruit and vegetable intakes may be different for participants who are more or less satisfied with their neighborhood fruit and vegetable environment.

There is a lack of consistent associations between the observed food environment and fruit and vegetable intakes which points to the utility of understanding satisfaction as another factor that may influence fruit and vegetable intakes. Satisfaction with the neighborhood fruit and vegetable environment is defined as being influenced by the observed food environment and the social environment, and other factors that may shape how satisfied one is with their fruit and vegetable environment more so than the foods actually available to them in their environment. For example, how satisfied one is with

their food environment may influence their fruit and vegetable intakes more than the actual food available to them in their neighborhood influences fruit and vegetable intakes due to factors beyond the observed food environment that influence satisfaction. Understanding the relationship between satisfaction and fruit and vegetable intakes and how it operates above and beyond the observed food environment is important for public health interventions seeking to reduce the excess burden of diet-related disease among African Americans. Such associations are important because the same observed food environments may influence fruit and vegetable intakes differently depending upon a person's level of satisfaction with what they hope or expect to find in their observed food environment. It is important for public health researchers and practitioners to understand variation in factors like satisfaction, that influence health behaviors like fruit and vegetable intakes among African Americans to design models and interventions that build on results of variation among them to reduce their excess burden of diet related disease.

Moore et al. (2008) and Zenk et al. (2009) have studied associations between satisfaction with food environments and dietary intakes using multiethnic cohorts (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). Moore et al. (2008) examined . associations between three variables reflective of observed characteristics of the neighborhood food environment and diet quality: supermarket density, participant-reported assessment of healthy neighborhood food, and aggregated survey responses of healthy neighborhood food from . neighborhood informants. Moore et al. (2008) used aggregated survey responses from . informants to verify and compare data from study participant reported assessments of their food environments and to obtain less biased and

more objective measures of the neighborhood food environment (Moore, Diez Roux, Nettleton, et al., 2008). The three separate measures of the neighborhood food environment were positively but not highly correlated with each other. Specifically, Moore et al. (2008) found significant associations between: the availability of supermarkets within 1-mile of participants' home and diet quality; satisfaction with the food environment and diet quality; and aggregated survey responses from . neighborhood informants and diet quality. Examination of associations between each of the measures of observed characteristics of the neighborhood food environment and diet quality were only tested . of each other. Significant findings from Moore et al. (2008) using three different assessments of healthy neighborhood food availability and diet quality suggest they may each capture different ways the observed neighborhood food environment is associated with dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008).

In contrast to Moore et al. (2008), Zenk et al. (2009) did not find support for the hypothesis that satisfaction with the food environment was associated with fruit and vegetable intakes in a multiethnic Detroit-based sample (Zenk, Lachance, et al., 2009). Studies by both Moore et al. (2008) and Zenk et al. (2009) use multiethnic samples and find significant . associations between observed characteristics of neighborhood food environment and diet quality (Moore, Diez Roux, Nettleton, et al., 2008) and fruit and vegetable intakes (Zenk, Lachance, et al., 2009). Differences in the significance of satisfaction with the food environment and dietary intakes may be attributed to differences in the socioeconomic status profile of each study population (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). Differences in study outcomes may also be attributed to the different measures of dietary intakes used by each

study. Zenk et al. (2009) used mean daily fruit and servings while Moore et al. (2008) used a dietary index and empirically derived dietary pattern to define overall diet quality versus fruit and vegetable intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). Additionally, differences in study outcomes may also be due to slight variations in measures of satisfaction with the food environment. Zenk et al. (2008) measured satisfaction with the food environment as satisfaction with the variety, cost, and quality of affordable produce that was a five minute drive or 10-15 minute walk around participants' homes (Zenk, Lachance, et al., 2009). Conversely, Moore et al. (2008) measured satisfaction with the food environment as the degree of participant agreeability that: a lack of access to adequate food shopping was a problem; there was a large selection of the fruits and vegetables in the neighborhood; and there was a large selection of low-fat products in a 1-mile area surrounding a participants' home (Moore, Diez Roux, Nettleton, Jacon, & Franco, 2009). Such differences highlight the need for additional examination of the effects of satisfaction with the food environment on health behaviors.

There is a growing body of literature that establishes relationships between observed characteristics of neighborhood food environments and fruit and vegetable intakes (Izumi, et al., 2011; Moore, Diez Roux, & Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009; Zenk, Schulz, et al., 2009). More limited literature examines the extent to which satisfaction with the neighborhood fruit and vegetable environment contributes to dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). The current research builds on previous studies by examining the mediating and moderating role of satisfaction with the

neighborhood fruit and vegetable environment on the association between the neighborhood food environment and fruit and vegetable intakes.

Understanding associations between satisfaction with the neighborhood fruit and vegetable environment and fruit and vegetable intakes can contribute to our understanding of the factors that influence evaluations of local food environments and their implications for health related behaviors, fruit and vegetable intakes and diet-related health outcomes such as obesity, type 2 Diabetes and heart disease (Brunner, et al., 2008; Guo, et al., 2004; Kant, 2004; Kennedy, et al., 2001; Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). Gaining an improved understanding of how satisfaction with the neighborhood fruit and vegetable environment is associated with observed characteristics of the neighborhood food environment and fruit and vegetable intakes may aid interventions seeking to improve dietary behaviors such as fruit and vegetable intake. For example, given that satisfaction with the neighborhood fruit and vegetable environment may influence dietary intakes in ways slightly separate or different from how observed characteristics of the neighborhood food environment influence dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008), public health interventions seeking improvements in dietary behavior should focus not only on informing residents of places they can access quality, healthy food, but on also acknowledging and understanding factors that shape perceptions of the neighborhood food environment, given that they may also influence dietary intakes. Additional contributions of this research aim to examine factors that influence satisfaction with the neighborhood fruit and vegetable environment. Specifically, I examine socioeconomic status and elements of the social environment as directly influencing and moderating the

relationship between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment.

Satisfaction with the neighborhood fruit and vegetable environment and individual level socioeconomic status. For literature that seeks to establish a connection between satisfaction with the neighborhood fruit and vegetable environment and fruit and vegetable intakes it becomes important to ascertain why or what makes satisfaction with the neighborhood fruit and vegetable environment an important predictor of fruit and vegetable intakes. In addition to the neighborhood food environment, proximate level social factors may also be important predictors of satisfaction with the neighborhood fruit and vegetable environment (See Figure 1.1). In large part, lower levels of education and income, proximate level factors highly associated with neighborhood poverty for African Americans, are also associated with decreased diet quality (Casagrande, et al., 2007; CDC, 2009; Darmon & Drewnowski, 2008; Schlundt, et al., 2003) and may be associated with satisfaction with the neighborhood fruit and vegetable environment. Such associations are significant because interventions seeking to improve diet quality among African Americans by improving satisfaction with the neighborhood fruit and vegetable environment would benefit from knowing how and in what ways to tailor intervention messages and activities to improve satisfaction among groups of lower versus higher socioeconomic status.

Few studies have examined associations between socioeconomic status and satisfaction with the neighborhood fruit and vegetable environment (Boyington, Schoster, Martin, Shreffler, & Callahan, 2009; Zenk, Schulz, et al., 2009). Most include socioeconomic status as one of several factors hypothesized to influence satisfaction with

the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009). Previous research by Zenk et al. (2009) found that education was associated with satisfaction with the neighborhood fruit and vegetable environment and moderated associations between observed characteristics of neighborhood food environment and residents' perceptions and satisfaction with their food environment (Zenk, Schulz, et al., 2009). Specifically, using a multiethnic sample, Zenk et al. (2009) found that those with less education were more satisfied with the variety, quality, cost and affordability of fresh fruits and vegetables in their neighborhoods than those with greater than a high school education (Zenk, Schulz, et al., 2009).

Research by Boyington et al. (2009) examined associations between neighborhood and individual level economic predictors with self-reported perceptions of the food environment among a sample of more than 2,400 African American and non-Hispanic white participants in NC (Boyington, et al., 2009). Boyington and colleagues (2009) found significant differences between poverty rate by census block group, individual level income, and education with residents' perceptions of affordability of their neighborhood fruit and vegetable environment (Boyington, et al., 2009). Residents' perceptions of affordability are one component of three (quality, variety & affordability) that compose commonly used satisfaction with the neighborhood food environment measures (Boyington, et al., 2009; Moore, Diez Roux, & Brines, 2008; Zenk, Schulz, et al., 2009). Common to Zenk et al. (2009) and Boyington et al. (2009) were significant associations between education and satisfaction with the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009).

Absent from above research by Zenk et al. (2009), Boyington and colleagues (2009), and others who examine relationships between socioeconomic status and satisfaction with the food environment-are associations between socioeconomic status and satisfaction with the neighborhood food environment when controlling for observed characteristics of the neighborhood food environment. It may be beneficial to examine the above listed associations within samples of African Americans. African Americans are more likely to live in urban and lower income areas compared to other racial and ethnic groups (Chang, 2006; Kumanyika, et al., 2007; Williams, Mohammed, Leavell, & Collins, 2010; Wilson, 2010). In addition, there are strong associations between neighborhood poverty, percent African American neighborhood composition, and access and availability of healthy foods (Cummins & Macintyre, 2006; Larson & Story, 2009; Larson, et al., 2009). Examination of the above relationships within samples of African Americans while controlling for the observed food environment may help disentangle unique relationships between socioeconomic status and satisfaction with the neighborhood fruit and vegetable environment.

Satisfaction with the neighborhood fruit and vegetable environment, observed characteristics of the neighborhood food environment and elements of the social environment. In addition to socioeconomic status and observed indicators of the food environment, satisfaction with the neighborhood fruit and vegetable environment may be influenced by characteristics of the social environment. Specifically, indicators of social engagement (organizational membership and neighborhood participation) are proximate level variables that are of particular interest in this study due to their potential to expose individuals to a wide range of attitudes, beliefs, and information above and beyond those

which they may normally be exposed. These attitudes, beliefs, and information, may in turn be related to a person's evaluation and perception of their local food environment, thus shaping their reports of satisfaction with the neighborhood fruit and vegetable environment.

Specifically, individuals who engage in activities that expose them to a broader range of social interactions may have greater access to information that shapes their assessments of, or satisfaction with, food resources available in their local neighborhoods (e.g., exposing individuals to different dietary practices, knowledge or information about dietary choices, knowledge of the location of food resources) (Cohen, 2004). Mechanisms by which this is achieved are by increasing opportunities for social interactions, expanding social networks, distracting people from daily stressors, and providing a sense of purpose. Such mechanisms are rewarding, fulfill civic obligations and reduce isolation and alienation (Cohen, 2004; Cohen, Gottlieb, & Underwood, 2004; Lindstrom, et al., 2001; Litt, et al., 2011). While research on neighborhood participation and membership in organizations has suggested positive associations with dietary intakes (Emmons, Barbeau, Gutheil, Stryker, & Stoddard, 2007; Litt, et al., 2011), little research has examined the ways that these two indicators of social engagement may be associated with satisfaction with the neighborhood fruit and vegetable environment. Associations between indicators of social engagement and satisfaction with the neighborhood fruit and vegetable environment may be particularly important for African Americans, who are more likely to live in neighborhoods with decreased access to healthy foods, have lower diet quality, and are more likely to suffer from diet-related disease compared to other racial and ethnic groups (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al.,

2007; Zenk, Schulz, Israel, et al., 2005). Disentangling associations between indicators of social engagement and satisfaction with the neighborhood fruit and vegetable environment may inform mechanisms by which indicators of social engagement influence diet quality and ultimately improve public health interventions seeking improvements in dietary behavior among African Americans.

Summary

In sum, a large and growing body of literature suggests the importance of understanding the ways that the foods available to individuals in their neighborhoods, and the ways that they access and make use of those foods, contribute to variations in dietary quality and ultimately to health outcomes. Researchers have begun to document important patterns linking race based residential segregation, concentrations of poverty, and observed characteristics of neighborhood food environment to variations in dietary quality linked to racial differences in health outcomes. This dissertation addresses two major gaps in the literature reviewed above: 1) a lack of a focus on variations in associations between factors that influence dietary behavior among African Americans, not in comparison to other racial and ethnic groups; and 2) gaps in understanding of variables beyond observed characteristics of the food environment that may influence satisfaction with the neighborhood fruit and vegetable environment. Conducting research that addresses such gaps among African Americans given their increased likelihood of residing in urban neighborhoods that are often of lower income and have less access to healthy food options when compared to other racial and ethnic groups (Cummins & Macintyre, 2006; Morland, Wing, Diez Roux, et al., 2002; Zenk, Schulz, Israel, et al.,

2005) may help increase fruit and vegetable intakes and reduce the excess burden of diet-related disease among African Americans.

Detroit offers an important context within which to examine questions related to social and built environmental conditions that are associated with dietary intakes among African Americans. As a majority African American city, Detroit provides a unique environment in which to research predictors, correlates and modifiers of fruit and vegetable intakes and satisfaction with the neighborhood fruit and vegetable environment among African Americans. Fundamental factors of race-based residential segregation and neighborhood poverty may work through many of the social and physical problems facing the city of Detroit to influence fruit and vegetable intakes and satisfaction with the neighborhood fruit and vegetable environment. In addition to elevated rates of black-white segregation (Logan & Stults, 2011), Detroit also has high rates unemployment and low household incomes. Household incomes in Detroit have fallen an estimated 31% since 2000 (White M., 2011; White M. M., 2011) and an estimated 31.3% of families lived below the federal poverty level in 2009 (US Census Bureau, 2012). According to the Bureau of Labor Statistics, annual unemployment rates for adults ages 16 or older in the Detroit Metropolitan Statistical area were higher than national averages at 7.3% in 2002 and 14.5% in 2010 (Bureau of Labor Statistics, 2012). Statistics and trends surrounding the above listed social conditions contribute to neighborhoods that have less access to resources needed to promote health.

While the above statistics portray a city desperate for a policy overhaul to improve many of the structural and social conditions necessary to promote health, Detroit is also the home of many of America's finest achievements. Detroit is credited as the

automotive capital and home to General Motors and Ford car companies. Detroit is also the original home of Motown Record Cooperation, a leading producer of rhythm and blues, soul, and hip hop music in the 1960s and 1970s. Within public health, Detroit has been an important setting for studying social determinants of health and community-based participatory research approaches to health.

Many areas of Detroit lack access to healthy food. Supermarkets in the Detroit metropolitan area are located further from low income African American than low income White neighborhoods (Zenk, Schulz, Israel, et al., 2005). Access to supermarkets is important because they are more likely to carry larger selections of healthy foods at lower costs and of better quality (Morland, Wing, Diez Roux, et al., 2002; Rose, Bodor, Hutchinson, & Swalm, 2010; Zenk, Schulz, Israel, et al., 2005). Without access to supermarkets, residents are often left to purchase food from liquor stores, convenience stores, gas stations, dollar stores, or party stores (Gallagher, 2007). These stores often charge higher prices for food that is of lesser quality than what may be found in stores in surrounding suburbs (Brown, 2003).

Several coalitions and councils have started in response to the lack of access to healthy food within the city of Detroit. Such organizations function to improve food security by increasing access and availability of healthy foods by developing local sustainable food systems within the city of Detroit (White M., 2011; White M. M., 2011). They also provide a space for local residents, educators and researchers to interact and organize behind issues of food security. All of the above listed factors make Detroit a unique place to research factors that influence satisfaction with the neighborhood fruit and vegetable environment and fruit and vegetable intakes among African American

adults. Findings from the research described in the following pages, as well as other research, offers an evidence base with which to inform these ongoing and future interventions to reduce racial and socioeconomic inequalities in diet-related mortality.

Research Questions

In this dissertation, I aim to address these gaps in the literature by examining three main research questions. First, what is the role of satisfaction with the neighborhood fruit and vegetable environment in mediating and moderating associations between observed characteristics of neighborhood food environment and the fruit and vegetable intakes of African Americans? Second, is socioeconomic status associated with satisfaction with the neighborhood fruit and vegetable environment among African Americans above and beyond observed characteristics of neighborhood food environment? Or does socioeconomic status moderate associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment? Finally, third, are indicators of social engagement, organizational membership and neighborhood participation, associated with satisfaction with the neighborhood fruit and vegetable environment among African Americans above and beyond observed characteristics of neighborhood food environment? Or do indicators of social engagement moderate associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment? Each of these major research questions is described in greater detail below, and in the following chapters.

Does satisfaction with the neighborhood fruit and vegetable environment mediate or moderate associations between observed characteristics of the neighborhood food

environment and fruit and vegetable environment among African Americans? To address the first question I examine baseline associations between satisfaction with the neighborhood fruit and vegetable environment and fruit and vegetable intakes. Next, I test whether satisfaction with the neighborhood fruit and vegetable environment mediates or modifies the relationship between observed characteristics of neighborhood food environment and fruit and vegetable intakes.

What role does socioeconomic status play in associations between the observed neighborhood food environment and satisfaction with neighborhood fruit and vegetable environment among African Americans?: Tests of main and modifying effects. For the second question I investigate associations between multiple indicators of socioeconomic status (operationalized as education, household poverty, car access, employment status, and home ownership) and satisfaction with the neighborhood fruit and vegetable environment. I also examine whether socioeconomic status modifies the relationships between the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment.

The proposed research extends previous research on direct associations between socioeconomic status and satisfaction with neighborhood food environments by examining associations between socioeconomic status and satisfaction with the neighborhood fruit and vegetable environment while controlling for the neighborhood food environment within a sample of African Americans. Second, it extends previous findings indicating moderating effects of education on associations between observed characteristics of neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment in a multiethnic sample (Zenk, Schulz, et al., 2009) by

examining modifying effects using a larger set of socioeconomic indicators, within a sample of African Americans. A within group examination of associations between socioeconomic status and satisfaction with the neighborhood fruit and vegetable environment among African Americans is important due to their increased rates of diet-related disease and increased tendency to live in racially homogenous, urban, and lower income neighborhoods with poor access to healthy food (Chang, 2006; Cummins & Macintyre, 2006; Kumanyika, et al., 2007; Larson & Story, 2009; Williams, et al., 2010; Wilson, 2010). Such environmental conditions have important implications for dietary intakes, and diet-related disease (Casagrande, et al., 2007; CDC, 2009; Darmon & Drewnowski, 2008; Schlundt, et al., 2003). Research that examines such associations among samples of African Americans may be helpful in developing culturally, socially, and environmentally sensitive interventions for improving dietary quality among African Americans and reducing disparities in diet-related disease (Bediako & Griffith, 2007).

What role do organizational membership and neighborhood participation play in associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment among African Americans?: Tests of main and modifying effects. I test organizational membership and neighborhood participation as associated with satisfaction with the neighborhood fruit and vegetable environment, above and beyond observed characteristics of the neighborhood food environment. Furthermore, I test the extent to which organizational membership and neighborhood participation modify associations between the observed characteristics of neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. To address this research question I test the base level

associations between organizational membership and neighborhood participation (separately) with satisfaction with the neighborhood fruit and vegetable environment, controlling for the neighborhood food environment. I then test whether organizational membership or neighborhood participation modify associations between observed characteristics of neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment.

This research contributes to a presently extremely small body of research (Lindstrom, et al., 2001; Litt, et al., 2011) by examining associations between neighborhood participation and organizational membership with satisfaction with the neighborhood fruit and vegetable environment while controlling for the neighborhood food environment among a sample of African Americans. The interactive effects of the physical presence or absence of healthy neighborhood food resources with the social roles, networks, and relationships people maintain may also work to influence one's satisfaction with their neighborhood fruit and vegetable environment. Thus, I also examine how organizational membership and neighborhood participation may modify associations between satisfaction with the neighborhood fruit and vegetable environment and the neighborhood food environment. No research found to date has examined the modifying roles of organizational membership and neighborhood participation on associations between satisfaction with the neighborhood fruit and vegetable environment and the neighborhood food environment. Finally, I conclude with a chapter that provides a summary of contributions of this research for additional research and implications for policy in efforts to improve dietary health behaviors.

A major contribution of the current research is that the above listed associations will be examined using a single-ethnic study of African Americans as opposed to the multiethnic samples included in the other studies (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009; Zenk, Schulz, et al., 2009). As stated earlier, African Americans are more likely to reside in urban neighborhoods that are of lower income and have less access to healthy food options when compared to other racial and ethnic groups (Cummins & Macintyre, 2006; Kumanyika, et al., 2007; Morland, Wing, Diez Roux, et al., 2002). African Americans are also more likely to suffer from diet related health conditions compared to those of other racial and ethnic groups (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). Thus, one way to reduce the prevalence of diet related disease among African Americans may be to tease out associations between modifiable features of the environment that may shape health behaviors around dietary intakes, such as satisfaction with the fruit and vegetable environment and less malleable aspects of the neighborhood food environment, such as the types of food resources that are currently available.

All three analytic chapters use data from the Healthy Environments Partnership (HEP) wave 1 community survey. The HEP is one component of a community-based participatory research project involving academic, health service providing, and community based organizations in Detroit, Michigan (Schulz, et al., 2005). The University of Michigan Institutional Review Board for Protection of Human Subjects approved the study in January 2001. The HEP survey uses a stratified 2 stage probability sample of occupied housing units designed for 1,000 completed interviews with adults ages $\geq$ 25 yrs across 3 areas of Detroit. Such a design allows for comparisons of residents

of similar demographics across geographic areas of the city of Detroit (Schulz, et al., 2005). The survey sample was designed to achieve adequate variation in socioeconomic position within each of the three predominant racial/ethnic groups in Detroit: African-American, Latino, and White in order to conduct analysis of socioeconomic status within and across racial and ethnic groups. The final sample consisted of 919 face-to-face interviews: interviews were completed with 75% of households in which an eligible respondent was identified and 55% of households with a known or potential respondent (Schulz, et al., 2005). The 919 respondents were nested within 69 census blocks. Of the total multiethnic sample, analysis for this study focuses on the 522 African American participants nested in 115 blocks and 67 census block groups throughout the Eastside, Southwest, and Northwest Detroit study areas.

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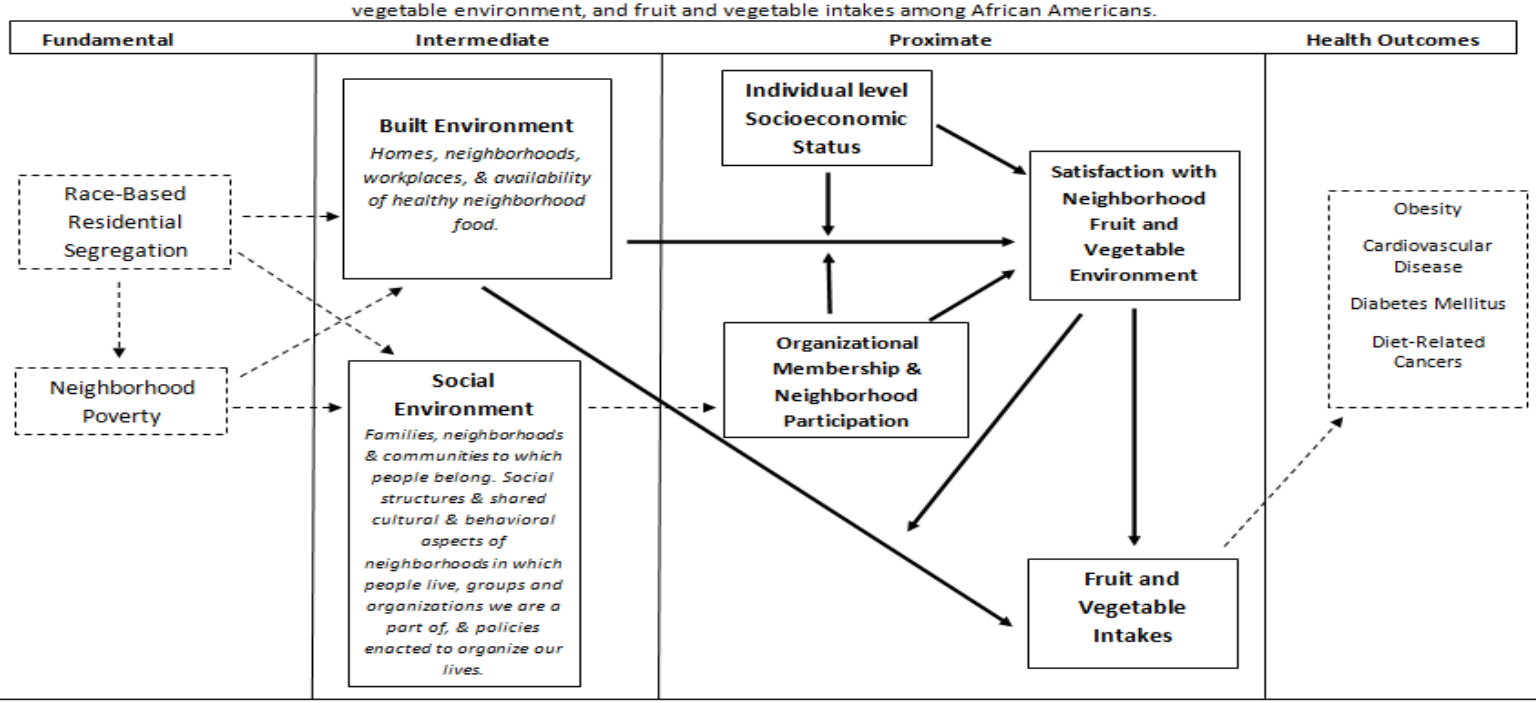
Figure 1.1. Fundamental determinants of health disparities framework applied to: Social and built environments, satisfaction with the neighborhood fruit and vegetable environment, and fruit and vegetable intakes among African Americans.



Associations represented by dotted lines are important, however not the main focus of this research.

Note: The model presented here is adapted from a conceptual model and framework proposed by Schulz, A. J., Williams, D. R., Israel, B. A., & Lempert, L. B. (2002). Racial and Spatial Relations as Fundamental Determinants of Health in Detroit. *The Millbank Quarterly, 80*(4), 677-707.

Chapter 2

Does Self-Reported Satisfaction with the Neighborhood Fruit and Vegetable Environment Mediate or Moderate Associations Between Observed Characteristics of the Neighborhood Food Environment and Fruit and Vegetable Intake Among African Americans?

Introduction

Race-based residential segregation and neighborhood poverty are fundamental factors that structure and pattern access to neighborhood level resources and opportunities that influence dietary intake and overall health (Darmon & Drewnowski, 2008; Kumanyika, et al., 2007; Kwate, 2008; Schulz & Northridge, 2004; Schulz, et al., 2002). As a part of the fundamental determinants of health disparities framework, race-based residential segregation and neighborhood poverty influence and shape dietary intakes and other diet related health outcomes by operating through mechanisms and pathways in the built and social environment (Casagrande, et al., 2007; Ford & Dzewaltowski, 2008; Kumanyika, et al., 2007; Kwate, 2008; Larson, et al., 2009; Powell, et al., 2007; Schulz, et al., 2002; Zenk, Lachance, et al., 2009).

In this chapter, I focus on two pathways in the fundamental determinants of health disparities framework that was modified for this dissertation (Figure 1.1): observed characteristics of the neighborhood food environment (measured as components of the built environment), and satisfaction with the neighborhood fruit and vegetable environment (a subjective measure of people's response to produce in the neighborhood food environment). Specifically, while a large body of literature examines associations

between observed characteristics of the neighborhood food environment (e.g., food store type and location) and fruit and vegetable intakes, this chapter examines the role of satisfaction with the neighborhood fruit and vegetable environment in conjunction with observed characteristics of the neighborhood food environment, to consider their joint influence in patterning such associations.

In examining these relationships, I use the location, count, and type of food stores within a given geographical area as measures of the observed neighborhood food environment. These measures have been hypothesized as important predictors of fruit and vegetable intakes (Bodor, Rice, Farley, Swalm, & Rose, 2010; Laraia, Siega-Riz, Kaufman, & Jones, 2004; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005; Zenk, Lachance, et al., 2009). Measures of satisfaction have also been hypothesized as important predictors of fruit and vegetable intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). Therefore, I also use a perception based measure that assesses the extent to which a person is satisfied with the variety, quality, cost and affordability of produce in their neighborhood as measures of satisfaction with the neighborhood fruit and vegetable environment (Zenk, Lachance et al 2009).

This chapter examines relationships between observed characteristics of the neighborhood food environment, satisfaction with the neighborhood fruit and vegetable environment, and fruit and vegetable intakes among African Americans. Previous research has documented the patterning of neighborhood food availability by neighborhood race, ethnicity, and socioeconomic status (Cummins & Macintyre, 2006; Larson, et al., 2009). Several studies have reported findings indicating that supermarkets

are located further away from predominantly African American versus predominantly White neighborhoods (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). It is important to note that Zenk et al. (2005) found racial differences in supermarket location only among the most impoverished African American neighborhoods compared to the most impoverished White neighborhoods (Zenk, Schulz, Israel, et al., 2005). When available, grocery stores in African American neighborhoods have been shown to be less likely to have healthy food items or healthy food substitutions, such as low fat or low sodium items compared to those found in predominantly White neighborhoods (Cummins & Macintyre, 2006; Morland, Wing, Diez Roux, et al., 2002). Findings from studies comparing results from in-store audits of produce in predominantly African American versus racially heterogeneous neighborhoods are mixed. While some find African American neighborhoods may also have decreased availability of fruits and vegetables compared to mixed race neighborhoods (Bodor, et al., 2010), others find no difference in the selection of fresh produce sold in predominately African American, low income neighborhoods compared to racially heterogeneous, middle income neighborhoods (Zenk, et al., 2006). Finally, some have suggested that African Americans' increased likelihood of residing in areas that have decreased access to fresh fruits and vegetables contributes to their increased likelihood of suffering from health conditions that result from eating diets low in fruits and vegetables (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005).

Associations examined in this chapter contribute to and advance current literature that examines associations between observed characteristics of the neighborhood food

environment and fruit and vegetable intakes and between satisfaction with the fruit and vegetable environment and dietary intakes. Specifically, I examine the role of satisfaction in conjunction with observed characteristics of the neighborhood fruit and vegetable environment as: independently predicting fruit and vegetable intakes above and beyond the observed characteristics of the neighborhood food environment, and as mediating and moderating associations between the observed characteristics of the neighborhood food environment and fruit and vegetable intakes. This research is important for improving the specificity and effectiveness of public health research and interventions that work to improve fruit and vegetable intakes and dietary health behaviors and reduce disparities in diet-related health outcomes that disproportionately burden African Americans.

Observed characteristics of the neighborhood food environment and fruit and vegetable intakes

Observed Characteristics of the Neighborhood Food Environment. Studies often use count or density measures of the number of food stores within a defined neighborhood environment or distance to a supermarket or food store from a residents' home when examining the relationship between the neighborhood food environment and fruit and vegetable intakes (Larson, et al., 2009; Zenk, Lachance, et al., 2009). The influence of supermarkets or large grocery stores on dietary intakes or fruit and vegetable consumption is measured more often than convenience stores or small corner stores because supermarkets and larger grocery stores have been found to be more likely to carry larger selections of healthier foods at lower costs and of better quality (Bodor, et al., 2010; Curtis & McClellan, 1995; Mantovani, Daft, Macaluso, Welsh, & Hoffman, 1997;

Morland, Wing, & Diez Roux, 2002; Rose, et al., 2010; Zenk, Schulz, Hollis-Neely, et al., 2005).

Quite a few research studies have examined relationships between neighborhood food store availability and fruit and vegetable intakes (Boone-Heinonen, et al., 2011; Laraia, et al., 2004; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005). Several patterns have emerged from this body of research. While many studies have found positive associations between the availability of supermarkets or large grocery stores and fruit and vegetable intakes (Laraia, et al., 2004; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005; Zenk, Lachance, et al., 2009), others have found conflicting or non-significant associations (Bodor, Rose, Farley, Swalm, & Scott, 2007; Boone-Heinonen, et al., 2011). The literature is examined below in greater detail.

Studies have examined and found associations between the location of supermarkets and large grocery stores with fruit and vegetable intakes among men, women, and different racial and ethnic groups. A study by Morland and colleagues (2002) of 10,623 Black and White adults from the Atherosclerosis Risk in Communities (ARIC) study found that when controlling for income and education, Blacks living in a census tract with at least one supermarket were significantly more likely to meet dietary guidelines for fruit and vegetable intakes compared to Blacks living in census tracts with no supermarkets (Morland, Wing, & Diez Roux, 2002). Among Blacks, when controlling for income and education, there was an average increase of 32% in daily servings of fruit and vegetable intake for each additional supermarket. A positive but not significant

relationship between the presence of a supermarket and increased fruit and vegetable intakes was found for Whites living in census tracts with at least one supermarket, where there was an 11% increase in fruit and vegetable intakes with the presence of one or more supermarkets (Morland, Wing, & Diez Roux, 2002).

Similarly, a cross-sectional multilevel analysis (level 1- individuals, N=919 and level 2- census blocks, N= 146) of the relationship between neighborhood food store availability and fruit and vegetable intakes among moderate to low-income African Americans, Latinos and non Hispanic Whites across three geographically distinct communities in Detroit, Michigan found the presence of a large grocery store in the neighborhood was associated with a significantly increased consumption of daily fruit and vegetable servings. This association held when adjusting for age, number of persons in the household, years residing in the neighborhood, gender, race and ethnicity, marital status, annual household income, education, employment, and car ownership. Associations between fruit and vegetable intakes and distance to the nearest supermarkets (miles), the presence of specialty stores, convenience stores without a gas station, liquor stores and small grocery stores in the neighborhood were not significant (Zenk, Lachance, et al., 2009).

Additionally, results from a secondary data analysis using data from the 1996-97 National Food Stamp Program Survey of 963 adults enrolled in the Food Stamp Program found that easy access to supermarkets was significantly associated with increased household fruit consumption. Households located one mile or less from a supermarket consumed significantly more fruit than households located five or more miles from a supermarket. Patterns for vegetable consumption were similar and in the same direction

as fruit consumption, however not significant (Rose & Richards, 2004). These associations held when controlling for urbanization (urban, mixed, rural location), household income and size, race and ethnicity, education, single parent status and employment status of the household respondent (Rose & Richards, 2004). Distance to the nearest supermarket (Rose & Richards, 2004) and density of large grocery stores (Zenk, Lachance, et al., 2009) may be more salient predictors of fruit and vegetable intakes for low to moderate income populations due to potential heavy reliance on public transportation or lack of car ownership.

Finally, two studies have examined relationships between food environments and dietary intakes in samples of women only. Results from a prospective study of pregnant women found that when controlling for age, race, education, income, and marital status, women who lived more than four miles from a supermarket had significantly lower mean diet quality index scores for pregnant women (DQI-P, calculated specifically for pregnant women in this sample) and a significant decreasing trend in mean DQI-P compared to women who lived fewer than 2 miles away from a supermarket. Density of food outlets per block group and within a ½ mile of each woman's home (supermarkets, grocery and convenience stores) was not associated with diet quality index score (Laraia, et al., 2004).

Additionally, a cross-sectional study of African American women from an area of Detroit with limited access to grocery stores found that on average, women who shopped at supermarkets and specialty stores consumed significantly more daily servings of fruits and vegetables than women who shopped at . grocery stores (Zenk, Schulz, Hollis-Neely, et al., 2005). Zenk and colleagues (2005) controlled for age, per capita income, years of education, store location, and participant ratings of store selection, quality and

affordability (Zenk, Schulz, Hollis-Neely, et al., 2005). Findings from Laraia et al. (2004) suggest that for women, measures of distance to a supermarket may operate differently than density of food outlets in one's immediate neighborhood in predicting measures of diet quality and fruit and vegetable intake (Laraia, et al., 2004). Specifically, Laraia et al. (2004) found that among pregnant women, living greater than 4 miles from a supermarket was associated with significant decreases in dietary intake compared to women who lived less than 2 miles from a supermarket (Laraia, et al., 2004). Conclusions from Zenk et al. (2005) suggest that shopping at supermarkets and specialty stores may be associated with improvements in diet quality and fruit and vegetable intakes, compared to shopping at . grocery stores (Zenk, Schulz, Hollis-Neely, et al., 2005). Results from the studies outlined above emphasize the importance of how people interact with their food environments (shopping at food stores) in addition to observed characteristics of the neighborhood food environment as influencing dietary intakes.

There have been two literature reviews published on associations between neighborhood supermarket availability and fruit and vegetable intakes (Larson & Story, 2009; Larson, et al., 2009). Several of the studies included in these reviews are summarized above (Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005; Zenk, Lachance, et al., 2009). Reviews conducted by Larson et al. (2009a, 2009b) used snowball strategies to find peer-reviewed articles and reviews conducted in the U.S. during the previous ten years (Larson & Story, 2009; Larson, et al., 2009). Findings from Larson and colleagues (2009a, 2009b) support that of other studies and conclude that in general, increased access to supermarkets and

decreased access to convenience stores and fast food outlets are associated with a healthier diet quality (Larson & Story, 2009; Larson, et al., 2009).

Not all studies have found significant relationships between measures of the observed neighborhood food environment and dietary intakes (Bodor, et al., 2007; Boone-Heinonen, et al., 2011; Zenk, Lachance, et al., 2009). Research conducted by Bodor et al. (2007) examined associations between the food environment and dietary intakes among one-hundred and two low- to-moderate-income majority African American female headed households randomly sampled across four census tracts in New Orleans (Bodor 2007). Results found no significant associations between distance to the nearest small food store or supermarket and daily fruit or vegetable consumption (Bodor, et al., 2007). In addition, similar to results by Laraia et al. (2004), having a small food store within 100 meters of a household (a measure of density) was not a significant predictor of mean daily fruit intakes (Bodor, et al., 2007).

Finally, using longitudinal data from the U.S. based Coronary Artery Risk Development in Young Adults (CARDIA) study of young adults ages 18-30, Boone-Heinonen and colleagues (2011) measured the influence of neighborhood supermarket and grocery store availability on diet quality and fruit and vegetable consumption. The study used GIS data to link time-varying neighborhood level food resources and U.S. census data to the homes of survey respondents in the CARDIA study over a 15-year period that included four examination times. Results showed that greater supermarket availability was generally unrelated to change in fruit and vegetable intakes and overall diet quality over time. Analyses controlled for age, race, education, income, marital status, number of children living in the home and the percentage of people with a household

income less than 150% of the federal poverty level within each census tract a respondent resided (Boone-Heinonen, et al., 2011). While other studies have examined and found significant negative or null associations between supermarket presence and fruit and vegetable intakes, they are often conducted outside of the U.S. (Cummins, Petticrew, Higgins, Findlay, & Sparks, 2005; White, et al., 2004; Wrigley & Warm, 2003).

In general, studies reviewed show inconsistent patterns in the literature examining associations between density, access, or distance to a supermarket or large grocery store and individual and household level fruit and vegetable intakes (Laraia, et al., 2004; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005). Results from these studies may vary due to differences in racial and ethnic group characteristics, socioeconomic status, or other demographic features of the sample or region where the studies were conducted. Results from these studies suggest there is wide variation in associations between neighborhood availability of supermarkets or large grocery stores and intakes of fruits and vegetables when looking specifically at the moderate to low-income racially heterogeneous or African American populations (Rose & Richards, 2004; Zenk, Lachance, et al., 2009). Given African Americans' excess burden of diet-related disease, these findings suggest the need for further studies to disentangle the factors that may influence African Americans' dietary intakes and examine mechanisms that may mediate or moderate relationships between observed characteristics of the neighborhood food environment and fruit and vegetable intakes. A focus on perceived measures, like satisfaction with the neighborhood fruit and vegetable environment, may contribute further to understanding how individuals interact with their food environments by

capturing the extent to which local food environments are consistent with what individuals might expect or hope to find in those environments.

Satisfaction with the Neighborhood Fruit and Vegetable Environment

The lack of a consistent association between observed characteristics of the neighborhood food environment and fruit and vegetable intakes suggests there may be unmeasured factors in these studies that influence dietary behaviors. Satisfaction may be an important factor in understanding the relationship between the observed food environment and fruit and vegetable intakes. In this dissertation, I define satisfaction as a subjective perception-based measure that is influenced by both the observed characteristics of the food environment and individual's expectations of those environments. For purposes of this dissertation, satisfaction reflects a person's perception of the quality, cost and affordability and variety of fresh produce in the observed food environment in which they live. Satisfaction is also influenced by factors in the social environment (e.g., socioeconomic status, age, gender, indicators of social engagement, cultural factors, and other mechanisms) that may influence norms and beliefs around dietary intake behaviors and patterns. Such factors may influence one's satisfaction with their neighborhood fruit and vegetable environment by shaping their expectations for or perceptions of produce in their observed food environment. In other words, satisfaction with local fruit and vegetable environments reflects a person's perception of the produce in their observed food environment and the degree to which the observed food environment meets their expectations.

Assessing a person's satisfaction with their neighborhood fruit and vegetable environment offers an opportunity to examine factors that influence relationships

between observed characteristics of the neighborhood food environment and fruit and vegetable intakes (Kumar, et al., 2011; Moore, Diez Roux, & Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008). There are several potential relationships between observed food environments, satisfaction, and fruit and vegetable intakes. First, individual-level perceptions of the fruit and vegetable environment may reflect observed characteristics of the food environment that mediate relationships between observed characteristics and fruit and vegetable intakes. Alternatively, associations between observed characteristics of the neighborhood food environment and fruit and vegetable intakes may vary depending on one's level of satisfaction with or evaluation of their neighborhood fruit and vegetable environment – in other words, the extent to which those observed food environments are consistent with what they expect or find desirable in a food environment. Finally, satisfaction with the neighborhood fruit and vegetable environment may be associated with fruit and vegetable intakes above and beyond observed characteristics of the neighborhood food environment.

Additionally, examining associations between satisfaction, the observed food environment, and fruit and vegetable intakes may contribute to further understanding of how the observed food environment shapes factors (e.g., satisfaction) that contribute to health behaviors (e.g., fruit and vegetable intakes) among African Americans. African Americans are more likely to reside in neighborhoods with lower levels of access to a variety of affordable, quality fresh produce, and have an increased burden of diet-related disease compared to White Americans (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). Understanding how the observed food environment works with or is associated with measures of satisfaction, and how

these, in turn, are associated with health-related behaviors (e.g., fruit and vegetable intakes) will contribute to further understanding of mechanisms that influence fruit and vegetable intakes and contribute to developing interventions to increase fruit and vegetable intakes among African Americans.

Results of such research will also contribute to understandings for how variations in observed food environments in which African Americans reside are associated with variations in satisfaction with the fruit and vegetable environment among African Americans and how such factors contribute to variations in fruit and vegetable intakes among African Americans- not between African Americans and Whites. Results of such research would inform public health researchers and interventionists of specific pathways and mechanisms through which characteristics of the observed food environment and satisfaction influence dietary intakes for African Americans. Such knowledge would increase the specificity of future research studies and interventions testing similar associations- by designing interventions to increase fruit and vegetable intakes and reduce diet-related disease based on research findings and mechanisms examined among African Americans, not between African americans compared to other racial and ethnic groups. Such an approach is essential for ultimate reductions in the excess burden of diet-related disease among African Americans.

There are many ways that satisfaction with the neighborhood fruit and vegetable environment may be associated with fruit and vegetable intakes. Measures of satisfaction with the neighborhood fruit and vegetable environment may be associated with individual fruit and vegetable intakes in ways that complement and/or add information not captured by objective measures of the neighborhood food environment (Moore, Diez Roux, &

Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009; Zenk, Schulz, et al., 2009).Results from the few studies that have examined the direct association between satisfaction with the neighborhood fruit and vegetable environment and dietary intakes are mixed. Research examining baseline data from the Multiethnic Study of Atherosclerosis (MESA) of U.S. adults ages 45-84 years old assessed ways to characterize neighborhood food availability (supermarket density, participant-reported satisfaction with the food environment, and . informants' perceptions and survey of the food environment) and their association with diet quality. Moore and colleagues (2008) found that when controlling for age, sex, race and ethnicity and socioeconomic indicators, all three neighborhood food environment measures (supermarket density, participant-reported satisfaction with the food environment, and . informants' perceptions and survey of the food environment) were independently significantly associated with dietary quality (Moore, Diez Roux, Nettleton, et al., 2008). While each of the three measures had varying degrees of measurement error and limitations, they were positively related and not highly correlated with each other and thus may represent different operational mechanisms for the relationship between different types of measured food availability and dietary quality (Moore, Diez Roux, Nettleton, et al., 2008).

Conversely, Zenk and colleagues (2009) found no significant associations between satisfaction with neighborhood fruit and vegetable environment and fruit and vegetable intakes in a racially and ethnically mixed sample of adults from three Detroit communities (Zenk, Lachance, et al., 2009), adjusting for age, number of persons in the household, years residing in the neighborhood, gender, race and ethnicity, marital status, annual household income, education, employment, and car ownership. Contrasting results

from these two studies highlight mixed results in associations between satisfaction with neighborhood fruit and vegetable environment and dietary intakes, and suggest the need for further clarification of these relationships. Additionally, neither Zenk et al. (2009) nor Moore et al. (2008) controlled for the observed neighborhood food environment when measuring the . association between satisfaction with the neighborhood food environment and fruit and vegetable intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). Given varied findings from the studies reviewed above, more research is needed to improve understanding of the relationships between neighborhood food environments, satisfaction with the neighborhood fruit and vegetable environment, and fruit and vegetable intakes. In addition, studies have yet to examine the mediating and moderating potential of satisfaction with the neighborhood fruit and vegetable environment on the association between the neighborhood food environment and fruit and vegetable intakes.

The research presented in this chapter builds on and addresses gaps in the studies reviewed above by considering satisfaction with the neighborhood fruit and vegetable environment as a factor that may be associated with, mediate, or moderate associations between observed characteristics of the neighborhood food environment and fruit and vegetable intakes among African Americans. The extent to which the observed environment influences satisfaction with the neighborhood fruit and vegetable environment may provide another pathway through which to understand how observed characteristics of the neighborhood food environment are associated with fruit and vegetable intakes. For example, an observed neighborhood fruit and vegetable environment with few options may be associated with lower levels of satisfaction with

the cost/affordability, variety and quality of their fruit and vegetable environment, and may in turn be associated with lower levels fruit and vegetable intakes compared with someone who reports high satisfaction due to greater availability of fruits and vegetables. An observed neighborhood food environment with many healthy food options may result in increased satisfaction with a person's fruit and vegetable environment: In this case, increased satisfaction may be associated with increased fruit and vegetable intakes due to greater availability of produce.

If the main pathway through which the observed food environment influences fruit and vegetable intakes is through satisfaction, it will be consistent with the hypothesis that satisfaction is a reflection of the observed food environment. Given that satisfaction is significantly positively associated with fruit and vegetable intakes, health interventions seeking reductions in the burden of diet-related disease among African Americans should then focus on improvements in the observed food environment. Interventions may focus on improving access to quality, healthy, affordable produce that would influence satisfaction and hence fruit and vegetable intakes. Examining these mediating pathways highlights the extent to which satisfaction reflects the observed food environment.

However, satisfaction may not be simply driven by the observed food environment (the mediating pathway), but may also reflect a much more complex interface between the observed environment and satisfaction (a reflection of what people would like to see in such food environments). In such a case, satisfaction may complicate relationships between the observed environment and fruit and vegetable intakes. Associations between observed characteristics of the food environment and fruit and vegetable intakes may vary for those with low or high satisfaction. For example, if

individuals find what they want in terms of fruit and vegetable availability in their observed neighborhood food environment then they may be more satisfied with it. In addition, if individuals do not find what they want in terms of fruit and vegetable availability in their observed food environment then they may be less satisfied with it. The extent to which a person is satisfied with their fruit and vegetable environment may modify associations between observed characteristics of the food environment and fruit and vegetable intakes depending on the extent to which characteristics of the observed neighborhood food environment meet their expectations.

Distinguishing between mediating and moderating pathways can provide important information to inform interventions to increase fruit and vegetable intakes that incorporate the different ways in which the observed food environment interacts with individual level characteristics to influence fruit and vegetable intakes. If, for example, residing in a poor observed food environment is more negatively associated with fruit and vegetable intakes for those with low versus high satisfaction would suggest that interventions ought to not only address the need for increased access to fresh, quality, and affordable produce but also to the need to examine factors that influence satisfaction with any given food environment.

Examining the above associations among a sample of African Americans is important for several reasons. Results from within-group analyses (African American only) may better inform interventions seeking to change diet-related behaviors among African Americans and contribute to the ultimate reduction of health disparities. For example, knowledge of how a poor observed food environment influences satisfaction and fruit and vegetable intakes for African Americans would help develop interventions

to increase fruit and vegetable intakes among African Americans specifically because they would be based on pathways and mechanisms of the influence of the observed food environment and fruit and vegetable intakes among African Americans. Examining the role of satisfaction with the neighborhood fruit and vegetable environment in relation to fruit and vegetable intakes among African Americans may also help disentangle the role of observed characteristics of the neighborhood food environment from social environmental factors that may influence satisfaction and fruit and vegetable intakes. Improved understanding of relationships between such factors will assist public health professionals in designing better interventions that account for the influence of multiple factors (satisfaction as influenced by the observed food environment and other social factors) as influencing fruit and vegetable intakes. For example, an intervention focused on increasing access to fresh produce by having produce trucks circulate throughout neighborhoods with low access should also consider the social factors that may influence satisfaction. It would be important to not only ensure produce trucks were circulating in neighborhoods with decreased access to healthy foods but to also ensure that the produce on the trucks is within what residents can afford and would prefer to eat. Interventions making such efforts may see the best improvements in fruit and vegetable intakes and ultimate reductions in the prevalence of diet-related disease among African Americans and disparities in diet-related disease. To that end, this study examines the following research questions and hypotheses:

(1) Is satisfaction with the neighborhood fruit and vegetable environment associated with fruit and vegetable intakes among African Americans, above and beyond observed characteristics of the neighborhood food environments?

(H1) Satisfaction with the neighborhood fruit and vegetable environment will be a significant predictor of fruit and vegetable intakes among African Americans, above and beyond observed characteristics of the neighborhood food environment. Specifically, African Americans who report higher levels of satisfaction with their neighborhood fruit and vegetable environment will consume significantly more fruits and vegetables than those with lower levels of satisfaction with their neighborhood fruit and vegetable environment, after accounting for observed characteristics of the neighborhood food environment.

(2) Does satisfaction with the neighborhood fruit and vegetable environment mediate associations between observed characteristics of the neighborhood food environment and fruit and vegetable intakes among African Americans?
(H2) Satisfaction with the neighborhood fruit and vegetable environment will significantly mediate the relationship between the observed characteristics of the neighborhood food environment and fruit and vegetable intakes among African Americans.

   a. Specifically, variations in observed characteristics of the neighborhood food environment (measured both as proximity to supermarkets and the count or presence of other stores) will significantly account for variations in satisfaction with the satisfaction with the neighborhood fruit and vegetable environment.

b. Variations in satisfaction with the neighborhood fruit and vegetable environment will significantly account for variations in daily fruit and vegetable intakes.

c. When satisfaction with the neighborhood fruit and vegetable environment is controlled, previously significant associations between observed characteristics of the neighborhood food environment (measured both as proximity to supermarkets and the count or presence of other stores) and daily fruit and vegetable intakes will become weak or not significant (Baron & Kenny, 1986).

(3) Does satisfaction with the neighborhood fruit and vegetable environment modify associations between observed characteristics of the neighborhood food environment and fruit and vegetable intakes among African Americans?

(H3) Satisfaction with the neighborhood fruit and vegetable environment will significantly modify the relationship between observed characteristics of the neighborhood food environment and fruit and vegetable intakes among African Americans. Specifically, proximity to supermarkets or living in areas with greater availability of large grocery stores will be associated with greater increases in fruit and vegetable intakes for those who are more satisfied with their neighborhood fruit and vegetable environments compared to those who are less satisfied with their fruit and vegetable environment.

Methods

Study Design and Sample Description

Data for this study are drawn from the Healthy Environments Partnership (HEP) wave 1 2002 community survey. The HEP is one component of a community-based participatory research project involving academic, health service providing, and community based organizations in Detroit, Michigan (Schulz, et al., 2005). The University of Michigan Institutional Review Board for Protection of Human Subjects approved the study in January 2001. The HEP survey uses a stratified 2 stage probability sample of occupied housing units designed for 1,000 completed interviews with adults ages ≥ 25 years across 3 areas of Detroit. Such a design allows for comparisons of residents of similar demographics across geographic areas of the city of Detroit (Schulz, et al., 2005). The survey sample was designed to achieve adequate variation in socioeconomic position within each of the three predominant racial and ethnic groups in Detroit: African-American, Latino, and White in order to conduct analysis of socioeconomic status within and across racial and ethnic groups. Data were imputed to account for missing values. The final sample consisted of 919 face-to-face interviews: interviews were completed with 75% of households in which an eligible respondent was identified and 55% of households with a known or potential respondent (Schulz, et al., 2005). The 919 respondents were nested within 69 census blocks. Of the total multiethnic sample, analysis for this study focuses on the 522 African American participants nested in 115 blocks and 67 census block groups throughout the Eastside, Southwest, and Northwest Detroit study areas.

Measures

Dependent

Fruit and vegetable intakes. This study used a modified Block 98 item semi-quantitative Food Frequency Questionnaire to collect dietary information from survey participants (Berkeley Nutrition Services, Berkeley, California) (Block, Coyle, Hartman, & Scoppa, 1994; Block, et al., 1986; Block, Woods, Potosky, & Clifford, 1990). Daily servings of fruits and vegetables were calculated by multiplying the frequency of reported intakes for each item by its portion size. In the analysis, I use the mean daily fruit and vegetable servings (minus fried potatoes and other white potatoes) (Zenk, Lachance, et al., 2009)

Satisfaction with the neighborhood fruit and vegetable environment. Satisfaction with the neighborhood fruit and vegetable environment was measured at the individual-level using the mean value from a three-question scale. The questions, "How satisfied are you with the (1) variety, (2) quality, and (3) cost and affordability of fresh fruits and vegetables in their neighborhood?" had response options ranging from (1) not satisfied at all, (2) not very satisfied, (3) somewhat satisfied, and (4) very satisfied. The mean of responses to the three items was modeled in the analysis. Higher scores signified higher satisfaction. The neighborhood food environment was defined as, "foods that are available to you within a 10-15 minute walk or 5 minute drive from your home, including grocery stores, convenience stores, or other places you might buy food."

Neighborhood Food Environment. Information on several store type variables was captured using dichotomous (yes or no) indicators of the following food stores by type at the census block level located in each neighborhood. Neighborhoods were defined using

a 0.5 mile Euclidean distance buffer from the centroid of the residential census block (Zenk, Lachance, et al., 2009).

Large grocery stores. Large grocery stores were defined as non-chain stores that had three or more operating cash registers.

Small grocery stores. Small grocery stores were defined as non-chain stores with one or two operating cash registers.

Convenience stores. Convenience stores or food stores were defined as those without gas stations and that limited capacity for check-out.

Specialty stores. Specialty stores were defined as fruit and vegetable or meat or seafood markets.

Supermarkets. Supermarkets were defined as full service chain stores. There was only one supermarket in the 146 census blocks used for this study in 2002. Thus, supermarket proximity was used as a measure of availability instead of a count of stores. ArcGIS Network Analyst 9.1(Environmental Systems Research Institute, Redlands, California) was used to measure supermarket proximity as the street network distance in miles from the centroid of the residential census block to the nearest supermarket.

Liquor or party stores. Liquor or party stores were defined according to their classification as liquor store in the telephone directory, the presence of liquor or party store in their names or a main food sign in front of the store containing liquor, beer, or wine. Liquor or party stores were measured using a count of the number of liquor stores present in each census block.

Control Variables

Several variables previously demonstrated to be associated with fruit and vegetable consumption were included as control variables. These included both neighborhood and individual level variables, as described below.

Individual Level Controls. The following individual level controls were shown previously in the literature to be associated with dietary intakes and were therefore controlled in this research.

Self-reported *gender* (male or female), *age* (continuous), *education level* (less than high school, high school diploma or GED, and some college or greater), *marital status* (married/in a relationship or not currently married /separated /divorced /widowed) *and employment status* (currently working for pay or not currently working for pay) were controlled for due to their associations with fruit and vegetable consumption (Deshmukh-Taskar, et al., 2007; Laraia, et al., 2004; Trudeau, Kristal, Li, & Patterson, 1998; Watters, Satia, & Galanko, 2007; Zenk, Lachance, et al., 2009). *Car access* was modeled as a binary variable. Car access was defined as easy car access (having a car or not having a car but it being not very difficult or not difficult at all to access a car) or limited car access (not having a car and it being somewhat to very difficult to access a car). Having a car may influence fruit and vegetable consumption by broadening one's perception of their neighborhood food environment and by expanding their neighborhood boundaries and access to stores that sell fruit and vegetables (Rose & Richards, 2004). *Length of residence in the neighborhood* was defined as participant report of the

number of years they resided in their current neighborhood. The neighborhood was defined to participants as the blocks that surround the block in which they lived and was within walking distance of their homes. Length of residence in the neighborhood was modeled as a continuous variable in years. *Household Poverty* was calculated for the HEP sample using 2002 census estimates for the U.S. poverty thresholds (organized by family size and number of children) and HEP survey data available for total household income and the total number of adults and children in the household for 2002. Household poverty was modeled as a binary variable of whether household per capita income fell below or above the Federal Poverty Level for 2002.

Neighborhood Level Controls. Percent poverty and percent Black or African American were modeled as census block group level (level 3) control variables due to their indirect associations with fruit and vegetable intakes among African Americans by influencing neighborhood food availability. Modeling level 3 block group variables, mean percent poverty and mean percent African American, allowed the opportunity to control for non-independence of observations at levels 2 (block) and 1 (individual) in the analysis. Percent poverty was defined as the percent of individuals in the census block group who had family incomes below the federal poverty line (FPL). Percent Black or African American was defined as the percent of non-Hispanic African American residents in each census block group. Data for percent African American and percent poverty measures were generated from Census 2000 data files. The mean percent poverty and mean percent Black or

African American for each census block group were modeled as continuous measures in the analysis.

Data Analysis

Several analytic steps were taken to address the research questions in this chapter. First, weighted descriptive statistics and univariate procedures were performed using SAS software, Version [9.3] for Windows. All sample statistics were adjusted for sample weights for unequal probabilities of selection within each stratum and to match the sample to Census 2000 population distributions for the study areas. Given the complex sample design, demographic statistics were calculated using proc surveyfreq, proc surveymeans, and IVEware % describe commands to estimate weighted means and proportions.

The second analytic step was to test study hypotheses. Three-level hierarchical regression models for a continuous outcome were estimated using HLM 7 (Scientific Software International, Lincolnwood, IL, 2011). Level 1 were the 522 African American survey respondents; level 2 were the 115 census blocks in which respondents lived; and level 3 were the 67 census block groups. I first examined the hypothesis that satisfaction with the neighborhood fruit and vegetable environment was an independent predictor of fruit and vegetable intakes after accounting for the observed characteristics of the neighborhood food environment (level 2). Specifically, model 2 tested if those reporting higher levels of satisfaction with the food environment reported higher levels of fruit and vegetable intakes than those reporting lower levels of satisfaction with the food environment. Second, I tested a series of models to examine the extent to which satisfaction with the neighborhood fruit and vegetable environment mediated

relationships between the observed food environment and fruit and vegetable intakes. To do this, I followed the multiple step regression procedure proposed by Baron and Kenny (1986) (Baron & Kenny, 1986). This included regression of: (1) fruit and vegetable intakes on observed characteristics of the neighborhood food environment; (2) satisfaction with the neighborhood fruit and vegetable environment on observed characteristics of the neighborhood food environment; (2) fruit and vegetable intakes on satisfaction with the neighborhood fruit and vegetable environment; and (3) fruit and vegetable intakes on observed characteristics of the neighborhood food environment while controlling for satisfaction with the neighborhood fruit and vegetable environment.

Finally, to test for the moderating effects of residents' satisfaction with the neighborhood fruit and vegetable environment I followed the regression procedure outlined in Baron and Kenny (1986) which included testing associations between daily fruit and vegetable intakes and the interaction between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment (Baron & Kenny, 1986; Bauer, Preacher, & Gil, 2006; Kenny, Korchmaros, & Bolger, 2003; Krull & MacKinnon, 1999; MacKinnon, Fairchild, & Fritz, 2007). All models were controlled for level 1 demographic variables and percent poverty and percent African American at level 3.

Results

Table 2.1 displays weighted sociodemographic characteristics of the HEP African American sample. The mean age of this sample was 46.6 years. The majority of the sample was female (56.3%). Roughly a quarter of the sample was married (27.4%) and just over one third (34.2%) had a high school diploma or GED. Roughly two thirds

(67.4%) of the sample was employed or currently working, 85.4% had easy access to a car. The mean length of respondents' residence their neighborhood was 18.3 years. Finally, the mean percent poverty value for all 67 block groups was 32.5%. The mean percentage of African Americans across all block groups was 67.5%.

The second half of table 2.1 describes average characteristics of the main . and dependent variables. Mean daily fruit and vegetable servings were the main dependent variable at the individual level. Participants reported 4.2 mean daily fruit and vegetable servings. On a scale of 1 to 4, mean satisfaction with the variety, quality, cost and affordability of fruit and vegetables was 2.8, indicating most participants were between not very satisfied to somewhat satisfied with the produce in their neighborhood food environment.

On average, survey participants traveled 3.5 miles to the nearest supermarket, and lived in census blocks with an average of 4.6 liquor stores. Roughly a third (30.4%) of all blocks had at least one large grocery store; 22.6% had at least one specialty store; 23.5% had at least one small grocery store; and 28.7% had at least one convenience store.

Table 2.2 presents multilevel regression results from the test of the first research question, associations between satisfaction with the neighborhood fruit and vegetable environment and mean daily fruit and vegetable intakes. Model 1 is a fully unconditional model that indicates significant variation in mean daily fruit and vegetable intakes at the census block group level ($\beta= 2.95$, s.e.$= 0.12$; $p<0.01$). Based on the intraclass correlation at the block level (block level neighborhood variation divided by the sum of the block group level neighborhood variation + block level neighborhood variation + individual variance), 0.13% of the variation in mean daily fruit and vegetable intakes was between

census blocks. Based on the intraclass correlation at the block group level (block group level neighborhood variation divided by the sum of the block group level neighborhood variation + block level neighborhood variation + individual variance), 2.08% of the variation in mean daily fruit and vegetable intakes was between census block groups. Model 2 added individual sociodemographic variables collectively at one time. After adjusting for individual level covariates in model 2, 0.13% of the variance in mean daily fruit and vegetable servings remained at the census block level and 0.73% at the census block group level. Despite low intraclass correlations, multilevel modeling was necessary due to the structure of the data collected for this study. The data was collected using a two-stage probability sample. The two-stage probability sample first selected a sample of census block groups within 6 strata that were categorized and sectioned by percent neighborhood poverty and percent African American. Second, households within those block groups were selected. Ignoring the above described multilevel nature of the data would be inappropriate for the study sampling design.

Results from the test of the first research question, associations between satisfaction with the neighborhood fruit and vegetable environment and mean daily fruit and vegetable intakes, show that as satisfaction with the neighborhood fruit and vegetable environment increased mean daily fruit and vegetable intakes also increased. Associations between satisfaction with the neighborhood fruit and vegetable environment and fruit and vegetable intakes were significant when controlling for observed characteristics of the neighborhood food environment ($\beta = 0.32$, s.e.$= 0.10$; $p < 0.01$, Model 4, Table 2.2) and when not controlling for observed characteristics of the

neighborhood food environment (β= 0.35, s.e.= 0.10; p< 0.01, Model 3, Table 2.2), as shown in Table 2.2.

Results for the second research question, satisfaction with the neighborhood fruit and vegetable environment as mediating associations between observed characteristics of the neighborhood food environment and mean daily fruit and vegetable intakes, are shown in Tables 2.2 through 2.5. This analysis used Baron and Kenny's (1986) method of testing mediation which specifies that variations in observed characteristics of the neighborhood food environment must significantly account for variations in satisfaction with neighborhood fruit and vegetable environment (Path B, Figure 2.1). Next, variations in satisfaction with the neighborhood fruit and vegetable environment must significantly account for variations in mean daily fruit and vegetable intakes (Path C, Figure 2.1). Finally, when paths B and C in Figure 2.1 are controlled, previously significant associations between observed characteristics of the neighborhood food environment and mean daily fruit and vegetable should become weak or non-significant (Baron & Kenny, 1986).

I first examined the baseline association between observed characteristics of the neighborhood fruit and vegetable environment and mean daily fruit and vegetable intakes (Path A, Figure 2.1). Observed characteristics of the neighborhood food environment variables were measured collectively and individually. After controlling for both neighborhood and individual level covariates and modeling all characteristics of the observed neighborhood food environment together, there was a significant negative association between the presence of a small grocery store and mean daily intake of fruit and vegetables (β= -0.55, s.e. = 0.21; p= 0.0, Model 3, Table 2.3). When observed

characteristics of the neighborhood food environment variables were modeled separately distance to the nearest supermarket (β= -0.34, s.e.= 0.14; p = 0.02, Model 4, Table 2.3), the number of liquor stores per block (β= -0.08, s.e.= 0.04; p = 0.05, Model 5, Table 2.3), and the presence of a small grocery store (β= -0.64, s.e.= 0.18; p < 0.01, Model 6, Table 2.3) were each significantly and negatively associated with mean fruit and vegetable intakes (Models 4- 6, Table 2.3). Associations between large grocery stores, convenience stores, and specialty stores and mean daily fruit and vegetable intakes were not significant (Models 7-9, Table 2.3).

I next examined associations between observed characteristics of the neighborhood food environment and satisfaction with neighborhood fruit and vegetable environment in Table 2.4 (Path B, Figure 2.1). To examine such associations I modeled observed characteristics of the neighborhood food environment all together or collectively and separately, choosing distance to the nearest supermarket, number of liquor stores, and the presence of a small grocery stores due to their significant associations with mean daily fruit and vegetable intakes in Table 2.3. Only distance to the nearest supermarket was significantly associated with satisfaction with the neighborhood fruit and vegetable environment (Models 3-4, Table 2.4). Distance to the nearest supermarket was significantly associated with satisfaction with the neighborhood fruit and vegetable environment when modeled with (β= -0.19, s.e. = 0.06; p= <0.01, Model 3, Table 2.4) and without (β= -0.16, s.e.= 0.04; p< 0.01, Model 4, Table 2.4) the full measures of the observed characteristics of the neighborhood food environment.

Next, I examined associations between satisfaction with the neighborhood fruit and vegetable environment and mean daily fruit and vegetable intakes (Path C, Figure

2.1). Results show satisfaction with the neighborhood fruit and vegetable environment was significantly associated with mean daily fruit and vegetable intakes (β= 0.35, s.e. = 0.10; p= <0.01, Model 3, Table 2.2).

Finally, I examined associations between observed characteristics of the neighborhood food environment and mean daily fruit and vegetable intakes while controlling for satisfaction with the neighborhood fruit and vegetable environment (Table 2.5). Satisfaction with the neighborhood fruit and vegetable environment was significantly associated with mean daily fruit and vegetable intakes (β= 0.31, s.e.= 0.10; p= <0.01, Model 1, Table 2.5). Results from model 1 in Table 5 show satisfaction with the neighborhood fruit and vegetable environment partially mediated the association between distance to the nearest supermarket and mean daily fruit and vegetable intakes because distance to the nearest supermarket remains significantly associated with mean daily fruit and vegetable intakes in the model (β= -0.29, s.e.= 0.14; p= 0.05, Model 1, Table 2.5). Baron and Kenny (1986) detail that failure to fully eliminate associations between the main . and dependent variable, observed characteristics of the neighborhood food environment and mean daily fruit and vegetable intakes, does not exclude the potential for mediation. Instead, partial mediation is present (Baron & Kenny, 1986; James, Mulaik, & Brett, 2006; MacKinnon, et al., 2007). Thus, satisfaction with the neighborhood fruit and vegetable environment partially mediates the relationships between distance to the nearest supermarket and mean daily fruit and vegetable intakes. It is also important to note that satisfaction with the neighborhood fruit and vegetable environment remained a significant . predictor of fruit and vegetable intakes above and

beyond observed characteristics of the neighborhood food environment in this analysis (β=0.32, s.e.= 0.10; $p< 0.01$, Model 2, Table 2.5).

Results from the third research question, the modifying effects of satisfaction with the neighborhood fruit and vegetable environment on the association between the observed characteristics of the neighborhood food environment and fruit and vegetable intakes among African Americans are not shown. Satisfaction was not a significant modifier of the association between observed characteristics of the neighborhood food environment and mean daily fruit and vegetable intakes. Observed characteristics of the neighborhood food environment variables were modeled collectively and as . variables in the moderation analysis, none of which interacted with satisfaction with the neighborhood fruit and vegetable environment.

Discussion

There were three main findings from the analyses reported here. First, satisfaction with the neighborhood fruit and vegetable environment was significantly associated with fruit and vegetable intakes. This association was significant even after adjusting for observed characteristics of the neighborhood food environment. Second, satisfaction with the neighborhood fruit and vegetable environment partially mediated associations between observed characteristics of the neighborhood food environment and fruit and vegetable intakes. Third, there were no significant modifying effects of satisfaction with local food environments on the relationship between observed food environments and fruit and vegetable intakes. Each of these findings is discussed in greater detail below.

Main associations between satisfaction and fruit and vegetable intakes. This study found that satisfaction with neighborhood fruit and vegetable environment was

significantly positively associated with mean daily fruit and vegetable intakes among African Americans. This association was robust after accounting for observed characteristics of the neighborhood food environment (Models 3 and 4, Table 2.2). The findings reported here differ from those reported by Zenk et al. (2009) who examined similar relationships using the HEP multiethnic sample of White, Latino, and African Americans participants. Zenk and colleagues did not find significant associations between satisfaction and fruit and vegetable intakes in the multiethnic sample (Zenk, Lachance, et al., 2009). There were several differences between the two studies that may contribute to inconsistencies in their results. First, Zenk and colleagues (2009) conducted their analysis using a multiethnic sample, rather than restricting the analysis to African Americans only as in this study. Second, the study reported here controlled for characteristics of the observed food environment at the census block level and for block group level variables percent poverty and percent African American, which were not included in the analyses conducted by Zenk and colleagues.

Significant associations between satisfaction and fruit and vegetable intakes in this chapter are consistent with research conducted by Moore and colleagues using the MESA study and adjusting for age, sex, race and ethnicity, and socioeconomic status (Moore, Diez Roux, Nettleton, et al., 2008). Moore and colleagues (2008) found that when controlling for age, sex, race and ethnicity, and socioeconomic indicators, participant-reported satisfaction with the food environment was significantly positively associated with diet quality. Moore et al. (2008) also did not control for observed characteristics of the food environment at the block level or concentrations of neighborhood poverty and African American composition at the block group level when

examining associations between satisfaction and diet quality (Moore, Diez Roux, Nettleton, et al., 2008).

Differences in statistical models used in the above listed studies prevents cross comparison of study results for associations between satisfaction and fruit and vegetable intakes. As such, it is hard to know if differences in associations may have resulted from differences in statistical models used across studies or whether they may reflect different patterns of associations among African Americans compared to multiethnic samples. It was important for this chapter to examine associations between satisfaction and fruit and vegetable among African Americans while controlling for census block (observed characteristics of the food environment) and block group level variables due to the strong patterning of race and ethnicity with healthy food availability for African Americans living in majority African American neighborhoods (the case for the majority of African Americans in the current sample) and to account for variation in the observed food environment or elements of neighborhood poverty that may influence such associations. There is a need for studies examining associations between satisfaction and fruit and vegetable intakes or diet quality to use similar statistical models. Doing so would enable cross comparison of study results and contribute to explanations for African Americans increased risk of diet-related disease- we would know if differences may be attributed to within group variation in factors, such as satisfaction, that influence health behaviors like fruit and vegetable intakes.

In addition, while neither Moore et al. (2008) nor Zenk et al. (2009) controlled for the observed food environment when examining associations between satisfaction and diet quality (Moore, Diez Roux, Nettleton, et al., 2008) or fruit and vegetable intakes

(Zenk, Lachance, et al., 2009), results from the analyses reported here find little evidence that controlling observed characteristics of the food environment influenced these associations, The findings reported here extend those reported in earlier studies by explicitly testing the hypothesis that satisfaction is associated with fruit and vegetable intakes after accounting for observed characteristics of the food environment (Models 3 & 4, Table 2.2). This finding is consistent with the hypothesis that for African Americans in this study, satisfaction is associated with fruit and vegetable intakes above and beyond characteristics of the observed food environment. Understanding the relationship between satisfaction and fruit and vegetable intakes and how it operates above and beyond the observed food environment is important for public health interventions seeking to reduce the excess burden of diet-related disease among African Americans by increasing fruit and vegetable intakes. Given the goal of reducing the excess burden of diet-related disease among African Americans, determining variation in factors that contribute to fruit and vegetable intakes, which are strongly associated with diet-related disease, would assist with interventions developed specifically to improve fruit and vegetable intakes among African Americans. Doing so may prove most effective for decreasing the burden of diet-related disease among African Americans because they would be based on variation in factors and health behaviors among them, not in comparison to other racial and ethnic groups.

Mediating and moderating effects of satisfaction with the neighborhood fruit and vegetable environment. This was one the first studies to examine the mediating and moderating effects of satisfaction with neighborhood fruit and vegetable environment on the relationship between observed characteristics of the neighborhood food environment

and fruit and vegetable intakes. Results from tests of the mediation hypothesis indicate partial mediation (Model, 1, Table 2.5). When satisfaction (mediator) was included in the model, base associations between observed characteristics of the neighborhood food environment decrease but remain statistically significantly associated with fruit and vegetable intakes. In addition, use of the Sobel test for indirect effects confirmed mediation, or that the indirect effect of satisfaction on fruit and vegetable intakes is significantly different from zero. If the model were fully mediated by satisfaction, the association of observed characteristics of the neighborhood food environment would no longer be associated with fruit and vegetable intakes and would travel completely through satisfaction, which is significantly associated with fruit and vegetable intakes. The result of partial mediation of satisfaction on the relationship between observed characteristics of the neighborhood food environment and fruit and vegetable intakes indicates that observed characteristics of the neighborhood food environment still account for a portion of the variance in fruit and vegetable intakes when satisfaction is included in the model. These findings are consistent with the hypothesis that satisfaction with food environments is a reflection of both observed characteristics of the neighborhood food environment and the social environment.

While not a central research question posed in this chapter, it is also interesting to note that small grocery stores, while not significantly associated with satisfaction (see Table 2.4), were an . significant predictor of fruit and vegetable intakes. This association was robust after controlling for satisfaction with the neighborhood fruit and vegetable environment (Model 2, Table 2.5). The significant negative association between presence of small grocery stores and fruit and vegetable intakes while controlling for satisfaction

suggests that small grocery stores are associated with fruit and vegetable intakes above and beyond satisfaction. Thus, the presence of small grocery stores is associated with fruit and vegetable intakes even after accounting for satisfaction and the influence of other social environment factors that may influence satisfaction and fruit and vegetable intakes. Small grocery stores may be key elements of the neighborhood fruit and vegetable environment for African Americans though they are less likely to carry high or even adequate selections of healthy, fresh, quality, and affordable produce (Cummins & Macintyre, 2006; Morland, Wing, Diez Roux, et al., 2002). As a result, their presence may be associated with decreased fruit and vegetable intakes.

Finally, results from leg A (Figure 2.1) of the mediation model in this study found increased distance to the nearest supermarket, increased count of liquor stores, and the presence of any small grocery stores were negatively associated with fruit and vegetable intakes among African Americans (Models 4-6, Table 2.3) when each was included alone (without other indicators of the food environment) in statistical models. Results from Zenk et al. (2009) using the multiethnic sample found significant positive associations between the presence of a large grocery store and fruit and vegetable intakes (Zenk, Lachance, et al., 2009). Failure to find a similar association between large grocery stores and fruit and vegetable intakes among African Americans, and finding significant negative associations between other observed characteristics of the food environment suggests that the quality, variety, and cost or affordability of fresh produce in majority African American neighborhoods may be substantially different or of lower quality that what is found when looking across several racial and ethnic groups (Cummins & Macintyre, 2006; Morland, Wing, Diez Roux, et al., 2002). As stated earlier, models for

this dissertation differed from those by Zenk et al (2009) in that they included controls for neighborhood poverty and racial composition, while Zenk and colleagues did not (Zenk, Lachance, et al., 2009). To further examine the possibility that these findings reflect differences among African Americans, in comparison to multiethnic samples, future research should specifically test this hypothesis by running models within African American-only samples and tri-ethnic samples that both account for neighborhood poverty and racial composition.

There were no moderating effects of satisfaction with the neighborhood fruit and vegetable environment on associations between observed characteristics of the food environment and fruit and vegetable intakes. The lack of significance of moderating effects suggests that there were no significant differences in associations between observed characteristics of the food environment and fruit and vegetable intakes for those with low or high satisfaction.

Limitations. There are several limitations associated with this research. Additional research on mediating and moderating effects of satisfaction with the neighborhood fruit and vegetable environment in patterning associations between characteristics of the observed food environment and fruit and vegetable intakes would benefit from including in-store audits of the food environment. Data provided by in-store audits of the food environment, such as records of the variety, quality, and price of fruits and vegetables by store type would improve specificity of models examining associations between observed characteristics of the neighborhood food environment, satisfaction with the fruit and vegetable environment, and dietary intakes. Additionally, the sample is cross-sectional and thus generalizability and information on trends over time were unavailable. Finally,

while every effort was made to correctly count and categorize characteristics of the observed neighborhood food environment, there may still be misclassification or errors in measures of the neighborhood food environment.

Conclusions. Results from this chapter highlight the need for continued research to examine methods and mechanisms necessary for improving dietary intakes among African Americans who reside in majority African American environments with decreased access to healthy food. Given their excess risk of diet-related disease, a major goal of this dissertation was to examine the above listed factors in relation to reducing diet-related disease among African Americans, not between African Americans and other racial and ethnic groups. Results from this chapter emphasize the importance of considering the observed food environment and satisfaction as influencing fruit and vegetable intakes among African American only samples. Specifically, many factors that contribute to African Americans' excess risk of diet-related disease may be due to the neighborhood conditions in which they live. African Americans are more likely to reside in racially segregated lower income neighborhoods compared to Whites (Kumanyika, et al., 2007). Public health research and interventions that conceptually take into account the effects of race-based residential segregation and neighborhood poverty on observed characteristics of the food environment, satisfaction, and fruit and vegetable intakes by examining associations between such mechanisms among samples of African Americans yield results that demonstrate variation in relationships among such factors. Such results, when applied to public health research and interventions, may work to improve fruit and vegetable intakes and reduce disparities in diet-related diseases that disproportionately burden African Americans.

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Figure 2.1. Mediating and moderating effects of satisfaction with the neighborhood fruit and vegetable environment on associations between observed characteristics of the neighborhood food environment and mean daily fruit and vegetable intakes.

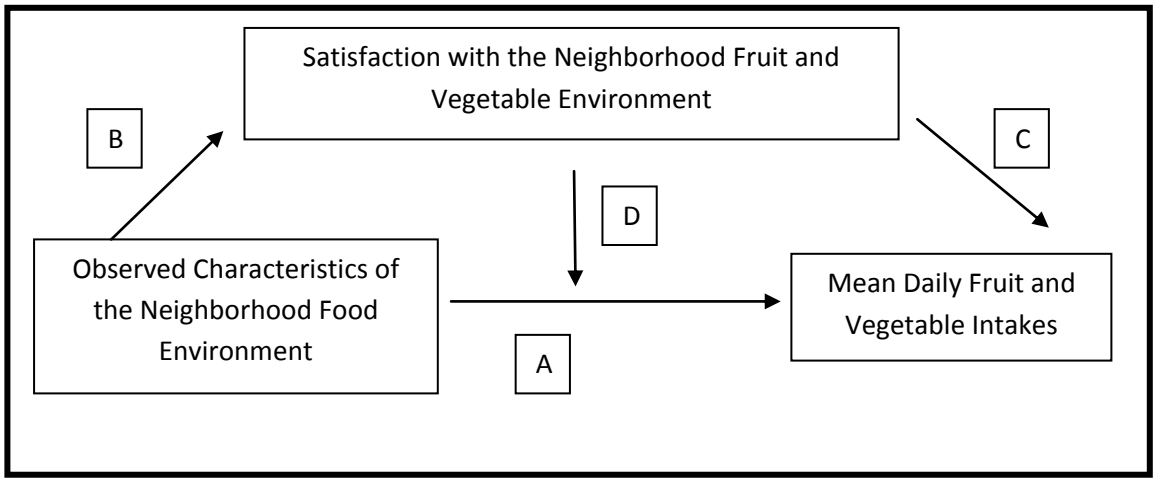

Table 2.1 Descriptive statistics for individual level, census block, and census block group variables, Sample, N=		
	Mean (SE)	**Percent**
Level 1: Individual Level Predictors & Covariates		
Age (years)	46.6 (1.18)	
Female		56.3
Education		
< High school		28.2
High school diploma or GED		34.2
> High school		37.6
Married/ living together		27.4
Households with incomes above the Federal Poverty Level, FPL		62.5
Easy Car Access		85.4
Employed		67.4
Length of Residence in Neighborhood (years)	18.3 (0.81)	
Owns a Home		45.6
Level 1: Individual Level Food Intake and Satisfaction Variables		
Number of daily fruit and vegetable servings	4.2 (0.15)	
Satisfaction with variety, quality, cost and affordability of fruits and vegetables *(1- not satisfied to 4- very satisfied)*	2.8 (0.04)	
Level 1: Individual Level Social Environment Variables		
Organizational Membership		
Not a member of any groups or organizations		81.4%
Neighborhood Participation (organizations, groups, or activities)		
None		53.6%
1		23.9%
2 or 3		22.5%
Level 2: Census Block Neighborhood Variables		
Distance to nearest supermarket, miles	3.5 (0.08)	
Count of Liquor Stores	4.6 (0.25)	
Any Small Grocery Store		23.5%
Any Large Grocery Store		30.4%
Any Convenience Store		28.7%
Any Specialty Store		22.6%
Level 3: Census Block Group Neighborhood Variables		
Mean Percent Poverty	32.5 (1.44)	
Mean Percent African American	67.5 (4.28)	
*All level 1 summary statistics were weighted.		

Table 2.2

Mean daily fruit and vegetable intakes regressed on self-reported satisfaction with the neighborhood fruit and vegetable environment

	Model 1: Fully Unconditional			Model 2: Individual Covariates			Model 3: Satisfaction with Fruits & Vegetables			Model 4: Satisfaction with Fruits & Vegetables		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.95	0.12	<0.01	3.57	0.35	<0.01	3.55	0.34	<0.01	3.72	0.38	<0.01
Age (years)*				<0.01	0.01	0.60	<0.01	0.01	0.63	<0.01	0.01	0.82
Gender (reference: male)				-0.25	0.21	0.23	-0.24	0.21	0.24	-0.27	0.21	0.20
Length of residence in neighborhood (years)*				-0.01	0.01	0.10	-0.02	0.01	0.08	-0.01	0.01	0.22
Marital status (reference: married)				-0.32	0.24	0.18	-0.28	0.22	0.21	-0.27	0.22	0.24
Car Access (reference: easy car access)				0.01	0.29	0.97	0.11	0.28	0.70	0.12	0.27	0.66
Education < High School (ref: at least some college)				-0.51	0.30	0.09	-0.59	0.31	0.06	-0.56	0.32	0.08
High School Diploma or GED (ref: at least some college)				-0.33	0.24	0.17	-0.40	0.25	0.11	-0.41	0.25	0.10
Employment Status (reference: employed)				0.02	0.29	0.94	0.03	0.29	0.92	0.08	0.29	0.78
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)				0.06	0.26	0.81	0.04	0.26	0.89	0.10	0.26	0.71
Satisfaction with the neighborhood fruit and vegetable environment*							**0.35**	**0.10**	**<0.01**	**0.32**	**0.10**	**<0.01**
Census Block Level												
Distance to nearest supermarket (miles)*										-0.15	0.20	0.45
Count of Liquor Stores*										-0.03	0.05	0.63
Any Small Grocery Store (ref: none)										**-0.52**	**0.19**	**0.01**
Any Large Grocery Store (ref: none)										0.01	0.20	0.96
Any Convenience Store (ref: none)										-0.14	0.22	0.52
Any Specialty Store (ref: none)										-0.26	0.27	0.35
Census Block Group Level												
Mean Percent Poverty*				<-0.01	0.01	0.66	<-0.01	0.01	0.78	<-0.01	0.01	0.88
Mean Percent African American*				<0.01	<0.01	0.58	<0.01	<0.01	0.31	<-0.01	<0.01	0.94
Sigma squared, σ^2			5.74941			5.70009			5.65370			5.56895
Tau pi, $T\pi$			0.00737			0.00739			0.00411			0.00330
Tau beta, $T\beta$			0.12207			0.04216			0.01395			0.00699

* Variables were grand-mean centered

§ SE indicates standard error

ǂ Census block level variables were entered separately in the model

All models were adjusted at the individual level for age, length of residence in neighborhood, gender, education, marital status, household poverty, and car access. All models were adjusted at the block group level for % Poverty and % African American.

Table 2.3

Mean daily fruit and vegetable intakes regressed on observed characteristics of the neighborhood food environment

	Model 1: Fully Unconditional			Model 2: Individual Covariates			Model 3: Food Store Environment			Model 4: Distance to Supermarket			Model 5: Count of Liquor Stores		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.95	0.12	<0.01	3.57	0.35	<0.01	3.64	0.46	<0.01	3.49	0.33	<0.01	3.56	0.35	<0.01
Age (years)*				<0.01	0.01	0.60	<0.01	0.01	0.79	<0.01	0.01	0.68	<0.01	0.01	0.63
Gender (reference: male)				-0.25	0.21	0.23	-0.29	0.22	0.18	-0.28	0.21	0.19	-0.28	0.21	0.20
Length of residence in neighborhood (years)*				-0.01	0.01	0.10	-0.01	0.01	0.31	-0.01	0.01	0.27	-0.01	0.01	0.21
Marital status (reference: married)				-0.32	0.24	0.18	-0.30	0.24	0.21	-0.32	0.24	0.18	-0.33	0.24	0.16
Car Access (reference: easy car access)				0.01	0.29	0.97	0.03	0.28	0.91	0.02	0.28	0.93	-0.01	0.29	0.99
Education < High School (ref: at least some college)				-0.51	0.30	0.09	-0.48	0.31	0.13	-0.40	0.31	0.19	-0.47	0.30	0.12
High School Diploma or GED (ref: at least some college)				-0.33	0.24	0.17	9.34	0.25	0.17	-0.29	0.25	0.25	-0.31	0.24	0.20
Employment Status (reference: employed)				0.02	0.29	0.94	0.09	0.30	0.76	0.08	0.29	0.79	0.04	0.29	0.88
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)				0.06	0.26	0.81	0.13	0.26	0.63	0.12	0.26	0.66	0.12	0.27	0.67
Census Block Level															
Distance to nearest supermarket (miles)*							-0.18	0.21	0.38	**-0.34**	**0.14**	**0.02**			
Count of Liquor Stores*							-0.03	0.06	0.59				**-0.08**	**0.04**	**0.05**
Any Small Grocery Store (ref: none)							**-0.55**	**0.21**	**0.01**						
Any Large Grocery Store (ref: none)							-0.01	0.24	0.95						
Any Convenience Store (ref: none)							-0.18	0.21	0.42						
Any Specialty Store (ref: none)							-0.27	0.33	0.42						
Census Block Group Level															
Mean Percent Poverty*				<-0.01	0.01	0.66	<-0.01	0.01	0.80	<0.01	0.01	0.82	<-0.01	0.01	0.78
Mean Percent African American*				<0.01	<0.01	0.58	<-0.01	<0.01	0.65	<0.01	<0.01	0.73	<0.01	<0.01	0.35
Sigma squared, σ^2			5.74941			5.70009			5.62222			5.66303			5.66856
Tau pi, Tπ			0.00737			0.00739			0.00346			0.00607			0.00625
Tau beta, Tβ			0.12207			0.04216			0.01174			0.01489			0.03816

* Variables were grand-mean centered

§ SE indicates standard error

ł Census block level variables were entered separately in the model

All models were adjusted at the individual level for age, length of residence in neighborhood, gender, education, marital status, household poverty, and car access. All models were adjusted at the block group level for % Poverty and % African American.

Table 2.3 Continued

Mean daily fruit and vegetable intakes regressed on observed characteristics of the neighborhood food environment

	Model 6: Small Grocery Stores			Model 7: Large Grocery Stores			Model 8: Convenience Store			Model 9: Specialty Store		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	3.71	0.37	<0.01	3.59	0.37	<0.01	3.65	0.38	<0.01	3.63	0.36	<0.01
Age (years)*	<0.01	0.01	0.69	0.04	0.01	0.60	<0.01	0.01	0.61	<0.01	0.01	0.70
Gender (reference: male)	-0.25	0.21	0.24	-0.25	0.21	0.23	-0.25	0.21	0.23	-0.26	0.21	0.22
Length of residence in neighborhood (years)*	-0.01	0.01	0.13	-0.01	0.01	0.11	-0.01	0.01	0.10	-0.01	0.01	0.16
Marital status (reference: married)	-0.31	0.24	0.19	-0.32	0.24	0.19	-0.33	0.24	0.17	-0.30	0.24	0.21
Car Access (reference: easy car access)	0.02	0.29	0.94	0.01	0.29	0.96	0.02	0.29	0.96	0.03	0.29	0.93
Education < High School (ref: at least some college)	-0.54	0.30	0.08	-0.51	0.30	0.09	-0.54	0.31	0.08	-0.50	0.20	0.10
High School Diploma or GED (ref: at least some college)	-0.36	0.24	0.14	-0.34	0.24	0.17	-0.36	0.24	0.14	-0.34	0.24	0.17
Employment Status (reference: employed)	0.03	0.29	0.93	0.02	0.29	0.94	0.02	0.29	0.95	0.05	0.30	0.86
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)	0.09	0.27	0.73	0.07	0.26	0.80	0.06	0.26	0.82	0.06	0.26	0.82
Census Block Level												
Distance to nearest supermarket (miles)*												
Count of Liquor Stores*												
Any Small Grocery Store (ref: none)	**-0.64**	**0.18**	**<0.01**									
Any Large Grocery Store (ref: none)				-0.06	0.20	0.75						
Any Convenience Store (ref: none)							-0.23	0.22	0.31			
Any Specialty Store (ref: none)										-0.42	0.31	0.18
Census Block Group Level												
Mean Percent Poverty*	<-0.01	0.01	0.50	<-0.01	0.01	0.68	<-0.01	0.01	0.66	-0.01	0.01	0.61
Mean Percent African American*	<-0.01	<0.01	0.61	<0.01	<0.01	0.56	<0.01	<0.01	0.44	<0.01	<0.01	0.96
Sigma squared, σ^2			5.66127			5.69489			5.70261			5.64892
Tau pi, Tπ			0.00439			0.00630			0.00621			0.00132
Tau beta, Tβ			0.03160			0.04793			0.03014			0.08548

* Variables were grand-mean centered

§ SE indicates standard error

ł Census block level variables were entered separately in the model

All models were adjusted at the individual level for age, length of residence in neighborhood, gender, education, marital status, household poverty, and car access. All models were adjusted at the block group level for % Poverty and % African American.

Table 2.4

Self-reported satisfaction with the neighborhood fruit and vegetable environment regressed on observed characteristics of the neighborhood food environment

	Model 1: Fully Unconditional			Model 2: Individual Covariates			Model 3: Food Store Environment			Model 4: Distance to Supermarket			Model 5: Count of Liquor Stores			Model 6: Small Grocery Stores		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.75	0.04	<0.01	2.78	0.12	<0.01	2.74	0.13	<0.01	2.75	0.12	<0.01	2.77	0.12	<0.01	2.78	0.12	<0.01
Age (years)*				<0.01	<0.01	0.56	<0.01	<0.01	0.60	<0.01	<0.01	0.65	<0.01	<0.01	0.58	<0.01	<0.01	0.56
Gender (reference: male)				-0.04	0.07	0.57	-0.05	0.07	0.48	-0.05	0.07	0.46	-0.05	0.07	0.52	-0.04	0.07	0.57
Length of residence in neighborhood (years)*				<0.01	<0.01	0.10	0.01	<0.01	0.03	0.01	<0.01	0.02	0.01	<0.01	0.06	<0.01	<0.01	0.09
Marital status (reference: married)				-0.12	0.08	0.14	-0.12	0.08	0.13	-0.12	0.08	0.12	-0.12	0.08	0.13	-0.12	0.08	0.14
Car Access (reference: easy car access)				-0.25	0.10	0.02	-0.25	0.10	0.02	-0.25	0.10	0.02	-0.26	0.10	0.02	-0.25	0.10	0.02
Education < High School (ref: at least some college)				0.23	0.09	0.02	0.27	0.09	<0.01	0.27	0.09	<0.01	0.23	0.09	0.01	0.23	0.09	0.02
High School Diploma or GED (ref: at least some college)				0.2	0.09	0.03	0.21	0.09	0.02	0.21	0.09	0.02	0.20	0.09	0.03	0.19	0.09	0.03
Employment Status (reference: employed)				-0.02	0.08	0.80	0.01	0.09	0.95	<0.01	0.09	0.97	-0.01	0.09	0.87	-0.02	0.08	0.80
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)				0.08	0.08	0.35	0.09	0.08	0.28	0.10	0.08	0.25	0.09	0.08	0.28	0.08	0.08	0.35
Census Block Level																		
Distance to nearest supermarket (miles)*							**-0.19**	**0.06**	**<0.01**	**-0.16**	**0.04**	**<0.01**						
Count of Liquor Stores*							<-0.01	0.02	0.63				-0.02	0.01	0.07			
Any Small Grocery Store (ref: none)							0.09	0.11	0.43							<-0.01	0.11	0.97
Any Large Grocery Store (ref: none)							-0.06	0.08	0.46									
Any Convenience Store (ref: none)							-0.02	0.07	0.81									
Any Specialty Store (ref: none)							0.01	0.10	0.93									
Census Block Group Level																		
Mean Percent Poverty*				<-0.01	<0.01	0.16	<-0.01	<0.01	0.91	<-0.01	<0.01	0.63	<-0.01	<0.01	0.18	<-0.01	<0.01	0.16
Mean Percent African American*				<-0.01	<0.01	0.01	<-0.01	<0.01	0.05	<-0.01	<0.01	<0.01	<-0.01	<0.01	0.02	<-0.01	<0.01	0.03
Sigma squared, σ^2			0.62629			0.59889			0.59596			0.59722			0.59932			0.59885
Tau pi, $T\pi$			0.02289			0.01402			0.01143			0.01191			0.01556			0.01411
Tau beta, $T\beta$			0.01088			0.01146			0.00015			0.00012			0.00536			0.01141

* Variables were grand-mean centered

§ SE indicates standard error

ł Census block level variables were entered separately in the model

All models were adjusted at the individual level for age, length of residence in neighborhood, gender, education, marital status, household poverty, and car access. All models were adjusted at the block group level for % Poverty and % African American.

Table 2.5

Self-reported satisfaction with the neighborhood fruit and vegetable environment as mediating associations between mean daily fruit and vegetable intakes and observed characteristics of the neighborhood food environment

	Model 1: Mediation:Distance to Supermarket			**Model 2: Full Mediation Neigh. Food Environment**		
	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	3.49	0.32	<0.01	3.72	0.38	<0.01
Age (years)*	<0.01	0.01	0.70	<0.01	0.01	0.82
Gender (reference: male)	-0.27	0.21	0.20	-0.27	0.21	0.20
Length of residence in neighborhood (years)*	-0.01	0.01	0.20	-0.01	0.01	0.22
Marital status (reference: married)	-0.29	0.23	0.21	-0.27	0.22	0.24
Car Access (reference: easy car access)	0.10	0.28	0.71	0.12	0.27	0.66
Education < High School (ref: at least some college)	-0.48	0.31	0.12	-0.56	0.32	0.08
High School Diploma or GED (ref: at least some college)	-0.35	0.26	0.17	-0.41	0.25	0.10
Employment Status (reference: employed)	0.08	0.29	0.79	0.08	0.29	0.78
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)	0.09	0.26	0.74	0.10	0.26	0.71
Satisfaction with the neighborhood fruit and vegetable environment*	**0.31**	**0.10**	**<0.01**	**0.32**	**0.10**	**<0.01**
Census Block Level						
Distance to nearest supermarket (miles)*	**-0.29**	**0.14**	**0.05**	-0.15	0.20	0.45
Count of Liquor Stores*				-0.03	0.05	0.63
Any Small Grocery Store (ref: none)				**-0.52**	**0.19**	**0.01**
Any Large Grocery Store (ref: none)				0.01	0.20	0.96
Any Convenience Store (ref: none)				-0.14	0.22	0.52
Any Specialty Store (ref: none)				-0.26	0.27	0.35
Census Block Group Level						
Mean Percent Poverty*	<0.01	0.01	0.79	<-0.01	0.01	0.88
Mean Percent African American*	<0.01	<0.01	0.43	<-0.01	<0.01	0.94
Sigma squared, σ^2			5.61368			5.56895
Tau pi, $T\pi$			0.00195			0.00330
Tau beta, $T\beta$			0.00955			0.00699

* Variables were grand-mean centered

§ SE indicates standard error

ł Census block level variables were entered separately in the model

All models were adjusted at the individual level for age, length of residence in neighborhood, gender, education, marital status, household poverty, and car access. All models were adjusted at the block group level for % Poverty and % African American.

Chapter 3

What Role Does Socioeconomic Status Play In Associations Between the Observed Neighborhood Food Environment And Satisfaction With Neighborhood Fruit And Vegetable Environment Among African Americans? Tests of Main And Modifying Effects

Introduction

In this chapter I examine: 1) relationships between indicators of socioeconomic status (SES) and satisfaction with the neighborhood fruit and vegetable environment, controlling for observed characteristics of the neighborhood food environment, and 2) whether SES modifies the relationship between observed characteristics of the food environment and satisfaction with the food environment. SES is often researched as an important predictor of health behaviors such as dietary intake (CDC, 2009; Darmon & Drewnowski, 2008; Kant & Graubard, 2007). However, relatively few studies have examined relationships between indicators of SES and satisfaction with the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009). Understanding such associations may contribute to our understanding of the pathways through which SES is associated with health-related behaviors and health outcomes. This may be particularly important given findings reported elsewhere (including in the previous chapter), which suggest that satisfaction with the fruit and vegetable environment is associated with and fruit and vegetable intakes (Moore, Diez Roux, Nettleton, et al., 2008), and some evidence that these relationships are evident even after

accounting for observed characteristics of the food environment (Chapter 2 of this dissertation, Model 3, Table 2.4).

In this chapter I build on findings from the previous chapter indicating that observed characteristics of the neighborhood food environment are associated with satisfaction with the neighborhood fruit and vegetable environment (as one component of a larger mediating effect, Chapter 2, Models 3 and 4 Table 2.4). Here I examine factors that influence the direction or strength of that relationship. As a strong predictor of health behaviors in general and dietary health behaviors specifically (Darmon & Drewnowski, 2008), SES may influence satisfaction with the neighborhood fruit and vegetable environment through a number of pathways, which I discuss in greater depth below. The aims of this chapter are to examine direct relationships between SES and satisfaction with the neighborhood fruit and vegetable environment, while controlling for observed aspects of the neighborhood food environment, and to examine whether SES moderates associations between observed characteristics of the neighborhood food environment and satisfaction with the fruit and vegetable environment.

This chapter examines the above listed . and moderating associations among African American adults across three neighborhoods in Detroit, MI. There are several reasons why it is important to understand associations between SES, observed characteristics of the neighborhood food environment, and satisfaction with the neighborhood fruit and vegetable environment among African Americans. There are strong associations between neighborhood poverty, percent African American neighborhood composition, and access and availability of healthy foods (Cummins & Macintyre, 2006; Larson & Story, 2009; Larson, et al., 2009). Disentangling associations

between SES, observed characteristics of the neighborhood food environment, and satisfaction with the neighborhood fruit and vegetable environment is important for improving fruit and vegetable intakes among African Americans. Such research would help determine how SES influences satisfaction in conjunction with or above and beyond ways in which observed characteristics of the neighborhood food environments influence satisfaction. It may also help better tailor interventions that work to shape factors that are associated with satisfaction with the neighborhood fruit and vegetable environment. Examining how SES affects dietary intakes may help inform strategies to reduce diet-related disease among African Americans (Moore, Diez Roux, Nettleton, et al., 2008) (Chapter 2 of this dissertation).

Satisfaction with the neighborhood fruit and vegetable environment

Satisfaction is a subjective perception-based measure that reflects both aspects of the observed food environment and individual's assessment of those environments. First, satisfaction reflects a person's perception of the quality, cost and affordability and variety of fresh produce in the observed food environment in which they live. Second, satisfaction is influenced by factors in the social context and social environment (e.g., socioeconomic status, age, gender, personal preferences, and different cultural and economic factors (Moore, Diez Roux, & Brines, 2008)) that may influence norms and beliefs around dietary intake behaviors and patterns. Such factors may influence one's satisfaction with their neighborhood fruit and vegetable environment by shaping their expectations for or perceptions of produce in their observed food environment. A person's perception of the produce in their observed food environment and the degree to which the observed food environment meets a person's expectations influences

satisfaction. These factors may be associated with satisfaction with the neighborhood fruit and vegetable environment above and beyond the observed characteristics of the neighborhood food environment, or may interact with them.

In this chapter, I conceptualize satisfaction with the neighborhood fruit and vegetable environment as a proximate level factor in the fundamental determinants of health disparities framework adapted for this dissertation (Chapter 1, Figure 1.1). As a proximate level factor, satisfaction with the neighborhood fruit and vegetable environment is influenced by intermediate level factors (the built and social environment), other proximate level factors, and works to influence proximate level health behaviors (fruit and vegetable intakes) (See Figure 1.1) (Schulz & Northridge, 2004). This chapter focuses on intermediate and proximate level factors that influence satisfaction with the neighborhood fruit and vegetable environment.

In order to influence dietary behaviors such as fruit and vegetable intakes and reduce disparities in diet-related diseases that disproportionately affect African Americans, it is important to determine factors that shape dietary intakes. Research suggests that in addition to associations between observed characteristics of the food environment and dietary intakes (Laraia, et al., 2004; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005; Zenk, Lachance, et al., 2009), there may also be relationships between an individual's perception of healthy food in their environment and dietary behaviors (Moore, Diez Roux, Nettleton, et al., 2008). One way individual-level perceptions of healthy food in a neighborhood are evaluated is through measuring a person's degree of satisfaction with their neighborhood fruit and vegetable environment. Satisfaction with

the neighborhood fruit and vegetable environment is a perception based measure that assesses the extent to which one is satisfied with produce in their neighborhood. Such measures are often used instead of or in addition to observed characteristics of the neighborhood food environment to examine health behaviors such as dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009).

To interpret the influence of observed characteristics of the neighborhood food environment on satisfaction with the neighborhood fruit and vegetable environment and also understand how such measures influence dietary intakes, it is important to know exactly *what* measures of satisfaction with the neighborhood food environments capture. Research examining baseline data from the Multiethnic Study of Atherosclerosis (MESA) has used two measures to define satisfaction with the neighborhood fruit and vegetable environment. In one study, participants were asked the extent to which they agreed that their neighborhoods: had a large selection of fruits and vegetables, fresh fruits and vegetables were of high quality, and had a large selection of low fat products (Moore, Diez Roux, & Brines, 2008). Participant responses were recorded on a 5-point Likert scale with options ranging from strongly agree to strongly disagree and reverse coded such that higher scores reflected increased satisfaction with the local food environment (Moore, Diez Roux, & Brines, 2008).

In another study using MESA data, both participants within the study area and aggregated responses from separate set of . informants within the study area were asked to record the degree to which they agreed with statements that there was: “a lack of access to adequate food shopping”, “a large selection of fruits and vegetables available”, and a “large selection of low-fat products is available” (Moore, Diez Roux, Nettleton, et

al., 2008). Participant responses for "a lack of access to adequate food shopping" were recorded on a 4-point Likert scale with options ranging from very serious problem to not really a problem. Participant responses for there being "a large selection of fruits and vegetables available" and a "large selection of low-fat products is available," were recorded on a on a 5-point Likert scale with reverse coded options ranging from low to high, strongly disagree to strongly agree such that higher scores reflected increased satisfaction with the local food environment (Moore, Diez Roux, Nettleton, et al., 2008). Additionally, in both studies, neighborhoods were defined to participants as the 1-mile area around their home (Moore, Diez Roux, & Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008). Other studies have used self-report perception measures to obtain information on the variety, quality, and cost or affordability of produce in the neighborhood stores in which they shop. Two studies by Zenk et al. (2009a and 2009b) of a multiethnic sample in Detroit, MI asked study participants to rate their satisfaction with the variety, quality, and cost or affordability of fruits and vegetables in their neighborhood food. The neighborhood environment was defined to participants as the 10-15 walk or 5-minute driving area from their home. Responses were captured on a four-point scale with response options ranging from not at all satisfied to very satisfied (Zenk, Lachance, et al., 2009; Zenk, Schulz, et al., 2009). Details of the above listed measures of satisfaction with the neighborhood fruit and vegetable environment demonstrate slight variations in the types of information that such measures are able to capture.

Associations between observed characteristics of the food environment and satisfaction with the fruit and vegetable environment.

In this chapter, I conceptualize observed characteristics of the neighborhood food environment as factors that may influence satisfaction with the neighborhood fruit and vegetable environment. Having access to a wide variety of fresh fruit and vegetables in the neighborhood food environment is one example of ways in which observed characteristics of the neighborhood food environment may influence satisfaction with the neighborhood fruit and vegetable environment. A small body of literature has examined associations between observed characteristics of the food environment and satisfaction with the fruit and vegetable environment. For example, Moore and colleagues (2008) examined baseline data from the MESA study and found that when controlling for race and ethnicity and household income, participants who resided in neighborhoods with the lowest supermarket densities rated perceived availability of healthy foods significantly lower than participants who lived in areas with the highest densities of supermarkets. The same relationship held true when comparing perception of healthy food and supermarket densities among participants who lived in areas with moderate versus high supermarket density (Moore, Diez Roux, & Brines, 2008).

Similar to research by Moore and colleagues (2008), Zenk et al. (2009) examined multilevel predictors of satisfaction with the neighborhood fruit and vegetable environment among African American, non Hispanic Whites and Latinos in three communities across Detroit, MI (Zenk, Schulz, et al., 2009). Zenk and colleagues found that after accounting for neighborhood racial composition and poverty rates in immediate and surrounding neighborhood areas, distance to the nearest supermarket, as an observed characteristic of the neighborhood food environment, was significantly associated with satisfaction with the neighborhood fruit and vegetable environment. These analyses also

controlled for age, household size, years of neighborhood residence, gender, race and ethnicity, marital status, employment status, car ownership, and annual household income (Zenk, Schulz, et al., 2009).

Research from chapter 2 of this dissertation found results similar to Moore and colleagues (2008) and Zenk et al. (2009). Specifically, I found significant associations between observed characteristics of the neighborhood food environment (distance to the nearest supermarket) and satisfaction with the neighborhood fruit and vegetable environment when controlling for age, gender, length of residence in the neighborhood, marital status, car access, education, household poverty, neighborhood poverty and percent of African Americans in the neighborhood. Specifically, as distance to the nearest supermarket increased, satisfaction with the neighborhood fruit and vegetable environment decreased (Johnson, Dissertation Chapter 2, Models 3 and 4, Table 2.4). When included alone in the model (not accounting for other characteristics of the food environment), satisfaction was also negatively associated with the number of liquor stores in the neighborhood, and with the presence of a small grocery store in the neighborhood.

Results from these studies highlight potential associations between observed characteristics of the food environment such as distance to the nearest supermarket or density of other types of food stores, and satisfaction with the neighborhood fruit and vegetable or healthy food environment. While these studies report associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable or healthy food environment (Moore, Diez Roux, & Brines, 2008; Zenk, Schulz, et al., 2009), there remain inconsistencies in findings related to associations between satisfaction with the neighborhood food environment and

observed characteristics of the neighborhood food environment (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009).

Research that helps to illuminate other factors (beyond observed characteristics of the neighborhood food environment) that are associated with satisfaction with the neighborhood fruit and vegetable environment may help better understand these inconsistencies. Such associations may be particularly important for African Americans, who are more likely to live in neighborhoods with decreased access to healthy foods, have lower diet quality, and are more likely to suffer from diet-related disease (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005).

Predictors of satisfaction with the neighborhood fruit and vegetable environment

Socioeconomic status. This chapter focuses on the effects of SES on satisfaction with the neighborhood fruit and vegetable environment. SES has been shown to be associated with diet quality (Darmon & Drewnowski, 2008; Kant & Graubard, 2007). Individuals of lower SES often have poorer diet qualities compared to those of higher SES (Darmon & Drewnowski, 2008). For example, in a review of several cross-sectional studies, Darmon et al. (2008) found that high quality diets, those rich in whole grains, lean meats, fish, low-fat dairy products and fresh fruits and vegetables, were more likely to be consumed by groups of higher SES. In return, individuals with lower SES were more likely to consume lower quality diets, and greater quantities of refined grains and added fats (Darmon & Drewnowski, 2008). The associations between SES and diet quality have also been confirmed in results from several national surveys. Results from the 2009 BRFSS survey show adult consumption of 5+ fruits and vegetables a day

increased with increasing income and education (CDC, 2009). Additionally, results from NHANES (1988-94, 1999-2002) showed that those with a household income above the poverty threshold were significantly more likely to meet the U.S. Department of Agriculture (USDA) fruit and vegetable requirements compared to those with PIRs below the poverty threshold. Results were similar for education. Those who completed high school or more were significantly more likely to meet USDA fruit and vegetable guidelines compared to those who had not completed high school (Casagrande, et al., 2007). Given findings reported in chapter 2 of this dissertation and in research by Moore and colleagues (Moore, Diez Roux, Nettleton, et al., 2008) demonstrating that satisfaction with the food environment remains significantly associated with fruit and vegetable intake, above and beyond the observed characteristics of the good environment, understanding the role of socioeconomic status in shaping satisfaction can contribute to an understanding of potential points of intervention.

There are three main pathways through which SES may be associated with satisfaction with the neighborhood fruit and vegetable environment. Each of these pathways demonstrates potential relationships between SES and satisfaction with the neighborhood fruit and vegetable environment. First, neighborhood SES may influence observed characteristics of the neighborhood food environment and thus, satisfaction with the neighborhood fruit and vegetable environment. Second, household SES may be associated with satisfaction with the neighborhood fruit and vegetable environments, above and beyond neighborhood SES and observed characteristics of the food environment, by, for example, shaping food preferences or affordability. Third, household SES may modify relationships between observed food environments and

satisfaction by, for example, influencing access to foods outside the immediate neighborhood. Below I briefly review the literature relevant to the first of these pathways, followed by a more extensive review of the literature pertaining to the second and third pathways, which are the focus of the analyses in this chapter.

Neighborhood SES and satisfaction with food environments (brief review)

Observed characteristics of the neighborhood food environment may be associated with satisfaction with the neighborhood fruit and vegetable environment through associations with observed characteristics of the food environment. For example, in a recent review paper, Larson and colleagues (2009) note that findings from several studies suggest that neighborhoods with lower SES have less access to healthy food resources (Larson, et al., 2009). As a result, residents with low SES, who are more likely to live in neighborhoods characterized by low SES, may report lower levels of satisfaction with the neighborhood fruit and vegetable environment in part due to observed characteristics of those environments. In the analyses reported here, I account for (control for) neighborhood SES, but limit my research questions to the effects of household SES over and above neighborhood SES. These pathways are described in greater detail below.

Main effects of SES on satisfaction with the neighborhood fruit and vegetable environment. SES may influence satisfaction with the neighborhood fruit and vegetable environment . of observed characteristics of the neighborhood food environment. For example, a person of higher SES may have a more negative satisfaction with their neighborhood fruit and vegetable environment regardless of the quality of food resources available in their neighborhoods due to potentially having resources for increased exposures to other neighborhoods with healthier food environments and a higher standard

of healthy food. In addition, a person of lower SES may have more negative (or positive) satisfaction with the neighborhood fruit and vegetable environment regardless of the quality of food resources available due to the influence of factors beyond the observed food environment that influence perceptions that form satisfaction with the neighborhood fruit and vegetable environment. Such factors may be influenced by the social environment or social context of the neighborhood in which a person lives. Few studies have examined associations between socioeconomic predictors and satisfaction with the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009). Most include SES as one of several factors hypothesized to influence satisfaction with the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009).

Zenk et al. (2009) examined multilevel predictors of satisfaction with the neighborhood fruit and vegetable environment among African American, non Hispanic Whites and Latinos in three communities across Detroit, MI (Zenk, Schulz, et al., 2009). Zenk and colleagues found that those with equal to or less than a high school education were more satisfied with the neighborhood fruit and vegetable environment than those with greater than a high school education when controlling for individual level age, household size, length of residence in the neighborhood, gender, race/ethnicity, marital status (Zenk, Schulz, et al., 2009). Additionally, those who owned a home were more satisfied with their neighborhood fruit and vegetable environment compared to those who did not own their own home (Zenk, Schulz, et al., 2009). It is important to note that Zenk et al. (2009) did not control for effects of observed characteristics of the neighborhood food environment when examining associations between SES measures and satisfaction

with the neighborhood fruit and vegetable environment. Results from Zenk and colleagues (2009) demonstrate the importance of individual level SES variables that influence satisfaction with the neighborhood fruit and vegetable environment.

Boyington et al. (2009) examined associations between neighborhood and individual level economic predictors with perceptions of the food environment among a sample of more than 2,400 African American and non-Hispanic white participants in NC (Boyington, et al., 2009). Boyington and colleagues (2009) conducted chi square tests and found significant differences between poverty rate by census block group (< 12.3% vs. ≥ 12.3%), individual level income (< 30,000 vs. ≥ 30,000), and education (< high school vs. ≥ high school) and residents' perceptions of affordability of their neighborhood fruit and vegetable environment (Boyington, et al., 2009). Residents' perceptions of affordability are one component of three (quality, variety & affordability) that compose commonly used satisfaction with the neighborhood food environment measures (Boyington, et al., 2009; Moore, Diez Roux, & Brines, 2008; Zenk, Schulz, et al., 2009). Results from Boyington and colleagues (2009) provide evidence that significant differences in variation between predictors of SES and perceived affordability of the neighborhood fruit and vegetable environment may also influence overall perceptions of satisfaction with the neighborhood fruit and vegetable environment.

Common to Zenk et al. (2009) and Boyington et al. (2009) were significant associations between education and satisfaction with the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009). While directions of associations between SES measures and satisfaction were not available from Boyington et al. (2009), results from Zenk and colleagues (2009) highlight interesting

patterns in ways in which SES variables may influence satisfaction with the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009). The positive associations between home ownership and decreased levels of education and satisfaction with the neighborhood fruit and vegetable environment highlight interesting patterns that would benefit from further clarifications of associated mechanisms. It is important to note that while Zenk et al. (2009) did not control for effects of observed characteristics of the neighborhood food environment when examining associations between individual SES measures and satisfaction with the neighborhood fruit and vegetable environment, it may be important for future studies to do to in order to gain a better understanding of such mechanisms.

Moderating effects of socioeconomic status on satisfaction with the neighborhood fruit and vegetable environment. SES may also moderate associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Specifically, associations between observed characteristics of the food environment and satisfaction with the neighborhood fruit and vegetable environment would vary for those with high versus low SES (car access). For example, someone with high SES who resides in an area with a good observed food environment may be satisfied with their food environment due to being of high SES (for example, having easy car access) and having an extra outlet to compensate for what may or may not be available in their own environment. Being of high SES might weaken the negative effects of living in a poor food environment (that is, show a weaker relationship with satisfaction compared to those of low SES who are may be limited to their local food environment by not having access to transportation). As such,

those with low SES (limited car access) and who reside in areas with good food environments may be very satisfied with their food environment due to having to rely on an environment that is high in access and availability of fresh produce. Finally, I would expect someone with limited car access residing in a poor food environment to be more dissatisfied with their food environment than someone with easy car access due to not having fresh produce in their neighborhood and not having access to a car (easy car access) to travel outside of one's neighborhood to obtain fresh produce.

Zenk and colleagues also examined moderating effects of SES on associations between the neighborhood food environment and satisfaction (Zenk, Schulz, et al., 2009). Zenk and colleagues (2009) theorized that SES may interact with components of the neighborhood food environment to influence satisfaction with the neighborhood fruit and vegetable environment. Among the only studies we found examining moderating effects, Zenk et al. (2009) found modifying effects of education on associations between the neighborhood food environment (convenience, liquor and small grocery stores) and satisfaction with the neighborhood fruit and vegetable environment when controlling for observed characteristics of the neighborhood food environment and age, household size, length of residence in the neighborhood, gender, race/ethnicity, marital status at the individual level (Zenk, Schulz, et al., 2009). Specifically, the presence of a liquor, convenience, or small grocery store was associated with decreased satisfaction with the food environment among participants with less than a high school education and high school graduates compared to those with at least some college education (Zenk, Schulz, et al., 2009). Such results add complexity to the common associations found between SES and health in which higher SES often affords residence in neighborhoods with

healthier food resources, improved health behavior, and improved health outcomes (Adler & Ostrove, 1999; Darmon & Drewnowski, 2008; Kennedy, Paeratakul, Ryan, & Bray, 2007).

Summary and Gaps in the Literature. Given the limited body of research described above, additional research is needed to determine the mechanisms, direction, and magnitude of associations between individual level SES and satisfaction with the neighborhood fruit and vegetable environment. Zenk and colleagues (2009) found significant associations between individual level education and home ownership with satisfaction with the neighborhood fruit and vegetable environment among a sample of African American, non-Hispanic Whites, and Latinos, however did not control for the effects of the observed neighborhood food environment (Zenk, Schulz, et al., 2009). In addition, using chi-square tests Boyington et al. (2009) also found significant differences in satisfaction with the affordability of fruits and vegetables in the neighborhood environment across levels of income, education and census block group level poverty (Boyington, et al., 2009). This chapter contributes and builds upon research by Zenk et al. (2009) and others by further examining associations between SES and satisfaction with the neighborhood fruit and vegetable environment while adjusting for observed characteristics of the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009).

This chapter also examines the role of SES as modifying associations between the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and

vegetable environment may differ for those with higher levels of education or income compared to those with lower levels of education or income. Research by Zenk and colleagues (2009) is the only study found to date that examined associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment (Zenk, Schulz, et al., 2009). The interaction of SES with elements of the neighborhood food environment, for residents of lower SES residing in areas of low healthy food access in particular, may heavily influence satisfaction with the neighborhood fruit and vegetable environment. Therefore it becomes important to look at SES not only as a predictor of satisfaction with the neighborhood fruit and vegetable environment while controlling for observed characteristics of the neighborhood environment, but also as a potential modifier of relationships between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Further examination of the above listed associations may be particularly important for African Americans, whose diets and diet-related health outcomes often suffer the worst given their increased likelihood for residing in low income areas that may have poorer observed food environments (Cummins & Macintyre, 2006; Larson & Story, 2009; Larson, et al., 2009). Determining ways in which SES interacts with observed characteristics of the neighborhood food environment or influences satisfaction with the neighborhood food environment above and beyond effects of observed characteristics of the neighborhood food environment may help improve the accuracy and tailoring of public health interventions seeking to improve dietary intakes and other diet related health behaviors.

To that end, this study contributes to the body of literature mentioned above by examining the following research questions and hypotheses:

(1) Is household SES associated with reported satisfaction with the neighborhood fruit and vegetable environment after accounting for observed characteristics of the neighborhood food environment?

(H1) African American participants of with lower SES (modeled as not owning a home, being currently unemployed, having a household income below the federal poverty level, and with limited car access) will have levels of satisfaction with the neighborhood fruit and vegetable environment that are significantly different from those of higher SES (owning a home, being currently employed, having a household income above the federal poverty level, and having car access). These associations will hold while controlling for observed characteristics of the neighborhood food environment.

(H2) African Americans with lower education levels will have higher satisfaction with the neighborhood fruit and vegetable environment compared to African Americans with higher levels of education, after controlling for observed characteristics of the food environment (Zenk, Schulz, et al., 2009).

(2) Does household SES modify relationships between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment?

(H2) SES (education, home ownership, employment status, household poverty, and car access) will significantly modify the relationship between observed characteristics

of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment.

(H2a) More specifically, the relationship between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment will vary in strength or direction across levels of SES predictors. Building on results from Zenk et al. (2009), observed characteristics of the neighborhood food environment will be more strongly associated with satisfaction among those with lower, compared to higher, SES (Zenk, Schulz, et al., 2009).

Methods

Study Design and Sample Description

Data for this study are drawn from the Healthy Environments Partnership (HEP) wave 1 2002 community survey. The HEP is one component of a community-based participatory research project involving academic, health service providing, and community based organizations in Detroit, Michigan (Schulz, et al., 2005). The University of Michigan Institutional Review Board for Protection of Human Subjects approved the study in January 2001. The HEP survey uses a stratified 2 stage probability sample of occupied housing units designed for 1,000 completed interviews with adults ages $\geq$ 25 years across 3 areas of Detroit. Such a design allows for comparisons of residents of similar demographics across geographic areas of the city of Detroit (Schulz, et al., 2005). The survey sample was designed to achieve adequate variation in socioeconomic position within each of the three predominant racial and ethnic groups in Detroit: African-American, Latino, and White in order to conduct analysis of SES within and across racial and ethnic groups. Data were imputed to account for missing values.

The final sample consisted of 919 face-to-face interviews: interviews were completed with 75% of households in which an eligible respondent was identified and 55% of households with a known or potential respondent (Schulz, et al., 2005). The 919 respondents were nested within 69 census blocks. Of the total multiethnic sample, analysis for this study focuses on the 522 African American participants nested in 115 blocks and 67 census block groups throughout the Eastside, Southwest, and Northwest Detroit study areas.

Measures

Dependent

Satisfaction with the neighborhood fruit and vegetable environment. Satisfaction with the neighborhood fruit and vegetable environment was measured at the individual-level using the mean value from a three-question scale. The questions, "How satisfied are you with the (1) variety, (2) quality, and (3) cost and affordability of fresh fruits and vegetables in their neighborhood?" had response options ranging from (1) not satisfied at all, (2) not very satisfied, (3) somewhat satisfied, and (4) very satisfied. The mean of responses to the three items was modeled in the analysis. Higher scores signified higher satisfaction. The neighborhood food environment was defined as, "foods that are available to you within a 10-15 minute walk or 5 minute drive from your home, including grocery stores, convenience stores, or other places you might buy food."

Socioeconomic Status.

Education level was modeled as a three level variable; less than high school, high school diploma or GED, and some college or greater).

Employment status was modeled as a binary variable defined as currently working for pay or not currently working for pay.

Home ownership was modeled as a binary variable defined as owning a home or buying a home versus renting a home for money, occupying a home without paying rent, or something else.

Car access was modeled as a binary variable. Car access was defined as easy car access (having a car or not having a car but it being not very difficult or not difficult at all to access a car) or limited car access (having a car and it being not to somewhat to very difficult to access a car). Having a car may influence fruit and vegetable consumption by broadening one's perception of their neighborhood food environment and by expanding their neighborhood boundaries and access to stores that sell fruit and vegetables (Rose & Richards, 2004).

Household Poverty was calculated for the HEP sample using 2002 census estimates for the U.S. poverty thresholds (organized by family size and number of children) and HEP survey data available for total household income and the total number of adults and children in the household for 2002. Household poverty was modeled as a binary variable of whether household per capita income fell below or above the Federal Poverty Level for 2002.

Observed Characteristics of the Neighborhood Food Environment. Information on several store type variables was captured using dichotomous (yes or no) indicators of the following food stores by type at the census block level located in each neighborhood. Neighborhoods were defined using a 0.5 mile Euclidean distance buffer from the centroid of the residential census block (Zenk, Lachance, et al., 2009).

Large grocery stores. Large grocery stores were defined as non-chain stores that had three or more operating cash registers.

Small grocery stores. Small grocery stores were defined as non-chain stores with one or two operating cash registers.

Convenience stores. Convenience stores or food stores were defined as those without gas stations and that limited capacity for check-out.

Specialty stores. Specialty stores were defined as fruit and vegetable or meat or seafood markets.

Supermarkets. Supermarkets were defined as full service chain stores. There was only one supermarket in the 146 census blocks used for this study in 2002. Thus, supermarket proximity was used as a measure of availability instead of a count of stores. ArcGIS Network Analyst 9.1(Environmental Systems Research Institute, Redlands, California) was used to measure supermarket proximity as the street network distance in miles from the centroid of the residential census block to the nearest supermarket.

Liquor or party stores. Liquor or party stores were defined according to their classification as liquor store in the telephone directory, the presence of liquor or party store in their names or a main food sign in front of the store containing liquor, beer, or wine. Liquor or party stores were measured using a count of the number of liquor stores present in each census block.

Control Variables

Several variables previously demonstrated to be associated with satisfaction with the neighborhood fruit and vegetable environment were included as control

variables. These included both neighborhood and individual level variables, as described below.

Individual Level Controls

Gender (male or female), *age* (continuous), and *marital status* (married/in a relationship or not currently married /separated /divorced /widowed). *Length of residence in the neighborhood* was defined as participant report of the number of years they resided in their current neighborhood. The neighborhood was defined to participants as the blocks that surround the block in which they lived and was within walking distance of their homes. Length of residence in the neighborhood was modeled as a continuous variable in years.

Neighborhood Level Controls

Percent poverty and percent Black or African American were modeled as census block group level (level 3) control variables due to their indirect associations with satisfaction with the neighborhood fruit and vegetable environment among African Americans by influencing observed characteristics of the neighborhood food availability. Modeling level 3 block group variables, mean percent poverty and mean percent African American, allowed the opportunity to control for non-independence of observations at levels 2 (block) and 1 (individual) in the analysis. Percent poverty was defined as the percent of individuals in the census block group who had family incomes below the federal poverty line (FPL). Percent Black or African American was defined as the percent of non-Hispanic African

American residents in each census block group. Data for percent African American and percent poverty measures were generated from Census 2000 data files. The mean percent poverty and mean percent Black or African American for each census block group were modeled as continuous measures in the analysis.

Data Analysis

Several analytic steps were taken to address research questions. First, weighted descriptive statistics and univariate procedures were performed using SAS software, Version [9.3] for Windows. All sample statistics were adjusted for sample weights for unequal probabilities of selection within each stratum and to match the sample to Census 2000 population distributions for the study areas. Given the complex sample design, demographic statistics were calculated using proc surveyfreq, proc surveymeans, and IVEware % describe commands to estimate weighted means and proportions.

The second analytic step was to test study hypotheses. Three-level hierarchical regression models for a continuous outcome were estimated using HLM 7 (Scientific Software International, Lincolnwood, IL, 2011). Level 1 were the 522 African American survey respondents; level 2 were the 115 census blocks in which respondents lived; and level 3 were the 67 census block groups. I first tested the hypothesis that African Americans of lower SES would have levels of satisfaction with the fruit and vegetable environment with the neighborhood food environment that were significantly different from those of higher SES. Associations between SES and satisfaction with the fruit and vegetable environment controlled for observed characteristics of the neighborhood food environment. Socioeconomic variables were entered in the model as three separate sets of

predictors due to several variables being correlated with other. Education and home ownership were modeled together (p= 0.97), car access and employment were modeled together (p= 0.15) and household poverty was modeled alone due to high correlation with all of the other SES predictors. Observed characteristics of the neighborhood food environment or in this case, store presence variables (distance to the nearest supermarket (in miles), number of liquor stores, and the presence or lack of any small or large grocery stores, convenience stores, and specialty stores) were modeled as a collectively set of control variables. All continuous variables at the individual block and block group levels were grand mean centered.

Second, I examined the hypothesis that SES would significantly modify relationships between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. This chapter used Baron and Kenny's (1986) method of testing for moderation to test for the moderating effects of SES on the relationship between observed characteristics of the neighborhood food environment and residents' satisfaction with neighborhood fruit and vegetable environment (Baron & Kenny, 1986). Moderation is significant if the interaction is significant. A moderation effect between the two variables is not dependent on whether or not there were significant main effects between the predictor and moderator variables with the dependent variable (Baron & Kenny, 1986). Thus, moderation effects were examined for all socioeconomic variables regardless of if they were significantly associated with of satisfaction with the neighborhood fruit and vegetable environment. All models controlled for demographic variables at the individual level (age, gender, marital status, and length of residence in the neighborhood) and percent poverty and

percent African American at the block group level. All continuous variables were grand mean centered**.**

Results

Table 2.1 displays weighted sociodemographic characteristics of sample (n=522). The mean age was 46.6 years, and 56.3% were female. Roughly a quarter of the sample was married (27.4%). The mean length of residence in a neighborhood was 18.3 years. Finally, the mean percent poverty value for all 67 block groups was 32.5%. The mean percentage of African Americans across all block groups was 67.5%.

The second half of table 2.1 describes average characteristics of the main . and dependent variables. At the individual level, satisfaction with the neighborhood fruit and vegetable supply was the dependent variable. On a scale of 1 to 4, mean satisfaction with the variety, quality, cost and affordability of fruit and vegetables was 2.8, indicating most participants were between not very satisfied to somewhat satisfied with the produce in their neighborhood food environment.

Socioeconomic status variables were modeled at the individual level as main independent variables. Just below half of participants owned their own home (45.6%) and slightly more than a third (34.2%) had a high school diploma or GED. Roughly two thirds (67.4%) of the sample was employed or currently working and 85.4% had easy car access. Finally, 37.5% of participants resided in household with incomes below the federal poverty level. Observed characteristics of the neighborhood food environment were modeled as variables at the census block level. On average, survey participants traveled 3.5 miles to the nearest supermarket, and lived in census blocks with an average of 4.6 liquor stores. Roughly a third (30.4%) of all blocks had at least one large grocery

store; 22.6% had at least one specialty store; 23.5% had at least one small grocery store; and 28.7% had at least one convenience store.

Main associations between SES and Satisfaction. Tables 3.1 to 3.3 present multilevel regression results from the test of the first research question, associations between SES and satisfaction with the neighborhood fruit and vegetable environment . of observed characteristics of the neighborhood food environment. Model 1 is a fully unconditional model that indicates significant variation in mean daily fruit and vegetable intakes at the census block group level (β= 2.75, s.e. = 0.04; $p<0.01$). Based on the intraclass correlation at the block level (block level neighborhood variation divided by the sum of the block group level neighborhood variation + block level neighborhood variation + individual variance), 3.47% of the variation in mean daily fruit and vegetable intakes was between census blocks. Based on the intraclass correlation at the block group level (block group level neighborhood variation divided by the sum of the block group level neighborhood variation + block level neighborhood variation + individual variance), 1.65% of the variation in mean daily fruit and vegetable intakes was between census block groups. Model 2 in tables 3.1 to 3.3 added individual sociodemographic variables collectively, all at one time. After adjusting for individual level covariates in model 2, 1.78% of the variance in mean daily fruit and vegetable servings remained at the census block level and 1.15% at the census block group level. Despite low intraclass correlations, multilevel modeling was necessary due to the structure of the data collected for this study. The data was collected using a two-stage probability sample. The two-stage probability sample first selected a sample of census block groups within 6 strata that were categorized and sectioned by percent neighborhood poverty and percent African

American. Second, households within those block groups were selected. Ignoring the above described multilevel nature of the data would be inappropriate for the study sampling design.

Results from the regression of socioeconomic variables on satisfaction with the neighborhood fruit and vegetable environment are presented in tables 3.1 to 3.3. As described earlier, SES variables were entered into the models in sets, in order to account for correlations among these indicators. Specifically, table 3.1 presents results from models including education and home ownership; table 3.2 presents findings from models including employment and car ownership; and table 3.3 presents findings from models including household poverty level alone, due to correlations with other indicators of SES. Education was significantly associated with satisfaction with the neighborhood fruit and vegetable environment when controlling for observed characteristics of the neighborhood food environment and home ownership. Specifically, when controlling for observed characteristics of the neighborhood food environment and home ownership, those with less than a high school education were significantly more likely to be satisfied with their fruit and vegetable environment compared to those with at least some college education ($\beta = 0.28$; s.e = 0.09; $p < 0.01$, Model 5a, Table 3.1), after accounting for the observed characteristics of the neighborhood food environment and home ownership. Similarly, those with a high school diploma or GED were significantly more likely to be satisfied with their fruit and vegetable environment compared to those with at least some college education ($\beta = 0.21$; s.e = 0.09; $p = 0.02$, Model 5a, Table 3.1). The same models included home ownership as an indicator of socioeconomic status. Associations between home ownership and satisfaction were not significant. The remaining two groups of SES

variables, car access and employment (modeled together in Table 3.2) and household poverty (Table 3.3) were not significantly associated with satisfaction with the neighborhood fruit and vegetable environment when controlling for observed characteristics of the neighborhood food environment.

Modifying effects of SES on relationship between observed food environment and satisfaction. Moderating effects of SES variables on the relationship between the observed food environment and satisfaction were also entered into the models in sets in order to account for correlations among these indicators. Results from the second research question, the modifying effects of SES on relationships between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood food environment among African Americans are shown in Table 3.4. Only SES groups with significant interactions are shown. Car access significantly moderated associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment (Model 1, Table 3.4). Specifically, participants with limited car access and who lived in census blocks with at least one specialty store, reported higher levels of satisfaction with the neighborhood fruit and vegetable environment compared to those who had a car or did not have a car but it not being very difficult or not difficult at all to access a car (hereafter referred to as 'having a car or not having a car but having easy access to a car') ($\beta = 0.38$; s.e = 0.16; $p = 0.02$, Model 1, Table 3.4). Moderating associations between other SES variables on the relationship between observed characteristics of the neighborhood food environment and satisfaction were not significant.

Discussion

This chapter contributes to previous research in two main ways; first, by examining the question of whether indicators of socioeconomic status are associated with satisfaction with the neighborhood fruit and vegetable environment among African Americans; and second, examining whether indicators of socioeconomic status modify associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Several socioeconomic variables were examined, including: education, home ownership, employment status, household poverty, and car access. The above listed variables were chosen as indicators of SES due to their potential as predictors of satisfaction and for previously documented associations with satisfaction with the neighborhood fruit and vegetable environment (Boyington, et al., 2009; Zenk, Schulz, et al., 2009).

Main effects of SES on satisfaction with the neighborhood fruit and vegetable environment. This study found those with some college education reported lower levels of satisfaction with their neighborhood fruit and vegetable environment compared to those who had not completed high school as well as those who had graduated high school but not gone on to college. The significant negative associations between education and satisfaction with the neighborhood fruit and vegetable environment are similar to results from a study by Zenk and colleagues (Zenk, Schulz, et al., 2009). Previous research by Zenk et al. (2009) used the full multiethnic sample from which the African American population for the current study was drawn. Zenk and colleagues (2009) found that those with less education were more satisfied with their neighborhood fruit and vegetable availability compared to those with greater than a high school education when controlling

for individual level age, household size, length of residence in the neighborhood, gender, race/ethnicity, marital status (Zenk, Schulz, et al., 2009). There are several possible explanations for the association between education and satisfaction with the neighborhood fruit and vegetable environment found in this chapter (Table 3.1) and in research by Zenk and colleagues (Zenk, Schulz, et al., 2009). Those with higher levels of education may be more cognizant of the underlying issues (race-based residential segregation and neighborhood poverty) that shape their access to healthy food. Those with higher levels of education may be more likely to eat more fruits and vegetables (Casagrande, et al., 2007; Darmon & Drewnowski, 2008) than those with lower levels of education and thus be less satisfied if options are limited. Finally, those with higher levels of education may have more a more critical appraisal and heightened expectations for the variety, quality, cost, and affordability of fresh produce due to increased exposure to other environments. Those with lower levels of education may have lower expectations for fresh produce due to having less exposure to what other environments or neighborhoods may have. Satisfaction with the neighborhood fruit and vegetable environment was not significantly associated with the remaining SES indicators (car access, employment, home ownership, and household poverty). This may have been due to the remaining SES variables not associated with satisfaction not having captured enough variation in their respective measures . from characteristics of the observed food environment to influence satisfaction with the neighborhood fruit and vegetable environment among this sample of African Americans.

Moderating effects of SES on associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and

vegetable environment. There were however, significant moderating effects of car access on associations between observed characteristics of the food environment and satisfaction with the fruit and vegetable environment. Results from examination of moderating effects in chapter 3 show associations between having a specialty store in the neighborhood and satisfaction differ according to whether or not a person has access to a car. Specifically, for with limited car access, those who live in food environments that include a specialty store report higher levels of satisfaction, compared to those who live in neighborhoods without a specialty store. There is a weaker association for those with easy car access, which is consistent with the hypothesis that those without a car are more dependent on their local food environments, and their levels of satisfaction are more strongly shaped by the resources that are available within those environments (Model 1, Table 3.4). Specialty stores were defined as produce or meat markets. Those with limited car access may be more satisfied with specialty stores in their neighborhood due to having to rely more on the produce available in their neighborhood compared to those with easy car access. Those with easy car access may put forth less effort into finding sources of fresh produce in their neighborhood due to having the ability to travel or reach other resources for fresh produce. Findings from this moderating effect highlight the importance of having healthy food in a neighborhood, especially for those who do not have easy access to food resources outside of their neighborhood environment. Interpretations of this interaction effect are limited because the data used in this study does not provide information on the type of produce available in stores by store type.

Limitations. There were several limitations associated with this research. The sample is cross-sectional and thus generalizability and information on trends over time

were unavailable. Additionally, while every effort was made to correctly count and categorize characteristics of the observed neighborhood food environment, there may still be misclassification or errors in measures of the neighborhood food environment. Furthermore, the limitation of the sample to African American residents of Detroit only, while a strength in that it allows for extensive within group analyses that account for environmental and social factors unique to African Americans, also introduces constraints. In particular, results from this study should only be interpreted as generalizable to African Americans residing in similar urban environments and may not necessarily remain consistent when examining similar associations on a national level or with multiethnic samples that do not share the same neighborhood level characteristics.

Conclusion. This research has implications for understanding the influence of SES on relationships between observed characteristics of the neighborhood food environment and satisfaction with the fruit and vegetable environment. Major contributions of this chapter are the significant associations between lower levels of education and increased satisfaction with the neighborhood fruit and vegetable environment and the moderating effect of car access on the relationship between specialty stores and satisfaction. These results occur when adjusting for observed characteristics of the food environment and highlight the need to consider not only individual level factors that may influence satisfaction, like SES, but how such factors are influenced and structured by larger level factors, like neighborhood poverty and race-based residential segregation. Neighborhood poverty and race-based residential segregation influence observed characteristics of the neighborhood food environment and household poverty. African Americans are more likely to reside in racially segregated neighborhoods that

have higher concentrations of poverty compared to Whites (Kumanyika, et al., 2007). In addition, healthy food resources in African American neighborhoods are less available and when present are of lower quality than that found in other neighborhoods (Chang, 2006; Cummins & Macintyre, 2006; Kumanyika, et al., 2007; Larson & Story, 2009; Larson, et al., 2009; Williams, et al., 2010; Wilson, 2010). Associations examined in this chapter among a sample of African Americans help to illuminate unique factors that are essential for improving fruit and vegetable intakes among African Americans and patterns that may be illustrative of important features and relationships that contribute to their increased burden of diet-related disease.

Results from this research have several implications for public health interventions seeking to reduce African Americans' excess burden of diet-related disease. The significant findings of decreased education associated with increased satisfaction and car access as moderating associations between specialty stores and satisfaction with the neighborhood fruit and vegetable environment supports interventions that seek to: 1) improve local access to good food, particularly for those with limited car access; and/or 2) improve public transportation to enable those without a car to access foods outside of their immediate neighborhoods. Specifically, attention focused on those with low SES (limited car access) residing in environments with less access to healthy food (lower numbers of specialty stores) may benefit from the most targeted interventions focused on increased access to healthy, fresh produce.

Specifically, for interventions working with populations that have limited car access, local access to healthy foods may be of particular importance. Strategies may include the use of food trucks to bring healthy food to neighborhoods with low access, or

offering incentives to owners of small grocery stores or convenience stores to carry fresh, quality, and affordable produce. Such efforts may be ways to improve the quality, variety, and affordability of healthy food in poor observed food environments. In addition, providing increased transportation through bus routes or designated carpools that go from neighborhoods with low healthy food access to areas where there are stores selling healthy, quality and affordably produce may also improve access to fresh fruits and vegetables (given there are stores available within a reasonable distance that residents' would be likely to shop in). Finally, mobile healthy cooking demonstrations could accompany food trucks in order to increase education about making healthy food choices within the context of increasing access and opportunity to make healthy food choices.

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Table 3.1

Self-reported satisfaction with the neighborhood fruit and vegetable environment regressed on socioeconomic status controlling for observed characteristics of the neighborhood food environment

	Model 1a: Fully Unconditional			Model 2a: Covariates			Model 3a: Neighborhood Food Environment			Model 4a: Education + Home Ownership			Model 5a: SES Variables + Neighborhood Food		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.75	0.04	<0.01	2.89	0.09	<0.01	2.91	0.10	<0.01	2.80	0.12	<0.01	2.77	0.12	<0.01
Age (years)*				<0.01	<0.01	0.22	<0.01	<0.01	0.15	<0.01	<0.01	0.66	<0.01	<0.01	0.55
Gender (reference: male)				-0.05	0.07	0.48	-0.06	0.07	0.39	-0.03	0.07	0.73	-0.04	0.08	0.62
Length of residence in neighborhood (years)*				<0.01	<0.01	0.19	<0.01	<0.01	0.09	<0.01	<0.01	0.22	0.01	<0.01	0.08
Marital Status (reference: married)				-0.11	0.08	0.16	-0.11	0.08	0.17	-0.10	0.08	0.23	-0.10	0.08	0.20
Education < High School (ref: at least some college)										**0.24**	**0.09**	**0.01**	**0.28**	**0.09**	**<0.01**
High School Diploma or GED (ref: at least some college)										**0.19**	**0.09**	**0.03**	**0.21**	**0.09**	**0.02**
Home Ownership (reference: owns a home)										-0.10	0.08	0.17	-0.08	0.07	0.25
Census Block Level															
Distance to nearest supermarket (miles)*							-0.16	0.06	0.01				-0.19	0.06	<0.01
Count of Liquor Stores*							0.01	0.02	0.51				0.01	0.02	0.47
Any Small Grocery Store (ref: none)							0.07	0.11	0.54				0.09	0.11	0.42
Any Large Grocery Store (ref: none)							-0.05	0.08	0.49				-0.04	0.07	0.60
Any Convenience Store (ref: none)							-0.06	0.07	0.44				-0.03	0.07	0.73
Any Specialty Store (ref: none)							-0.03	0.09	0.75				-0.02	0.10	0.87
Census Block Group Level															
Mean Percent Poverty*				<-0.01	<0.01	0.28	<-0.01	<0.01	0.99	<-0.01	<0.01	0.20	<-0.01	<0.01	0.96
Mean Percent African American*				<-0.01	<0.01	0.01	<-0.01	<0.01	0.04	<-0.01	<0.01	0.01	<-0.01	<0.01	0.03
Sigma squared, σ^2			0.62629			0.62069			0.61769			0.60687			0.60404
Tau pi, $T\pi$			0.02289			0.01135			0.00892			0.01292			0.00933
Tau beta, $T\beta$			0.01088			0.00737			0.00012			0.00968			0.00010
* Variables were grand-mean centered															
§ SE indicates standard error															
All models were adjusted at the individual level for age, length of residence in neighborhood, gender, and marital status. All models were adjusted at the block group level for % Poverty and % African American.															

Table 3.2

Self-reported satisfaction with the neighborhood fruit and vegetable environment regressed on socioeconomic status controlling for observed characteristics of the neighborhood food environment

	Model 1b: Fully Unconditional			Model 2b: Covariates			Model 3b: Neighborhood Food Environment			Model 4b: Hard to Access a Car + Not Employed			Model 5b: SES Variables + Neighborhood Food		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.75	0.04	<0.01	2.89	0.09	<0.01	2.91	0.10	<0.01	2.92	0.10	<0.01	2.93	0.10	<0.01
Age (years)*				<0.01	<0.01	0.22	<0.01	<0.01	0.15	<0.01	<0.01	0.35	<0.01	<0.01	0.36
Gender (reference: male)				-0.05	0.07	0.48	-0.06	0.07	0.39	-0.07	0.07	0.35	-0.08	0.07	0.28
Length of residence in neighborhood (years)*				<0.01	<0.01	0.19	<0.01	<0.01	0.09	<0.01	<0.01	0.18	<0.01	<0.01	0.08
Marital Status (reference: married)				-0.11	0.08	0.16	-0.11	0.08	0.17	-0.11	0.08	0.18	-0.10	0.08	0.19
Car Access (reference: easy car access)										-0.19	0.10	0.07	-0.17	0.10	0.10
Employment Status (reference: employed)										0.02	0.08	0.84	0.05	0.08	0.57
Census Block Level															
Distance to nearest supermarket (miles)*							-0.16	0.06	0.01				-0.16	0.06	0.01
Count of Liquor Stores*							0.01	0.02	0.51				0.01	0.02	0.54
Any Small Grocery Store (ref: none)							0.07	0.11	0.54				0.07	0.11	0.53
Any Large Grocery Store (ref: none)							-0.05	0.08	0.49				-0.05	0.07	0.52
Any Convenience Store (ref: none)							-0.06	0.07	0.44				-0.06	0.07	0.42
Any Specialty Store (ref: none)							-0.03	0.09	0.75				-0.03	0.09	0.79
Census Block Group Level															
Mean Percent Poverty*				<-0.01	<0.01	0.28	<-0.01	<0.01	0.99	<-0.01	<0.01	0.32	<0.01	<0.01	0.94
Mean Percent African American*				<-0.01	<0.01	0.01	<-0.01	<0.01	0.04	<-0.01	<0.01	0.01	<-0.01	<0.01	0.05
Sigma squared, σ^2			0.62629			0.62069			0.61769			0.61628			0.61409
Tau pi, Tπ			0.02289			0.01135			0.00892			0.01219			0.00859
Tau beta, Tβ			0.01088			0.00737			0.00012			0.00667			0.00022

* Variables were grand-mean centered

§ SE indicates standard error

All models were adjusted at the individual level for age, length of residence in neighborhood, gender, and marital status. All models were adjusted at the block group level for % Poverty and % African American.

Table 3.3

Self-reported satisfaction with the neighborhood fruit and vegetable environment regressed on socioeconomic status controlling for observed characteristics of the neighborhood food environment

	Model 1c: Fully Unconditional			Model 2c: Covariates			Model 3c: Neighborhood Food Environment			Model 4c: Household Poverty			Model 5c: Household Poverty + Neighborhood Food		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.75	0.04	<0.01	2.89	0.09	<0.01	2.91	0.10	<0.01	2.86	0.10	<0.01	2.88	0.10	<0.01
Age (years)*				<0.01	<0.01	0.22	<0.01	<0.01	0.15	<0.01	<0.01	0.25	<0.01	<0.01	0.18
Gender (reference: male)				-0.05	0.07	0.48	-0.06	0.07	0.39	-0.05	0.07	0.49	-0.06	0.07	0.39
Length of residence in neighborhood (years)*				<0.01	<0.01	0.19	<0.01	<0.01	0.09	<0.01	<0.01	0.15	0.01	<0.01	0.06
Marital Status (reference: married)				-0.11	0.08	0.16	-0.11	0.08	0.17	-0.11	0.08	0.15	-0.11	0.08	0.16
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)										0.08	0.08	0.32	0.10	0.08	0.20
Census Block Level															
Distance to nearest supermarket (miles)*							-0.16	0.06	0.01				-0.17	0.06	0.01
Count of Liquor Stores*							0.01	0.02	0.51				0.01	0.02	0.58
Any Small Grocery Store (ref: none)							0.07	0.11	0.54				0.06	0.11	0.56
Any Large Grocery Store (ref: none)							-0.05	0.08	0.49				-0.06	0.08	0.44
Any Convenience Store (ref: none)							-0.06	0.07	0.44				-0.05	0.08	0.52
Any Specialty Store (ref: none)							-0.03	0.09	0.75				-0.02	0.09	0.81
Census Block Group Level															
Mean Percent Poverty*				<-0.01	<0.01	0.28	<-0.01	<0.01	0.99	<-0.01	<0.01	0.24	<-0.01	<0.01	0.96
Mean Percent African American*				<-0.01	<0.01	0.01	<-0.01	<0.01	0.04	<-0.01	<0.01	0.01	<-0.01	<0.01	0.04
Sigma squared, σ^2			0.62629			0.62069			0.61769			0.61710			0.61339
Tau pi, Tπ			0.02289			0.01135			0.00892			0.01314			0.01095
Tau beta, Tβ			0.01088			0.00737			0.00012			0.00824			0.00023
* Variables were grand-mean centered															
§ SE indicates standard error															
All models were adjusted at the individual level for age, length of residence in neighborhood, gender, and marital status. All models were adjusted at the block group level for % Poverty and % African American.															

Table 3.4

Socioeconomic status as modifying associations between observed characteristics of the neighborhood food environment and self-reported satisfaction with the neighborhood fruit and vegetable environment

	Model 1: Car Access			Model 2: Employment Status		
	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.92	0.10	<0.01	2.97	0.11	<0.01
Car Access (reference: easy car access)	-0.16	0.17	0.35	-0.17	0.10	0.11
Employment Status (reference: employed)	0.03	0.09	0.72	-0.08	0.12	0.50
Census Block Level						
Distance to nearest supermarket (miles)*	-0.16	0.06	0.02	-0.13	0.06	0.03
Count of Liquor Stores*	<0.01	0.02	0.84	0.01	0.02	0.74
Small Grocery Store (% any vs. none)	0.09	0.12	0.46	-0.02	0.13	0.85
Large Grocery Store (% any vs. none)	-0.04	0.08	0.61	-0.04	0.09	0.68
Convenience Store (% any vs. none)	-0.03	0.08	0.70	-0.10	0.10	0.36
Specialty Store (% any vs. none)	-0.10	0.09	0.31	-0.12	0.10	0.25
Interactions	**Car Access**			**Employment Status**		
Distance to nearest supermarket (miles)*	0.09	0.28	0.75	-0.08	0.14	0.58
Count of Liquor Stores*	0.05	0.08	0.54	0.01	0.04	0.80
Any Small Grocery Store (ref: none)	-0.25	0.20	0.21	0.29	0.20	0.17
Any Large Grocery Store (ref: none)	-0.04	0.17	0.84	0.01	0.14	0.92
Any Convenience Store (ref: none)	-0.18	0.25	0.49	0.09	0.18	0.61
Any Specialty Store (ref: none)	**0.38**	**0.16**	**0.02**	0.22	0.20	0.28
Sigma squared, σ^2			0.60174			0.61207
Tau pi, $T\pi$			0.01239			0.00518
Tau beta, $T\beta$			0.00026			0.00011

* Variables were grand-mean centered

§ SE indicates standard error

All models were adjusted at the individual level for age, length of residence in neighborhood, gender, and marital status.
All models were adjusted at the block group level for % Poverty and % African American.

Chapter 4

What Role Do Organizational Membership and Neighborhood Participation Play in Associations Between Observed Characteristics of the Neighborhood Food Environment and Self-Reported Satisfaction with the Neighborhood Fruit and Vegetable Environment Among African Americans?: Tests of Main and Modifying Effects

Introduction

Satisfaction with the neighborhood fruit and vegetable environment has been shown to be associated with fruit and vegetable intakes, in conjunction with observed characteristics of the neighborhood food environment (Moore, Diez Roux, Nettleton, et al., 2008). Here, I extend that research by examining how aspects of the social environment may influence satisfaction, above and beyond, or in conjunction with observed characteristics of the neighborhood food environment. Specifically, I examine whether indicators of social engagement, in this case, organizational membership and neighborhood participation, are associated with satisfaction with the neighborhood fruit and vegetable environment. The social interactions and connections that emerge from membership in neighborhood organizations and participation in neighborhood groups and activities may influence satisfaction with the neighborhood fruit and vegetable environment by, for example, exposing individuals to a range of attitudes, beliefs, and resources about food in their neighborhood environment and beyond.

Relatively little research to date has examined how aspects of the social environment, may contribute to, or operate in conjunction with, observed characteristics of the neighborhood food environment, such as the number and type of food stores in an area. Measures of social engagement, such as membership in civic organizations or

participation in neighborhood activities, tap one aspect of the social environment, reflecting individual's participation in social networks that extend beyond the immediate family and, in the case of civic organizations, extend beyond one's immediate neighborhood. To that end, the aims of this chapter are twofold: 1) to examine the direct associations between two indicators of social engagement, organizational membership and neighborhood participation, and satisfaction with the neighborhood fruit and vegetable environment; and 2) to examine the extent to which organizational membership and neighborhood participation modify relationships between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Increased understanding of how indicators of social engagement influence satisfaction with the neighborhood fruit and vegetable environment as operating in conjunction with or over and above observed characteristics of the neighborhood food environment will provide important information to public health interventions on the use of social connections and interactions as mechanisms of dietary behavior change. This chapter examines the above listed main and moderating associations among African American adults across three neighborhoods in Detroit, MI. African Americans, who have lower quality diets than other racial and ethnic groups and are more likely to reside in areas with decreased access to healthy food (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). Examining the realm of social engagement as mechanisms that may improve health behaviors around diet may ultimately help reduce diet-related disparities in health outcomes by informing public health interventions as to mechanisms to intervene upon (in this case indicators of social

engagement) that influence satisfaction, which is significantly associated with dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008) (Chapter 2 of this dissertation).

Satisfaction with the neighborhood fruit and vegetable environment

In this chapter, I conceptualize satisfaction with the neighborhood fruit and vegetable environment as a proximate level factor in the fundamental determinants of health disparities framework adapted for this dissertation (Chapter 1, Figure 1.1). As a proximate level factor, satisfaction with the neighborhood fruit and vegetable environment is influenced by intermediate level factors (the built and social environment), other proximate level factors, and works to influence proximate level health behaviors (fruit and vegetable intakes) (See Figure 1.1) (Schulz & Northridge, 2004). This chapter focuses on intermediate and proximate level factors that influence satisfaction with the neighborhood fruit and vegetable environment.

In order to influence dietary behaviors such as fruit and vegetable intakes and reduce disparities in diet-related diseases that disproportionately affect African Americans, it is important to determine factors that shape dietary intakes. Research suggests that in addition to associations between observed characteristics of the food environment and dietary intakes (Laraia, et al., 2004; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005; Zenk, Lachance, et al., 2009), there may also be relationships between an individual's perception of healthy food in their environment and dietary behaviors (Moore, Diez Roux, Nettleton, et al., 2008). One way individual-level perceptions of healthy food in a neighborhood are evaluated is through measuring a person's degree of satisfaction with their neighborhood fruit and vegetable environment. Satisfaction with

the neighborhood fruit and vegetable environment is a perception based measure that assesses the extent to which one is satisfied with produce in their neighborhood. Such measures are often used instead of or in addition to observed characteristics of the neighborhood food environment to examine health behaviors such as dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009).

In this dissertation I define satisfaction as a subjective perception based measure that is influenced by both observed and subjective assessments. First, satisfaction reflects a person's perception of the quality, cost and affordability and variety of fresh produce in the observed food environment in which they live. Second, satisfaction is influenced by factors in the social environment (e.g., socioeconomic status, age, gender, personal preferences, and different cultural and economic factors (Moore, Diez Roux, & Brines, 2008)) that may influence norms and beliefs around dietary intake behaviors and patterns. Such factors may influence one's satisfaction with their neighborhood fruit and vegetable environment by shaping their expectations for or perceptions of produce in their observed food environment. A person's perception of the produce in their observed food environment and the degree to which the observed food environment meets a person's expectations influences satisfaction. These factors may be associated with satisfaction with the neighborhood fruit and vegetable environment above and beyond the observed characteristics of the neighborhood food environment or may interact with them.

In order to determine and interpret the influence of observed characteristics of the neighborhood food environment on satisfaction with the neighborhood fruit and vegetable environment and also understand how such measures influence dietary intakes, it is important to know exactly what measures of satisfaction (hereafter, simply

'satisfaction') with the neighborhood fruit and vegetable or healthy food environments capture. Research examining baseline data from the Multiethnic Study of Atherosclerosis (MESA) has used two measures to define satisfaction with the neighborhood fruit and vegetable environment. In one study, participants were asked the extent to which they agreed that their neighborhoods had: a large selection of fruits and vegetables, fresh fruits and vegetables were of high quality, and a large selection of low fat product (Moore, Diez Roux, & Brines, 2008). Participant responses were recorded on a 5-point Likert scale with options ranging from strongly agree to strongly disagree and reverse coded such that higher scores reflected increased satisfaction with the local food environment (Moore, Diez Roux, & Brines, 2008).

In another using MESA data, participants were asked to record the degree to which they agreed with statements that there was: "a lack of access to adequate food shopping", "a large selection of fruits and vegetables available", and a "large selection of low-fat products is available" (Moore, Diez Roux, Nettleton, et al., 2008). Participant responses for "a lack of access to adequate food shopping" were recorded on a 4-point Likert scale with options ranging from very serious problem to not really a problem. Participant responses for there being "a large selection of fruits and vegetables available" and a "large selection of low-fat products is available," were recorded on a on a 5-point Likert scale with reverse coded options ranging from low to high, strongly disagree to strongly agree such that higher scores reflected increased satisfaction with the local food environment (Moore, Diez Roux, Nettleton, et al., 2008). Additionally, in both studies, neighborhoods were defined to participants as the 1-mile area around their home (Moore, Diez Roux, & Brines, 2008; Moore, Diez Roux, Nettleton, et al., 2008).

Other studies have used self-report perception measures to obtain information on the variety, quality, and cost or affordability of produce in the neighborhood stores in which they shop. Two studies by Zenk et al. (2009a and 2009b) of a multiethnic sample in Detroit, MI asked study participants to rate their satisfaction with the variety, quality, and cost or affordability of fruits and vegetables in their neighborhood food. The neighborhood environment was defined to participants as the 10-15 walk or 5-minute driving area from their home. Responses were captured on a four-point scale with response options ranging from not at all satisfied to very satisfied (Zenk, Lachance, et al., 2009; Zenk, Schulz, et al., 2009). Details of the above listed measures of satisfaction with the neighborhood fruit and vegetable environment demonstrate slight variations in the types of information that such measures capture.

Associations between observed characteristics of the food environment and satisfaction with the fruit and vegetable environment. In this chapter, I conceptualize observed characteristics of the neighborhood food environment as intermediate level components of the built environment that may influence satisfaction with the neighborhood fruit and vegetable environment (a more proximate variable). Having access to a wide variety of fresh fruit and vegetables in the neighborhood food environment is one example of ways in which observed characteristics of the neighborhood food environment may influence satisfaction with the neighborhood fruit and vegetable environment. A small body of literature has examined associations between observed characteristics of the food environment and satisfaction with the fruit and vegetable environment.

Research examining baseline data from the Multiethnic Study of Atherosclerosis (MESA) of U.S. adults ages 45-84 years old assessed associations between participant-reported satisfaction with healthy foods in their environment and supermarket density (Moore, Diez Roux, & Brines, 2008). The environment or neighborhood was defined as being the 1 mile area around a person's home. Moore and colleagues (2008) found that when controlling for race and ethnicity and household income, participants who resided in neighborhoods with the lowest supermarket densities rated perceived availability of healthy foods significantly lower than participants who lived in areas with the highest supermarket densities. The same relationship held true when comparing perception of healthy food and supermarket densities among participants who lived in areas with moderate versus high supermarket density (Moore, Diez Roux, & Brines, 2008).

Similar to research by Moore and colleagues (2008), Zenk et al. (2009) examined multilevel predictors of satisfaction with the neighborhood fruit and vegetable environment among African American, non Hispanic Whites and Latinos in three communities across Detroit, MI (Zenk, Schulz, et al., 2009). Zenk and colleagues found that after accounting for neighborhood racial composition and poverty rates in immediate and surrounding neighborhood areas, distance to the nearest supermarket, as an observed characteristic of the neighborhood food environment, was significantly associated with satisfaction with the neighborhood fruit and vegetable environment. These analyses also controlled for age, household size, years of neighborhood residence, gender, race and ethnicity, marital status, employment status, car ownership, and annual household income (Zenk, Schulz, et al., 2009).

Research from chapter 2 of this dissertation found results similar to Moore and colleagues (2008) and Zenk et al. (2009). I found significant associations between observed characteristics of the neighborhood food environment (distance to the nearest supermarket) and satisfaction with the neighborhood fruit and vegetable environment when controlling for age, gender, length of residence in the neighborhood, marital status, car access, education, household poverty, neighborhood poverty and percent of African Americans in the neighborhood. Specifically, as distance to the nearest supermarket increased satisfaction with the neighborhood fruit and vegetable environment decreased. Distance to the nearest supermarket was the only observed characteristics of the neighborhood food environment significantly associated with satisfaction with the neighborhood fruit and vegetable environment. (Johnson, Dissertation Chapter 2, Models 3-4, Table 2.4).

Results from these studies highlight potential associations between observed characteristics of the food environment such as distance to the nearest supermarket or density of other types of food stores, and satisfaction with the neighborhood fruit and vegetable or healthy food environment. While these studies report associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable or healthy food environment (Moore, Diez Roux, & Brines, 2008; Zenk, Schulz, et al., 2009), there remain inconsistencies in research that examines associations between satisfaction with the neighborhood food environment and dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009).

Research that helps to illuminate other factors (beyond observed characteristics of the neighborhood food environment) that are associated with satisfaction with the

neighborhood fruit and vegetable environment may help better understand these inconsistencies. Such associations may be particularly important for African Americans, who are more likely to live in neighborhoods with decreased access to healthy foods, have lower diet quality, and are more likely to suffer from diet-related disease (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005).

Indicators of Social Engagement: Organizational Membership and Neighborhood Participation

There is relatively little research examining how aspects of the social environment are associated with satisfaction with the neighborhood fruit and vegetable environment. The social environment is defined as social structures and shared cultural and behavioral aspects of neighborhoods in which people live, groups and organizations people are members of, and policies enacted to organize their lives (Larson & Story, 2009). A wide variety of terminology is used to describe the influence of social variables on health behaviors. What Emmons and colleagues refer to as social context could also be described as an aspect of the social environment (Emmons, et al., 2007). Emmons et al. (2007) describes social context as life experiences, social relationships, organizational structures, and societal influences (Emmons, et al., 2007). There is an increasing need for empirical examinations of mechanisms by which measures of social environment influence and are associated with health behaviors and outcomes. Features of the social environment, like social structures and social contexts, influence group culture, attitudes, and norms (Larson & Story, 2009). Group norms, culture, and attitudes may influence proximate and individual-level perceptions and behaviors regarding the food environment

and satisfaction with the neighborhood fruit and vegetable environment (Emmons, et al., 2007).

In this chapter, I use organizational membership and neighborhood participation as indicators or measures of social engagement, as an aspect of the social environment. I examine organizational membership and neighborhood participation, as proximate level factors that may influence attitudes, norms, and expectations related to neighborhood food environments. These attitudes, norms and expectations may, in turn, be related to their evaluations and perceptions of the local food environment, thus shaping their reports of satisfaction with local environments. These relationships, and the relevant literature, are described in greater detail below.

Indicators of social engagement and dietary intakes. A small body of literature has examined associations between indicators of social engagement and dietary intake behaviors. Such literature finds those who are more socially engaged in neighborhood organizations, groups, and activities, or who have close family and friends with positive health behaviors are significantly more likely to have greater fruit and vegetable intakes compared to those who are less socially engaged in their neighborhood environments (Cohen, 2004; Emmons, et al., 2007; Litt, et al., 2011). There are several mechanisms through which associations between indicators of social engagement and fruit and vegetable intakes may operate. Being socially involved or having social influences may help people establish social connections (Cohen, 2004; Cohen, et al., 2004; Litt, et al., 2011). Cohen (2004) theorizes that social connections may influence health behaviors such as diet by, for example, providing increased opportunity for social interactions, expanding social networks, distracting people from daily stressors, and providing a sense

of purpose. Below, I review research that has examined associations between indicators of social engagement and dietary intakes.

Litt and colleagues (2011) examined cross-sectional associations between social involvement and fruit and vegetable intakes among 436 multiethnic adults in Denver, Colorado. Litt et al. (2011) hypothesized that social involvement, measured as the degree of engagement or participation in neighborhood meetings may provide a person with access to social resources and opportunities for social learning that would in turn affect their food behavior. Litt and colleagues (2011) found that those who participated in a greater number of neighborhood meetings were significantly more likely to consume a greater number of fruits and vegetables, adjusting for educational attainment, physical activity levels, and neighborhood aesthetics (Litt, et al., 2011).

A study by Emmons and colleagues (2007) examined cross-sectional relationships between social influences and fruit and vegetable intakes among Boston area adults from a work site sample (N= 1,740) and health care sample (N= 2,216). Social influences were operationalized as social networks and social norms. Social networks were defined on a scale of 0 to 4 as: being an active member of neighborhood clubs or organizations, being an active member of a church or synagogue, having a spouse/partner, and having two or more close friends or relatives. Social norms were defined as how many of a person's family and friends consumed at least 5+ fruits and vegetables per day. Response options for social norms were having few to none, some, most to all, or not knowing how many of your family and friends consumed 5+ fruits and vegetables per day. Emmons et al. (2007) found that for the work site sample, larger social networks were significantly associated with increased fruit and vegetable intakes. Similarly, for the health care

sample, increased social norms, meaning having more family and friends who consumed at least 5 fruits and vegetables per day, were also significantly associated with increased fruit and vegetable intakes (Emmons, et al., 2007).

Results from the studies described above provide evidence for associations between social involvement and dietary intakes. Social involvement may influence health behaviors like fruit and vegetable intakes by enabling access to social resources and opportunities for social learning and defining and reinforcing social roles within neighborhood and home environments (Berkman & Glass, 2000; Litt, et al., 2011). This chapter focuses on associations between indicators of social engagement, specifically organizational membership and neighborhood participation, and satisfaction with the fruit and vegetable environment. Mechanisms that drive associations between indicators of social engagement and satisfaction with the fruit and vegetable environment may function in ways similar to associations between social engagement and diet; however no research found to date has examined them. Below, I describe several pathways through which indicators of social engagement used in this study, organizational membership and neighborhood participation, may be associated with satisfaction with the neighborhood fruit and vegetable environment.

Main effects of indicators of social engagement on satisfaction with the neighborhood fruit and vegetable environment. Similar to the mechanisms mentioned above regarding fruit and vegetable intakes (Emmons, et al., 2007; Litt, et al., 2011), I hypothesize that indicators of social engagement, organizational membership and neighborhood participation, may influence satisfaction with the neighborhood fruit and vegetable environment by operating through access to knowledge and resources about

healthy food in their neighborhood that result from social interactions, increased social networks, and weak ties. Weak ties are more likely to be formed by social networks and may provide more novel information about healthy neighborhood food resources than the strong ties people have with close family and friends. In comparison, information transmitted through strong ties is more likely to be reflective of what a person already knows or has access to (Granovetter, 1973, 1983, 2005). In addition to being rewarding, fulfilling civic obligations, and reducing isolation and alienation (Cohen, 2004; Cohen, et al., 2004; Lindstrom, et al., 2001; Litt, et al., 2011), larger social networks or increased social communication and interactions may facilitate the flow of information in ways that result in more effective use of neighborhood resources (Cohen, 2004; Cohen, Gottlieb, & Underwood, 2000), or that may provide new and different information with which to evaluate the resources that are available.

People who are members of civic organizations or who participate in neighborhood groups and activities are likely to have larger social networks that create more weak ties and greater access to information about resources – including, but not limited to, food (Cohen, 2004; Cohen, et al., 2004; Granovetter, 1973, 1983, 2005). Such information may shape satisfaction with the food environment (Cohen, et al., 2000) as for example information gained from social networks, interactions, and weak ties may increase awareness of healthy food resources either within their own neighborhood or in other neighborhoods, shaping relative satisfaction of local food availability.

Moderating effects of indicators of social engagement on associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. This chapter also examines the

moderating effect of indicators of social engagement on associations between the observed neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. No studies found to date have examined such associations- thus the direction of association may be hard to determine. In this chapter, I test the hypothesis that the association between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment varies by level of social engagement (organizational membership or neighborhood participation). Specifically, those with high levels of social engagement residing in neighborhoods with good access to fresh produce may be very satisfied with their neighborhood food environment compared to those with low levels of social engagement who reside in neighborhoods with good access to fresh produce due to perhaps increased awareness of where to buy and what to buy in terms of fresh produce to increase fruit and vegetable intakes. Those with low levels of social engagement residing in neighborhoods with good access to fresh produce may be less satisfied with their food environment compared those with high levels of social engagement due to being less aware of where to buy affordable, quality fresh produce. In addition, I would expect someone with low levels of social engagement residing in a poor food environment to be less satisfied with their food environment compared to someone with high levels of social engagement in a poor food environment. Those who are not socially engaged may not have access to the social knowledge of the effects of a poor food environment on fruit and vegetable intakes or of the few resources for healthy food that may be available in the neighborhood compared to someone with high levels of social engagement residing in poor food environments. A person with high levels of social engagement residing in poor food

environment would be more satisfied with their food environment due to increases knowledge of the limited resources that may be available to purchase affordable, quality fresh produce.

Building on literature that finds significant associations between the observed neighborhood food environment and satisfaction (Moore, Diez Roux, & Brines, 2008; Zenk, Schulz, et al., 2009), satisfaction and dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008), and engagement in neighborhood activities or having family and friends with positive health behaviors (e.g., increased produce intakes) and fruit and vegetable intakes (Emmons, et al., 2007; Litt, et al., 2011), it is plausible that participation may raise awareness of one's own local food environment in terms of availability, quality, and/or prices, and result in more satisfaction on the part of those who live in poor food environments due to gained knowledge on the few healthy resources that may be available. In this case, those with high participation and poor observed environments would be expected to report higher levels of satisfaction compared with those with low participation and poor observed environments. In contrast, participation in neighborhood groups through membership or involvement in activities may raise awareness of one's own local food environment in comparison to others, in terms of availability, quality, and/or prices, and thus result in less satisfaction on the part of those who live in poor food environments. In this case, those with high participation and poor observed environments would be expected to report lower levels of satisfaction compared to those with low participation and poor observed environments.

Based on the literature and hypotheses proposed above, I examine the extent to which organizational membership and neighborhood participation are associated with

satisfaction with the neighborhood fruit and vegetable environment. I also examine the moderating effects of organizational membership and neighborhood participation on relationships between observed characteristics of the neighborhood food environment and satisfaction. Specifically, this study examines the following research questions and hypotheses, among African Americans in Detroit:

(1) Are indicators of social engagement associated with satisfaction with the neighborhood fruit and vegetable environment, independent of observed characteristics of the neighborhood food environment?

(H1) Members of neighborhood organizations will be more satisfied with their neighborhood fruit and vegetable environment compared to those with no organizational memberships. A positive association would be consistent with the hypothesis that organizational membership is associated with exposure to positive information and resources regarding one's neighborhood fruit and vegetable environment availability.

(H3) Those who participate in more neighborhood groups and activities will be more satisfied with their neighborhood fruit and vegetable environment compared to those who participate in fewer neighborhood groups and activities. A positive association would be consistent with the hypothesis that neighborhood participation is associated with exposure to positive information and resources regarding one's neighborhood fruit and vegetable environment availability.

(2) Do indicators of social engagement modify associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment?

(H1) Organizational membership will significantly modify the relationship between the observed indicators of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Direction of modifying effects will be consistent with relationships observed in the first research question.

(H2) Neighborhood participation will significantly modify the relationship between the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Direction of modifying effects will be consistent with relationships observed in the first research question.

Methods

Study Design and Sample Description

Data for this study are drawn from the Healthy Environments Partnership (HEP) wave 1 2002 community survey. The HEP is one component of a community-based participatory research project involving academic, health service providing, and community based organizations in Detroit, Michigan (Schulz, et al., 2005). The University of Michigan Institutional Review Board for Protection of Human Subjects approved the study in January 2001. The HEP survey uses a stratified 2 stage probability sample of occupied housing units designed for 1,000 completed interviews with adults ages ≥ 25 years across 3 areas of Detroit. Such a design allows for comparisons of residents of similar demographics across geographic areas of the city of Detroit (Schulz,

et al., 2005). The survey sample was designed to achieve adequate variation in socioeconomic position within each of the three predominant racial and ethnic groups in Detroit: African-American, Latino, and White in order to conduct analysis of socioeconomic status within and across racial and ethnic groups. Data were imputed to account for missing values. The final sample consisted of 919 face-to-face interviews: interviews were completed with 75% of households in which an eligible respondent was identified and 55% of households with a known or potential respondent (Schulz, et al., 2005). The 919 respondents were nested within 69 census blocks. Of the total multiethnic sample, analysis for this study focuses on the 522 African American participants nested in 115 blocks and 67 census block groups throughout the Eastside, Southwest, and Northwest Detroit study areas.

Measures

Dependent

Satisfaction with the neighborhood fruit and vegetable environment. Satisfaction with the neighborhood fruit and vegetable environment was measured at the individual-level using the mean value from a three-question scale. The questions, "How satisfied are you with the (1) variety, (2) quality, and (3) cost and affordability of fresh fruits and vegetables in their neighborhood?" had response options ranging from (1) not satisfied at all, (2) not very satisfied, (3) somewhat satisfied, and (4) very satisfied. The mean of responses to the three items was modeled in the analysis. Higher scores signified higher satisfaction. The neighborhood food environment was defined as, "foods that are available to you

within a 10-15 minute walk or 5 minute drive from your home, including grocery stores, convenience stores, or other places you might buy food."

Indicators of Social Engagement.

Organizational Membership was highly skewed and thus modeled as a dichotomous variable defined as being or not being a member of any group or organization, such as a civic organization like the Lions or the Optimists; a sorority or fraternity like the Masons or the Eastern Star, a union, a professional organization, or a sports league like bowling or baseball. As included in the variable definition, places of worship or church membership were not included in measure of organizational membership.

Neighborhood Participation was defined as participation in a variety of neighborhood groups, activities or organizations over the past twelve months. Specifically, neighborhood participation assessed whether a candidate: 1) attended a block club, neighborhood association, or police precinct meeting, 2) participated in a neighborhood clean-up or beautification project, crime watch, Angel's Night, or other neighborhood activity, and 3) had served on a committee, helped organize meetings, or served in a position of leadership for any local organization such as a block club, church, parent teacher or other school organization, or any other organization. Binary (yes or no) responses to the questions listed above options were grouped into an index where participants were required to answer "yes" or "no" to at least two of the three questions. Neighborhood participation was modeled as an index of the number of questions to which the participant indicated "yes", ranging from 0-3. Higher scores

indicated higher levels of participation. If participants responded "no" to all three questions they were categorized as having no participation in neighborhood organizations and activities.

Observed Characteristics of the Neighborhood Food Environment. Information on several store type variables was captured using dichotomous (yes or no) indicators of the following food stores by type at the census block level located in each neighborhood. Neighborhoods were defined using a 0.5 mile Euclidean distance buffer from the centroid of the residential census block (Zenk, Lachance, et al., 2009).

Large grocery stores. Large grocery stores were defined as non-chain stores that had three or more operating cash registers.

Small grocery stores. Small grocery stores were defined as non-chain stores with one or two operating cash registers.

Convenience stores. Convenience stores or food stores were defined as those without gas stations and that limited capacity for check-out.

Specialty stores. Specialty stores were defined as fruit and vegetable or meat or seafood markets.

Supermarkets. Supermarkets were defined as full service chain stores. There was only one supermarket in the 146 census blocks used for this study in 2002. Thus, supermarket proximity was used as a measure of availability instead of a count of stores. ArcGIS Network Analyst 9.1(Environmental Systems Research Institute, Redlands, California) was used to measure supermarket proximity as the street

network distance in miles from the centroid of the residential census block to the nearest supermarket.

Liquor or party stores. Liquor or party stores were defined according to their classification as liquor store in the telephone directory, the presence of liquor or party store in their names or a main food sign in front of the store containing liquor, beer, or wine. Liquor or party stores were measured using a count of the number of liquor stores present in each census block.

Control Variables

Several variables previously demonstrated to be associated with satisfaction with the neighborhood fruit and vegetable environment were included as control variables. These included both neighborhood and individual level variables, as described below.

Individual Level Controls

Gender (male or female), *age* (continuous), *education level* (less than high school, high school diploma or GED, and some college or greater), *marital status* (married/in a relationship or not currently married /separated /divorced /widowed) *and employment status* (currently working for pay or not currently working for pay) were controlled for due to their associations with fruit and vegetable consumption (Deshmukh-Taskar, et al., 2007; Laraia, et al., 2004; Trudeau, et al., 1998; Watters, et al., 2007; Zenk, Lachance, et al., 2009). *Car access* was modeled as a binary variable. Car access was defined as easy car access (having a car or not having a car but it being not very difficult or not difficult at all to access a car) or limited car access (not having a car and it

being somewhat to very difficult to access a car). Having a car may influence fruit and vegetable consumption by broadening one's perception of their neighborhood food environment and by expanding their neighborhood boundaries and access to stores that sell fruit and vegetables (Rose & Richards, 2004). *Length of residence in the neighborhood* was defined as participant report of the number of years they resided in their current neighborhood. The neighborhood was defined to participants as the blocks that surround the block in which they lived and was within walking distance of their homes. Length of residence in the neighborhood was modeled as a continuous variable in years. *Household Poverty* was independently calculated for the HEP sample using 2002 census estimates for the U.S. poverty thresholds (organized by family size and number of children) and HEP survey data available for total household income and the total number of adults and children in the household for 2002. Household poverty was modeled as a binary variable of whether household per capita income fell below or above the Federal Poverty Level for 2002.

Neighborhood Level Controls

Percent poverty and percent Black or African American were modeled as census block group level (level 3) control variables due to their indirect associations with satisfaction with the neighborhood fruit and vegetable environment among African Americans by influencing observed characteristics of the neighborhood food availability. Modeling level 3 block group variables, mean percent poverty and mean percent African American,

allowed the opportunity to control for non-independence of observations at levels 2 (block) and 1 (individual) in the analysis. Percent poverty was defined as the percent of individuals in the census block group who had family incomes below the federal poverty line (FPL). Percent Black or African American was defined as the percent of non-Hispanic African American residents in each census block group. Data for percent African American and percent poverty measures were generated from Census 2000 data files. The mean percent poverty and mean percent Black or African American for each census block group were modeled as continuous measures in the analysis.

Data Analysis

Several analytic steps were taken to address research questions. First, I performed weighted descriptive statistics and univariate procedures using SAS software, Version [9.3] for Windows. All sample statistics were adjusted for sample weights for unequal probabilities of selection within each stratum and to match the sample to Census 2000 population distributions for the study areas. Given the complex sample design, demographic statistics were calculated using proc surveyfreq, proc surveymeans, and IVEware % describe commands to estimate weighted means and proportions.

The second analytic step was to test study hypotheses. Three-level hierarchical regression models for a continuous outcome were estimated using HLM 7 (Scientific Software International, Lincolnwood, IL, 2011). Level 1 were the 522 African American survey respondents; level 2 were the 115 census blocks in which respondents lived; and level 3 were the 67 census block groups. I first tested the hypothesis that African

American participants who were members of neighborhood organizations or who participated in more neighborhood groups and activities will have levels of satisfaction with the neighborhood fruit and vegetable environment that were significantly different from those who were not members of neighborhood organizations or who participated less in neighborhood groups and activities while controlling for characteristics of the observed neighborhood food environment. Organizational membership and neighborhood participation variables were highly correlated ($p<0.0001$) and entered as separate indicators of social engagement in all models. Observed characteristics of the neighborhood food environment or in this case, store presence variables (distance to the nearest supermarket (in miles), number of liquor stores, and the presence or lack of any small or large grocery stores, convenience stores, and specialty stores) were modeled as a collective set of control variables. All continuous variables at the individual block and block group levels were grand mean centered.

Second, I examined the hypothesis that organizational membership and neighborhood participation would significantly modify relationships between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. This chapter used Baron and Kenny's (1986) method of testing for moderation to test for the moderating effects of socioeconomic status on the relationship between the neighborhood food environment and residents' satisfaction with neighborhood fruit and vegetable environment (Baron & Kenny, 1986). Moderation was significant if the interaction p-value was significant. A moderation effect between the two variables was not dependent on whether or not there were significant main effects between the predictor and moderator variables with the

dependent variable (Baron & Kenny, 1986). Thus, I examined moderation effects for all organizational membership and neighborhood participation variables regardless of if they were significant predictors of satisfaction with the neighborhood fruit and vegetable environment. All models controlled for demographic variables at the individual level and percent poverty and percent African American at the block group level. All continuous variables at individual, census block, and census block group levels were grand mean centered.

Results

Table 2.1 displays weighted sociodemographic characteristics of the HEP African American sample. The mean age of this sample was 46.6 years. The majority of the sample was female (56.3%). Roughly a quarter of the sample was married (27.4%) and just over one third (34.2%) had a high school diploma or GED. Roughly two thirds (67.4%) of the sample was employed or currently working, 85.4% had access to a car. The mean length of respondents' residence their neighborhood was 18.3 years. Finally, the mean percent poverty value for all 67 block groups was 32.5%. The mean percentage of African Americans across all block groups was 67.5%.

The second half of table 2.1 describes average characteristics of the main independent and dependent variables. At the individual level, satisfaction with the neighborhood fruit and vegetable supply was the dependent variable. On a scale of 1 to 4, mean satisfaction with the variety, quality, cost and affordability of fruit and vegetables was 2.8, indicating most participants were between not very satisfied to somewhat satisfied with the produce in their neighborhood food environment.

Indicators of social engagement were main independent variables at the individual level. Just over 80% of participants were not members of organizations and slightly less than half were involved in neighborhood organizations, groups, or activities. Observed characteristics of the neighborhood food environment were modeled as independent variables at the census block level. On average, survey participants traveled 3.5 miles to the nearest supermarket, and lived in census blocks with an average of 4.6 liquor stores. Roughly a third (30.4%) of all blocks had at least one large grocery store; 22.6% had at least one specialty store; 23.5% had at least one small grocery store; and 28.7% had at least one convenience store.

Associations between indicators of social engagement and satisfaction. Tables 4.1 and 4.2 present multilevel regression results from the test of the first research question, direct relationships between organizational membership and neighborhood participation, and satisfaction with the neighborhood fruit and vegetable environment among African Americans. Model 1 in tables 4.1 and 4.2 is a fully unconditional model that indicates significant variation in satisfaction with the neighborhood fruit and vegetable environment at the census block group level ($\beta = 2.75$, s.e. = 0.04; $p < 0.01$). Based on the intraclass correlation at the block level (block level neighborhood variation divided by the sum of the block group level neighborhood variation + block level neighborhood variation + individual variance), 3.47% of the variation in satisfaction with the neighborhood fruit and vegetable environment was between census blocks. Based on the intraclass correlation at the block group level (block group level neighborhood variation divided by the sum of the block group level neighborhood variation + block level neighborhood variation + individual variance), 1.65% of the variation in satisfaction with

the neighborhood fruit and vegetable environment was between census block groups. Model 2 in tables 4.1 and 4.2 added individual sociodemographic variables collectively. After adjusting for individual level covariates in model 2, 2.25% of the variance in satisfaction with the neighborhood fruit and vegetable environment remained at the census block level and 1.84% at the block group level. Despite low intraclass correlations, multilevel modeling was necessary due to the structure of the data collected for this study. The data was collected using a two-stage probability sample. The two-stage probability sample first selected a sample of census block groups within 6 strata that were categorized and sectioned by percent neighborhood poverty and percent African American. Second, households within those block groups were selected. Ignoring the above described multilevel nature of the data would be inappropriate for the study sampling design.

Organizational membership and neighborhood participation were entered in separate regression models due to being highly correlated (Tables 4.1 and 4.2). We found no evidence of significant association between organizational membership and satisfaction with the neighborhood food environment when controlling for observed characteristics of the neighborhood food environment (Model 5, Table 4.1). There were no significant associations between neighborhood participation and satisfaction with the neighborhood food environment, when controlling for observed characteristics of the neighborhood food environment (Model 5, Table 4.2). Thus, we are unable to reject the null hypotheses of no main associations between organizational membership and neighborhood participation, as indicators of social engagement, with satisfaction with the

food environment, after accounting for the effects of observed indicators of the neighborhood food environment.

Modifying effects of indicators of social engagement on relationships between the observed food environment and satisfaction. Results for the second research question, modifying associations between organizational membership and neighborhood participation are presented in table 4.3. There were no modifying effects of organizational membership on associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment.

Participants who reported being active in two or more neighborhood activities and who lived in census blocks with a greater number of liquor stores reported lower levels of satisfaction with neighborhood food environments compared to those living in similar neighborhoods who did not participate in any neighborhood activities or groups (β= -0.09, s.e. = 0.03; $p< 0.01$, Model 2, Table 4.3).

Discussion

This chapter broadens the limited literature examining associations between organizational membership and fruit and vegetable intakes while controlling for socioeconomic status (Cohen, 2004; Cohen, et al., 2004; Lindstrom, et al., 2001; Litt, et al., 2011). Specifically, by examining associations between organization membership and neighborhood participation, and satisfaction with the neighborhood fruit and vegetable environment, we extend the extant literature on relationships between social engagement and satisfaction with the food environment.

Based on the findings reported here, we are unable to reject the null hypothesis of no association between organizational memberships or neighborhood participation with

satisfaction with the neighborhood fruit and vegetable environment, controlling for observed indicators of the neighborhood food environment. There were however, significant moderating effects of neighborhood participation on associations between the observed food environment and satisfaction with the food environment. Relationships between observed neighborhood food environment variables and satisfaction with the neighborhood fruit and vegetable environment differed for those who participated in several neighborhood organizations compared to those who were not involved in neighborhood groups and activities. Specifically, increasing numbers of liquor stores in census blocks were associated with lower levels of satisfaction with the neighborhood fruit and vegetable environment for those who participated in 2-3 neighborhood activities or groups compared to those who did not participate in neighborhood activities or groups (Model 2, Table 4.3).

Limitations. There were several limitations associated with this research. The sample is cross-sectional and thus generalizability and information on trends over time were unavailable. Additionally, while every effort was made to correctly count and categorize characteristics of the observed neighborhood food environment, there may still be misclassification or errors in measures of the neighborhood food environment. Additionally, due to the structure of the raw variable, extensive manipulation or categorization of the neighborhood participation variable was not possible. Furthermore, the limitation of the sample to African American residents of Detroit only, while a strength in that it allows for extensive within group analyses that account for environmental and social factors unique to African Americans, also introduces constraints. In particular, results from this study should only be interpreted as

generalizable to African Americans residing in similar urban environments and may not necessarily remain consistent when examining similar associations on a national level or with multiethnic samples that do not share the same neighborhood level characteristics.

Conclusions. This study examined main associations between indicators of social engagement and satisfaction with the neighborhood fruit and vegetable environments, and the extent to which indicators of social engagement modified associations between observed characteristics of the neighborhood food environment and satisfaction with the fruit and vegetable environment. This research examined these relationships within a sample of urban African American adults living in racially homogenous neighborhoods. The majority of previous studies have examined similar relationships using fruit and vegetable intakes instead of satisfaction as the dependent variable, in multiethnic samples (Emmons, et al., 2007; Litt, et al., 2011). African Americans are more likely to live in lower income, urban environments with poor access to healthy food (Chang, 2006; Cummins & Macintyre, 2006; Kumanyika, et al., 2007; Larson & Story, 2009; Larson, et al., 2009; Williams, et al., 2010; Wilson, 2010), when compared to other racial and ethnic groups. These environmental conditions may contribute to poorer diet quality and increased prevalence of diet-related disease when compared to other racial and ethnic groups (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). In order to specifically examine the extent to which these relationships influence satisfaction *among* African Americans (rather than in relation to other racial and ethnic groups) the analyses described here were restricted to a sample of African Americans. They contribute to an understanding of relationships among factors associated with dietary intakes among African Americans. Understanding these

relationships can inform interventions designed to improve dietary intakes among African Americans, thus contributing to reductions in racial and ethnic disparities in diet-related disease.

This research fills several gaps in the literature. Few studies have examined the influence of indicators of social engagement on fruit and vegetable or dietary intakes (Emmons, et al., 2007; Litt, et al., 2011). I could identify no studies that have examined associations between indicators of social engagement, like organizational membership and neighborhood participation, and satisfaction with the neighborhood fruit and vegetable environment. Additionally, no research found to date has examined the role of indicators of social engagement as modifying relationships between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment.

Results from this study provide an initial look at a much larger needed body of research needed to understand associations between social environment variables like indicators of social engagement, satisfaction with the neighborhood fruit and vegetable environment, and fruit and vegetable intakes. While indicators of social engagement may not have been associated with satisfaction with the neighborhood fruit and vegetable environment, significant moderating effects suggest the importance of the interaction of observed characteristics of the neighborhood food environment and indicators of social engagement as influencing satisfaction. Results from interaction examination in chapter 4 show associations between having more liquor stores in the neighborhood and satisfaction differ according to whether or not a person participates in neighborhood groups, activities, or organizations. Specifically, those who participate in neighborhood

organizations and who reside in neighborhoods with more liquor stores are more dissatisfied compared to those who do not participate in neighborhood groups and who reside in neighborhoods with more liquor stores. This may be because those who are involved in neighborhood groups have more access to social knowledge of the effects of a poor food environment (increased liquor stores) on their health outcomes and fruit and vegetable intakes compared to those who are not involved in neighborhood groups. In addition, there was no significant moderating effect of organizational memberships on associations between the observed food environment and satisfaction. This may have been due to the large percentage of participants who were no members of any organizations. Low variation in organizational membership across African American participants may have driven the lack of significance in results.

Results from this research also emphasize the importance of observed characteristics of the neighborhood food environment as being associated with satisfaction. Distance to the nearest supermarket, for example, remained significantly associated with satisfaction with the neighborhood food environment even after indicators of social engagement were in the model (Model 5, Tables 4.1 and 4.2). Thus, indicating that observed characteristics of the neighborhood food environment may be associated with satisfaction with the fruit and vegetable environment above and beyond indicators social engagement and are important to consider in models of future research examining ways to reduce the burden of diet-related disease among African Americans.

Examining how indicators of social engagement interact with observed characteristics of the neighborhood food environment to influence satisfaction with the neighborhood fruit and vegetable environment has important implications for

interventions seeking ways to improve fruit and vegetable intakes. Such models add the influence of specific neighborhood level context (observed characteristics of the food environment) in which indicators of social of social engagement may be most effective at influencing satisfaction with the neighborhood food environment and influencing fruit and vegetable intakes. Interventions aiming to reduce the burden of diet-related disease among African Americans and increase fruit and vegetable intakes should consider the influence of the observed food environment and neighborhood participation (or other indicators of social engagement) as shaping satisfaction with the neighborhood fruit and vegetable environment. Specifically, attention focused on increasing the quality of fresh produce in neighborhood food environments (decreasing liquor stores and other outlets with decreased fresh produce) and encouraging neighborhood participation would achieve the largest increases in satisfaction and hence fruit and vegetable intakes. Examples of such interventions may include starting neighborhood gardens that are collectively managed and cared for. Such activities would increase access to fresh fruits and vegetables and also increase social engagement. It would also be important for neighborhoods with poor or decreased access to healthy food to obtain increased access through perhaps offering incentives to small grocery store owners or convenience stores to carry affordable, quality healthy produce or through the use of mobile food trucks. Findings also suggest that opportunities for participating in neighborhood activities might provide more avenues for individuals to gather or convene to influence their local food environment in ways that may ultimately result in more health-supporting environments overall.

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Table 4.1

Self-reported satisfaction with the neighborhood fruit and vegetable environment regressed on organizational membership controlling for observed characteristics of the neighborhood food environment

	Model 1: Fully Unconditional			Model 2: Covariates			Model 3: Neighborhood Food Environment			Model 4: Organizational Membership			Model 5: Org. Mem + Neighborhood Food Environ.		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.75	0.04	<0.01	2.78	0.12	<0.01	2.74	0.13	<0.01	2.79	0.13	<0.01	2.77	0.13	<0.01
Age (years)*				<0.01	<0.01	0.56	<0.01	<0.01	0.60	<0.01	<0.01	0.55	<0.01	<0.01	0.57
Gender (reference: male)				-0.04	0.07	0.57	-0.05	0.07	0.48	-0.04	0.07	0.56	-0.06	0.08	0.46
Length of residence in neighborhood (years)*				<0.01	<0.01	0.10	0.01	<0.01	0.03	<0.01	<0.01	0.09	0.01	<0.01	0.03
Marital Status (reference: married)				-0.12	0.08	0.14	-0.12	0.08	0.13	-0.12	0.08	0.14	-0.12	0.08	0.12
Car Access (reference: easy car access)				-0.25	0.10	0.02	-0.25	0.10	0.02	-0.26	0.10	0.01	-0.25	0.10	0.02
Education < High School (ref: at least some college)				0.23	0.09	0.02	0.27	0.09	<0.01	0.22	0.09	0.02	0.26	0.09	<0.01
High School Diploma or GED (ref: at least some college)				0.20	0.09	0.03	0.21	0.09	0.02	0.19	0.09	0.04	0.20	0.09	0.02
Employment Status (reference: employed)				-0.02	0.08	0.80	0.01	0.09	0.95	-0.02	0.09	0.79	<0.01	0.09	0.98
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)				0.08	0.08	0.35	0.09	0.08	0.28	0.07	0.08	0.36	0.09	0.08	0.29
Organizational Memberships (ref: not a member of any groups or organizations)										-0.04	0.10	0.69	-0.06	0.09	0.52
Participation in 1 type of neighborhood organization or activity (ref: no participation in neighborhood groups, organizations, & activities)															
Participation in 2 or 3 types of neighborhood organizations or activities (ref: no participation in neighborhood groups, organizations, & activities)															
Census Block Level															
Distance to nearest supermarket (miles)*							-0.19	0.06	<0.01				-0.20	0.06	<0.01
Count of Liquor Stores*							<0.01	0.02	0.63				0.01	0.02	0.63
Any Small Grocery Store (ref: none)							0.09	0.11	0.43				0.09	0.11	0.42
Any Large Grocery Store (ref: none)							-0.06	0.08	0.46				-0.06	0.08	0.45
Any Convenience Store (ref: none)							-0.02	0.07	0.81				-0.02	0.07	0.84
Any Specialty Store (ref: none)							0.01	0.10	0.93				0.01	0.10	0.90
Census Block Group Level															
Mean Percent Poverty*				<-0.01	<0.01	0.16	<-0.01	<0.01	0.91	<-0.01	<0.01	0.16	<-0.01	<0.01	0.92
Mean Percent African American*				<-0.01	<0.01	0.01	<-0.01	<0.01	0.05	<-0.01	<0.01	0.01	<-0.01	<0.01	0.05
Sigma squared, σ^2			0.62629			0.59889			0.59596			0.59866			0.59591
Tau pi, Tπ			0.02289			0.01402			0.01143			0.01439			0.01091
Tau beta, Tβ			0.01088			0.01146			0.00015			0.01110			0.00014

* Variables were grand-mean centered

§ SE indicates standard error

All models were adjusted at the individual level for age, employment status, length of residence in neighborhood, gender, education, marital status, household poverty, and car access. All models were adjusted at the block group level for % Poverty and % African American.

Table 4.2

Self-reported satisfaction with the neighborhood fruit and vegetable environment regressed on neighborhood participation controlling for observed characteristics of the neighborhood food environment

	Model 1: Fully Unconditional			Model 2: Covariates			Model 3: Neighborhood Food Environment			Model 4: Neighborhood Participation			Model 5: Neigh. Participation + Neigh. Food Environment		
	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.75	0.04	<0.01	2.78	0.12	<0.01	2.74	0.13	<0.01	2.80	0.14	<0.01	2.76	0.13	<0.01
Age (years)*				<0.01	<0.01	0.56	<0.01	<0.01	0.60	<0.01	<0.01	0.57	<0.01	<0.01	0.59
Gender (reference: male)				-0.04	0.07	0.57	-0.05	0.07	0.48	-0.04	0.07	0.61	-0.05	0.07	0.51
Length of residence in neighborhood (years)*				<0.01	<0.01	0.10	0.01	<0.01	0.03	<0.01	<0.01	0.10	0.01	<0.01	0.03
Marital Status (reference: married)				-0.12	0.08	0.14	-0.12	0.08	0.13	-0.12	0.08	0.15	-0.12	0.08	0.14
Car Access (reference: easy car access)				-0.25	0.10	0.02	-0.25	0.10	0.02	-0.26	0.10	0.01	-0.25	0.10	0.02
Education < High School (ref: at least some college)				0.23	0.09	0.02	0.27	0.09	<0.01	0.22	0.10	0.03	0.27	0.10	0.01
High School Diploma or GED (ref: at least some college)				0.20	0.09	0.03	0.21	0.09	0.02	0.19	0.09	0.04	0.21	0.09	0.02
Employment Status (reference: employed)				-0.02	0.08	0.80	0.01	0.09	0.95	-0.02	0.09	0.82	0.01	0.09	0.95
Household Poverty (ref: households with incomes above the Federal Poverty Level, FPL)				0.08	0.08	0.35	0.09	0.08	0.28	0.08	0.08	0.36	0.09	0.09	0.30
Organizational Memberships (ref: not a member of any groups or organizations)															
Participation in 1 type of neighborhood organization or activity (ref: no participation in neighborhood groups, organizations, & activities)										-0.06	0.08	0.47	-0.06	0.08	0.47
Participation in 2 or 3 types of neighborhood organizations or activities (ref: no participation in neighborhood groups, organizations, & activities)										-0.02	0.10	0.85	<-0.01	0.09	0.99
Census Block Level															
Distance to nearest supermarket (miles)*							-0.19	0.06	<0.01				-0.19	0.06	<0.01
Count of Liquor Stores*							<0.01	0.02	0.63				<0.01	0.02	0.62
Any Small Grocery Store (ref: none)							0.09	0.11	0.43				0.09	0.11	0.43
Any Large Grocery Store (ref: none)							-0.06	0.08	0.46				-0.06	0.08	0.46
Any Convenience Store (ref: none)							-0.02	0.07	0.81				-0.02	0.07	0.83
Any Specialty Store (ref: none)							0.01	0.10	0.93				0.01	0.10	0.92
Census Block Group Level															
Mean Percent Poverty*				<-0.01	<0.01	0.16	<-0.01	<0.01	0.91	<-0.01	<0.01	0.17	<-0.01	<0.01	0.93
Mean Percent African American*				<-0.01	<0.01	0.01	<-0.01	<0.01	0.05	<-0.01	<0.01	0.01	<-0.01	<0.01	0.05
Sigma squared, σ^2			0.62629			0.59889			0.59596			0.59799			0.59515
Tau pi, $T\pi$			0.02289			0.01402			0.01143			0.01494			0.01162
Tau beta, $T\beta$			0.01088			0.01146			0.00015			0.01095			0.00016

* Variables were grand-mean centered

§ SE indicates standard error

All models were adjusted at the individual level for age, employment status, length of residence in neighborhood, gender, education, marital status, household poverty, and car access. All models

Table 4.3

Indicators of social engagement as modifying associations between observed characteristics of the neighborhood food environment and self-reported satisfaction with the neighborhood fruit and vegetable environment

	Model 1: Organizational Memberships			Model 2: Participation in Neighborhood Organizations		
	Estimate	SE §	*p*	Estimate	SE §	*p*
Intercept	2.74	0.14	<0.01	2.77	0.13	<0.01
Organizational Memberships (ref: not a member of any groups or organizations)	-0.08	0.11	0.46			
Participation in 1 type of neighborhood organization or activity (ref: no participation in neighborhood groups, organizations, & activities)				-0.04	0.13	0.78
Participation in 2 or 3 types of neighborhood organizations or activities (ref: no participation in neighborhood groups, organizations, & activities)				-0.09	0.12	0.43
Census Block Level						
Distance to nearest supermarket (miles)*	-0.15	0.06	0.01	-0.23	0.06	<0.01
Count of Liquor Stores*	0.01	0.02	0.74	0.04	0.02	0.09
Any Small Grocery Store (ref: none)	0.09	0.11	0.43	0.10	0.14	0.45
Any Large Grocery Store (ref: none)	-0.04	0.08	0.66	-0.08	0.09	0.38
Any Convenience Store (ref: none)	-0.05	0.08	0.56	-0.10	0.10	0.36
Any Specialty Store (ref: none)	0.05	0.11	0.67	-0.07	0.25	0.77
Interactions	**Any Organizational Memberships x Food Environment Interactions**			**Participation in 1 group x Food Environment Interactions**		
Distance to nearest supermarket (miles)*	-0.24	0.13	0.07	0.13	0.09	0.17
Count of Liquor Stores*	0.02	0.05	0.78	-0.06	0.04	0.16
Any Small Grocery Store (ref: none)	-0.06	0.30	0.83	-0.12	0.16	0.45
Any Large Grocery Store (ref: none)	-0.14	0.22	0.54	0.05	0.14	0.75
Any Convenience Store (ref: none)	0.15	0.23	0.52	0.03	0.17	0.87
Any Specialty Store (ref: none)	-0.13	0.26	0.61	0.11	0.64	0.87
Participation in 2-3 groups x Food Environment Interactions				**Participation in 2-3 group x Food Environment Interactions**		
Distance to nearest supermarket (miles)*				0.13	0.10	0.18
Count of Liquor Stores*				**-0.09**	**0.03**	**<0.01**
Any Small Grocery Store (ref: none)				-0.06	0.20	0.77
Any Large Grocery Store (ref: none)				0.08	0.16	0.61
Any Convenience Store (ref: none)				0.33	0.19	0.08
Any Specialty Store (ref: none)				-0.50	0.57	0.37
Sigma squared, σ^2			0.59020			0.58521
Tau pi, $T\pi$			0.00914			0.01106
Tau beta, $T\beta$			0.00005			0.00014

* Variables were grand-mean centered

§ SE indicates standard error

All models were adjusted at the individual level for age, employment status, length of residence in neighborhood, gender, education, marital status, household poverty, and no car and somewhat to very difficult car access. All models were adjusted at the block group level for % Poverty and % African American.

Chapter 5

Associations Between Observed Characteristics of the Food Environment, Satisfaction With the Neighborhood Fruit And Vegetable Environment, and Fruit And Vegetable Intakes Among African Americans: Implications For Public Health Research, Policy, and Practice

Summary of Goals, Aims, and purpose

The primary aim of this dissertation was to examine intermediate and proximal factors (Figure 1.1) associated with fruit and vegetable intakes of African Americans, in order to consider potential strategies for interventions to improve intakes of fruits and vegetables. To that end, a major focus of this dissertation has been to explicate pathways through which observed characteristics of the food environment, satisfaction with the neighborhood fruit and vegetable environment, and fruit and vegetable intakes are related. I examined the main effects of satisfaction with the neighborhood fruit and vegetable environment on fruit and vegetable intakes controlling for observed characteristics of the neighborhood food environment and the mediating and modifying effects of satisfaction on relationships between observed characteristics of the food environment and fruit and vegetable intakes. I also examined the influence of socioeconomic status (SES) and indicators of social engagement (organizational membership and neighborhood participation) as they were associated with satisfaction when controlling for the observed food environment or as they modified associations between the observed food environment and satisfaction with the neighborhood fruit and vegetable environment. In doing so, this dissertation has sought to address two major gaps in the literature: 1)

understanding variables beyond observed characteristics of the food environment that may influence satisfaction with the neighborhood fruit and vegetable environment and 2) a lack of a focus on variations in associations between factors that influence dietary behavior among African Americans, not in comparison to other racial and ethnic groups. Below, I expand upon the contribution of this dissertation in addressing the above listed gaps.

Understanding variables beyond observed characteristics of the food environment that may influence satisfaction with the neighborhood fruit and vegetable environment. A substantial body of literature has examined associations between observed characteristics of the food environment and fruit and vegetable intakes (Bodor, et al., 2010; Laraia, et al., 2004; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, & Diez Roux, 2002; Rose & Richards, 2004; Zenk, Schulz, Hollis-Neely, et al., 2005; Zenk, Lachance, et al., 2009). Less has focused on understanding perceptions of the food environment, such as satisfaction with the neighborhood fruit and vegetable environment, and their association with fruit and vegetable intakes in conjunction with observed indicators. While some studies find associations between observed characteristics of the food environment and satisfaction with the neighborhood food environment (Moore, Diez Roux, & Brines, 2008; Zenk, Schulz, et al., 2009), there remain inconsistencies in findings from research that examines associations between satisfaction with the neighborhood fruit and vegetable environment and dietary intakes (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009).

Assessing the influence of satisfaction with the neighborhood fruit and vegetable environment on fruit and vegetable intakes is important for several reasons. Throughout

this dissertation, I define satisfaction with the quality, cost and affordability, and variety of fresh produce in one's neighborhood as a subjective indicator that is influenced not only by observed characteristics of the food environment, but also by factors in the social environment (e.g., socioeconomic status, age, gender, personal preferences, cultural and economic factors (Moore, Diez Roux, & Brines, 2008)) that may influence norms, beliefs, and expectations related to dietary intake behaviors and patterns. Such factors may influence a person's satisfaction with their neighborhood fruit and vegetable environment by shaping their expectations or perceptions of produce in their observed food environment. The influence of factors in the social environment may be associated or simply interact with satisfaction with the neighborhood fruit and vegetable environment beyond the observed characteristics of the food environment.

Given established associations between satisfaction and fruit and vegetable intakes in chapter 2 of this dissertation and by Moore et al. (Moore, Diez Roux, Nettleton, et al., 2008), a second major focus of this dissertation has been to examine factors that are associated with satisfaction with the neighborhood fruit and vegetable environment . of and interacting with observed characteristics of the food environment. A major thesis of the research described here is that a better understanding of the joint relationships among observed characteristics of the food environment, satisfaction with that environment, and fruit and vegetable intakes specifically among African Americans (rather than in comparison to other racial and ethnic groups), will contribute to a better understanding of mechanisms that contribute to African Americans increased burden of diet-related disease and designing health interventions to reduce such excess burden. In the following section,

I describe these pathways in greater detail, and discuss their potential implications for the design of interventions to promote diet-related health among African Americans.

Factors that influence dietary behavior among African Americans. Understanding pathways through which the social and built environments influence health behaviors such as fruit and vegetable intakes is important for reducing the excess burden of diet-related disease among African Americans. Few studies examine factors that influence dietary behavior *among* African Americans. The majority of studies have involved multiethnic samples or comparisons across racial and ethnic groups. Thus, while they yield important information about how observed food environments experienced by African Americans may be similar to or different from those experienced by White or Latino Americans, they tell us relatively less about how these conditions are related to dietary intakes among African Americans or African Americans' perceptions or expectations of their local food environments.

African Americans have an increased prevalence of diet-related disease (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). Specifically, many factors that contribute to African Americans' excess risk of diet-related disease may be due to the neighborhood conditions in which they live (e.g., race-based residential segregation and neighborhood poverty) that structure access to produce, factors that influence fruit and vegetable intakes (e.g., satisfaction and observed food environment), fruit and vegetable intakes, and negative diet-related health outcomes. This dissertation conceptualized the social and built environment as intermediate level factors that are influenced by fundamental factors of race-based residential segregation (RBRS) and neighborhood poverty. RBRS and neighborhood poverty shape and structure

access to resources in the built and social environments that are necessary to maintain a healthy diet (Cummins & Macintyre, 2006; Larson & Story, 2009; Larson, et al., 2009; Morland, Wing, Diez Roux, et al., 2002).

African Americans are more likely than Whites to reside in neighborhoods with food environments that are often not conducive to maintaining a healthy diet (Cummins & Macintyre, 2006; Larson & Story, 2009; Larson, et al., 2009). In addition, African Americans are more likely than other racial and ethnic groups to live in urban, lower income and racially homogenous or segregated areas (Chang, 2006; Kumanyika, et al., 2007; Logan & Stults, 2011; Williams, et al., 2010; Wilson, 2010). When available, grocery stores in Black neighborhoods have often been found to have lower availability of have healthy food items or healthy food substitutions, such as low fat or low sodium items, compared to those found in predominantly White neighborhoods (Cummins & Macintyre, 2006; Morland, Wing, Diez Roux, et al., 2002). A growing body of evidence suggests that African Americans' increased likelihood of residing in areas that have decreased access to fresh fruits and vegetables, contributes to increased likelihood of suffering from health conditions that result from eating diets too low in fruits and vegetables (Larson, et al., 2009; Moore & Diez Roux, 2006; Powell, et al., 2007; Zenk, Schulz, Israel, et al., 2005). When modeled in African American only samples, the effects of RBRS and neighborhood poverty on the observed food environment may be better controlled for and explained and are often obscured or not included when looking at comparative studies.

Results from the within-group analyses approach taken in this research contribute to a clearer understanding of conditions associated with diet-related behaviors among

African Americans. As highlighted in chapter one of this dissertation, comparative studies inform us as to how the food environments of African Americans may differ systematically from the food environments of Whites. Within group studies tell us the factors that are associated with levels of satisfaction among African Americans, not in comparison to Whites, but in comparison to other African Americans. Results from such an approach suggest that if a component of the observed food environment or satisfaction changes, it is likely to be associated with changes in fruit and vegetable intakes among African Americans because the variation in such mechanisms has been examined among them. Therefore, these types of within group studies can inform public health interventions seeking to reduce the excess burden of diet-related disease among African Americans by suggesting factors that are likely to improve fruit and vegetable intakes among African Americans. For example, in this dissertation, knowledge of how a poor, observed food environment influences satisfaction and fruit and vegetable intakes for African Americans would help develop interventions to increase fruit and vegetable intakes among African Americans specifically (not in relation to Whites or Latinos) because they would be based on pathways and mechanisms of the influence of the observed food environment and fruit and vegetable intakes among African Americans. Such a focus suggests that that improvement in those environments might be associated with improvements in African Americans' fruit and vegetable intakes and is vital for improving diet-related negative health outcomes among African Americans. Below, I describe how results from specific chapters in this dissertation address aims and gaps outlined for this research and contribute to explanations for associations between

observed characteristics of the food environment and satisfaction with the neighborhood fruit and vegetable environment on fruit and vegetable intakes.

Summary of chapters and results

Chapter 2. Chapter 2 examined relationships between satisfaction with the neighborhood fruit and vegetable environment and fruit and vegetable intakes, in conjunction with the observed food environment. Specifically, I examined main effects of satisfaction on fruit and vegetable intakes, and mediating and moderating associations of satisfaction on relationships between observed characteristics of the food environment and fruit and vegetable intakes. Findings reported in chapter 2 were consistent with the hypothesis that satisfaction with the neighborhood fruit and vegetable environment is positively associated with mean daily fruit and vegetable intakes among African Americans. This relationship was robust and remained significant after controlling for observed characteristics of the neighborhood food environment (Models 3 and 4, Table 2.2). This result differs from findings reported by Zenk et al. (2009) among the full, multiethnic (African American, White, and Latino) sample from the same HEP dataset (Zenk, Lachance, et al., 2009). These differences may be due to differences in the statistical models used in the analyses. Zenk and colleagues used two level models that accounted for local food environments, but not neighborhood level poverty or racial composition (Zenk, Lachance, et al., 2009), while the study reported here used three level models that controlled for neighborhood poverty and African American racial composition. Difference in results from Zenk et al. (2009) and the current dissertation analysis may also reflect differences in the samples, specifically the use of a multiethnic sample versus an African American only sample in this study. Further analyses that use

comparable statistical models to examine relationships within the multiethnic sample compared to the African American only sample would help to distill the extent to which the differences in findings are a function of the statistical models or the restricted sample. However, the findings reported here suggest that within this sample of African Americans, and after accounting for neighborhood poverty levels and African American racial composition, satisfaction with the local fruit and vegetable environment is associated with fruit and vegetable intakes, above and beyond the effects of observed characteristics of the food environment. Furthermore, findings reported here suggest that among African Americans and controlling for neighborhood poverty levels and African American racial composition, there were some differences in relationships between the observed food environment, fruit and vegetable intakes, and satisfaction, compared to findings reported previously. These results and their implications for interventions and for further research are described in greater detail below.

Results from this dissertation's examination of associations between satisfaction and fruit and vegetable intakes are, however, consistent with research conducted by Moore and colleagues using the MESA study and adjusting for age, sex, race/ethnicity and SES (Moore, Diez Roux, Nettleton, et al., 2008). Moore and colleagues (2008) found that when controlling for age, sex, race and ethnicity and socioeconomic indicators, participant-reported satisfaction with the food environment was significantly associated with dietary quality (Moore, Diez Roux, Nettleton, et al., 2008). Neither Moore et al. (2008) nor Zenk et al. (2009) controlled for observed characteristics of the neighborhood food environment at the census block level or neighborhood poverty levels and African American racial composition at the census block group level (Moore, Diez Roux,

Nettleton, et al., 2008; Zenk, Lachance, et al., 2009). The added benefit of doing so in this analysis is the ability to extend research implications to observed characteristics of the food environment in which African American participants lived. It also enables this research to speak about intervention efforts that incorporate the influence of the observed food environment and satisfaction with the neighborhood fruit and vegetable environment in efforts to improve fruit and vegetable intakes among African Americans. For example, controlling for concentrations of neighborhood poverty and African American racial composition allows results from models in the current dissertation examining associations between the observed food environment, satisfaction, and fruit and vegetable intakes, to extend beyond the effects of neighborhood poverty levels and African American racial composition. Further, significant associations between the observed food environment, satisfaction, and fruit and vegetable intakes in this dissertation emphasize the importance for interventions aiming to reduce the burden of diet-related disease among African Americans to consider variations in such associations among all African Americans, not just those residing in neighborhoods with high concentrations of neighborhood poverty and African American racial composition.

In results from the mediation analysis, I found that satisfaction with neighborhood fruit and vegetable environment partially mediated the relationship between distance to the nearest neighborhood supermarket and mean daily fruit and vegetable intakes. Research conducted in this dissertation suggests that improving access to supermarkets may increase fruit and vegetable intakes (Leg A, Figure 2.1), a finding also shared with Moore and colleagues in a multiethnic sample (Moore, Diez Roux, Nettleton, et al., 2008). The findings reported here also suggest that higher concentrations of liquor stores and

presence of a small grocery store in the neighborhood were associated with poorer fruit and vegetable intake, and that increased distance to the nearest supermarket may be associated with reduced satisfaction with local food environments (Leg A, Figure 2.1). Results from Zenk et al. (2009) that used the same data to examine the above associations among a multiethnic sample of participants found that only the presence of a large grocery store in the neighborhood was associated with fruit and vegetable intakes, and this was a positive association. These results may reflect differences in the range and quality of fresh produce available in predominantly African American neighborhoods compared to what is available in White and Latino neighborhoods (Cummins & Macintyre, 2006; Morland, Wing, Diez Roux, et al., 2002). Such trends may explain the negative association between the presence of a small grocery store and increasing count of liquor stores with decreased fruit and vegetable intakes and the lack of significance in association between the presence of a large grocery store and fruit and vegetable intakes in this dissertation. Differences in the structure of models in Zenk et al. (2009), which did not control for neighborhood poverty levels and African American racial composition (Zenk, Lachance, et al., 2009), and this study which accounted for such effects, may drive the variations in associations between observed characteristics of the food environment and fruit and vegetable intakes in the two studies. Additional analyses that use comparable statistical models to examine relationships within the multiethnic sample compared to the African American only sample would help to determine the extent to which the differences in findings are a function of the variables included in statistical models versus the restricted sample of African Americans. For example, differences in associations between observed characteristics of the neighborhood environment and fruit

and vegetable intakes across multiethnic and African American only samples using the same statistical models would suggest that conditions unique to neighborhoods within which African Americans reside compared to other groups may drive associations and are particularly important to account for when designing interventions to improve fruit and vegetable intakes and reduce the prevalence of diet-related disease among African Americans.

In addition, distance to the nearest supermarket was significantly negatively associated satisfaction in models adjusting for additional elements of the observed food environment (liquor stores, small grocery stores etc.), concentrations of neighborhood poverty, and African American racial composition (Leg B, Figure 2.1). Another study by Zenk and colleagues (2009), separate from the one described above, but that also used the multiethnic sample of HEP participants, found similar results using a similar statistical model that controlled for additional elements of the observed food environment (liquor stores, small grocery stores, etc.) and concentrations of neighborhood poverty and African American racial composition (Zenk, Schulz, et al., 2009). Like results from this chapter, Zenk et al (2009) found distance to the nearest supermarket was significantly negatively associated with satisfaction when adjusting for additional elements of the observed food environment (liquor stores, small grocery stores, etc.), concentrations of neighborhood poverty and African American racial composition (Zenk, Schulz, et al., 2009). Similarities in associations between distance to the nearest supermarket (more so than other elements of the food environment) and satisfaction with the fruit and vegetable environment when controlling for differences in concentrations of neighborhood poverty and African American racial composition in African American and multiethnic HEP

samples suggest distance to the nearest supermarket is associated with satisfaction regardless of other characteristics of the neighborhood food environment and beyond neighborhood poverty concentration and sample racial and ethnic composition. Results also suggest interventions working to improve fruit and vegetable intakes by improving the observed food environment, specifically access to supermarkets, may also yield increases in satisfaction.

Finally, since distance to the nearest supermarket is associated with satisfaction (Leg B, Figure 2.1), satisfaction is associated with fruit and vegetable intakes (Leg C, Figure 2.1), and satisfaction partially mediates associations between distance to the nearest supermarket and fruit and vegetable intakes, a better understanding of what mechanisms work through such pathways of satisfaction with the fruit and vegetable environment may also help us improve dietary intakes. Significant associations between satisfaction with the neighborhood fruit and vegetable environment as associated with fruit and vegetable intakes even after controlling for the observed food environment, and as a partial mediator of associations between the neighborhood food environment and fruit and vegetable intakes establishes satisfaction as a factor that may be important for improving dietary intake behaviors. Building on findings reported in chapter 2 of this dissertation, chapters 3 and 4 aimed to better understand factors associated with satisfaction with the neighborhood fruit and vegetable environment.

Chapter 3. Chapter 3 examined SES as associated with satisfaction with the neighborhood fruit and vegetable environment when controlling for observed characteristics of the food environment and as a modifier of associations between the observed food environment and satisfaction with the neighborhood fruit and vegetable

environment. Only one of the studies referenced so far had previously examined the direct associations between SES and satisfaction with the food environment and the moderating associations of SES on relationships between the observed food environment and satisfaction with the neighborhood food environment (Zenk, Schulz, et al., 2009). In contrast to the analysis by Zenk and colleagues (2009), the analysis reported here re-examined such associations among African Americans, rather than a multiethnic sample, and controlled for the observed food environment, concentrations of neighborhood poverty, and African American racial composition. The study by Zenk and colleagues (2009) did not control for the observed food environment, concentrations of neighborhood poverty, or African American racial composition when examining associations between SES and satisfaction, but did adjust for observed characteristics of the food environment at the census block level when examining moderating associations of SES on relationships between the observed food environment and satisfaction (Zenk, Schulz, et al., 2009). Chapter 3 strengthened evidence for associations between education, one indicator of SES, and satisfaction with the fruit and vegetable environment by controlling for the observed food environment and examining such mechanisms among a sample of African Americans in hopes to parse out associations between indicators of SES and satisfaction with the neighborhood fruit and vegetable environment. In addition, significant moderating effects highlight the importance of the joint or interacting influence of observed characteristics of the neighborhood food environment and ability to access a car as these are associated with satisfaction with the neighborhood fruit and vegetable environment.

Findings from chapter 3 show education was associated with satisfaction with the neighborhood fruit and vegetable environment when controlling for observed characteristics of the neighborhood food environment (Model 5a, Table 3.1) and after accounting for neighborhood poverty levels and African American racial composition. Specifically, those with less than a college education (less than high school or a high school GED or diploma) reported lower levels of satisfaction with the neighborhood fruit and vegetable environment, after controlling for observed characteristics of that environment, compared to those with more education. Such results suggest that as education increases, African Americans may have different expectations of their food environments compared to those with lower educational attainments. Those with higher levels of education may have broader exposure to food environments outside of their immediate neighborhood that contribute to a more critical assessment the immediate neighborhood food environment.

Results for associations between education and satisfaction with the neighborhood fruit and vegetable environment are consistent with those reported by Zenk and colleagues (2009) who used a multiethnic sample, but did not control for observed indicators of the food environment, neighborhood poverty levels and African American composition (Zenk, Schulz, et al., 2009). The lack of similarity in statistical models used in analyses by Zenk et al. (2009) using the HEP multiethnic sample and this dissertation's use of only African American participants in the HEP sample do not allow for cross-comparison of associations between SES and satisfaction in the multiethnic and African American samples.

In addition to main effects of education as one indicator of SES, there was also a moderating effect of having access to a car on associations between observed characteristics of the food environment and satisfaction with the neighborhood fruit and vegetable environment. Specifically, participants with limited car access who lived in neighborhood blocks with at least one specialty store reported higher levels of satisfaction with the neighborhood fruit and vegetable environment compared to those with limited car access who lived in neighborhoods without a specialty store (Model 1, Table 3.4). These findings suggest that for those without access to a car, small modifications of the local food environment may be associated with improvements in satisfaction.

The significant finding of car access as moderating associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment, and main associations between education and satisfaction have implications for public health interventions seeking to improve fruit and vegetable intakes. For example, interventions may benefit from a primary focus on improving access to affordable, quality and healthy food in neighborhood environments with low access to such resources. Interventions such as fresh produce food trucks with healthy food cooking demonstrations would increase access to healthy food and offer methods and techniques for healthy food preparation in efforts to increase fruit and vegetable intakes. In addition, the moderating effect of car access suggests the need for a more critical assessment among those with limited transportation. Specifically that those with limited car access are less able to access food outside of their own local environment and may be more likely to have increased satisfaction with the presence of any stores

selling fresh produce, regardless of the quality or affordability. Such differences suggest that small changes in the local food environment may have a larger effect on those with limited car access compared to those with a car. Perhaps offering improved transportation options or improving public transportation allowing residents to more readily access healthy food outlets would also work to improve dietary intakes.

Chapter 4. Chapter 4 examined associations between organizational membership and neighborhood participation, as indicators of social engagement, and satisfaction with the neighborhood fruit and vegetable environment when controlling for the observed food environment. It also examined organizational membership and neighborhood participation as modifying associations between the observed food environment and satisfaction with the neighborhood fruit and vegetable environment. Neither organizational membership nor neighborhood participation was associated with satisfaction with the neighborhood fruit and vegetable environment. of the observed characteristics of the neighborhood food environment. Neighborhood participation, however, significantly moderated associations between the observed neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment: those who were more active in neighborhood activities were less satisfied with local food environments with higher concentrations of liquor stores compared to those who were less active in neighborhood activities.

There may be several reasons for the absence of an association between organizational membership and satisfaction with the neighborhood fruit and vegetable environment. Based on the measure used in these analyses, 85% of participants were not members of any organization. Thus, this measure may not have captured sufficient

variation to see an association with satisfaction with the neighborhood food environment. Future studies should consider use of indicators of social engagement that capture more detailed information on the type and frequency of participant involvement in organizations, and may want to consider inclusion of a wider range of organizational memberships, for example including faith based organizations. In addition, preliminary studies on the types of information received from involvement with organizations may be more helpful for models estimating their association with satisfaction with the neighborhood food environment and other health behaviors.

Neighborhood participation modified associations between observed characteristics of the neighborhood food environment and satisfaction with the neighborhood fruit and vegetable environment. Increasing numbers of liquor stores in a neighborhood blocks were associated with greater reductions in satisfaction with the neighborhood fruit and vegetable environment for those who participated in 2-3 neighborhood activities or groups compared to those who did not participate in any neighborhood activities or groups (Model 2, Table 4.3). Significant moderating effects highlight the importance of the joint or interacting influence of observed characteristics of the neighborhood food environment and indicators of social engagement on satisfaction with the neighborhood fruit and vegetable environment, perhaps suggesting a more critical assessment among those who are active and working toward change. Causal associations for these relationships were unavailable do to the cross sectional nature of the data.

Conclusions from chapter 4 highlight the need for additional research to examine the direction of effects of associations between indicators of social engagement and

satisfaction with the neighborhood food environment or dietary intakes using longitudinal data. Such research would help disentangle mechanisms that drive associations between indicators of social engagement, like neighborhood participation, and satisfaction with the fruit and vegetable environment or dietary intakes. Future public health interventions that share the goal of improving dietary intakes and reducing disparities in diet-related disease and health outcomes should consider results from this research and others that similarly examine factors that directly or indirectly influence fruit and vegetable intakes.

Limitations

There were several limitations associated with research for this dissertation. Perhaps of primary significance is sample generalizability. The HEP Community Survey does not have a nationally representative sample of African Americans. Thus, results from this dissertation do not suggest or imply associations between observed characteristics of the neighborhood food environment, satisfaction with the neighborhood fruit and vegetable environment, fruit and vegetable intakes, and associated predictors, modifiers and mediators on a national level. Data for this study were collected from 522 self-identified African Americans who resided in 67 census block groups and 115 census blocks throughout Eastside, Southwest, and Northwest neighborhoods of Detroit, Michigan. While other American cities have high rates of segregation, according to 2000 and 2010 census reports using Dissimilarity and Isolation indexes, Detroit has the highest rates of black-white segregation in the country (Logan & Stults, 2011). Detroit also has high rates of unemployment (White M., 2011) and is a city in which African American neighborhoods are often located further from supermarkets than majority white neighborhoods (Zenk, Schulz, Israel, et al., 2005). Thus, results from this research may

only be generalizable to African Americans living in racially homogenous, low income environments with poor access to and availability of healthy food and fresh fruits and vegetables.

In addition, the data used in this study are cross-sectional. The cross-sectional nature of data in this study restricted our ability to assess long-term effects or changes in associations between observed characteristics of the neighborhood food environment, fruit and vegetable intakes, satisfaction with the neighborhood fruit and vegetable environment, and associated predictors, modifiers and mediators of such associations. Finally, there may be limitations with the use of fruit and vegetable intakes as a proxy for diet quality and predictor of health outcomes (Chapter 2). Foods are not consumed in isolation, but with other foods and may interact with other foods to influence health. Future studies should consider use of dietary indexes in addition to fruit and vegetable intakes. This may provide more accurate or complete measures of diet intakes and their associations with the observed food environment and satisfaction with the food environment (Jacobs Jr & Steffen, 2003; Moore, Diez Roux, Nettleton, et al., 2008). Despite the above listed limitations, use of the 2002 HEP Community Survey provided the current dissertation with the environmental conditions and participants necessary for testing the current study hypotheses.

Despite the above limitations, use of the 2002 HEP Community Survey provided the current dissertation with the environmental conditions (measures of percent African American, percent neighborhood poverty, and observed indicators of the food environments) necessary to examine factors associated with fruit and vegetable intakes among African Americans. A major contribution of this research was the ability to

examine factors associated with observed characteristics of the food environment, satisfaction with the neighborhood fruit and vegetable environment, and fruit and vegetable intakes jointly among African Americans. Doing so allowed me to account for the unique aspects of the social and built environments in which African Americans reside and their associations with satisfaction and fruit and vegetable intakes. Other studies examining associations similar to those in chapters two and three of this dissertation do not control for the observed food environment, nor do they control for neighborhood poverty or racial composition of the neighborhood (Moore, Diez Roux, Nettleton, et al., 2008; Zenk, Lachance, et al., 2009).

Implications

The research conducted in this dissertation has several implications for improving fruit and vegetable intakes and reducing disparities, diet-related disease and health outcomes. Below, I discuss implications of findings of this dissertation for advancing public health research and informing public health policy and practice.

Research. A major contribution of this dissertation was examining the role of satisfaction with the neighborhood fruit and vegetable environment in mediating or moderating associations between observed characteristics of the food environment and dietary intakes. I also examined the role of SES and indicators of social engagement as being independently associated with satisfaction or as moderating associations between the observed food environment and dietary intakes. Future studies should consider the role of in-store audits of fresh fruits and vegetables in shaping associations between characteristics of the observed food environment, satisfaction with the neighborhood fruit and vegetable environment and dietary intakes. Inclusion of in-store audit measures may

help improve specificity of models examining associations between observed characteristics of the neighborhood food environment, satisfaction with the fruit and vegetable environment, and dietary intakes.

An important yet less examined predictor of health behaviors surrounding fruit and vegetable intakes is the influence of cultural factors. Cultural norms and expectations, and the built and social environment, can shape people's racial and ethnic identity and health behavior (Bediako, Kwate, & Rucker, 2004; Evans, et al., 2009; Hargreaves, et al., 2002; James, 2004; Pollard, et al., 2002). Such factors may function as independently associated with dietary intakes or may interact with observed characteristics of the neighborhood food environment to influence dietary intakes (Odums-Young, Zenk, & Mason, 2009). There have been numerous studies examining the role of cultural factors on health behaviors (Arthur & Katkin, 2006; Bediako, et al., 2004; James, 2004). Many of these studies have been qualitative in nature. There is a need to incorporate measures that assess the influence of cultural factors as influencing dietary intakes. Doing so may provide public health researchers and those developing interventions with a better idea of the influence of culture on mechanisms that drive associations between the observed food environment, satisfaction with the food environment, and dietary intakes and may suggest ways for how to adapt interventions to accordingly incorporate the influence of culture.

Results from chapters 3 and 4 of this dissertation may also have implications for future research. Given significant relationships between SES and satisfaction with the food environment found by other studies (Boyington, et al., 2009; Zenk, Schulz, et al., 2009) and chapter 3 of this dissertation, and the importance of satisfaction in shaping dietary intakes, future research may consider examining satisfaction with the

neighborhood food environment as mediating or moderating associations between SES and dietary intakes. Results from such research may further inform public health interventions seeking to improve dietary behavior of ways in which to tailor or develop intervention messages towards those of low versus high SES or for those with low versus high degrees of satisfaction with the neighborhood fruit and vegetable environment.

Additionally, given significant associations between indicators of social engagement and dietary intakes in other studies (Emmons, et al., 2007; Litt, et al., 2011), it may be beneficial for future studies to examine similar relationships. Chapter 4 of this dissertation examined associations between indicators of social engagement and satisfaction with the neighborhood fruit and vegetable environment. Future studies should consider using a more diverse or detailed set of social indicators to capture more variation in what or which aspects of social engagement may influence dietary intakes. In addition, to further disentangle associations between indicators of social engagement and dietary intakes, it may also be interesting to examine the moderating effects of satisfaction with the neighborhood food environment on associations between indicators of social engagement and dietary intakes. Finally, given limitations on how observed characteristics of the food environment were measured in this dissertation, it might it also be important to examine satisfaction with the neighborhood food environment as moderating associations between the observed food environment and dietary intakes with better measures of food environment, such as the range, price and quality of fruits and vegetables available in local stores.

Policy. This research has several implications for public health policy. The findings reported here affirm the importance of access to fruits and vegetables in relation

to satisfaction with local food environments and also in terms of fruit and vegetable intakes. Those with higher levels of neighborhood participation who lived in environments with large numbers of liquor stores, perhaps have a more critical assessment of satisfaction with those food environments compared to those with lower levels neighborhood participation. Similarly, those who had limited car access who lived in neighborhoods with at least one specialty store were more satisfied with their neighborhood food environment. These findings suggest both the importance of transportation in shaping food access, with those without transportation more dependent on their local food environments, and also the effects of small differences in the local food environment in shaping satisfaction among those with more circumscribed access to transportation. Associations between car access and factors that are associated with health behaviors, like satisfaction, and fruit and vegetable intakes are particularly important for African Americans given the large proportion of African Americans with limited car access (Saenz, 2005).

Increasing access to healthy food, namely fresh fruit and vegetables, is an important policy issue emerging at city, state, and national levels (Karpyn, et al., 2009). At the core of several policy agendas are the structures that frame society and influence fruit and vegetable intakes (Lang, Barling, & Caraher, 2009). Policy is often needed to change such structures (Lang, et al., 2009). Decreased access to healthy food in African American or lower income neighborhoods and higher prices on healthy food versus less healthy options when they are available (Horowitz, Colson, Hebert, & Lancaster, 2004) makes such environments important to target for developing policy agendas.

The Food Trust, an organization that began in Philadelphia, Pennsylvania, developed a 5-step framework to increase access to fresh and healthy food (Karpyn, et al., 2009). Karpyn et al. (2010) provided an outline of the successful framework, which was modeled to increase access to healthy food on local, state, and national levels. As developed by the Food Trust, Karpyn et al. (2009) outlined the 5-step framework as involving: preparing and informing neighborhood residents, empowering residents, strategizing, changing policy, and finally implementing, monitoring, and evaluating such policies (Karpyn, et al., 2009). Some of these activities, while not formally reflective the Food Trust's 5-step framework, are ongoing in Detroit, the site for which data for this study emerged.

The Double Up Food Bucks Program, offered by the Fair Food Network, operates by matching Supplemental Nutrition Assistance Programs (SNAP) money dollar for dollar for spending on produce at farmers' markets in Detroit at values of up to $20 per day. There are also larger conversations about structural level changes that are needed to increase access to healthy produce for residents of Detroit. A group, Undoing Racism in the Food System, is involved with such activities by leading informal discussions on how to identify and combat racism in Detroit's food system (Pothukuchi, 2011). In light of structural level changes that would increase access to healthy foods, there remain real individual level constraints that may still influence whether a person can take advantage of a structural changes that may improve food environments. For example in a community like Detroit, transportation may be a barrier to access desired or healthy foods that may not be available in one's immediate neighborhood and thus may also be a significant barrier to improving dietary intakes. Thus, it is important for research and

policy efforts to consider the interface or potential interaction between structural level changes that may shape actual or perceived access to healthy foods and individual level factors, like education or knowledge and car access, that present more intrinsic barriers to improving dietary intakes. It would also be important for researchers interested in the influence of structural level policy change on health behaviors to document such initiatives and their effectiveness in improving fruit and vegetable intakes and reducing the excess burden of diet-related disease among African Americans. Keeping record of such efforts may help produce other interventions, models, and policies for similar change.

Practice. Results from this dissertation emphasize the need for interventions seeking to reduce disparities in diet-related disease by increasing fruit and vegetable intakes to consider factors at several levels that influence such health behaviors. This dissertation considered the influence of factors at the fundamental, intermediate, and proximate levels. In addition, this is the first study to date that examines indicators of social engagement, organizational membership and neighborhood participation, as associated with satisfaction with the neighborhood food environment and as moderating associations between the observed food environment and satisfaction. The significant finding of neighborhood participation as moderating associations between the observed food environment and satisfaction (given significant associations between satisfaction and fruit and vegetable intakes) has important implications for interventions seeking to increase fruit and vegetable intakes.

Specifically in Detroit there are joint community and academic efforts to discuss community level strategies for improving access to fresh, affordable produce for Detroit

residents. Many of such efforts highlight approaches and steps that can be taken to reduce the excess burden of diet-related disease suffered by African Americans. In 2006, the Healthy Environments Partnership (HEP) conducted a series of focus groups with residents of the city of Detroit across the neighborhoods from which data for this study were drawn to better understand ways in which neighborhoods impact dietary health among other things. Two issues that emerged from focus groups with Detroit residents were the need to grow foods locally and have more local stores carry quality, good food. Many of the issues highlighted reflect what research shows: there is a need for fresh, quality, and affordable foods at local stores, and that stores should be within walking distance and easy to access.

Grow food locally. Urban gardening is increasingly used as a method to improve access to healthy produce, empower neighborhood residents and provide education on gardening techniques, and ultimately increase fruit and vegetable intakes (Litt, et al., 2011). The increased opportunities for neighborhood participation in communities with often otherwise poor access to healthy foods may yield important intervention techniques for increasing fruit and vegetable intakes and reducing the burden of diet-related disease among African Americans. Detroit residents are currently engaged in a wide range of active efforts to improve local food access and security. A 2011 report compiled by the Detroit Food Policy Council (DFPC) highlighted several of these efforts including citywide urban agriculture programs that serve as good resources for fresh produce by establishing community gardens and training residents in farming practices. Many of these gardens are starting on the thousands of acres of vacant land across the city of Detroit. In addition to starting community gardens, the DFPC report also highlighted the

growing number of neighborhood farmers' markets across Detroit that not only bring fresh produce to City residents, but also generate revenue for farmers (Pothukuchi, 2011). In terms of public health practice, and given the significant findings in this dissertation for associations between neighborhood participation, the observed food environment and satisfaction, it may be important for public health practitioners to document, participate, and support such efforts. Doing so may offer insight into additional techniques and methods useful for improving fruit and vegetable intakes and reducing the excess burden of diet-related disease among African Americans in other neighborhoods with similar conditions.

More local stores carrying quality, good food. Results from the focus groups described above are in line with results from this dissertation. This dissertation found participants residing in poor observed food environments had decreased satisfaction and fruit and vegetable intakes. Intervention techniques to increase access to affordable, quality, healthy food in stores may consider offering small grocery or convenience store owner's financial incentives and resources for increasing or adding fresh produce to their inventory. Specifically, such activities could involve obtaining grants to subsidize the cost of healthy produce from local farmers or other distributers, adding refrigeration cases to store fresh produce as needed, or even reimbursing store owners for money lost during transitions to selling healthier products. Such efforts involve working through multiple levels and pathways to improve the observed food environment, satisfaction, and fruit and vegetable intakes.

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