Building Environments to Promote Healthy Weights among Childbearing Women

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BUILDING ENVIRONMENTS TO PROMOTE HEALTHY WEIGHTS AMONG CHILDBEARING WOMEN

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Ecological models of the causes of overweight and obesity emphasize the embedded nature of individual characteristics and behaviors within interpersonal, organizational, community, national, and even global levels of influence. To begin to understand these complex interrelated factors, the food environment in a rural 8700 square mile area of Upstate NY was investigated in relation to a sample of 555 women in early pregnancy living in that area. Household addresses of the 555 women were mapped using ArcGIS (version 9.1, copyright 2001-2004, ESRI, Redlands, CA) and food environments around each woman were created to correspond to all the food stores (N = 870), one, five, ten, and twenty miles from her home. All the food stores were visited in-person and surveyed using a modified version of the Nutrition Environment Measurement Survey for Stores to ascertain the availability of 14 categories of foods sold in these stores. Within each food category, a healthier and less healthy food type was identified, with the exception of the produce category where all foods were presumed healthy. The number of varieties of each food within each food category were counted. Many "non-traditional" food stores such as drug stores, dollar stores, and general merchandise stores were very common in the food environment and were found to sell a wide variety of food. However, fresh produce was only available in 43% of the surveyed stores (mainly supermarkets and grocery stores, and about a third of convenience stores). Less healthful foods like soda and potato chips were sold in nearly all stores. Of the surveyed stores, 54.3% were convenience stores, and this store type was on average the closest type of store to the women. Two ways of handling the

challenge of collating and summarizing this large amount of information about the food environment were explored by creating a Healthy Food Availability Index and groupings of stores based on cluster analysis. The cluster analysis created five distinct store categories based on the number of varieties of surveyed foods, but the Healthy Food Availability Index with its wide range of scores from 0 - 37 allowed for finer distinctions between the smaller and non-traditional food stores. Analysis of the relationship between women's residential location and the food environment showed that generally the more stores in a woman's near food environment (one and five miles) the higher her odds for being overweight or obese. Unlike what has been found in several studies of the urban food environment, women having at least one supermarket one mile from home or a supermarket or grocery store within five miles from home were at higher risk for being obese or overweight, respectively, in this rural environment. In addition, this was the first known study to analyze the spatial relationship to a natural food stores and found proximity was associated with a reduced odds of being obese. Further analysis in a subset of the lower income women showed that more supermarkets and food stores of any kind five miles from a woman's home predicted more smaller shopping trips made in a supermarket and more frequent smaller shopping trips. More supermarkets within five and ten miles of a woman's home increased the chance that she would score highly on a composite score of daily fruit and vegetable, whole grain and milk intake. Finally, an analysis of the capacity of public health practitioners to work to improve this environment to promote healthy weights showed that many current practitioners are interested in creating environmental change, but face significant challenges for doing so including: a lack of "community time," lack of efficacy for working with non-traditional partners, concerns about getting too involved in local power and politics, and a need to learn more about effective approaches for environmental change.

BIOGRAPHICAL SKETCH

Leigh Gantner, PhD grew up in Ithaca, NY and has spent most of her life living, learning, and working in the area. She received her Bachelors Degree from Binghamton University with a double major in Biology and Anthropology where she received several academic and athletic scholarships including the Goldstein Award in Anthropology. Her Honors Thesis examined the relationship between diet, stress and blood pressure in normotensive women. She then pursued her Masters in Nutrition at Cornell University where she was awarded her degree in 2001. In her Masters Thesis she examined communication about agricultural biotechnology within the context of a land-grant institution. She worked for 3 years at Cornell Cooperative Extension in Cayuga County as a Nutrition Educator where she supervised the Food Stamp Nutrition Education Program and the Expanded Food and Nutrition Education Program. She recently completed her Doctorate in Nutrition at Cornell University where she was awarded the Orilla Wright Butts Fellowship in Human Ecology and a National Institute of Health Nutrition Training Grant. She also recently completed her training in Dietetics. She looks forward to beginning her new career as an Assistant Professor at Syracuse University in Syracuse, NY and enjoying life with her husband and two dogs.

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CHAPTER ONE

INTRODUCTION

Research Goals

This thesis has three major sections with some sections including two chapters. The first two sections focus on the food environment in a rural area of Upstate NY, and the third focuses on a community-based partnership that aimed to develop and implement environmental interventions to promote healthy weights among childbearing women and their children in the same rural area. The research goals for each of the three major sections are listed below:

1) **To assess and characterize the retail food store environment in an area of rural Upstate NY and investigate ways of characterizing food stores beyond traditionally used categories and labels.** (Chapter Two and Chapter Three)

Observations were conducted in 870 food stores in a rural area of Upstate NY to describe the availability and variety of foods in 14 different food categories, including fresh and processed foods, across the geographic area. Data were analyzed to determine the extent to which different foods were available in different types of food stores. Several methods were employed to investigate alternative ways of summarizing food availability within different types of stores and the utility of these alternative characterizations was investigated.

2) To examine the relationships between the food environment in rural Upstate New York and women's body weight in early pregnancy, and identify potentially mediating food-related behaviors and modifying socio-demographic characteristics. (Chapter Four and Chapter Five)

Geographic and demographic data collected from 555 women in early pregnancy (less than 14 weeks) in a rural Upstate NY area were linked to data from food stores within a 20 mile radius around each woman's home. This allowed for the investigation of the relationship between early pregnancy weight and food environment characteristics including distance to different types of food stores and the availability of healthy foods within a given radius of the women's homes. Household income was investigated as a potential modifier of this relationship. Among a subset of these women (N = 131) food shopping and dietary behaviors were investigated as potential mediators of environmental influences on weight.

3) To identify and understand the successes and challenges faced by public health professionals in developing and implementing environmental interventions to promote healthy weights among childbearing women and their infants. (Chapter Six)

A community-based partnership was developed in the same rural eight- county area. It brought together local public health professionals working in both the private and public sector, to design and implement environmental interventions to promote healthy weights in childbearing women and their infants. The process evaluation aimed to understand the challenges faced by community-based public health professionals in planning and implementing environmental interventions that focused on making changes in policy and the built and social environments.

Literature Review

The Context

Overweight (BMI $\geq$ 25) and obesity (BMI $\geq$ 30) are complex, multi-factorial problems in the US affecting nearly every demographic sub-group of the population.

Overweight and obesity may develop differently in women than in men, given the influence of childbearing on weight gain and changes in body composition. Data from the National Center of Health Statistics from 1999 – 2004 shows that 25% of women aged 12 – 44 years are overweight (BMI> 25 kg/m^2), and another 30% are obese (BMI > 30 kg/m^2) (Institute of Medicine 2009). The growing number of overweight or obese individuals is a serious medical concern as these conditions increase risk for diabetes, heart disease, stroke, and some forms of cancer.

Taking a life course perspective, key events in a woman's life may be important in putting her on a trajectory towards an unhealthy weight. The weight gain associated with childbearing is 0.4 to 1.8 kg more than that due to aging alone (Olson and Stawderman 2003). While the Institute of Medicine (IOM) has issued guidelines in 1990, and again in 2009, on the appropriate amount of weight gain during pregnancy based on pre-pregnancy BMI, many pregnant women gain above these recommended amounts (Abrams et al 2000, IOM 2009). In fact, the number of women gaining above the recommended amounts is increasing (Schieve et al 1998, IOM 2009). Additionally, women who gain more than the recommended amount during pregnancy are two to three times as likely to become overweight after pregnancy (Gunderson et al 2003). An analysis from NHANES I data has shown that rural, low-income, and less educated women were more at risk of experiencing parity-related weight gain (Wolfe et al 1997).

Weight gain during pregnancy, however, is not the only point of concern regarding healthy pregnancy outcomes. As noted above, the large number of childbearing aged women who are currently overweight or obese implies that many women will be entering pregnancy already at a high BMI. From the start, these women are at a higher risk for pregnancy complications, and weight gain above the recommended amount may only exacerbate their health issues. Among the increased

health risks are gestational diabetes, cesarean section, and macrosomia (Edwards et al 1996, Rhodes et al 2003). Appropriate pre-pregnancy weight and weight gain during pregnancy may also have long-term benefits for the offspring. Several studies suggest that the intrauterine environment may program long-term metabolic processes that lead to increased risk of overweight and obesity (Srinivasan et al 2006, Oken 2003), as well as diabetes in offspring (Silverman et al 1998, Dabelea et al 2000). Thus, interventions that increase the number of women who enter pregnancy at a healthy weight, gain an appropriate amount of weight during pregnancy, and support women in weight loss efforts after pregnancy can aid in nationwide efforts to curb the obesity epidemic in women and their children.

Theoretical Frameworks

Understanding why women are increasingly prone to gain too much weight during pregnancy and retain that weight long-term requires an understanding of the environments in which they live and how behaviors are shaped by those environments. These environments include physical surroundings, inter-personal relationships, social and cultural influences, and economic and political structures. One way to make sense of these complex inter-related factors is Social-Ecological Theory. First proposed by Urie Bronfenbrenner, the theory considers the nested effects of the microsystem (individual and interpersonal factors), mesosytem (organizational relationships), exosystem (community and social networks), and macrosystem (cultural) influences on child development (Bronfenbrenner 1994). Since it was first proposed, however, the theory has evolved to frame a variety of health promotion efforts, and underlies many interventions that seek to target the underpinning conditions that promote health and well-being. Commonly, it is used to explain the multiple underlying and interconnected influences on a health condition, and consequently the need to

understand and intervene at multiple levels of society to promote solutions to a public health concern. For instance, public health efforts to promote smoking cessation targeted not only individuals with smoking cessation classes and other educational efforts to increase personal knowledge of the harms associated with smoking and smoking cessation strategies, but also organizational policies that banned smoking in workplaces, cultural influences that turned public perception against smoking, and national legislation that heavily taxed cigarettes and required health warnings on all packages.

Stokols (1996) describes Social-Ecological Theory as the integration of two distinct health promotion perspectives: behavioral change theory and environmental enhancement. In so doing Social-Ecological Theory describes the interaction between individual-level factors (like biology, genetic predisposition, knowledge, attitudes and beliefs), and environmental-level influences (like cultural contexts, pollution, and the built environment) on health. As a result, the environment influences individual behaviors, but individual behaviors also influence the environment. If someone lives in an environment with poor access to fruits and vegetables, Social-Ecological Theory would hypothesize that it is less likely this person will eat fruits and vegetables, particularly if individual-level factors like income, cooking skills, and time constraints hinder an individual's ability to eat well. Increased demand for healthier foods by community members (i.e. as a result of education, improved access to financial resources etc.), however, could cause neighborhood stores to carry healthier items. Another component of Social-Ecological Theory suggests that individual-level behavioral factors can modify a person's response to environmental factors (Stokols 1996). So someone with a strong culinary skills and a high degree of self-efficacy may be able to piece together a healthful diet in a bleak food environment, whereas

someone without these personal attributes may be much more susceptible to health problems stemming from a deficient food environment.

One specific application of Social-Ecological Theory related to understanding the food and physical activity environment influences on health has been the Center for Disease Control's (2009)1 socio-ecological model to prevent obesity and other chronic diseases (Figure 1.1). This model emphasizes five successive levels of influences on health from the knowledge, attitudes, and beliefs of individuals, through to the relationships of those individuals with friends and family (interpersonal level); schools, workplaces, and churches (organizational level); and policies and cultural influences at the community and societal levels.

Figure 1.1: Center for Disease Control Socio-Ecological Model to Prevent Obesity and Other Chronic Diseases (2009)

Other environmental models build on Social-Ecological Theory, but list more specific elements of the food and physical activity environment and demonstrate how these elements may influence weight (and consequent health related outcomes)

through their effect on individual behaviors. For instance, the National Heart, Lung, and Blood Institute (2004) developed a model (Figure 1.2) showing a variety of influences on weight-related health outcomes, among them biological (including genetic) and psychological influences stemming from the individual, socio-cultural and organizational influences, and physical environment and policy level influences. A model developed by Glanz et al (2005) focused specifically on diet-related variables, but still took an ecological focus pointing to the policy, physical environment, and media level influences on eating patterns through the mediation of individual-level sociodemographic variables (Figure 1.3).

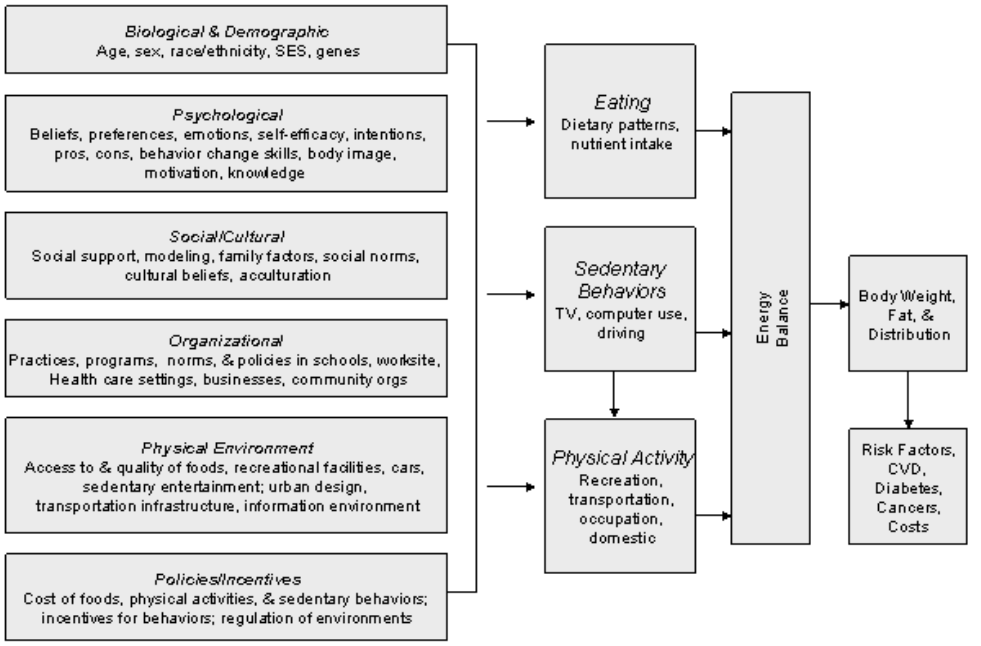

Figure 1.2: National Heart Lung and Blood Institute Ecological Model (2004)

Attention to how behavior is conceptualized in these socio-ecological models is important, particularly when models are operationalized to support research and intervention. While the thrust of the models may still be on environmental antecedents to health outcomes (as opposed to focusing only on an individual's knowledge, attitudes, and beliefs), the critical framing of behavior should be noted (McLeroy et al 1988). Certainly behavior and individual choices have a major role to

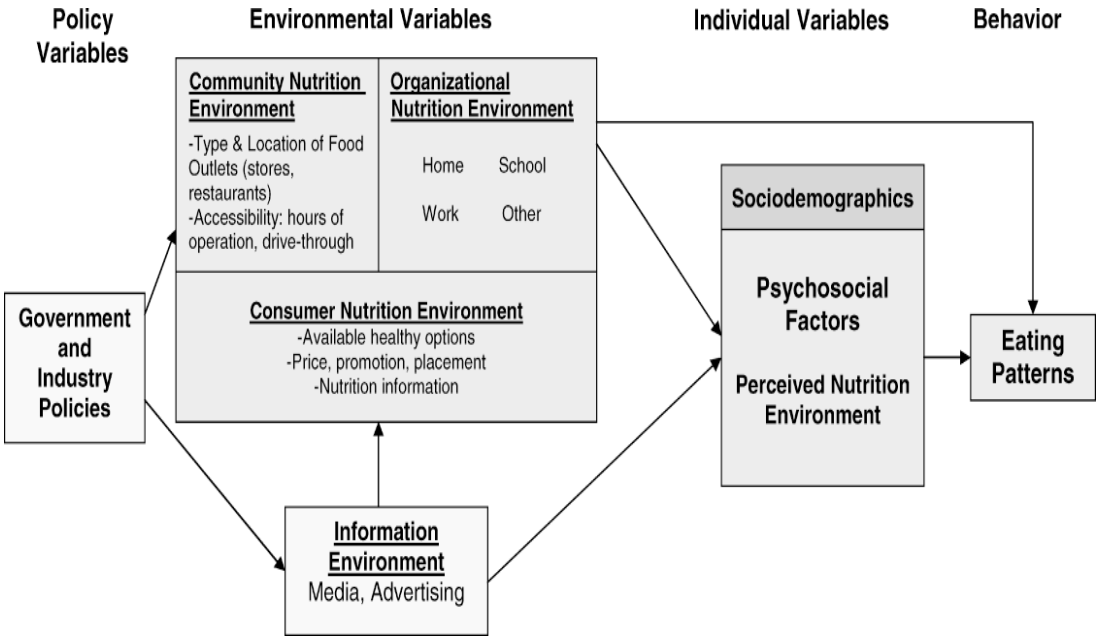

Figure 1.3: Glanz et al Model of Social-Ecological Influences on Diet-Related Behaviors (2005)

play, often as mediators and modifiers of the relationship between health and the environment, but ecological models also allow one to understand distal environmental influences on behavior that individuals may not necessarily be aware of (or aware of their influence on choice and behavior). This distinction may be more than theoretical when these theories are applied to "real-world" situations in the assessment, planning, and implementation of healthy weight programs. For instance, McLeroy (1988)

discusses how the framing of individual behavior change can affect the development and implementation of smoking cessation programs. Two programs may purport to take a social-ecological perspective. In one the influence of peer pressure and other inter-personal relationships are recognized and tools are taught in the program to help participants resist those pressures. In the second program, also taking a social-ecological approach, the focus is on changing the nature of those inter-personal relationships such that they support more positive messages. In both, inter-personal relationships (and the social context which they create) are viewed as important, but only in the second program is the *target* of the intervention these social relationships. This distinction will be discussed further in Chapter Six of the thesis where the challenges of operationalizing the social-ecological model to create changes targeting the environmental or social contexts that influence behavior, versus teaching the skills to overcome these social and environmental pressures, were confronted among public health professionals.

Social-Ecological Theory and models like those shown here formed the theoretical foundation of all the papers in this thesis. The physical environment, specifically retail food stores and the foods sold within them, and their influence on weight is at the core of Chapters Two through Four. In addition, in Chapter Five some of the individual-level factors and behaviors theorized to mediate and modify the relationship of the broader environment on health outcomes are investigated. In Chapter Six the challenges of operationalizing the tenets of Social-Ecological Theory to create environmental changes supportive of healthy weights among public health practitioners are discussed, particularly the challenges these practitioners faced in modifying their approaches to community health away from individually-oriented educational programs.

Social Cognitive Theory

Another important theoretical perspective when analyzing environmental influences on weight and chronic disease is Social Cognitive Theory (Bandura 1977). Social Cognitive Theory is a learning theory that attempts to explain how an individual learns about and adapts to changing circumstances. Social Cognitive Theory includes three basic interrelated components: environment, personal factors, and behavior (Figure 1.4). These components interact in a reciprocal way such that these three factors are continuously influencing each other. This reciprocal determinism has direct application to food environment research - just as environment and cognitions about what to eat may influence diet-related behavior, eating patterns are likely to shape the environment and modify cognitions through new experiences.

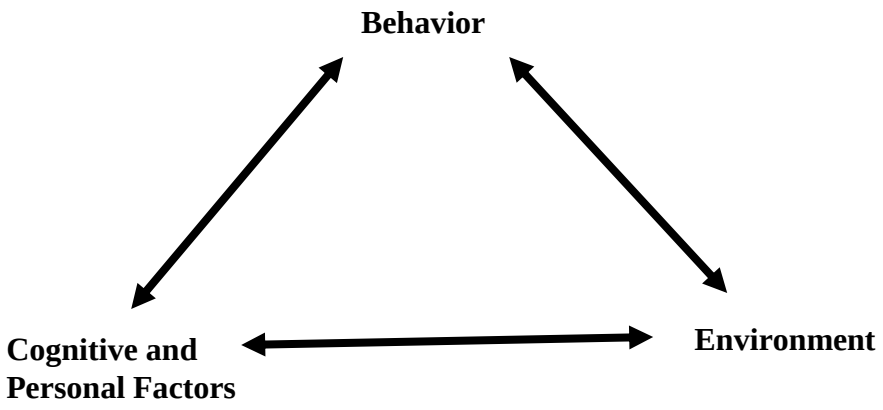

Figure 1.4: Social Cognitive Theory

Research on the influence of the food environment on weight is still in its nascent stages, such that the full impact of this triadic relationship has not yet been investigated. Those studies that have looked at the influence of the environment on behavior, and to a limited extent on cognitions, have been cross-sectional so that the

direction of these influences could not be determined (Morland et al 2002b, Laraia et al 2004 , Zenk et al 2005b, Zenk et al 2009). For instance, a study by Laraia et al (2004) found that the closer a woman's home was to a supermarket the healthier her diet, but studies of this type are susceptible to selection bias such that people who desire healthier diets may choose to live closer to supermarkets or may encourage the growth of healthier options in their neighborhood in other ways. Another study in England examined the changes in eating behavior before and after the introduction of a new supermarket, and found small positive changes in eating behaviors among a limited subset of those potentially affected (Wrigley et al 2002). Limited evidence in these studies suggests that more than supermarket proximity influences food choices and behavior, including perceptions, habits, attitudes, knowledge and skills. Indeed, researchers of food choice have documented that food decisions are an incredibly complex process with influences on present behavior accumulating over the life course (Glanz et al 1998, Devine et al 1998, Connors et al 2001). More research is needed regarding how residents make food choices in the context of their food environment, given multiple demands in their lives. Chapter Five attempts to analyze some of the additional factors (e.g. self-efficacy and diet) that may intervene between the food environment and weight. Since the data are cross-sectional, it is not possible to assess cause-and-effect in the triadic relationship shown in Figure 1.4, but it does suggest directions for future research.

Building the Case for Environmental Change

An increasing number of studies are examining the relationship between the food environment, diet, and weight. The majority of these studies have been conducted in urban and suburban areas. The few that have examined the rural food

environment have generally found that people in rural areas have poor access to food stores, but have not investigated the connection between this poor access to diet and health outcomes (Morton et al 2007, Liese at al 2007, Kaufman 1998). Several studies in urban and suburban areas, however, have found a relationship between a lack of nearby supermarkets or large grocery stores, and poor diet (Morland et al 2002b, Rose 2004, Zenk et al 2005b, Laraia 2004, Moore et al 2008). These effects were more pronounced among African American and low-income populations. A handful of studies have also found a relationship between the availability of fruits, vegetables, and other healthful foods and indications of a better diet among nearby residents (Bodor et al 2008, Fisher et al 1999, Cheadle 1991). Similarly, relationships have been found is several studies of both adults and children between the increased availability of supermarkets and/or healthier food and reduced prevalence of overweight and obesity (Morland et al 2006, Powell et al 2007a, Inagami et al 2006, Sturm and Datar 2005).

While most of these food environment studies make an effort to control for individual-level and/or neighborhood-level covariates, their cross-sectional nature hinders the ability to assess the direction of the influence. Basic marketing analysis and economics would suggest that supermarkets and stores selling healthful foods would locate near populations willing and able to buy the healthier foods sold within these stores. Nonetheless, individuals living in areas with poor access to healthier foods, who desire to eat more healthful foods, may find their neighborhood environment a significant challenge, particularly if transportation is not available to transport residents to neighborhoods with healthier resources. Access to healthy food is a necessary, but not sufficient, factor for improving diet and health.

Consequently increasing attention has been focused on the emerging evidence which suggests supermarkets and high quality foods are not evenly distributed among

communities; areas with large minority populations, neighborhoods with high levels of poverty, and rural areas generally show lower access (Morland et al. 2007, Hosler et al 2006, Zenk et al. 2005a, Baker et al. 2006, Zenk et al. 2005b, Moore et al. 2006, Morland et al. 2002, Jetter et al. 2006, Powell et al. 2007b, Morton et al. 2007, Kaufman 1998, Liese et al. 2007). While some of these disparities may be related to lower demand for these foods, particularly in highly impoverished areas, and low population densities in rural areas, it may be that racial and income discrimination may also underlie these disparities, particularly in urban areas. Indeed, at least one study has found that low-income and high minority census block groups in a rural area of Texas had better access to supermarkets and other food stores, although the median distance to a supermarket for all the rural residents was still 14.9 km (Sharkey et al. 2008).

Recent policy efforts have sought to improve food access in neighborhoods with poor food access and availability. These efforts have included establishing farmers' markets in previously underserved areas, creating community gardens so residents can grow their own food, and in some cases active lobbying to bring large grocery stores to communities previously large food stores (Community Food Security Coalition 2007, The Food Trust 2009). The research community can look forward to the evaluation of these types of efforts in improving residents' diet and health, but a study from England offers a cautionary tale. Wrigley et al (2002) found that after the introduction of a supermarket in a previously underserved urban neighborhood, the diets of residents marginally improved among residents who had previously had the worst diet (i.e. < 1 serving of fruits and vegetables per day). While a longer-term assessment of residents diet may have shown greater improvements (after residents had a chance to adjust to their new food resources), the study does suggests that

improving the food environment may have some direct benefits, but that other factors still impact food choice.

In addition the Centers for Disease Control (CDC) and the Institute of Medicine IOM) have recently published reports recommending a series of community-based strategies to reduce obesity (CDC 2009, IOM 2009). While the IOM report focused on preventing childhood obesity, and the CDC report targeted all individuals, both reports emphasized the need to improve access to healthy foods in communities by introducing retail food outlets in underserved areas, and improving the quality of foods in existing community food stores. Other strategies were also discussed including building and maintaining the appropriate and safe infrastructure for physical activity, improving public transportation, improving the quality of foods in schools and workplaces, limiting junk food advertising to children, promoting breastfeeding, and building local food systems.

These types of local community-based efforts were among the interventions proposed to promote healthy weights of childbearing women and their children in the community-based partnership discussed in Chapter Six. The Healthy Start Partnership brought together a variety of public-health practitioners with an interest in maternal and child nutrition in a six county area of New York State. Local community-based partnerships have become a popular mechanism for assessing, planning, and implementing public health interventions that are perceived to have a multi-factorial etiology, and that are deemed to require interventions and other change efforts at multiple levels of society (e.g. neighborhood, state, national levels) and/or in variety of venues (e.g.. schools, workplaces, home) (Butterfosss 2007). Because partnerships are able to bring together people with a variety of skills, strengths, and resources, well-functioning partnerships have the potential to combine these resources to tackle a health problem at these multiple levels and in a variety of venues. Well-functioning

partnerships, however, require multiple inputs and continuous management and communication. Mattessich and colleagues (2001) have formulated a comprehensive list of partnership characteristics predictive of a well-functioning partnership, among them: history of collaboration in the community, collaborative group seen as a legitimate leader, mutual respect and trust among members, appropriate cross-section of members, ability to compromise, development of clear roles and policy guidelines, adaptability, open communication, sufficient funding and so forth. Not surprisingly, many partnerships are often unsuccessful in meeting their goals because they are unable to successfully make their collaboration work.

Public health partnerships have been formed and studied in relation to their efforts to combat smoking, drunk driving, adolescent pregnancy, and a variety of other efforts. Partnerships to reduce overweight and obesity, particularly by creating environmental change that would support healthier food decisions and more active lifestyle, are only beginning to emerge and may face unique challenges. Among them are the transition from a more educational approach, to one requiring interaction with businesses, politicians, and professions as varied as planning, recreation, medicine, and food service. Not only must these public health practitioners seek out new partners, they must also change their mindset from one of information delivery to one of creating system change in the policy and built environments. The Healthy Start Partnership endeavored to increase the capacity of the local public health practitioners to work in these new arenas and with new partners, but significant challenges continue to exist. In Chapter Six, these challenges are investigated, with an emphasis on the training and organizational changes that may be needed for public health practitioners to successfully engage in these activities. As calls for more local partnership development are made by institutions like the CDC and IOM in order to create policy and environmental change in communities, it is increasingly imperative we understand

not only what makes partnerships successful (i.e. Mattessich criteria), but what are the capacity-building needs of local public health practitioners and their organizations to best support these efforts.

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CHAPTER TWO

UNDERSTANDING FOOD AVAILABILITY IN A WIDE RANGE OF STORE TYPES IN A RURAL AREA OF UPSTATE NEW YORK

Introduction

Ecological models of the causes of overweight, obesity, and chronic diseases like heart disease emphasize the embedded nature of individual characteristics and behaviors within interpersonal, organizational, community, national, and even global levels of influence (McLeroy et al.1988; Wells and Olson 2006; Davison and Birch 2001; National Heart, Lung and Blood Institute 2004; Centers for Disease Control 2009; Glanz et al 2005). While individual-level characteristics like genetics, physiology, and personal knowledge and skills are important, it is recognized that contexts external to the individual also play a major role in how behaviors are created and manifested. To this end, increasing attention is being paid to the food environment in which people live and how food stores in this environment contribute to eating habits and consequent health status (Lake and Townsend 2006, Booth et al 2001, Powell et al 2007, United States Department of Agriculture 2009, Rose et al 2004, Larson et al 2009).

This study aims to address three critical gaps in the literature. First, a rural food environment is examined, an environment which has been relatively neglected in the literature. Second, a large number of food store types are included in the analysis, which differs from many past studies where the analysis has been limited to more traditional food stores. Third, the paper attempts to address the challenge of operationalizing "rural neighborhoods" by examining the rural food environment

centered on an individual woman's home (i.e., the environment from her perspective) and at a much greater distance than has been examined in past studies owing to greater distance most rural residents must travel to reach a store.

The studies of urban and suburban food environments have shown that the increased availability of supermarkets and grocery stores near a person's home is associated with increased consumption of fruits and vegetables, a generally healthier diet and decreased risk of overweight and obesity (Morland et al 2002b; Morland et al 2006; Laraia et al 2004; Edmonds et al 2001; Zenk et al 2005; Cheadle et al 1991; Franco et al 2009, Moore at al 2008). The availability of food stores in rural areas has been much less studied. Studies examining the rural food environment have found fewer food stores per square mile than more urbanized areas (Liese et al 2007, Bustillos et al 2009, Hosler 2009, Kaufmann 1998, Morton and Blanchard 2007). Convenience stores have been found to dominate the rural landscape (Liese et al 2007, Bustillos et al 2009, Hosler 2009, Stand and Kossover 2005), and some residents must travel 20 miles or more to reach a supermarket (Kaufman 1998, Sharkey and Horel 2007). Additional challenges for access to food stores in rural areas are ongoing economic decline and population out-migration creating less of an economic base for food retail stores, resulting in the closure and consolidation of food stores (Morton and Blanchard 2007, Blanchard and Lyson 2005). Transportation issues are also different in rural areas than in urban ones. Lack of public transportation in rural areas is well-known, and this, combined with longer distances to a food store, makes walking less likely and increases the reliance on the automobile (Morton and Blanchard 2007, Blanchard and Lyson 2005). Measuring accessibility to food stores several miles from a resident's home, therefore, may be necessary to adequately capture the reality of a rural resident's food environment.

The types of food stores examined in some studies of the food environment, whether urban or rural, have also been limited. Traditional food stores like supermarkets and grocery stores tend to be most often studied, while less traditional food stores like drug stores, dollar stores, and general merchandise stores tend to be overlooked (Bustillos et al 2009). This may be a significant oversight given national data indicating the market share of traditional supermarkets and grocery stores has been declining, while that of nontraditional food stores including dollar stores has increased from 17.1% in 1994 to 31.6% in 2005 (Martinez 2007). Dollar stores are emerging as important sources of food for many Americans looking to stretch their food dollar, and the proliferation of drug stores is in part a retail strategy to appeal to "convenience" with 4.8% of all food sales occurring in drug stores in 2005 (Martinez 2007). Understanding the prevalence of these non-traditional food stores, and the types of foods available within them, appears increasingly imperative to understanding the complete food-retail landscape.

Another challenge for studying the food environment has been defining the scope and boundaries of neighborhoods. One approach to understanding the availability of food stores in both urban and rural areas has been to aggregate store data to the census-block group or zip-code level to represent neighborhoods (Sharkey et al 2008, Morland et al 2002a). This approach has been criticized for not adequately considering "real-life" boundaries of communities and shopping behaviors that may take residents outside of their defined neighborhood (Larson et al 2009). In rural areas, neighborhoods may be even harder to define given low population density and distance between homes and town centers. It may, therefore, make more sense to measure the distance from a resident's home to different types of stores, or stores offering different kinds of foods. Additionally, measuring many miles from a rural resident's home may overcome the challenge of low store density. One potential

hypothesis for the obesity epidemic discussed in the recent Economic Research Service report examining the existence of food deserts in the United States is that increased access to all foods, rather than lack of access to healthy foods in particular, may be facilitating poor food choices (United States Department of Agriculture 2009).

Methods

Study Participants

All women considered for inclusion had registered for obstetric care at Bassett Healthcare, a hospital and set of primary-care clinics serving a 10-county area in Upstate New York (NY). Data were collected from eligibility checklists on pregnant women screened for enrollment in a parallel study of weight gain during pregnancy. Data from the eligibility checklists were collected on the woman's early pregnancy characteristics during the recruitment period from June 2005 to March 2006 by trained recruiters from medical forms completed by women as part of the registration for prenatal care. To be eligible for the present study a woman had to be at least 18 years of age, and have had a home address within the general geographic area. She also needed a pre-pregnancy weight or early pregnancy weight ($\leq$ 14 weeks gestation). Women whose earliest weight was in the second trimester of pregnancy had their initial weight adjusted to the 9-11 week interval (see Olson and Strawderman 2003a for a description of the method). Women were considered ineligible for the present study if they had a medical condition that would likely affect their weight status (e.g., thyroid disease, severe kidney impairments, diagnosed eating disorders) or were taking medications that would strongly affect their weight. Data on each woman's address, parity, and enrollment in a prenatal care assistance program for lower income households were collected from a subsequent audit of medical records in mid-2006.

Thirty women who had been asked to participate in the parallel study, and refused to participate were excluded from the present analysis. The final sample consisted of 555 women from 672 screened for eligibility in the parallel study (See Appendix 2.A for how the sample size was determined). Forty-five percent of the sample was low-income women, defined based on enrollment in a state-supported Expanded Medicaid coverage for pregnancy program (the Prenatal Care Assistance Program or PCAP). PCAP enrollment was used as a proxy for low-income status, consistent with the protocol of past studies of pregnant women in the same geographical area (Olson et al 2003a, Olson et al 2003b, Olson et al 2004). Eligibility for PCAP is limited to women with household incomes less than 200% of the Federal Poverty Line. Early pregnancy Body Mass Indexes (BMIs) were categorized into weight categories based on the 1995 World Health Organization classification standards. See Table 2.1 for a description of the women's demographic profile. Data collection for the women was approved by the University Committee on Human Subjects at Cornell University and the Institutional Review Board at Bassett Healthcare Research Institute.

Table 2.1: Demographic Characteristics of the Women*

Characteristic	**All**	**Under-weight**	**Normal Weight**	**Over-weight**	**Obese**
Body Mass Index (BMI)		<18.5	18.5 – 24.99	25.00 – 29.99	≥ 30
N	555	12	261	142	140
Number ≤ 30 years old (%)	393 (70.8)	11 (91.7)[1]	198 (75.9)	96 (67.6)[2]	88 (62.9)[3]
Number nulliparous (%)	207 (37.6)	1 (8.3)[4]	115 (44.1)	51 (37.0)	40 (28.8)[5]
Number on PCAP (%)	249 (45.1)	7 (58.3)	116 (44.4)	68 (48.6)	58 (41.7)

* Tests of significant differences between normal weight women and other weight categories for the demographic characteristics (1, 2, 4 $p < 0.05$; 3, 5 $p < 0.01$)

Study Setting

The study was conducted in an area of Upstate New York comprising about 8700 square miles. The size and location of the study area was determined by the home location of the study women such that all stores within a 20-mile radius of each woman's home by the road network were surveyed. A 20-mile radius around each woman was chosen because previous descriptive work in one of the counties included in the geographic area revealed that the maximum distance women travelled to do their major food shopping was about 20 miles. The study area included all or a portion of 19 counties, plus a small portion of northern Pennsylvania.

There are several ways to define rurality and no one consistent measure is used. One common method used by the Census Bureau is to examine the population density of the census tracts. Urban census tracts are defined as individuals living in Urbanized Areas (defined as a central city and the surrounding territory with a population of 50,000 or more and a population density generally exceeding 1,000 people per square mile) and city, towns and villages outside of Urbanized Areas with more than 2,500 people per square mile (United States Department of Agriculture 2008). All other census tracts are defined as rural. Based on data from the 2000 United States Census, the average population density of the counties corresponding to where the women lived was 86.9 people per square mile with a minimum and maximum population density of 33.2 and 194.1 people per square mile, respectively. The largest city in the area had a population density of 3,709.5 with the rest of the cities having a population density of considerably less.

Mapping the Food Stores and the Women

Names and locations of food stores were obtained through a Freedom of Information request to the New York State Department of Agriculture and Markets

(NYSDAM). NYSDAM maintains a current database of all food stores for license and inspection purposes. This list includes supermarkets, grocery stores, convenience stores, drug stores, dollar stores, discount grocers, and other specialty food stores. It does not include restaurants, but food stores that also sell prepared food to the public would be included on the NYSDAM list. The list is regularly updated as stores receive and end licensure.

Locations of food stores were geocoded using ArcGIS software (version 9.1, copyright 2001-2004, ESRI, Redlands, CA). The base mapdata layer used for geocoding containing streets and street numbers was available through the New York State Geographic Information System (GIS) Clearinghouse and produced by the New York State Office of Cyber Security & Critical Infrastructure Coordination (downloaded 2006). All addresses not matched after the first round of geocoding were checked for spelling errors or alternative street names, and re-matched with a minimum match score of 60 (range 0 to 100) considered acceptable. Store addresses with incomplete information (for instance, a street name but no street number) were cross-checked in alternate databases like US Yellow pages for more complete information. In some cases, the store was called to obtain complete address information or identify location based on cross-streets or the location of neighboring establishments. These stores were then geocoded interactively based on the additional spatial information. The mapped food-store locations were then used to locate the food stores for surveying. This served as a ground-truth check to ensure mapping accuracy and provided additional spatial information for food stores that had been difficult to match. Seventy food stores from the original NYSDAM could not be located for observing or were found to be closed and were excluded from the analysis. An additional 61 stores appeared to be closed for the winter season (when the survey was conducted) and were also not surveyed. These included campground stores and

food stores that appealed to tourists. Food stores that did not sell foods listed on the survey were also excluded (n = 128). For instance, these were stores that only sold single products like pastries, candy, or cheese, as well as stores that did not appear to sell any food at all, but may have in the past. Several large distribution centers also fell in this category, but since they do not regularly sell food directly to the public they were excluded. Very few stores objected to the survey with only six stores requesting the surveyor leave. An additional 32 stores found while surveying were mapped and added to the analysis. The total number of stores mapped and surveyed was 870 (Table 2.2). A map of all the surveyed food stores is shown in Figure 2.1.

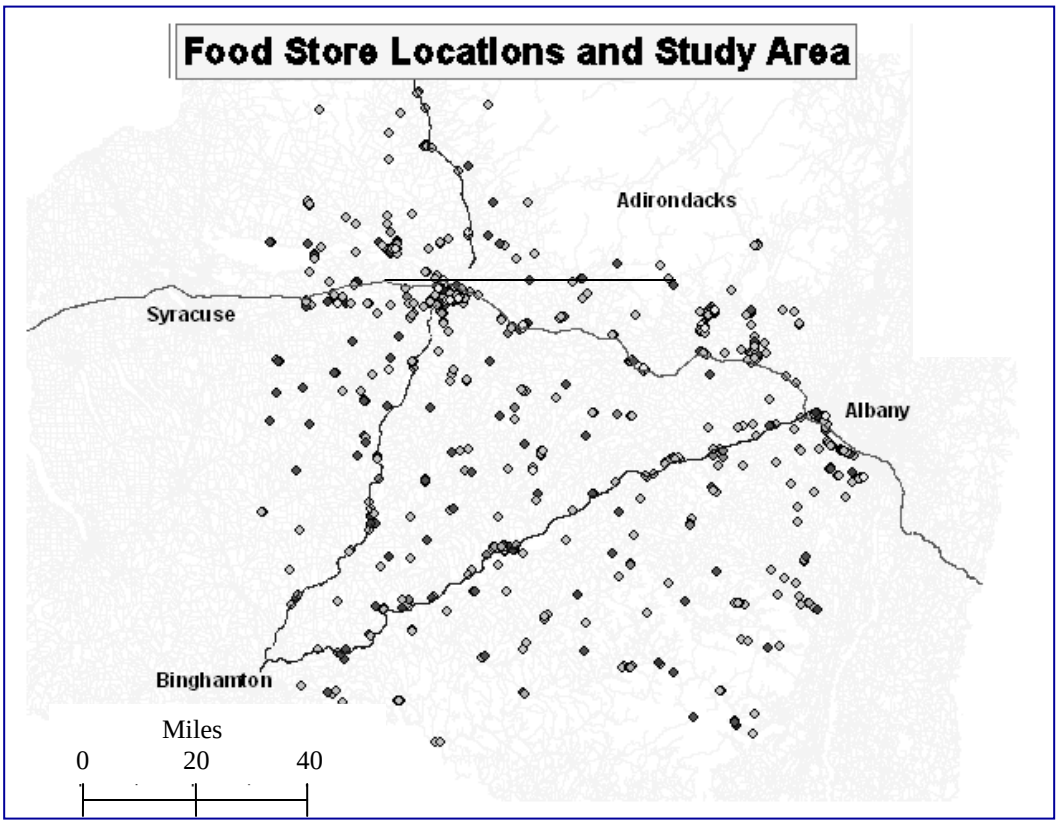


Figure 2.1: Map of Food Stores and Study Area

Women's home addresses were mapped using the same software as above. As with store addresses, unmatched women's home addresses were checked for spelling

errors and alternate names and re-matched. Of the total 555 women, 51 women with post-offices boxes or whose street addresses could not be found were mapped to the center of their respective village or city. Later analyses were run both including and excluding these women, and no major differences in results were found.

Table 2.2: Total Stores in Sample and Number Surveyed

	N	%
Total Stores	1117	100
Stores Surveyed	870	77.9
Does not sell surveyed food	110	9.8
Closed/Could not find	70	6.3
Closed Seasonally	61	5.5
Surveyor asked to leave	6	0.6

Measurements of Food Access

The food survey was based on the Nutrition Environment Measurement Survey developed and validated by Glanz et al (2007). Modifications were made to the survey to respond to local conditions (e.g., use of regional brand names) and to focus on foods perceived to be of greater importance to families of childbearing women by investigators. In addition, the entire number of varieties of each food item was counted in each food store, as opposed to the protocol of the original survey where only a limited number of varieties were assessed. Surveyed food categories were: fresh produce, canned fruits, canned vegetables (including canned tomatoes), milk, soda, juice, ground beef, packaged deli meats, canned tuna, bread, cereal, rice, potato chips, and frozen pizza. Within each food category, a healthier and less healthy food type was identified, with the exception of the produce category where all foods were presumed healthy. For instance, within the potato-chip category, low-fat and regular-fat potato chips were identified as the healthier and less healthy food types. The

availability of each food type within each food category was recorded, as well as the number of varieties of each food type. A variety was defined as each individual flavor within a brand. For instance, Brand X salt-and-vinegar-flavor potato chips and Brand X barbeque-flavor potato chips would have counted as two individual varieties of regular-fat potato chips. Availability of fresh produce was measured in two ways. First, the number of the top ten fruits and top ten vegetables eaten in the United States sold in each store was assessed. Secondly, the number of additional varieties of fruits and vegetables beyond these top ten were counted. One surveyor conducted 93% of the store surveys and another trained rater completed the other 7%. Food stores were surveyed between mid-October 2006 to mid-March 2007.

The type of food store was not available from the NYSDAM list. Therefore, criteria were established to determine the type of food store through both observation and contact with store management. To be considered a supermarket, a store had to have at least 8 cash registers and also sell a wide variety of food (fresh produce, fresh meat, processed foods, frozen foods, etc.). Grocery stores were similar to supermarkets in selling a wide variety of foods, but were generally smaller with no more than 7 cash registers. Grocery stores often belonged to regional recognizable chains, but also included smaller "mom and pop" stores. Contact with store management ensured that all stores classified as supermarkets covered at least 30,000 square feet, while grocery stores were smaller. Convenience stores sold a much more limited range of foods, were generally smaller than grocery stores, often belonged to regionally recognizable chains, and often had gas pumps outside. Drug stores and dollar stores belonged to recognizable regional and national chains. Discount grocers were stores that sold a wide range of foods in bulk but had limited variety, and were comprised of recognizable national chains. General merchandise stores sold a wide range of products including clothing, sporting equipment, farm equipment, automotive

parts, kitchen equipment, household products, etc. This category included large recognizable national chains, as well as other smaller independent stores. Other food stores that sold a narrow range of food products like bakeries, butchers, beverage stores, international food stores, etc. were classified based on observation and experience. The number of stores surveyed are shown by store type in Table 2.3.

Table 2.3: Surveyed Stores by Store Type

Store	**N**	**%**
Convenience Store	472	54.3
Grocery Store	90	10.3
Drug Store	90	10.3
Dollar	54	6.2
Supermarket	46	5.3
General Merchandise	26	3.0
Natural Food	18	2.1
Year-round Farmstand	15	1.7
Discount Grocer	13	1.5
International Food	13	1.5
Butcher/Fish	11	1.3
Bakery	11	1.3
Gourmet or Bulk	5	0.6
Beverage	5	0.6
Dairy	1	0.1
Total	**870**	**100%**

Data Analysis

The distance of each woman from a store type was calculated using ArcMap software's nearest facility tool. All descriptive statistical analysis was conducted using Statistical Analysis Software (version 9.1, 2002-2004, SAS Institute, Inc., Cary, NC). Categorical variables were constructed for the availability of each food type, while continuous variables were used for the total number of varieties of each food type.

Results

Store Type

The majority of the surveyed stores were convenience stores, with drug stores and grocery stores making up the next largest proportions (Table 2.3). Supermarkets represented only 5.3% of surveyed stores. Together drug stores, dollar stores, and general merchandise stores made up nearly one in five food stores in this food environment.

Food Availability

To be included in this analysis, surveyed stores had to sell at least one kind of food listed on the food survey. Not surprisingly, nearly all stores sold full calorie and diet soda, regular fat potato chips, juice, and juice drinks (Table 2.4). Almost as common were white bread, lower and higher fiber cereal, regular canned vegetables, and whole milk. The scarcest foods included low-sodium canned vegetables, brown rice, lean and standard ground beef, low-fat bologna, and low-fat pizza; these foods were more likely to be found in supermarkets, grocery stores, and to a lesser extent, discount grocers.

Fresh produce was available in 43.2% of stores. Among these stores, nearly 20% sold five or fewer varieties of produce. All supermarkets, grocery stores, and discount grocers sold fresh produce; 36.6% of convenience stores and 42.3% of general merchandise stores also sold some fresh produce. No dollar stores sold fresh produce. Skim milk, while slightly less-often found than whole milk (73.3% vs. 88.7% overall availability respectively), was still relatively common. It was almost always found in supermarkets, grocery stores, and discount grocers, but it was also found in the majority of general merchandise stores, conveniences stores, and drug

Table 2.4: Percentage of Stores Offering Any of the Surveyed Foods

	% of All Stores	Super-market	Grocery	Discount Grocer	General Merch.	Conven-ience	Drug	Dollar	Other*
Diet Soda	91.1	100	98.9	100	92.3	98.9	100	92.6	39.2
Regular Soda	95.9	100	100	100	96.1	99.8	100	98.1	58.2
Juice Drink	92.9	100	98.9	100	92.3	96.8	98.9	100	45.6
Juice	93.9	100	100	100	92.3	98.3	100	94.4	49.4
Low Fat Chips	50.9	100	64.4	23.1	50	53	74.4	1.9	6.3
Regular Fat Chips	92.3	100	100	100	96.1	96.6	97.8	90.7	51.9
Skim Milk	73.3	100	90.0	100	61.5	78.4	93.3	38.9	15.2
Whole Milk	88.7	100	100	92.3	80.8	97.7	92.2	46.3	44.3
Higher Fiber Cereal	81.2	100	98.9	100	88	78.4	97.8	98.1	31.7
Lower fiber cereal	86.8	100	97.8	100	92.3	87.7	97.8	98.1	36.7
Low Sodium Can Vegetable	17.7	100	57.8	7.8	26.9	8.1	1.1	13	3.8
Regular Can Vegetable	86.3	100	100	100	92.3	87.3	93.3	92.6	40.5
Whole Grain Bread	55.5	100	88.9	84.6	50	55.9	25.6	33.3	32.9
White Bread	80.7	100	98.9	100	61.5	90.2	47.8	38.9	60.8

Table 2.4 (Continued)

	% of All Stores	Super-market	Grocery	Discount Grocer	General	Conven-ience	Drug	Dollar	Other*
Light Can Tuna	78.7	100	95.6	84.6	65.4	80.9	97.8	75.9	45.6
Regular Can Tuna	34	100	73.3	69.2	23.1	29	31.1	0	17.7
Light Can Fruit	70.9	100	96.7	100	88.5	63.1	95.6	94.4	16.5
Heavy Syrup Can Fruit	69.2	100	96.7	92.3	84.6	69.1	87.8	42.6	8.9
Brown Rice	17.7	100	65.6	30.8	19.2	4	2.2	3.7	21.5
White Rice	65.2	100	97.6	92.3	76.9	65.7	41.1	57.4	30.4
Low Fat Pizza	11.9	91.8	34.4	61.5	7.7	1.3	8.9	0	5.1
Regular Pizza	56.3	100	86.7	100	38.5	50.9	78.9	44.4	11.4
All Fresh Produce	43.2	100	100	100	42.3	36.6	4.4	0	49.4
Packaged Deli Turkey	34.9	100	56.7	100	19.2	32.6	4.44	51.9	3.8
Packaged deli low-fat bologna	10.5	100	42.2	15.3	0	0.85	0	1.9	0
Packaged Deli Bologna	40.7	100	67.8	100	15.4	41.7	6.7	48.2	1.3
Lean Beef	12.6	100	52.2	84.6	0	0.2	0	0	7.6
Standard Beef	16.5	100	78.9	84.6	3.9	1.1	0	0	15.2

* Other: Year-round Farmstands, International Foods, Butcher/Fish Monger, Natural Food Stores, Gourmet or Bulk Foods, Bakeries, Beverage Stores; Dairy Stores

stores. Canned fruits and vegetables were also fairly common in the food environment. Fruit canned in light syrup or juice was about as available as fruit canned in heavy syrup, and among discount grocers, general merchandise stores, drug stores, and dollar stores, light canned fruit was more common than regular. While higher-sodium canned vegetables were considerably more common, overall, than low sodium canned vegetables (86.3% availability vs 17.7% availability), the canned vegetables were ubiquitous. In addition, tuna canned in water was far more common than tuna caned in oil, particularly among non-traditional food stores, and was available in nearly 80% of stores. Whole grain bread, while not as common as white bread, was available in nearly all supermarkets, grocery stores, and discount grocers, and available in a significant percentage of other food stores. A slight majority of convenience stores sold whole wheat bread. Higher and lower fiber cereals were available in nearly equal proportions among store types, but lower fat chips were available in only about half as many stores as regular potato chips.

Among stores selling any fresh produce, supermarkets consistently sold the greatest number of varieties, followed by grocery stores, and discount grocers (Table 2.5). Nonetheless many other store types sold a wide range of produce, most significantly general merchandise and convenience stores. Similarly, the greatest number of varieties of whole grain bread (Table 2.6), rows of skim milk (Table 2.7), and varieties of lean beef (Table 2.8) were sold by supermarkets, grocery stores, and discount grocers.

Nearest Foods and Nearest Stores

As shown in Table 2.9, for 70.5% of women the nearest store to their home was a convenience store, and the next closest type of store was a grocery store. For fewer than 1% of the women, the nearest store was a supermarket. As discussed

Table 2.5: Distribution of Fresh Produce by Store Type

Variety Quartile*	Supermarket N = 46	Grocery N = 90	Discount Grocer N = 13	General Merchandise N = 26	Convenience N = 472	Drug N = 90	Dollar N = 54	Other N = 79
Q4 (N = 55 +)	100%	43.3%	30.8%		-	-	-	5.1%
Q3 (N = 15 – 54)	-	33.3%	69.2%	15.4%	5.9%	1.1%	-	20.3%
Q2 (N = 8 – 14)	-	15.6%	-	7.7%	14.4%	2.2%	-	11.4%
Q 1 (N =1 – 7)	-	7.8%	-	19.2%	16.3%	1.1%	-	12.7%

* Left hand columns represent the number of varieties of each food type among stores that sold at least one variety broken into 4 quartiles.

Table 2.6: Distribution of Whole Grain Bread by Store Type

Variety Quartile*	Supermarket N = 46	Grocery N = 90	Discount Grocer N = 13	General Merchandise N = 26	Convenience N = 472	Drug N = 90	Dollar N = 54	Other N = 79
Q4 (N = 6 +)	100%	53.3	15.4	7.7	3.2	-	-	6.3
Q3 (N = 3 – 5)	-	21.1	7.7	11.5	13.1	1.1	-	11.4
Q2 (N= 2)	-	4.4	15.4	15.4	11.2	2.2	-	7.6
Q 1 (N = 1)	-	10.0	46.2	15.4	28.6	22.2	33.3	7.6

* Left hand columns represent the number of varieties of each food type among stores that sold at least one variety broken into 4 quartiles.

Table 2.7: Distribution of Skim Milk by Store Type

Shelf-space Quartile*	Supermarket N = 46	Grocery N = 90	Discount Grocer N = 13	General Merchandise N = 26	Convenience N = 472	Drug N = 90	Dollar N = 54	Other N = 79
Q4 (N =7 +)	100%	44.4%	76.9	19.2	7.0	28.9	-	-
Q3 (N = 5 – 6)	-	13.3%	23.1	3.9	13.4	32.2	3.7	1.3
Q2 (N = 3 – 4)	-	12.2%	-	19.2	26.9	22.2	11.1	2.5
Q 1 (N = 1 – 2)	-	20.0%	-	19.2	31.1	10.0	24.1	11.4

* Left hand columns represent the number of varieties of each food type among stores that sold at least one variety broken into 4 quartiles.

Table 2.8: Distribution of Lean Beef by Store Type

Variety Quartile*	Supermarket N = 46	Grocery N = 90	Discount Grocer N = 13	General Merchandise N = 26	Convenience N = 472	Drug N = 90	Dollar N = 54	Other N = 79
Q4 (N = 3 +)	43.5	-	-	-	-	-	-	-
Q3 (N = 2)	47.8	7.8	15.4	-	-	-	-	1.3
Q1 & Q2 (N = 1)	8.7	44.4	69.2	-	0.2	-	-	6.3

* Left hand columns represent the number of varieties of each food type among stores that sold at least one variety broken into 4 quartiles.

Table 2.9: Number of Women for Whom the Specified Store Type is Nearest to Her Home

	Number of Women (N = 555)	% of Women
Supermarket	5	0.9
Grocery Store	63	11.4
Discount Grocer	0	0
General Merchandise Store	21	3.8
Convenience	391	70.5
Drug	30	5.4
Dollar	11	2.0
Other	34	6.1

Table 2.10: Average Distance from Women's Homes to Nearest Selected Foods

Food	Average Nearest Distance (miles)
Apple	3.2
Banana	3.2
Tomato	3.3
Carrot	3.5
Whole Grain Bread	2.9
Skim Milk	2.0
Potato Chips	1.9
Soda	1.9

above, some healthier foods are available in these non-traditional food stores, but the greatest availability and variety of foods is still found in supermarkets (the nearest store for only 0.9% women). As summarized in Table 2.10, this reality is underscored by the fact that the nearest apple (3.2 miles) on average was more than 50% further away than the nearest chips and soda (1.9 miles) (Table 2.10).

Discussion

This study is unique in surveying all the types of food stores in a large, predominantly rural area, and consequently gives a more complete picture of the depth and breadth of the rural food environment. Studying a large area of the food environment may be especially important in rural areas because food resources are more spread out than in suburban and urban areas, such that a resident may need to travel 20 miles to reach a large food store. Visiting and surveying each store allowed for ground-truthing not only the stores existence and location, but also ensured that food stores were classified appropriately.

To the author's knowledge, this study surveyed more food stores than any other to date, and included a wider variety of types of food stores. Consistent with other studies in rural areas, the majority of stores were convenience stores, but only 54.3% of the stores in this study were convenience stores compared with 70.4 - 74.7% of the stores in other studies (Sharkey and Horel 2007; Hosler 2009, Liese et al 2007; Bustillos et al 2009). This study was different from these other rural studies in that the study area was in the northeastern part of the United States. In addition the lower percentage of convenience stores observed in this study may be due to the relatively large number of other food store types measured. In rural-area studies where the supermarket-to convenience-store ratio could be calculated, the studies assessing the greatest number of store types had supermarket-to-convenience store ratios more similar to the present study (Sharkey and Horel 2007; Bustillos et al 2009).

The large number of store types surveyed also allowed for better estimation of the availability of foods by store type, creating an opportunity for more robust comparisons. Supermarkets consistently had the greatest availability of healthy and less healthy foods, which has been found in other studies (Liese et al 2007; Bustillos et

al 2009, Franco et al 2000). This study also revealed, however, that many of the less traditional food stores like convenience stores, drug stores, and dollar stores regularly, but not always, sold healthier options, consistent with at least one other study of the rural food environment (Bustillos et al 2009). Most notably, about a third of convenience stores sold some fresh produce, with about half of that percentage selling more than 8 varieties. While quality of these fresh fruits and vegetables was not always as good as what would be seen in supermarkets, the produce almost always appeared edible. Indeed one convenience-store chain went out of their way to display fresh and appealing produce in an attractive cart at the store entrance. The majority of non-traditional food stores also sold canned fruits and vegetables, although lower-sodium canned vegetables were hard to find outside supermarkets and grocery stores.

The widespread availability of whole-wheat bread and especially higher-fiber cereals in a majority of stores may speak to rising consumer demand for these types of products. While the number of white bread and lower-fiber cereal varieties tended to be greater than the healthier versions, the high availability of the healthier versions is a promising sign. In the same way, whole milk often took up more shelf space than skim, but skim milk was available in nearly three out of four food stores. Fresh meats, either lean or regular, however, were still not commonly found. The short shelf-life and refrigeration requirements of meat probably prevent this food from being stocked in most stores, but canned sources of protein like canned light tuna were almost uniformly available across store-type. Packaged deli meats, with a medium term shelf-life, were also commonly found in non-traditional food stores, especially convenience and dollar stores.

Part of the reason for the large number of surveyed stores is due to the study's unique aim to measure the food environment 20 miles around each woman. While 91% of women had some kind of food store within five miles of her home, 36% of

women had to travel 10 or more miles to reach a supermarket. Given this large distance, a methodological issue arises about what is the proper scale at which to analyze the food environment of rural residents. In urban areas, a mile around a person's home has often been used, with the expectation that urban residents may easily walk this distance (despite the difficulties of walking with groceries and safety concerns). Given how few rural residents live this close to a food store, let alone a supermarket, in the present study, and the reasonable expectation that most food provisioning occurs via a car (whether owned, borrowed, or by "grabbing a ride"), the distance that a rural resident may travel for food may be quite far. Time, the cost of gas, and similar concerns play a role in how far or how often trips are made, but when they are made, a rural resident's food environment may be quite large. Documenting the paucity of stores within a mile or two of a resident's home is important, particularly when time and transportation issues are a concern, but so is documenting how rural residents operate in the full extent of their food environment. To this end, more research on the shopping, transportation, and food choice behaviors of rural resident's is needed.

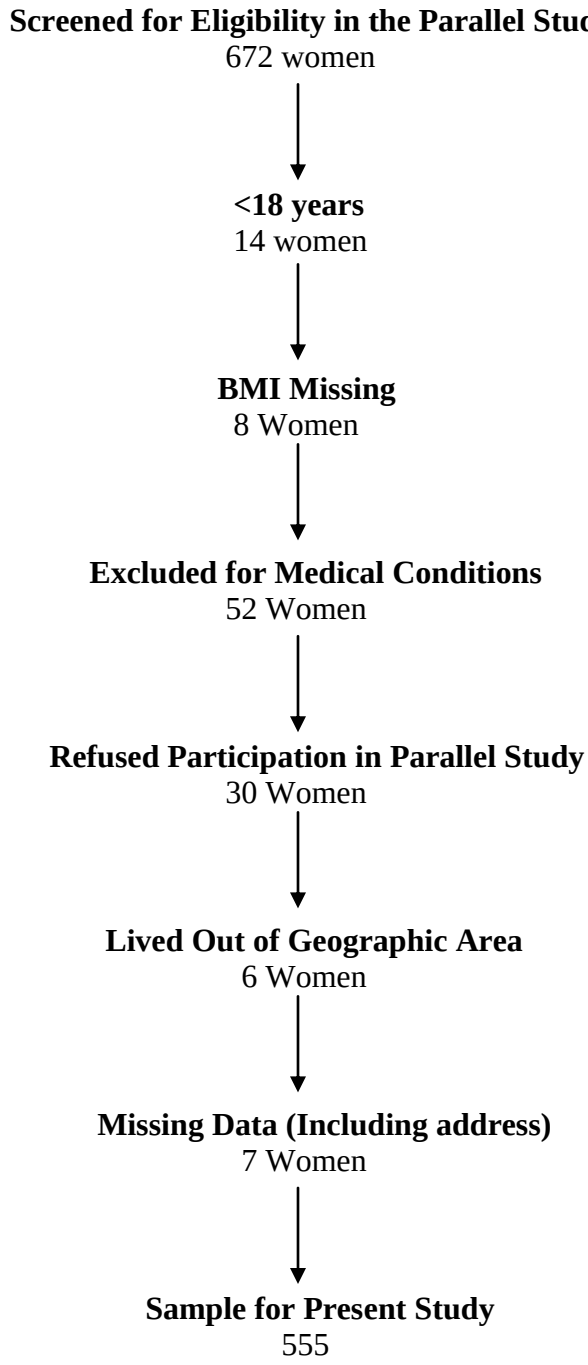
This study provides further evidence that a variety of non-traditional food stores carry food in rural areas (Bustillos et al 2009). Not only did this study show the importance of including non-traditional food stores, but the question arises about how to use and summarize information pertaining to all these stores. However, important questions remain for future research. Does proximity to a convenience store mean something drastically different in terms of food choice than proximity to a drug store? One could lump smaller food stores together (dollar stores, convenience stores, drug stores, etc.) and measure the impact of this large category on food choice and health related outcomes, but this may belie important and subtle differences not only between store types, but between individual stores regardless of their type. Perhaps the foods

contained within the stores are the more important unit of analysis (i.e., proximity to whole grain bread vs. white bread). This level of analysis would be much more intensive in time and resources because it would require that all the foods in the stores be surveyed. Not only is this an issue in epidemiological studies attempting to make connections between the health of the food environment and health-related behaviors and outcomes, but also for programs looking to intervene in the food environment. Should the objective be to increase the number of supermarkets and grocery stores, or to get existing stores (many of them non-traditional food stores) to carry more healthful options?

While this survey was limited to a 19-county region of Upstate NY, and may only be applicable to similar regions, it did survey a wide variety of food stores. The foods used in the survey represent a cross-section of typical foods available in supermarkets, while still allowing for distinctions to be made between larger food stores with more food selections and smaller food stores with fewer selections. Whether these are the best foods to be surveyed to understand how the food environment is related to individual health or how the food environment may change over time remains to be determined. More work is needed to understand how individuals with a variety of characteristics behave in a given food environment and make their food choices.

APPENDIX 2.A

Sample Size Determination of Women in Analysis



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CHAPTER THREE

CLUSTER ANALYSIS AND HEALTHY FOOD AVAILABILITY INDEX AS METHODS TO DESCRIBE VARIATION IN FOOD AVAILABILITY IN A RURAL FOOD ENVIRONMENT

Introduction

As rates of overweight, obesity, and chronic diseases rise, attention in the research and intervention communities is increasingly drawn to understanding the environments in which people live and make food decisions. Some of this work has tried to understand the association between environments with differential access to large supermarkets and grocery stores and the diet and weight of the individuals living nearby (Morland et al 2002b, Rose 2004, Zenk et al 2005b, Laraia 2004, Moore et al 2008, Morland et al 2006, Powell et al 2007a, Inagami et al 2006). While this research has resulted in important insights, it can also be criticized for not adequately understanding the kinds of foods sold within these stores and the extent to which healthful and less healthful options may be available from non-traditional retail food stores. A handful of studies have examined the actual availability of healthy food options in variety of stores, including a number of smaller inner-city markets, and found a positive association between availability and healthier dietary patterns (Bodor et al 2008, Fisher et al 1999, Cheadle et al 1991, Franco et al 2009).

In many studies assumptions have been made that supermarkets and large grocery stores offer the "healthiest" options, while convenience stores offer the least healthy (Morland et al 2002a; Morland et al 2002b; Morland et al 2006; Moore et al 2006, Powell 2007b, Moore et al 2008, Rose and Richards 2004). Such a distinction

may belie the important role that some small "mom and pop" stores may play in provisioning healthy and culturally appropriate foods (Short et al 2007). Indeed, in some rural areas where distance to a supermarket may be great because of low population density, nearby convenience stores and small- to-mid-size grocery stores may offer some healthy foods that are much more accessible than supermarkets further away (Bustillos et al 2009, Liese et al 2007). The expansion of traditional convenience-store chains to carry healthier alternatives is a notable market trend (Personal Communication William Drake). Rather than assuming the kinds of foods available by store type, this paper will examine the number and type of foods available in various stores and store types, and use this measure of availability in the analysis of the food environment.

Employing this method, however, is likely to result in a large amount of data about foods available in a wide variety of food stores. Methods must be employed to reduce and categorize information in a way that will still reveal important attributes of the food environment. One method used in past studies is to develop a Healthy Store Index (HSI) based on the availability and variety of foods in a food store (Glanz et al 2007, Franco et al 2008). Conceptually, this approach is appealing because it reduces a food environment to a single number, but as with most averages, it can also blur distinctions between qualitatively different environments. For instance, an environment with many great food resources and many poor resources would have the same score as an environment with many medium resources.

The objectives of this study were to 1) to explore strategies for summarizing a large amount of data about the food environment for use in future analyses and interventions (e.g. using the statistical tool of cluster analysis and the creation of a Healthy Food Availability Index); 2) to evaluate the effectiveness of these approaches

in comparison to store type as a proxy for food availability, particularly when considering a number of non-traditional food stores.

Methods

Food Store Survey

Food stores were surveyed in a rural area of Upstate NY comprising about 8700 square miles and enclosing all or portions of 19 counties and a small area of northern Pennsylvania. In all, 870 stores were surveyed with store names and locations provided by the New York State Department of Agriculture and Markets, which maintains a database of food stores for state licensing and inspection purposes. Surveyed stores included supermarkets and grocery stores, as well as non-traditional places to buy food like convenience stores, drug stores, dollar stores, and general merchandise stores. A full description of the surveyed store types is provided in Chapter Two.

Foods inside the stores were surveyed using the Nutrition Environment Measurement Survey (NEMS-S)(Glanz et al 2007) with modifications made for local brands and foods of interest to families of childbearing women. The survey assessed the availability and variety of common foods in 14 food categories. The first category surveyed the availability and variety of fresh fruits and vegetables, and the other 13 assessed the availability and variety of a healthier and less healthy alternatives in each food category. The healthier and less healthy alternatives in each food category were defined as food types. For instance, the bread category assessed the availability and number of varieties of whole wheat bread (healthier food type) versus white bread (less healthy food type). Variety was measured by counting the number of flavors within each brand for each food type available. Availability of fresh produce was

measured in two ways. First the number of the top ten fruits and top ten vegetables eaten in the United States sold in each store was assessed. Secondly, the number of additional varieties of fruits and vegetables beyond these top ten were counted. See Chapter Two for a more complete description of food store survey methods.

Cluster Analysis

Data from the food store surveys were analyzed using Statistical Analysis Software (version 9.1, 2002-2004, SAS Institute, Inc., Cary, NC). Cluster analysis was performed on the number of varieties of each of the measured food types to create clusters of stores that tended to offer similar kinds of foods in similar numbers of varieties. The clustering technique (Proc Cluster) used non-hierarchical analysis with K-means. Since the availability of fresh produce was of strong research interest, and was also one of the least available foods, the sample was stratified by whether or not stores offered any produce. Cluster analysis was performed on each sub-sample separately. This allowed clusters to be developed that distinguished stores with a great deal of fresh produce, from those with less produce, and to distinguish stores that generally offered limited varieties and types of food, but still sold some produce, from those that sold limited varieties and types of food and no fresh produce. Every variable entered into the analysis was standardized to have a mean of zero and standard deviation of one. Five clusters were used – two non-produce clusters, and three produce clusters. Five clusters allowed for maximum division of the sample, while still maintaining cell size greater than 10 stores.

Healthy Food Availability Index

A Healthy Food Availability Index (HFAI) was also created based on the availability and variety of foods available in each store. The formula for the HFAI

was based on the one developed by Glanz et al (2007) to be used with the NEMS-S and the modifications made to it by Franco et al (2008). The index was expanded to include the greater number of varieties surveyed in the present study. Only the number of varieties of the healthier food type in each food category was used to develop the index (Table 3.1). Some food types were sold in very few stores, such that the distribution for several food types contained many zeros. To overcome this challenge the 33rd and 66th percentile for all non-zero values for each food type were determined. A score of 3 was assigned if the number of varieties of that food type for a given store was above 66th percentile, a score of two was assigned if the number of varieties was between the 33rd and 66th percentile, and a score of one if the number of varieties sold was less than the 33rd percentile. A score of zero was assigned if a store sold none of that food type. Some food types were very scarce in the food environment (e.g., lean ground beef) such that the four-level scoring system was not warranted. In these cases a score of zero was assigned if none of that item was sold and a score of one if any of that item was sold. The maximum score a store could receive was 37.

Statistical Analyses

To test for differences between the average number of food type varieties among store type categories, ANOVA tests of significance were run with an analysis of contrasts between each mean and every other mean within a food type category. All analysis was conducted on Statistical Analysis Software (version 9.1, 2002-2004, SAS Institute, Inc., Cary, NC) with $p < 0.05$ considered significant.

Table 3.1: Scoring of Healthy Food Availability Index

Food Category*	Possible Scores
Fruit	0 = none 1: 1 - 5 varieties 2: 6 – 13 varieties 3: 14+
Vegetables	0: none 1: 1 - 6 2: 7 – 25 3: 26+
Lean beef	0: none 1: one or more
High fiber cereal	0: none 1: 1 -3 2: 4 - 7 3: 8+
Whole Grain Bread	0: none 1: 1 2: 2 - 4 3: 5+
Light canned fruit	0: none 1: 1 - 2 2: 3 – 5 3: 6+
Low-sodium canned vegetables	0: none 1: 1+
Real juice	0: none 1: 1- 9 2: 10 – 14 3: 15+
Brown rice	0: none 1: 1+
Low-fat chips	0: none 1: 1 2: 2 3: 3+
Light tuna	0: none 1: 1 2: 2 3: 3+
Low-fat pizza	0: none 1: 1+
Package deli turkey	0: none 1: 1 2: 2 3: 3+

Table 3.1 (Continued)

Food Category*	Possible Scores
Diet Soda	0: none 1: 1 -7 2: 8 - 13 3: 14+
Percent of milk rows belonging to skim / one percent milk	0: none 1: <30% 2: 30% - 40% 3: >40%
Total	37

* Scores based on availability of healthier food types

Results

The following analysis outlines the distribution of food stores (and the foods sold within them) by the results of cluster analysis and by HFAI score.

Cluster Analysis

The first two columns of Table 3.2 refer to stores that sold no-produce, while the last three columns correspond to stores that sold some produce. The no-produce medium variety cluster (NPMV) generally offered more varieties of the food types than the no-produce lower variety cluster (NPLV), although for some categories the average offerings were essentially the same (e.g., number of varieties of regular canned vegetables, number of varieties of packaged deli meats). The NPLV cluster contained the most stores of any cluster, corresponding to about 50% of the stores in the food environment. The three produce clusters also sorted by number of varieties. The produce high-variety cluster (PHV) contained stores with far more produce varieties than either of the other two produce clusters. PHV also represented stores

Table 3.2: Average Number of Food Type Varieties Offered by Each Food Store Cluster

	Non-Produce Clusters		Produce Clusters			Means NOT significantly different from each other in the food type category*
Food Type	**No-Produce Medium Variety (NPMV) N = 55**	**No Produce Low Variety (NPLV) N =440**	**Produce High Variety (PHV) N =39**	**Produce Medium Variety (PMV) N = 46**	**Produce Low Variety (PLV) N = 291**	
	N (%)	**N (%)**	**N (%)**	**N (%)**	**N (%)**	
Number of top 10 fruits	0	0	9.7 (0.61)	8.6 (1.2)	2.6 (2.1)	A
Number of the top 10 vegetable	0	0	9.6 (0.50)	9.3 (0.53)	3.8 (2.9)	A D
Additional Fruit	0	0	50.7 (9.7)	25 (9.3)	3.3 (4.2)	A
Additional Vegetable	0	0	138.0 (32.9)	62.6 (28.6)	6.0 (9.2)	A
Rows skim milk	6.7 (4.5)	2.1 (2.3)	32.2 (10.6)	13.0 (7.6)	3.5 (4.2)	
Rows of whole milk	8.0 (8.1)	4.0 (2.8)	35.1 (12.8)	18.5 (8.6)	6.4 (4.6)	
Lean beef	0	0.011 (0.11)	2.4 (0.72)	1.1 (0.71)	0.12 (0.37)	A
Standard beef	0	0.016 (0.14)	3.3 (1.0)	2.0 (0.59)	0.25 (0.59)	A
Diet soda	13.1 (4.5)	8.7 (5.6)	49.3 (9.9)	32.3 (9.8)	8.9 (6.2)	B
Regular soda	26.6 (8.1)	18.5 (9.8)	77.2 (18.7)	51.9 (12.1)	21.6 (12.4)	
Real juice	16.5 (6.5)	8.7 (5.3)	133.1 (26.3)	78.4 (26.8)	12.1 (8.3)	
Drink juice	27.3 (13.3)	15.2 (9.8)	118.5 (20.7)	85.8 (23.9)	15.8 (12.4)	B
Whole grain bread	1.2 (2.5)	0.66 (1.5)	42.5 (9.3)	19.7 (9.8)	2.2 (2.7)	A
White bread	5.3 (6.8)	3.5 (3.7)	95.6 (18.4)	52.2 (21.7)	8.2 (6.4)	A
Low fat chips	1.4 (1.4)	0.82 (1.2)	9.3 (2.6)	3.3 (2.5)	0.64 (0.92)	B
Regular chips	27.6 (7.2)	20.2 (11.6)	70.7 (9.1)	53.5 (13.6)	20.7 (12.1)	B
High fiber cereal	16.2 (8.2)	2.7 (3.1)	84.7 (25.0)	47.3 (15.6)	4.8 (6.3)	
Low fiber cereal	28.5 (14.5)	6.7 (6.5)	131.3 (22.8)	83.7 (19.5)	10.4 (9.2)	

Table 3.2 (Continued)

	NPMV	NPLV	PHV	PMV	PLV	Means NOT significantly different
	N (%)	N (%)	N (%)	N (%)	N (%)	
Light tuna	4.7 (2.5)	1.1 (0.95)	16.2 (3.1)	12.9 (2.4)	1.9 (1.7)	
Regular tuna	1.6 (1.1)	0.19 (0.50)	4.1 (1.7)	4.7 (2.8)	0.40 (0.68)	
Light can fruit	3.9 (3.1)	1.8 (2.5)	36.6 (6.9)	29.8 (8.9)	2.9 (3.5)	
Regular can fruit	2.9 (1.0)	1.1 (1.3)	13.5 (3.6)	15.5 (6.0)	2.7 (2.6)	C
Low sodium vegetables	0.27 (0.91)	0.075 (0.35)	15.6 (3.9)	11.0 (4.1)	0.22 (0.82)	A B C
High sodium vegetables	6.7 (6.8)	6.5 (6.5)	154.4 (19.0)	112.6 (27.0)	14.0 (14.4)	A
Packaged deli turkey	0.45 (0.94)	0.22 (0.46)	21.3 (4.7)	7.0 (4.1)	0.64 (1.3)	A C
Packaged deli low fat bologna	0.036 (0.19)	0.0091 (0.12)	4.1 (0.88)	2.1 (1.2)	0.017 (0.13)	A B C
Packaged deli bologna	0.42 (0.66)	0.28 (0.50)	6.0 (1.4)	4.3 (1.5)	0.83 (1.1)	A
Brown rice	0.091 (0.48)	0.057 (0.37)	10.4 (3.6)	4.5 (2.2)	0.36 (1.1)	A C
Flavored brown rice	0.055 (0.30)	0.046 (0.35)	9.2 (5.3)	2.7 (3.2)	0.13 (0.54)	A B C
White rice	0.87 (1.4)	0.79 (1.1)	24.4 (5.9)	12.2 (4.3)	2.0 (2.1)	A
Flavored white rice	2.11 (2.8)	1.5 (2.1)	84.8 (11.7)	52.1 (19.3)	3.1 (4.8)	A C
Low fat pizza	0.11 (0.31)	0.027 (0.21)	12.6 (3.9)	2.4 (2.6)	0.086 (0.38)	A B C
High fat pizza	3.8 (3.9)	1.2 (1.8)	76.3 (13.4)	30.2 (17.3)	3.7 (3.7)	C

* All means with a food type category are significantly different with the exception of those marked:

A NPMV and NPLV not significantly different

B NPLV and PLV not significantly different

C NPMV and PLV not significantly different

D PHV and PMV not significantly different

with far more varieties of juice and juice drinks, breads, cereals, canned vegetables, white rice, and pizza. The produce medium variety cluster (PMV) and produce low variety cluster (PLV) sorted in decreasing order of variety number. The PLV cluster contained many more stores (n = 291) than either of the other two produce clusters (PHV = 39 and PMV = 46). The NPLV cluster and PLV cluster are very similar in the number of varieties of foods offered, with the obvious exception that only the PLV cluster stores sold produce.

The standard deviations for the average number of variety of foods were sometimes quite large. For food types that were rare in the food environment (e.g. brown rice) these standard deviations may be several times larger than the average number of food types offered because so many stores offered no varieties of that food type. ANOVA tests of the differences in the number of varieties of the food types between all the clusters were conducted with the results displayed in the last column of Table 3.2. Generally significant differences ($p \leq 0.05$) were found between the clusters in the variety of food types offered, however, the NPMV and NPLV clusters most commonly had means not significantly different from each other, followed by the NPMV and PLV, and NPLV and PLV clusters. The two highest variety clusters selling produce (PLV and PMV) were significantly different from each other in all but one food variety category – the total number of the top 10 vegetables sold by stores.

Table 3.3 examines how the clusters sorted by store type and Table 3.4 provides store types sorted by cluster. The PHV cluster was composed entirely of supermarkets (Table 3.3), however, only 84.8 supermarkets were sorted into the PHV cluster with the remainder sorted into the PMV cluster (Table 3.4). The PMV cluster was comprised of smaller supermarkets and larger grocery stores, while the remaining smaller grocery stores (typically the "mom and pop" type) were sorted into the PLV cluster, along with many convenience stores and a handful of other stores (Table 3.3).

Table 3.3: Composition of Clusters by Store Type

	No-Produce		Produce		
Store Type	**No-Produce Medium Variety (NPMV)** **N = 55**	**No-Produce Low Variety (NPLV)** **N =440**	**Produce High Variety (PHV)** **N =39**	**Produce Medium Variety (PMV)** **Clus4 = 46**	**Produce Low Variety (PLV)** **Clus5 = 291**
Supermarket	0	0	100	15.2	0
Grocery	0	0	0	84.8	17.5
Convenience	29.1	64.5	0	0	59.6
Drug	58.2	12.3	0	0	1.4
Dollar	0	12.3	0	0	0
General Merchandise	12.7	1.8	0	0	3.8
Year-round Farmstand	0	0	0	0	5.2
International Food	0	1.4	0	0	2.4
Butcher/Fish	0	1.6	0	0	1.4
Natural Foods	0	1.4	0	0	4.1
Discount Grocer	0	0	0	0	4.5
Specialty Foods	0	0.9	0	0	0.34
Bakery	0	2.5	0	0	0
Beverage	0	1.1	0	0	0
Dairy	0	0.23	0	0	0
	100%	100%	100%	100%	100%

Table 3.4: Distribution of Store Types Across Clusters

	No-Produce		Produce			
Store Type	**No-Produce Medium Variety (NPMV)** **N = 55**	**No-Produce Low Variety (NPLV)** **N =440**	**Produce High Variety (PHV)** **N =39**	**Produce Medium Variety (PMV)** **Clus4 = 46**	**Produce Low Variety (PLV)** **Clus5 = 291**	
Supermarket	0	0	84.8	15.22	0	100%
Grocery	0	0	0	43.3	56.7	100%
Convenience	3.4	60.0	0	0	36.7	100%
Drug	35.6	60.0	0	0	4.4	100%
Dollar	0	100	0	0	0	100%
General Merchandise	26.9	30.8	0	0	42.3	100%
Year-round Farmstand	0	0	0	0	100	100%
International Food	0	46.2	0	0	53.9	100%
Butcher/Fish	0	63.6	0	0	36.4	100%
Natural Foods	0	33.3	0	0	66.7	100%
Discount Grocer	0	0	0	0	100	100%
Specialty Foods	0	80.0	0	0	20	100%
Bakery	0	100	0	0	0	100%
Beverage	0	100	0	0	0	100%
Dairy	0	100	0	0	0	100%

Among the non-produce clusters, the NPMV cluster is made up of only three store types: convenience stores, drug stores, and general merchandise stores. Stores in the NPMV cluster were generally larger than stores in the NPLV cluster. For instance, the General Merchandise stores falling into the NPMV cluster were the large national retailers. The NPLV cluster like the PLV cluster is made up of a number of store types. Most of the convenience stores, drug stores, butcher shops, and specialty food store fell into this category, as well as, all of the dollar stores, bakeries, beverage, and dairy stores.

Healthy Food Availability Index (HFAI)

The HFAI offered another way to describe stores based on the availability and variety of the healthier food types within each food category. Scores ranged from 0 – 37 with an average score of 14.3 (SD 9.0). About 75% of the stores received a score less than or equal to 17. As can be seen in Table 3.5, supermarkets had the highest HFAI scores with all supermarkets receiving a score of at least 35. Grocery stores had a fairly wide range, but on average their score was 26.2. Discount grocers also scored high on average (average HFAI = 23.9), but had a much tighter range of scores than grocery stores. Convenience stores, drug stores, and GM stores all had a fairly wide range of scores, although on average they scored low on the scale. Dollar stores and the "Other" category scored the lowest on average. The average HFAI scores for each store type were significantly different from each other ($P \leq 0.05$), with the exception of grocery stores versus discount grocers, convenience stores versus general merchandise stores and drug stores versus general merchandise stores.

The distribution of HFAI scores in Table 3.6 shows that all supermarkets and discount grocers scored in the uppermost quartile, as did most, but not all, grocery stores. General merchandise stores, conveniences stores, and drug stores distributed

Table 3.5: Average HFAI Score by Store Type

	Supermarket **N = 46**	**Grocery** **N = 90**	**Discount Grocer** **N = 13**	**GM** **N = 26**	**Con-venience** **N = 472**	**Drug** **N = 90**	**Dollar** **N = 54**	**Other** **N = 79**
Mean	36.74[2, 3,4, 5, 6, 7]	26.2[1, 4, 5, 6, 7]	23.9[1, 4, 5, 6, 7]	13.5[1, 2, 3, 7]	11.4[1, 2, 3, 6, 7]	15.2[1, 2, 3, 5, 7]	9.2[1, 2, 3, 4, 5, 6]	5.9[1, 2, 3, 4,5, 6, 7]
SD	0.57	8.7	3.7	6.4	4.6	2.8	3.8	5.6
Range	35-37	9 - 37	19 - 32	2 - 27	1 - 24	5 - 25	1 - 16	0 - 27

1: Significantly different from supermarket ($p \leq 0.001$)
2: Significantly different from grocery stores ($p \leq 0.001$)
3: Significantly different from discount grocers ($p \leq 0.001$)
4: Significantly different from general merchandise stores ($p \leq 0.001$)
5: Significantly different from convenience stores ($p \leq 0.001$ or $p < 0.05$)
6: Significantly different from drug stores ($p \leq 0.001$)
7: Significantly different from dollar stores ($p \leq 0.001$ or $p < 0.05$)

Table 3.6: Quartiles of HFAI Score by Store Type

HFAI Quartiles	Supermarket N = 46	Grocery N = 90	Discount Grocer N = 13	GM N = 26	Convenience N = 472	Drug N = 90	Dollar N = 54	Other N = 79
Q4 (N = 18+)	100%	76.7	100	26.9	9.3	10.0	0	3.8
Q3 (N = 14 – 17)	0	13.3	0	19.2	24.2	73.3	14.8	7.6
Q2 (N = 9 – 13)	0	10.0	0	34.6	39.0	14.4	38.9	13.9
Q 1 (N = 0-8)	0	0	0	19.2	27.5	2.2	46.3	74.7

Table 3.7: Quartiles of HFAI Score by Cluster

	No-Produce		Produce		
HFAI Quartiles	**No-Produce Medium Variety (NPMV)**	**No-Produce Low Variety (NPLV)**	**Produce High Variety (PHV)**	**Produce Medium Variety (PMV)**	**Produce Low Variety (PLV)**
Q4 (N = 18+)	27.3	1.1	100	100	29.6
Q3 (N = 14 – 17)	67.3	16.9	0	0	34.4
Q2 (N = 9 - 13)	5.5	39.4	0	0	24.4
Q 1 (N = 0 - 8)	0	42.6	0	0	11.7

across all four quartiles, and dollar stores distributed across the lower three quartiles. Finally, Table 3.7 shows how the store clusters vary among the same quartile ranges as in Table 3.6. All the stores in the PHV and PMV clusters classify in the uppermost quartile. Stores in the PLV cluster distributed rather evenly among all four quartiles, while the NPMV cluster distributed across the upper three quartiles and the NPLV distributed mainly across the lower three quartiles. Average HFAI scores for each of the clusters were significantly different from each other ($p \leq 0.05$).

Discussion

One of the challenges in analyzing the food environment is determining how to summarize the often voluminous amount of information available, so as to accurately and thoroughly characterize the environment in which people live (Lytle et al 2009, Glanz et al 2009). This paper examined two approaches to summarizing this information: 1) use of cluster analysis to divide stores into clusters based on the variety of foods (healthier and less healthy) sold within them, and 2) the use of a Healthy Food Availability Index to summarize in a single statistic the extent to which each store sold healthier food. It demonstrated that both of these methods have potential strengths. Cluster analysis effectively separated larger supermarkets from smaller supermarkets and larger grocery stores. However, even with the bifurcation of the store sample into stores that sold produce, and stores that did not sell produce, most of the rest of the stores got lumped into one of two large clusters (PLV – stores with produce; and NPLV – stores with no produce). The HFAI allowed for more variation in score among smaller stores, and so may be more useful in distinguishing smaller stores with more healthier choices from those with fewer healthier options.

Later analysis will examine how the clusters and the HFAI function to predict weight of women who live nearby.

In past studies, the type of food stores available in an environment (e.g. supermarket, convenience store) have functioned as a short-hand for the healthfulness of the foods sold within them (for example Morland et al 2002a). In other studies the actual availability of surveyed foods has been used to characterize the healthfulness of stores, and relate that information to the diets of those who live nearby (Cheadle et al 1991, Fisher et al 1999, Bodor et al 2007). In the former, assumptions are made about the types of foods available in each store type, and consequently assumptions are made about the relative healthfulness of different store types. However, store type and the healthfulness of the foods sold within are not always correlated, particularly when non-traditional food stores are considered. For instance, in the present study a handful of drug stores and an even greater number of convenience stores were found to sell a small assortment of fresh produce (See Chapter Two).

Complicating this problem is that food store information available from local, state, and industry databases do not always include information needed by the researcher. In the author's case, the list of food stores from the state office did not contain store type. While industry resources like Dunn and Bradstreet provide identifier codes indicating store type and more specific information like annual sales and number of employees per store, this mode of obtaining store categorizing information may not reveal the most important distinguishing features of stores from a nutrition and health perspective. For instance, there is increasing blurring among food store types as more non-traditional food stores enter the food retail business, and other food stores sell a wider variety of foods (Bustillos et al 2007, Martinez 2007). In addition small "mom and pop" stores may be important assets in a community selling healthful and culturally appropriate foods, and these stores would not be easily

distinguished in an industry database (Short et al 2007, McIntyre 2007, Bodor et al 2007). Other researchers have found that industry and other publicly available lists are not always accurate or up-to-date, with significant discrepancies found between these lists and ground-truthed findings (Larson et al 2009).

On the other hand, surveying the availability of actual foods gives a more accurate picture of tangible food availability, but presents its own challenges, specifically the amount of time it takes to do food store surveys and the challenge of how to combine and summarize all that information in a meaningful way (Lytle 2009). For instance, should one be concerned about the availability and proximity of any food regardless of "healthfulness," the relative proportion of healthful versus less healthful food, and/or the number of choices a person has in their environment?

In this paper two approaches were explored for summarizing information obtained through a food store survey in a rural food environment without reliance on the food store type. Cluster analysis offered the advantage of summarizing information from 15 store types and 870 food stores into five identifiable categories. The five categories demonstrated some association with food-store type. Although most of the supermarkets were sorted into the PHV category, others were sorted into the PMV category, which also contained larger grocery stores. By that same token grocery stores, were nearly evenly split among the PMV and the PLV categories. Cluster analysis offered a different way to consider the categorization of non-traditional food store types. Drug stores, for instance, separated into 3 distinct clusters. An additional advantage of cluster analysis was the ability to make an initial sort of food stores based on the availability of produce. Initial cluster analyses run without this initial sort did not sufficiently distinguish between stores with and without produce, although the largest supermarkets were consistently identified as a cluster all to their own. As produce is consistently linked with good health, and the availability of produce is

often a focus of food environment studies, as well as strategies to improve the food environment, distinguishing stores based on the availability of produce is important.

The HFAI also demonstrated a useful way to summarize information on food availability and distinguish between store categories. The HFAI was first developed by Glanz et al (2007) to be used with the NEMS-S, and the methods were adapted for the current food store survey. Like the cluster analysis, it consistently grouped supermarkets at the highest end of the range, although unlike the cluster analysis it did not differentiate between higher and lower variety supermarkets due to the way the index was scored. However, the HFAI did show that stores of the same types, particularly non-traditional food stores like drug stores and convenience stores, could receive very different scores, and thus underscores the importance of not relying on information about store type alone when evaluating the food environment. An advantage of the HFAI is that it allows for the creation of a continuous variable so that individual stores can be compared to each other on a continuum.

Conclusion

The relationship between the food environment, diet, and health is complex. While a number of studies indicate that increased availability of supermarkets and large grocery stores are associated with better diets or healthier weights, additional studies, which have surveyed actual food availability, have also shown that increased presence of fruits, vegetables, and low-fat milk correlate with increased consumption of these foods (regardless if these foods were sold in a supermarket) (Bodor et al 2007, Fisher et al 1999, Cheadle et al 1991). These latter studies suggest that important attributes of the food environment may be missed if actual food availability is not measured. This may particularly be the case in rural areas where a large number of

non-traditional food stores make up a significant part of the food landscape and carry a large amount of food (Bustillos et al 2007, Martinez 2007).

If the actual foods in the food environment are measured, then the challenge of summarizing all this information is created. This study presented two potential ways to summarize food store data from a predominantly rural area, both supporting that typical commercial food store classifications do not completely and accurately reflect the healthfulness and variety of foods found within them. The cluster analysis explored in this paper was useful for creating large groupings of stores based on the availability and number of varieties of the healthy and less healthy food types, however, two particularly large groupings of stores (the PLV and NPLV categories) may not sufficiently recognize smaller differences between stores grouped within them. The Healthy Food Availability Index allows for finer separation among stores based on the availability and variety of healthier food varieties, particularly when used as a continuous variable. Ultimately, the methods used for discerning the availability and variety of food in a given environment will need to be considered in the context of program and research goals.

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CHAPTER FOUR

EXAMINING THE RELATIONSHIP BETWEEN THE RURAL FOOD ENVIRONMENT AND WOMEN'S WEIGHT

Introduction

Social-ecological theory suggests that decisions about what, where, and when to eat are made in cultural and built environment contexts that include the types of food available within a given food environment (Glanz et al 2005). With the large increase in the number of overweight or obese individuals in the past several decades, increasing attention has been placed on the food environments in which we all live and make food decisions (Egger and Swinburn 2007, Booth et al 2001, Lake and Townsend 2006, United States Department of Agriculture 2009, Larson et al 2009). Much of the epidemiological research has focused on the availability and type of food stores in urban and suburban areas. These studies have shown that the availability of supermarkets and grocery stores near a person's home is associated with increased consumption of fruits and vegetables, and a generally healthier diet, while decreasing the risk of overweight and obesity (Morland et al 2002b; Morland et al 2006; Laraia et al 2004; Edmonds et al 2001; Zenk et al 2005b; Cheadle et al 1991; Franco et al 2009, Moore at al 2008).

Rural food environments have been much less studied, although recent analysis from the Behavioral Risk Factor Surveillance System indicates rural areas on average have a higher obesity prevalence (BMI $\geq$ 30) (23%, 95% Confidence Interval 22.6% - 23.4%) than urban regions (20.5%, 95% Confidence Interval 20.2% - 20.7%)) (Jackson et al 2005). Studies by Bustillos et al (2009) and Liese et al (2007) have

found that rural areas are characterized by many non-traditional food stores, some of which do carry more healthful items, although supermarkets were still found to carry the largest selection of healthful foods. National studies have indicated that rural residents may need to travel longer distances to reach these larger grocery stores or supermarkets than their urban counterparts (Powell et al 2007, Morton and Blanchard 2007). This greater travel distance can have consequences for diet and heath, particularly for lower income households (Blanchard and Lyson 2005). For instance, one study in the rural Lower Mississippi Delta found that the rural poor lived the furthest from large supermarkets and grocery stores, and were more likely to spend their limited food dollars in smaller, more expensive stores compared to wealthier rural residents (Kaufman 1998). However, the distribution of these larger stores may differ from urban areas, where poor and higher minority neighborhoods have been shown to lack nearby access, compared to higher income and predominantly white neighborhoods (Morland et al 2007, Hosler et al 2006, Zenk et al 2005a, Baker et al 2006, Zenk et al 2005b, Moore et al 2006, Morland et al 2002a, Jetter et al 2006, Powell et al 2007b, Morton and Blanchard 2007, Kaufman 1998, Liese et al 2007). A study in rural Texas found that the poorest neighborhoods, and those with the greatest proportions ethnic minority individuals, had the best access to food stores including supermarkets if proximity is the indicator for access (Sharkey 2008).

The effects of minority composition and economic segregation of neighborhoods on food access are likely to differ across rural regions of the country. For instance, Upstate NY where this study tales place, is much more homogenously white, than southern rural regions of the country. Additionally, while rural areas may have more lenient zoning and other land use regulations, which could reduce income segregation within the region, historical settlement patterns may still result in distinct poorer and wealthier regions. Finally, the relatively low population density of rural

areas combined with the demise of local grocery stores as larger supercenters are built in "regional hubs," may result in rural residents (regardless of racial or economic background) travelling great distances to reach a major food center (Blanchard and Lyson 2005, Sharkey 2009).

Because of the unique nature of the rural food environment Sharkey (2009) has recommended that it be examined in two major ways based on: 1) the proximity of a given store type to a point of interest (e.g., a home, a population centroid, workplace), and 2) the number of a given store type located a given distance from a point of interest. This allows for an examination of relative accessibility (e.g., what kind of stores are closest to a point of interest), and also how many choices within a given distance from a point of interest an individual may have (e.g., how many supermarkets does a person have to choose from). This study makes use of both of these measures, as well as an additional objective measure of the average quality of foods found within a woman's food environment known as the Healthy Food Availability Index.

Sharkey also maintains that an analysis of the rural food environment should include an inventory of traditional (e.g., supermarkets and grocery stores), as well as "non-traditional" food stores (e.g., drug stores and dollar stores) because non-traditional food stores are making up an increasingly important part of the rural retail food landscape. Earlier analysis in this dissertation of the rural food environment supports this finding (See Chapters Two and Three), and these non-traditional food stores were included in this study. This study also attempts to assess the effects of the rural food environment in a relatively homogenous racial/ethnic environment, allowing for the opportunity to assess the effects of access to food outside the additional confounding factors of racial discrimination and segregation.

Thus, the objectives of this paper were 1) to examine the relationship between the rural food environment in Upstate NY and early prenatal weights of childbearing women, and 2) to examine whether this relationship is modified by income status.

Methods

Women

Data were collected from eligibility checklists on pregnant women screened for enrollment in a parallel study of weight gain during pregnancy at Bassett Healthcare, a hospital and set of primary-care clinics serving a 10-county area in Upstate NY. Data from the eligibility checklists were collected on the woman's early pregnancy characteristics during the recruitment period from June 2005 to March 2006 by trained recruiters from medical forms completed by women as part of the registration for prenatal care. To be eligible for the present study a woman had to be at least 18 years of age, and have had a home address within the general geographic area. She also needed a pre-pregnancy weight or early pregnancy weight ($\leq$ 14 weeks gestation). Women whose earliest weight was in the second trimester of pregnancy had their initial weight adjusted to the 9-11 week interval (see Olson and Strawderman 2003a for a description of the method). Women were also considered ineligible for the present study if they had a medical condition that would likely affect their weight status (e.g., thyroid disease, severe kidney impairments, diagnosed eating disorders) or were taking medications that would strongly affect their weight. Data on each woman's address, parity, and enrollment in a prenatal care assistance program for lower income households were collected from a subsequent audit of medical records in the Fall of 2006.

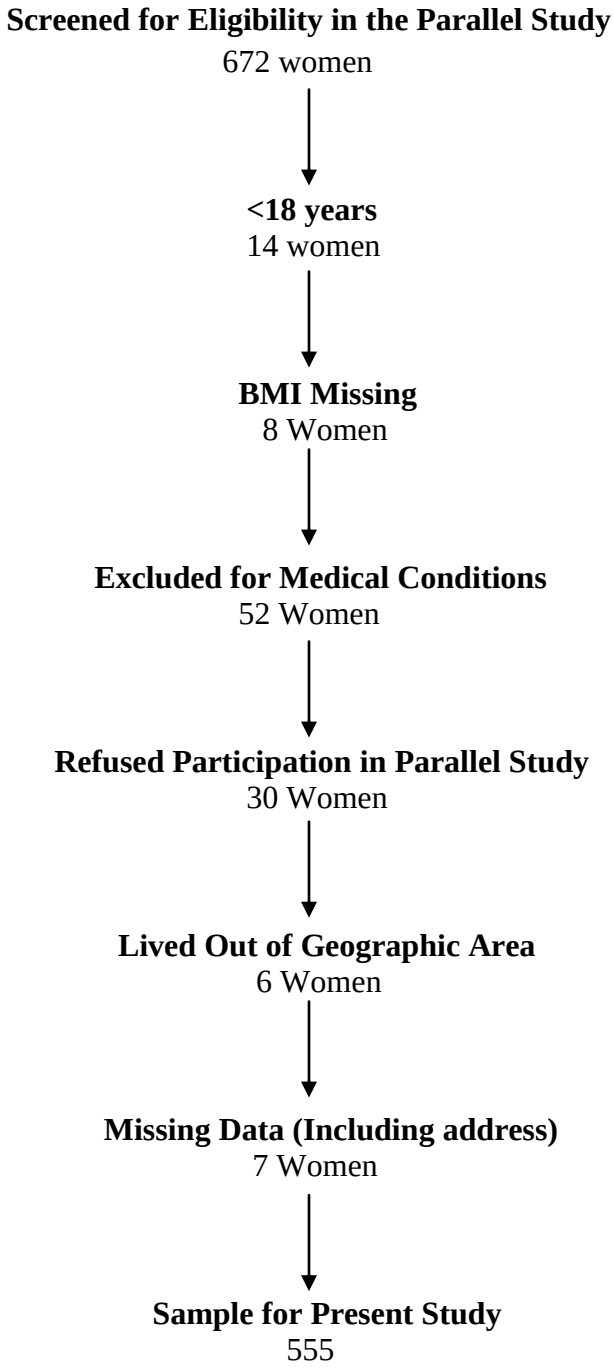

Figure 4.1: Sample Size Determination of Women in Analysis

Thirty women who had been asked to participate in the parallel study, and refused to participate, were excluded from the present analysis. The final sample

consisted of 555 women from 672 screened for eligibility in the parallel study (See Figure 4.1 for how the sample size was determined). Enrollment in a state-supported Expanded Medicaid coverage for pregnancy program (the Prenatal Care Assistance Program or PCAP) has been found to be a good proxy for low-income status in other studies of pregnant women from this area (Olson et al 2003a, Olson et al 2003b, Olson et al 2004). Eligibility for PCAP is limited to women with household incomes less than 200% of the Federal Poverty Line. Early pregnancy BMIs were categorized into weight categories based on the 1995 World Health Organization classification standards. See Table 4.1 for a description of the women's demographic profile. Data collection for the women was approved by the University Committee on Human Subjects at Cornell University and the Institutional Review Board at Bassett Healthcare Research Institute.

Table 4.1: Demographic Characteristics of the Women*

Characteristic	**All**	**Under-weight**	**Normal Weight**	**Over-weight**	**Obese**
BMI		<18.5	18.5 – 24.99	25.00 – 29.99	≥ 30
N	555	12	261	142	140
Number ≤ 30 years old (%)	393 (70.8)	11 (91.7)[1]	198 (75.9)	96 (67.6)[2]	88 (62.9)[3]
Number nulliparous (%)	207 (37.6)	1 (8.3)[4]	115 (44.1)	51 (37.0)	40 (28.8)[5]
Number on PCAP (%)	249 (45.1)	7 (58.3)	116 (44.4)	68 (48.6)	58 (41.7)

* Tests of significant differences between normal weight women and other weight categories for the demographic characteristics. (1, 2, 4 $p < 0.05$; 3, 5 $p < 0.01$)

Mapping the Women's Food Environment

Food stores were mapped and surveyed in a rural area of Upstate NY comprising about 8700 sq miles and enclosing all or portions of 19 counties and a

small piece of northern Pennsylvania. The census tracts where the women lived were primarily rural. Based on data from the 2000 Census the average population density was 312 people per square mile (maximum population density 1506 people per square mile). Forty-five percent of the census tracts had 30% or more of the inhabitants living at less than 185% of the poverty line. Store names and locations were provided by the New York State Department of Agriculture and Markets, which maintains a database of food stores for state licensing and inspection.

Locations of food stores were geocoded using ArcGIS software (version 9.1, copyright 2001-2004, ESRI, Redlands, CA). The base map data layer used for geocoding containing streets and street numbers was available through the New York State Geographic Information System (GIS) Clearinghouse and produced by the New York State Office of Cyber Security & Critical Infrastructure Coordination (downloaded 2006). All addresses not matched after the first round of geocoding were checked for spelling errors or alternative street names, and re-matched with a minimum match score of 60 considered acceptable. Store addresses with incomplete information (for instance, a street name but no street number) were cross-checked in alternate databases like US Yellow pages for more complete information. In some cases, the store was called to obtain complete address information or identify location based on cross-streets or the location of neighboring establishments. These stores were then geocoded interactively based on the additional spatial information. The mapped food store locations were then used to locate the food stores for surveying. This served as a ground-truth check to ensure mapping accuracy and provided additional spatial information for food stores that had been difficult to match.

Women's home addresses were mapped using the same software as above. As with store addresses, unmatched women's home addresses were checked for spelling errors and alternate names and re-matched. Fifty-one women with post-offices boxes

or whose street addresses could not be found were mapped to the center of their respective towns.

Food Store Survey

Seventy food stores from the original NYSDAM could not be located for surveying or were found to be closed and were excluded from the analysis. An additional 61 stores appeared to be closed for the winter season (when the survey was conducted) and were also not surveyed. These included campground stores and food stores that appealed to tourists. Food stores that did not sell foods listed on the survey were also excluded (n = 128). For instance, these were stores that only sold single products like pastries, candy, or cheese, as well as stores that did not appear to sell any food at all, but may have in the past. Several large distribution centers also fell in this category, but since they do not regularly sell food directly to the public they were excluded. Very few stores objected to the survey with only six stores requesting the surveyor leave. An additional 32 stores found while surveying were mapped and added to the analysis. In all 870 stores were surveyed and included in the analysis. The distribution of stores excluded from the current analysis are shown in Table 4.2.

Table 4.2: Total Stores in Sample and Number Surveyed

	N	**%**
Total Stores	1117	100%
Stores Surveyed	870	77.9%
Does not sell surveyed food	110	9.8%
Closed/Could not find	70	6.3%
Closed Seasonally	61	5.5%
Surveyor asked to leave	6	0.6%

The type of food store was not available from the NYSDAM list. Therefore, criteria were established to determine the type of food store through both observation and contact with store management. To be considered a supermarket, a store had to have at least eight cash registers and also sell a wide variety of food (fresh produce, fresh meat, processed foods, frozen foods, etc.). Grocery stores were similar to supermarkets in selling a wide variety of foods, but were generally smaller with no more than seven cash registers. Grocery stores often belonged to regional recognizable chains, but also included smaller "mom and pop" stores. Contact with store management ensured that all stores classified as supermarkets covered at least 30,000 square feet, while grocery stores were smaller. Convenience stores sold a much more limited range of foods, were generally smaller than grocery stores, often belonged to regionally recognizable chains, and often had gas pumps outside. Drug stores and dollar stores belonged to recognizable regional and national chains. Discount grocers were stores that sold a wide range of foods in bulk but in limited variety, and were comprised of recognizable national chains. General merchandise stores sold a wide range of products including clothing, sporting equipment, farm equipment, automotive parts, kitchen equipment, household products, etc. This category included large recognizable national chains, as well as other smaller independent stores. Other food stores that sold a narrow range of food products like bakeries, butchers, beverage stores, international food stores, etc. were classified based on observation and experience. The distribution of stores by store type are shown in Table 4.3.

Foods inside the stores were surveyed using the Nutrition Environment Measurement Survey (NEMS-S) (Glanz et al 2007) with modifications made for local brands and foods of interest to families of childbearing women. The survey assessed

the availability and variety of common foods in 14 food categories. See Chapters Two and Three for a fuller description of the food store survey. Data on the availability and variety of these foods were then entered into cluster analysis (non-hierarchical k-means clustering) as an alternate way of analyzing the type of food store, based on the availability and variety of foods, rather than the more traditional system of food store classification (e.g. supermarkets, drug stores etc.) Five different clusters were created, with a forced separation of the food stores into those with and without produce. Two clusters corresponded to stores with no produce – one cluster contained stores with a medium variety of other foods (NPMV) and the other cluster contained store with low variety of other foods (NPLV). The other three clusters corresponded to stores with produce: a cluster with high variety of other foods (PHV), a cluster with medium variety of other foods (PMV), and a cluster with low variety of other foods (PLV). See Chapter Three for a more complete description of the cluster formation and their characteristics.

Table 4.3: Surveyed Stores by Store Type

Store	**N**	**%**
Convenience Store	472	54.3
Grocery Store	90	10.3
Drug Store	90	10.3
Dollar	54	6.2
Supermarket	46	5.3
General Merchandise	26	3.0
Natural Food	18	2.1
Year-round Farmstand	15	1.7
Discount Grocer	13	1.5
International Food	13	1.5
Butcher/Fish	11	1.3
Bakery	11	1.3
Gourmet or Bulk	5	0.6
Beverage	5	0.6
Dairy	1	0.1

Measuring the Women's Food Environment.

Three calculations were made to describe each woman's food environment. First, service areas were created around each woman's home along the street network corresponding to overlapping "discs" of one, five, ten and twenty miles. This allowed for the analysis of food store density by food store type (i.e. commercial classification and according to the constructed clusters) falling within these service areas at the designated distance from each woman's home. Second, Healthy Food Availability Index (HFAI) scores were created based on the availability and variety of foods available in each store. See Chapter Three for a more complete description of how the HFAI scores were calculated for each store. An average of all the HFAI scores for each store within each woman's food environment (at one and five miles from her home) was calculated allowing for the comparison of the quality of the food environments among women. Third, a calculation of the distance to the nearest store by store type from each woman's home was made using the closest facility analysis layer. This calculation was also made along the street network.

Statistical Analysis

All statistical analysis was conducted using Statistical Analysis Software (version 9.1, 2002-2004, SAS Institute, Inc., Cary, NC). The covariates of household income, parity, age were constructed as categorical variables (Household income: enrolled [i.e. low income] or not enrolled in PCAP; parity: any live births versus none; and age: ≤30 years or > 30 years). F-tests tests were conducted for tests of significant differences between demographic variables across weight categories in Table 4.1.

Logistic regression (i.e. SAS proc logistic) was used to calculate the odds of being obese, overweight, or obese and overweight given the three major independent variables: 1) store density by food store type one and five miles from a woman's

home; 2) average HFAI score of stores within one and five miles of a woman's home; 3) the average nearest distance of each store type from a woman's home. Covariates in the models included PCAP status (as a marker of household income), parity, and age as categorical variables described above.

For some store types, the number of women having any of that store type a short distance from her home was small. For this reason, many of the independent variables in the store density models were constructed as categorical variables (e.g., any supermarkets vs. no supermarket). As a general rule, if about 60% or more of the women for a given store type had none of that store type at the given distance from her home, then the independent variable was modeled as a categorical variable. In some cases, results for the independent variables in both categorical and continuous form are presented for comparison. When store-type variables were modeled as continuous variables, attention was given to the effect of the distribution of the number of a given store type on the value of the odds ratios. When very long tails were observed the continuous variable was also modeled with this tail truncated. If the tail was found to have a significant impact on the odds ratio, the truncated variable was used. See Appendix 4.A for a table describing the quartiles for the number of stores one, five, ten and twenty miles from the women's homes. While models of store density were run for the one, five, ten and twenty miles analyses, results in this paper primarily focus on the food environments at one and five miles both to make the paper more manageable and to facilitate comparison with other studies in rural areas that examined similar distances. Results for the ten and twenty mile analyses are included in the Appendix.

For the nearest store analysis, most of the analyses examined the odds of being overweight, obese or overweight/obese for each one mile increase in the distance of the nearest food store of a given food type from her home. Convenience stores, and

the two lower variety clusters (NPLV and PLV), were much more likely to be located one mile or less from a woman's home, so these three store types were also analyzed for the odds of overweight, obese, and overweight/obese for each quarter mile increase in distance. Underweight women were excluded from all logistic regression analyses because their small sample size created unstable models.

To test the hypothesis that weight status in a given food environment may be modified by household income status, logistic regression models were run looking at the interaction of the food environment variables with enrollment in PCAP. Where significant interactions were found ($p \leq 0.10$), separate regression models were run on both income strata with the results presented for each income stratum.

Logistic analyses for the one and five mile food environment and nearest store analysis were run both including and excluding the 51 women who had been mapped to the center of their village or city. No major differences in results were found, and results included in this paper reflect the full sample. In addition no significant differences were found between women with PO Box addresses and the rest of the sample in average BMI, parity, age, or PCAP status.

Results

At one mile from a woman's home, only about half the sample had a store of any type located near her home, but by five miles nearly all the woman (90%) had at least one store five miles from her home (Table 4.4). Additionally, only 154 (27.8%) of the women had a supermarket or grocery store within a mile of her home. At five miles the number of women with a supermarket or grocery store near her home more than doubled, but there were still 36.2% of the women with neither a supermarket nor grocery store five miles from home. This relatively low density speaks to the general

rurality of the area under investigation. Appendix 4.B outlines the average number of each store type for each weight category one, five, ten and twenty miles from a woman's home.

Table 4.4: Number of Women with Any of the Given Store Type One and Five Miles from Her Home

Store Type	One Mile		Five Mile	
	N	%	N	%
Any Store	276	49.8	505	90.0
Supermarket	53	9.5	206	37.1
Grocery Store	110	19.8	287	51.7
Supermarket or Grocery Stores	154	27.8	354	63.8
Convenience Stores	263	47.4	493	88.8
Drug Stores	141	25.4	260	46.9
Dollar Stores	65	11.7	197	35.5
Discount Grocers	10	1.8	104	18.7
Natural Food Stores	49	8.8	129	23.2
General Merchandise Stores	36	6.5	103	18.6
No-Produce Medium Variety Stores (NPMV)	56	10.1	154	27.8
No-Produce Low Variety Stores (NPLV)	257	46.3	472	85.1
Produce High Variety Stores (PHV)	40	7.2	184	33.1
Produce Medium Variety Stores (PMV)	71	12.8	161	29.0
Produce Low Variety Stores (PLV)	205	36.9	414	74.6
Stores with Fresh Produce	224	40.4	438	78.9

Table 4.5 lists the odds of being overweight or obese based on the number of the specified store type within one mile from a woman's home. The odds of being obese more than doubled compared to normal weight women with the presence of one

Table 4.5: Odds of Overweight and Obesity by Presence of Specified Store Type within <u>One Mile</u> from Home*

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Number of Stores (continuous)	Overweight	1.022	0.967 – 1.081
	Obese	1.002	0.943– 1.064
	Overweight & Obese	1.011	0.964 – 1.059
Supermarkets (1+ vs 0)	Overweight	0.970	0.435 – 2.161
	Obese	**2.176**	**1.105 – 4.286**
	Overweight & Obese	1.543	0.840 – 2.836
Grocery Stores (1+ vs 0)	Overweight	1.337	0.810 – 2.208
	Obese	0.821	0.468 – 1.440
	Overweight & Obese	1.064	0.691 - 1.640
Supermarkets and Grocery (1+ vs 0)	Overweight	1.269	0.798 – 2.017
	Obese	1.243	0.774 – 1.995
	Overweight & Obese	1.252	0.851 – 1.843
Convenience Stores (1+ vs 0)	Overweight	1.049	0.691 – 1.592
	Obese	0.879	0.574 – 1.345
	Overweight & Obese	0.957	0.679 – 1.350
Drug Stores (1+ vs 0)	Overweight	1.062	0.656 – 1.717
	Obese	1.145	0.703 – 1.864
	Overweight & Obese	1.089	0.732 – 1.619
Dollar Stores (1+ vs 0)	Overweight	1.845	0.972 – 3.503
	Obese	1.456	0.737 – 2.875
	Overweight & Obese	1.641	0.940 – 2.864
Discount Grocers (1+ vs 0)	Overweight	2.120	0.516 – 8.719
	Obese	0.551	0.060 – 5.077
	Overweight & Obese	1.322	0.347 – 5.039
Natural Food Stores (1+ vs 0)	Overweight	1.203	0.618 – 2.342
	Obese	**0.356**	**0.132 – 0.957**
	Overweight & Obese	0.755	0.411 – 1.387
General Merchandise Stores (1+ vs 0)	Overweight	0.922	0.412 – 2.063
	Obese	0.407	0.146 – 1.136
	Overweight & Obese	0.646	0.318 – 1.312
No-Produce Medium Variety (NPMV) (1+ vs 0)	Overweight	1.183	0.570 – 2.453
	Obese	**1.996**	**1.027 – 3.882**
	Overweight & Obese	1.577	0.882 – 2.820
No-Produce Low Variety (NPLV) (1+ vs 0)	Overweight	1.101	0.726 – 1.671
	Obese	0.805	0.525 – 1.235
	Overweight & Obese	0.948	0.671 – 1.338
Produce High Variety (PHV) (1+ vs 0)	Overweight	1.471	0.625 – 3.463
	Obese	2.029	0.898 – 4.582
	Overweight & Obese	1.730	0.850 – 3.522

Table 4.5 Continued

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Produce Medium Variety (PMV) (1+ vs 0)	Overweight	0.949	0.511 – 1.761
	Obese	0.761	0.395 – 1.468
	Overweight & Obese	0.857	0.511 – 1.438
Produce Low Variety (PLV) (1+ vs 0)	Overweight	1.280	0.834 – 1.964
	Obese	1.086	0.697 – 1.693
	Overweight & Obese	1.177	0.824 – 1.682
Fresh Produce Available (1+ vs 0)	Overweight	1.159	0.759 – 1.770
	Obese	1.043	0.674 – 1.612
	Overweight & Obese	1.094	0.770 – 1.555
Fresh Produce (continuous)	Overweight	1.070	0.942 – 1.216
	Obese	1.006	0.873 – 1.159
	Overweight & Obese	1.037	0.929 – 1.157

*Tests of significance difference adjusted for age, parity, and household income status.

or more supermarkets a mile from a woman's home (OR: 2.176; CI: 1.105 – 4.286). In contrast, the odds of being obese decreased compared to normal weight women with the presence of a natural food store a mile from a woman's home (OR: 0.356; CI: 0.132 – 0.957). There were also significantly greater odds of being obese with the presence of a NPMV type store a mile from a woman's home (OR: 1.996; CI: 1.027 – 3.882).

For the five mile food environment (Table 4.6), the relationship with supermarkets alone was no longer present, but the odds of being overweight was higher with the presence of any store, grocery stores, the combined supermarkets and grocery store category, drug stores (as a continuous variable only), dollar stores (as a continuous variable only), and discount stores. The odds of being overweight or obese were also higher with the presence of more grocery stores (OR: 1.327; CI: 1.075 – 1.639) or the presence of a supermarket or grocery store within five miles (OR: 1.509; CI: 1.051 – 1.267). Like at one mile, the odds of being obese were lower by about

Table 4.6: Odds of Overweight and Obesity by Presence of Specified Store Type within Five Mile from Home *

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Number of Stores (continuous)	Overweight	**1.016**	**1.000 – 1.032**
	Obese	1.005	0.989 – 1.021
	Overweight & Obese	1.010	0.997 – 1.023
Supermarkets (1+ vs 0)	Overweight	1.067	0.695 – 1.637
	Obese	0.810	0.520 – 1.262
	Overweight & Obese	0.936	0.656 – 1.335
Grocery Stores (1+ vs 0)	Overweight	**1.641**	**1.071 – 2.515**
	Obese	1.142	0.747 – 1.745
	Overweight & Obese	1.377	0.973 – 1.947
Grocery Stores (Continuous)	Overweight	**1.469**	**1.132 – 1.907**
	Obese	1.220	0.961 – 1.549
	Overweight & Obese	**1.327**	**1.075 – 1.639**
Supermarkets and Grocery (1+ vs 0)	Overweight	**1.667**	**1.065 – 2.609**
	Obese	1.342	0.862 – 2.091
	Overweight & Obese	**1.509**	**1.051 – 2.167**
Supermarkets and Grocery (Continuous)	Overweight	**1.149**	**1.023 – 1.290**
	Obese	1.042	0.930 – 1.168
	Overweight & Obese	1.092	0.994 – 1.199
Convenience Stores (1+ vs 0)	Overweight	1.106	0.579 – 2.112
	Obese	1.426	0.700 – 2.903
	Overweight & Obese	1.258	0.729 – 2.172
Convenience Stores (Continuous)	Overweight	1.030	0.995 – 1.066
	Obese	1.013	0.979 – 1.049
	Overweight & Obese	1.020	0.992 – 1.050
Drug Stores (1+ vs 0)	Overweight	1.169	0.769 – 1.776
	Obese	1.002	0.655 – 1.531
	Overweight & Obese	1.087	0.770 – 1.534
Drug Stores (Continuous)	Overweight	**1.123**	**1.012 - 1.246**
	Obese	1.052	0.949 – 1.165
	Overweight & Obese	1.086	0.996 – 1.185
Dollar Stores (1+ vs 0)	Overweight	1.365	0.889 – 2.097
	Obese	0.734	0.465 – 1.159
	Overweight & Obese	1.013	0.707 – 1.452
Dollar Stores (Continuous)	Overweight	**1.201**	**1.033 – 1.395**
	Obese	1.065	0.913 – 1.243
	Overweight & Obese	1.129	0.996 – 1.280
Discount Grocers (1+ vs 0)	Overweight	**1.821**	**1.093 – 3.034**
	Obese	0.984	0.555 – 1.745
	Overweight & Obese	1.398	0.894 – 2.183
Natural Food Stores (1+ vs 0)	Overweight	0.886	0.544 – 1.443
	Obese	**0.579**	**0.341 – 0.983**
	Overweight & Obese	0.730	0.485 – 1.099

Table 4.6 Continued

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
General Merchandise Stores (1+ vs 0)	Overweight	0.938	0.555 – 1.587
	Obese	0.657	0.373 – 1.160
	Overweight & Obese	0.796	0.512 – 1.237
No-Produce Medium Variety (NPMV) (1+ vs 0)	Overweight	1.407	0.887 – 2.232
	Obese	1.237	0.769 – 1.991
	Overweight & Obese	1.331	0.904 – 1.960
No-Produce Low Variety (NPLV) (1+ vs 0)	Overweight	1.055	0.591 – 1.881
	Obese	1.151	0.633 – 2.093
	Overweight & Obese	1.095	0.678 – 1.767
No-Produce Low Variety (NPLV) (Continuous)	Overweight	1.028	0.997 – 1.061
	Obese	1.007	0.975 – 1.040
	Overweight & Obese	1.017	0.991 – 1.043
Produce High Variety (PHV) (1+ vs 0)	Overweight	1.165	0.756 – 1.797
	Obese	0.683	0.429 – 1.087
	Overweight & Obese	0.909	0.632 – 1.309
Produce Medium Variety (PMV) (1+ vs 0)	Overweight	1.091	0.688 – 1.729
	Obese	0.921	0.574 – 1.478
	Overweight & Obese	01.008	0.688 – 1.477
Produce Low Variety (PLV) (1+ vs 0)	Overweight	1.217	0.753 – 1.967
	Obese	1.378	0.839 – 2.262
	Overweight & Obese	1.301	0.876 – 1.931
Produce Low Variety (PLV) (Continuous, tail cut)	Overweight	1.053	0.983 – 1.127
	Obese	0.978	0.906 – 1.055
	Overweight & Obese	1.020	0.962 – 1.081
Fresh Produce Available (1+ vs 0)	Overweight	1.383	0.824 – 2.320
	Obese	1.400	0.825 – 2.376
	Overweight & Obese	1.410	0.924 – 2.151
Fresh Produce (continuous, tail cut)	Overweight	1.040	0.986 – 1.091
	Obese	0.976	0.920 – 1.036
	Overweight & Obese	1.011	0.966 – 1.059

* Tests of significance difference adjusted for age, parity, and household income status.

half compared to normal weight women with the presence or one or more natural food stores (OR: 0.579; CI: 0.341 – 0.983).

Analyses of the odds of being overweight, obese, and overweight or obese for store density in the ten and twenty mile food environments are shown in Appendices 4.C and 4.D. There were higher odds of being overweight compared to normal weight women with increasing numbers of PLV stores ten miles from a woman's home (OR: 1.032; CI: 1.000 – 1.066) and the presence of an NPMV store (OR: 1.602; CI: 1.047 – 2.451) . There were also lower odds of overweight and overweight/obesity with increased presence of dollar stores when that store type was treated as a categorical variable (any vs. none) (OR: 0.596; CI: 0.388 – 0.915). As at one and five miles, the relationship between presence of natural food stores and lower odds of overweight still existed in the 10 mile food environment (OR: 0.608; CI: 0.393 - 0.942). For nearly every store type category there were significantly increased odds for being overweight and overweight/obese with increasing number of the given store type twenty miles from a woman's home. While the odds ratios were significant, they are much smaller than the odds ratios at the smaller radiuses. Also unlike with the smaller food environments, the relationship between weight and natural food stores no longer existed.

Table 4.7 examines the odds of a woman being overweight, obese, and overweight or obese for each one unit increase in the average HFAI score for all stores located within one and five miles of her home. At five miles, higher HFAI scores were associated with higher odds of overweight and overweight or obese compared to normal weight, however, the odds ratios were relatively small (7 to 14% increased risk). Appendix 4.E shows the average HFAI scores among weight groups for all the stores located one, five, ten, and twenty miles from each woman's home. The results suggest similar findings as those in Table 4.7, with overweight women having significantly higher HFAI scores at five miles (14.90 versus 13.74). Appendix 4.F

shows the odds ratios for being overweight, obese and overweight or obese based on one unit increases in average HFAI score in for all the stores ten and twenty miles from a woman's home. No significant results were found at these distances.

Table 4.7: Odds Ratios of Overweight and Obesity by Average Healthy Food Availability Index (HFAI) Score * †

	Weight Category (Reference Normal Weight)	**Odds Ratio (95% CI)**
Average HFAI Score at One Mile	Overweight	1.056 (0.974 – 1.146)
	Obese	1.054 (0.960 – 1.157)
	Overweight & Obese	1.055 (0.982 – 1.133)
Average HFAI Score at Five Mile	Overweight	**1.135 (1.051 – 1.225)**
	Obese	1.029 (0.965 – 1.096)
	Overweight & Obese	**1.070 (1.013 – 1.130)**

* Odds modeled for each 1 unit increase in the average HFAI score.
†Tests of significance difference adjusted for age, parity, and household income status

Finally, the food environment was analyzed by examining the odds that a woman would be overweight, obese, or either overweight or obese by how far away the nearest store of different types were from her home (Table 4.8). The odds that a woman would be overweight decreased slightly for every one mile increase in the distance of the nearest grocery store or discount grocer from her home (OR:0.944; CI: 0.893 – 0.999 and OR: 0.967; CI: 0.937 – 0.998) . Additionally, the odds that a woman would be obese increased for every one mile increase in the distance of the nearest natural food store or general merchandise store from her home (OR: 1.036; CI: 1.000 – 1.074). Appendix 4.G provides more descriptive information about the relationship of the nearest store to a woman's home and weight status. On average the women are about 1.8 miles from the nearest store of any type. The nearest supermarkets are on average somewhat further away at about eight miles. The nearest

Table 4.8: Odds of Overweight and Obesity as Distance to the Nearest Store of a Specified Type Increases by One Mile

Distance to Nearest Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Any Store	Overweight	0.988	0.888 - 1.099
	Obese	0.963	0.861 - 1.077
	Overweight & Obese	0.977	0.894 - 1.068
Supermarket	Overweight	1.077	0.969 - 1.047
	Obese	1.022	0.984 - 1.061
	Overweight & Obese	1.014	0.983 - 1.046
Grocery Store	Overweight	**0.944**	**0.893 - 0.999**
	Obese	0.977	0.923 - 1.034
	Overweight & Obese	0.960	0.917 - 1.005
Supermarket or Grocery Store	Overweight	0.954	0.890 - 1.022
	Obese	0.938	0.874 - 1.008
	Overweight & Obese	0.947	0.895 - 1.003
Convenience Store	Overweight	0.976	0.885 - 1.076
	Obese	0.962	0.870 - 1.064
	Overweight & Obese	0.969	0.893 - 1.051
Convenience Store (400 meters)*	Overweight	0.944	0.970 - 1.018
	Obese	0.990	0.966 - 1.015
	Overweight & Obese	0.992	0.972 - 1.012
Drug Store	Overweight	1.000	0.960 - 1.042
	Obese	0.944	0.954 - 1.037
	Overweight & Obese	0.999	0.965 - 1.033
Dollar Store	Overweight	0.992	0.956 - 1.029
	Obese	1.020	0.982 - 1.060
	Overweight & Obese	1.077	0.976 - 1.038
Discount Grocer	Overweight	**0.967**	**0.937 - 0.998**
	Obese	0.999	0.967 - 1.032
	Overweight & Obese	0.983	0.958 - 1.009
Natural Food Store	Overweight	1.011	0.977 - 1.046
	Obese	**1.036**	**1.000 - 1.074**
	Overweight & Obese	1.024	0.995 - 1.054
General Merchandise Store	Overweight	1.010	0.976 - 1.045
	Obese	**1.050**	**1.014 - 1.088**
	Overweight & Obese	**1.028**	**1.000 - 1.057**
No-Produce Medium Variety (NPMV) Store	Overweight	0.970	0.939 - 1.002
	Obese	0.944	0.963 - 1.025
	Overweight & Obese	0.982	0.957 - 1.008
No-Produce Low Variety (NPLV) Store	Overweight	0.996	0.913 - 1.086
	Obese	0.983	0.902 - 1.072
	Overweight & Obese	0.991	0.923 - 1.064
No-Produce Low Variety (NPLV) Store (400 meters)*	Overweight	0.999	0.978 - 1.021
	Obese	0.996	0.975 - 1.018
	Overweight & Obese	0.998	0.980 - 1.016

Table 4.8 Continued

Distance to Nearest Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Produce High Variety (PHV) Store	Overweight	1.001	0.964 - 1.039
	Obese	1.033	0.995 - 1.072
	Overweight & Obese	1.016	0.986 - 1.048
Produce Medium Variety (PMV) Store	Overweight	1.012	0.974 - 1.051
	Obese	1.009	0.970 - 1.049
	Overweight & Obese	1.010	0.978 - 1.042
Produce Low Variety (PLV) Store	Overweight	0.949	0.878 - 1.025
	Obese	0.950	0.878 - 1.026
	Overweight & Obese	0.950	0.892 - 1.012
Produce Low Variety (PLV) Store (400 meters)*	Overweight	0.987	0.968 - 1.006
	Obese	0.987	0.968 - 1.006
	Overweight & Obese	0.987	0.972 - 1.003
Store with Fresh Produce	Overweight	0.944	0.869 - 1.026
	Obese	0.940	0.864 - 1.022
	Overweight & Obese	0.943	0.880 - 1.009

†Adjusted for age, parity, and household income status.
* Most analyses examined the odds ratio for each one mile increase in the distance of the nearest store type from each woman's home, however, for these indicated store type odds were also calculated for each quarter mile increase in distance.

discount grocer, general merchandise store, and natural food store are on average rather far from home (>11 miles away), whereas the nearest convenience store is generally fairly close to the women at around two miles.

Modifications by Income

It may also be that the way a woman interacts with her food environment may differ by her income status. For instance, lower income women may experience more transportation problems in accessing food, and thus be more prone to health repercussions in a less healthy near food environment. Consequently, the sample was divided into two strata based on their enrollment in the PCAP Program: women from lower income households and women from higher income households. Table 4.9

Table 4.9: Distance to the Nearest Specified Store Type and Average Number of Specified Store Type One and Five Miles from Home by Income Group †

	Nearest Store		Average Number of Stores		
Store Type	**Lower Income Women (Miles)**	**Higher Income Women (Miles)**		**Lower Income Women**	**Higher Income Women**
Any Store	2.01	1.84	One Mile Five Mile	2.27 9.24	2.23 9.31
Supermarkets	7.99	8.33	One Mile Five Mile	0.14 0.74	0.11 0.70
Grocery Stores	**5.72***	**4.85***	One Mile Five Mile	0.15 0.55	0.19 0.72
Supermarkets and Grocery Stores	4.33	3.86	One Mile Five Mile	0.29 1.29	0.30 1.42
Convenience Stores	2.25	2.02	One Mile Five Mile	1.23 4.61	1.18 4.68
Drug Stores	6.27	6.44	One Mile Five Mile	0.32 1.16	0.31 1.04
Dollar Stores	**7.91***	**9.10***	One Mile Five Mile	0.18 0.78	0.11 0.64
Discount Stores	**12.31***	**13.89***	One Mile Five Mile	0.02 0.30	0.01 0.25
Natural Food Stores	10.42	10.15	One Mile Five Mile	0.10 0.32	0.11 0.35
General Merchandise Stores	**12.22***	**11.11***	One Mile Five Mile	**0.04*** 0.19	**0.09*** 0.23
No-Produce Medium Variety (NPMV) Stores	9.80	10.35	One Mile Five Mile	0.12 0.50	0.12 0.50
No-Produce Low Variety (NPLV) Stores	2.51	2.37	One Mile Five Mile	1.22 4.90	1.21 4.82
Produce High Variety (PHV) Stores	8.61	9.04	One Mile Five Mile	0.12 0.66	0.09 0.63
Produce Medium Variety (PMV) Stores	9.47	8.71	One Mile Five Mile	0.09 **0.23***	0.13 **0.34***
Produce Low Variety (PLV) Stores	3.17	3.09	One Mile Five Mile	0.74 2.96	0.69 3.02
Fresh Produce	2.86	2.82	One Mile Five Mile	0.94 3.84	0.91 3.99

†Tests of significance difference adjusted for age and parity.
*: p value <0.05

shows how the nearness measure differed by the women's household income. On average women with higher incomes were more likely to have a grocery store and a general merchandise store closer to home than a lower income woman (4.85 miles versus 5.72 miles, and 11.11 miles versus 12.22 miles). On the other hand, higher income women were likely to have to travel further to reach the nearest dollar store or discount store compared to lower income women (9.10 miles versus 7.91 miles, and 13.89 miles versus 12.31 miles). Additionally, Table 4.9 examines the average number of each store type one and five miles from a woman's home by income status. There were few significant differences. Lower income women had fewer general merchandise stores at one and five miles from their homes and fewer PMV stores miles from their homes.

Few significant relationships were found between the odds of being overweight, obese, and overweight or obese according to the presence of store types one and five miles from home in the bifurcated sample (Table 4.10). There was a significant interaction between presence of a general merchandise store one mile from home and household income among obese women, with higher income obese women less likely compared to higher income normal weight women to have such a store one mile from home (OR: 0.273, CI: 0.077 – 0.972). There was no interaction between the presence of a supermarket one mile from home and household income. At five miles, there continued to be significantly higher odds for overweight women versus normal weight to have a grocery store five miles from home, but only among the lower income women (OR: 2.197; CI: 1.160 – 4.162). There also continued to be lower odds for an obese woman to live within 5 miles of a natural food store compared to a normal weight woman, but this time only among higher income women (OR: 0.393; CI: 0.194 – 0.794). Unlike in the full sample, a significant relationship between weight category and the presence of a general merchandise store and a store selling fresh

Table 4.10: Odds Ratios of Overweight and Obesity by Presence of Specified Store Type within One and Five Miles from Home by Household Income Status *

Store Type	Weight Categories (Reference: Normal Weight)	Lower Income Odds Ratio (95% CI) (N = 249)	Higher Income Odds Ratio (95% CI) (N = 306)
One Mile			
General Merchandise Stores (1+ vs 0)	Overweight	2.145 (0.415 – 11.091)	0.742 (0.289 – 1.904)
	Obese	1.711 (0.247 – 11.853)	**0.273 (0.077 – 0.972)**
	Overweight & Obese	1.926 (0.435 – 8.527)	0.476 (0.207 – 1.091)
Five Mile			
Grocery Stores (1+ vs 0)	Overweight	**2.197 (1.160 – 4.162)**	1.305 (0.730 – 2.333)
	Obese	1.805 (0.910 – 3.580)	0.903 (0.519 – 1.570)
	Overweight & Obese	**1.935 (1.133 – 3.304)**	1.091 (0.687 – 1.733)
Natural Food Stores (1+ vs 0)	Overweight	1.402 (0.669 – 2.939)	0.641 (0.332 – 1.240)
	Obese	1.056 (0.466 – 2.389)	**0.392 (0.194 – 0.794)**
	Overweight & Obese	1.269 (0.670 – 2.404)	**0.503 (0.292 – 0.868)**
General Merch. Store (1+ vs 0)	Overweight	1.572 (0.683 – 3.618)	0.694 (0.346 – 1.394)
	Obese	1.481 (0.606 – 3.622)	**0.429 (0.200 – 0.899)**
	Overweight & Obese	1.514 (0.741 – 3.096)	**0.547 (0.307 – 0.973)**
Produce High Variety Stores (1+ vs 0)	Overweight	1.829 (0.954 – 3.504)	0.834 (0.457 – 1.523)
	Obese	0.977 (0.477 – 2.003)	**0.539 (0.291 – 0.999)**
	Overweight & Obese	1.424 (0.817 – 2.483)	0.664 (0.406 – 1.087)

* Tests of significance adjusted for age and parity.

Table 4.11: Odds Ratios for Overweight and Obesity by Average Healthy Food Availability Index Score for Woman's Food Environment at <u>One and Five Miles</u> from Home among Household Income Groups *

	Weight Category (Reference Normal Weight)	**Lower Income Odds Ratio (95% CI)**	**Higher Income Odds Ratio (95% CI)**
One Mile	Overweight	1.128 (0.969 – 1.312)	1.021 (0.926 – 1.126)
	Obese	1.048 (0.900 – 1.220)	1.059 (0.940 – 1.194)
	Overweight & Obese	1.082 (0.959 – 1.221)	1.038 (0.950 – 1.134)
Five Mile	Overweight	**1.208 (1.064 – 1.373)**	1.084 (0.983 – 1.194)
	Obese	0.960 (0.865 – 1.066)	1.074 (0.987 – 1.168)
	Overweight & Obese	1.064 (0.976 – 1.159)	**1.073 (1.000 – 1.152)**

* Tests of significance adjusted for age and parity.

produce was found when examining these food environment variables as an interaction with household income. There were significantly decreased odds for an obese higher income woman to live within five miles of a general merchandise store (OR: 0.429; CI: 0.200 – 0.899) or a store selling fresh produce (OR: 0.539; CI: 0.291 – 0.999).

The results for the bifurcated samples regarding the relationship to HFAI scores are similar to those for the full sample (Table 4.11). The only significant relationships are in the five mile food environment. Lower income overweight women are more likely than normal weight lower income women to have a higher average HFAI score at five miles, however, higher income overweight/obese women are more likely than normal weight higher income women to have higher scores at five miles. Thus, the findings of a relationship in the full sample between HFAI and overweight are likely driven by both income subsets.

Discussion

While the patterns in the data are not completely consistent, they do suggest that women who have more stores of any type closer to their home are at increased risk for being overweight and/or obese. Of particular interest, women who have more supermarkets within one mile of their home were more likely to be obese, and women who had or a grocery store with five miles of their home were more likely to be overweight. Overweight women and overweight and obese women were also significantly more likely to have higher average healthy food availability index scores for a given food environment compared to normal weight women. The opposite relationship was found with natural food stores. Obese women were less likely to

have a natural food store one and five miles from her home compared to normal weight women. There also appears to be a moderate relationship with income. Higher-income obese women tend to have decreased odds of a general merchandise store one and five miles from home and decreased odds of having a natural food store, and a store selling fresh produce five miles from home. On the other hand, lower-income overweight women were more likely to have a grocery store within 5 miles of home.

This is not the first study to find higher BMI's in proximity to supermarkets and grocery stores. Another study conducted in four mid-size California cities also found that higher BMIs were associated with greater presence of grocery stores or supermarkets in a subject's neighborhood (Wang et al 2007). It may be that supermarkets and grocery stores, while carrying a large amount of healthy food, also carry a large amount of less healthy food, and the greater availability of these foods contributes to diet and weight.

There are also important distinctions between urban studies and the predominantly rural area in the present study. Data from studies in urban areas have found that poor and often minority areas tend to lack supermarkets, and that these same areas correspond to high rates of overweight and obesity (Morland et al 2007, Hosler et al 2006, Zenk et al 2005a, Baker et al 2006, Zenk et al 2005b, Moore et al 2006, Morland et al 2002, Jetter et al 2006, Powell et al 2007b, Morton et al 2007, Kaufman 1998, Liese et al 2007). Lower population density in rural areas ensures that many individuals will have to travel further to food retail outlets, as well as other important locations like work, schools, parks, and fitness centers. These greater travel distances increase dependence on reliable transportation, and given that public transportation in rural areas is often lacking, car ownership becomes paramount (and the costs associated with maintaining a car can be an impediment for lower income

families). Additionally, urban areas may experience more distinct spatial segregation between higher and lower income residents than in rural areas. While there may be pockets of poorer residents in rural areas, the generally smaller rural towns and decreased zoning regulations, may create a more homogenous distribution of individuals by income. The association in past urban studies between the food environment, eating behaviors, and weight has also raised considerable attention to the inadequate distribution of food resources in predominantly racial minority neighborhoods. These studies strongly suggest the social forces of racism, "red-lining," and other discriminatory practices underpin the structural inequities in these communities leading to health disparities. In the present study, however, the majority of the population was white, decreasing the likelihood of disparities in the retail food environment by race. The uniqueness of the present study setting, therefore, allowed for the analysis of the affect of the food environment on weight without the presence of the confounding factors of spatial segregation by race.

Sharkey (2009) recently outlined the numerous contextual factors of special consideration in rural food environments. Among the considerations are that the rural food environment may contain a wider variety of food stores than more urban areas, specifically rural areas may have a higher prevalence of non-traditional food stores that sell food (e.g. drug stores dollar stores etc.). Descriptive analysis of the food environment presented in Chapters Two and Three confirms this observation in this study area. For this reason, the present paper included in the analysis drug stores, dollar stores, general merchandise stores, discount food stores, and natural food stores. Additionally, Sharkey describes consolidation in the rural food retail sector that has led to fewer food stores overall and the creation of large supercenters in "regional hub towns." The result being that existing smaller food stores face higher costs due to the challenge of smaller economies of scale, have less ability to carry a large variety of

items (including fresh foods), and charge higher prices. Rural residents must also travel longer distances to reach the larger supercenters and supermarkets, a particular challenge for low-income, disabled, and elderly households (Blanchard and Lyson 2005). In some cases convenience stores may be the only food stores available in town. Data from this study confirm, that of all the store types studied, convenience stores were the closest on average to the rural women residents (average 2.0 miles), and only 9.6% of women had a supermarket within a mile of their home (a distance considered walkable).

No studies of the urban or rural food environment have examined the relationship between BMI and the presence of natural food stores. The relationship found in this study of decreased odds of being overweight with the presence of one or more natural food stores one and five miles from home may be due to the presence of these natural food stores typically in "college towns" where the demographics of the community may tend toward higher educational and income levels. These populations may have an overall lower prevalence of being overweight or obese. Additional analysis of the food environment controlling for these important community contextual affects through census block group variables will be an important next step in this analysis.

The interaction between the food environment and income allows for a limited exploration of food-access problems that may be precipitated by transportation challenges. Blanchard and Lyson (2005) suggest that the consolidation of the rural food environment may have resulted in lower income families, who may face the most acute transportation troubles, being "distanced out" of the retail food environment. That is rural residents in general, and lower income residents in particular, may have to travel greater distances to reach food. This study found that generally speaking lower income women faced food environments not all that different from higher

income women. For instance, average distance to the nearest supermarket did not differ among income groups. There is some indication, however, that higher income women may not have to travel as far to reach a grocery store. Additionally, given lower income women's presumed lower purchasing power, it was interesting that this group on average is likely to have to travel less distance than higher income women to reach a discount grocery store or a dollar store. This may speak to these stores locating in neighborhoods more likely to reach low income households. The observation that there were not many significant differences in the measure of the average number stores of a given store type within one and five miles from a woman's home among the two income groups also speaks to the relative consistency of the food environments faced by lower and higher income groups.

Another study of a rural food environment in Texas failed to support the "distanced out' hypothesis. In that study neighborhoods with increased deprivation tended to be closer to supermarkets and other stores with access to fresh fruits and vegetables, and that more deprived neighborhoods actually had more of these store types close to their home at one, three, and five miles (Sharkey 2008). The inconsistent results between the finding in Texas and the findings in this study could be attributed to many factors, including that in this analysis income was considered at the individual level as opposed to at the census block group level in the Texas study. Analysis of the food environment in this rural Upstate NY area as it varies with changes in the economic and social characteristics at the census block group level will be an important next step.

At five miles, lower-income overweight women were actually more likely to have a grocery store near their home than normal weight lower income women (even though higher income women, regardless of weight, were more likely to have more grocery stores near their home). The increased concentration of lower income

overweight women five miles from a grocery store may suggest that these low-income overweight women are living in the same neighborhoods as higher income women of all weights. Communities falling about five miles from a grocery store may be located solidly in rural areas, in places not equipped for long distance walking along county roads. The decreased odds of being obese observed in the whole sample with increased presence of natural food stores, appears to be driven largely by the higher income women. This supports the above hypothesis that the relationship between lower weight and closeness to natural food stores is actually indicative of a larger demographic tendency for higher income, better educated women to live in "college towns," which also tended to be where the natural food stores are located.

Strengths

This paper had several strengths. All the stores used in the analysis were visited by the researcher to verify their existence and location (i.e., ground-truthing). Non-traditional, as well as, traditional food stores were included in the analysis, as is deemed increasingly important in studies of the rural food environment, and as was verified in Chapters Two and Three (Sharkey 2009, Sharkey 2008, Liese et al 2007). During the store visits an extensive survey of the types and variety of food sold within each was conducted to better classify the stores by food availability. Store types were then considered both by their commercial classification (e.g. drug store), as well as, by the types of foods that they sold (through cluster analysis). The study also made use of the home locations of women within the area to create a unique food environment for each woman. This allowed an understanding of the distinctive food choices available to each woman, as opposed to aggregating her choices based on her zip code, census block group, or county. Of course, this also assumes that women tend to live in

the same location for a long enough period of time for the food environment to influence their weight.

Weaknesses

Weaknesses of this study include that more information was not know about the shopping and eating behaviors, as well as, the psychosocial characteristics of the study subjects. These are likely important mediators and moderators of the relationship between food environment and health and weight. The next paper attempts to understand these relationships in a sub-sample of the women examined in this study. In addition to knowing more about individual women, it would also lend more explanatory power to examine the relationship between neighborhood level characteristics, the food environment, and the weight of study subjects. A follow-up study is underway to examine the relationship between neighborhood level characteristics (like median income, percent of households in poverty, population density, and percent of farming households) at the census block group level and characteristics of the food environment. This study is also cross-sectional in nature so very little can be said about the direction of the relationship between the food environment and weight. Finally, results of the study area under investigation may be unique to Upstate NY.

Conclusions

The rural food environment presents unique challenges over the urban food environment for managing food access and ultimately for planning and implementing interventions to improve the health and well-being of residents. Decreased population density and industry trends toward larger regional supermarkets and supercenters (and the decline of smaller more local grocery stores) mean many households will be

increasingly distant from "traditional" food stores. The increasing presence and growing food offerings of "non-traditional" food stores like drug and dollar stores may fill in some of these gaps in food access, but as of now these "non-traditional' stores do not even begin to equal the availability and access to fresh foods found in supermarkets and many grocery stores. It appears that while there are some differences in food access by weight category and household in this area of Upstate NY, notably that obese women are more likely to live within a mile of a supermarket, the bigger message is that most women regardless of the demographic variables available in this study, face a relatively low-density food environment compared to residents of urban areas. Additionally, while issues of food access in urban and some southern rural areas may be closely tied to race and income segregation, access in rural areas similar to Upstate New York may be more closely tied to declining population and economic opportunities. Future research examining food access by "neighborhood" level characteristics at the census block level may lend further understanding to the determinants of food access, as will an analysis of how the creation of alternative food systems may support the nutritional needs of rural residents while building economic opportunities.

APPENDIX 4.A

Distribution by Quartiles of the Number of Stores of a Given Type One, Five, Ten, and Twenty Miles from the Women's Homes

Store Type	**1 mile**	**5 mile**	**10 mile**	**20 mile**
Any Food Store				
Q1	0	0 - 2	1 -11	18 – 51
Q2	0	3 - 5	11 – 17	52 – 61
Q3	1 - 4	6 - 12	17 – 29	62 – 80
Q4	4 – 28	13 -129	30 – 153	81 – 267
Mean	2.47	9.6	20.97	81.06
Supermarkets				
Q1	0	0	0	0 – 2
Q2	0	0	0 – 1	2 – 4
Q3	0	0-1	1 – 2	4 – 5
Q4	0 – 2	2 – 9	2 – 10	5 – 17
Mean	0.12	0.73	1.30	4.57
Grocery Store				
Q1	0	0	0 – 1	0 – 5
Q2	0	0 – 1	1	5 – 6
Q3	0	1	1 – 2	6 – 8
Q4	1- 2	1 – 8	2 – 11	8 – 21
Mean	0.20	0.68	1.68	7.10
Supermarket or Grocery Store				
Q1	0	0	0 – 2	2 – 7
Q2	0	0 – 1	2	7 – 10
Q3	0	1 – 2	2 – 4	10 – 12
Q4	1 -3	2 – 17	4 – 19	12 – 37
Mean	0.32	1.41	2.98	11.68
Convenience Store				
Q1	0	0 – 1	0 – 7	9 – 31
Q2	0	2 – 3	7 - 10	31 – 36
Q3	1 -2	3 – 6	10 – 15	36 – 45
Q4	3 – 17	7 – 59	15 – 75	45 – 127
Mean	1.31	4.83	11.47	44.85
Drug Store				
Q1	0	0	0 – 1	0 – 3
Q2	0	0	1	3 – 5
Q3	0 – 1	0 – 1	1 – 3	5 – 10
Q4	1 – 5	2 – 20	3 – 23	10 – 38
Mean	0.37	1.15	2.30	8.53
Dollar Store				
Q1	0	0	0	0 – 2
Q2	0	0	0 – 1	2
Q3	0	0 – 1	1 – 2	3 – 6
Q4	1 -3	2 – 11	2 -11	6 – 23
Mean	0.15	0.74	1.34	4.87

APPENDIX 4.A CONTINUED

Store Type	**1 mile**	**5 mile**	**10 mile**	**20 mile**
Discount Grocer				
Q1	0	0	0	0
Q2	0	0	0	0 – 1
Q3	0	0	0 – 1	1 – 2
Q4	0 -1	0 -1	1 – 2	2 – 5
Mean	0.02	0.28	0.44	1.29
Natural Food Store				
Q1	0	0	0	0 – 1
Q2	0	0	0	1 – 2
Q3	0	0	0 - 1	2 – 3
Q4	0 – 2	1 -2	1 – 2	3 – 4
Mean	0.11	0.32	0.60	1.83
General Merchandise				
Q1	0	0	0	0 – 1
Q2	0	0	0	1
Q3	0	0	0 – 1	1 – 3
Q4	0 – 1	1 – 3	1 – 4	3 – 8
Mean	0.06	0.20	0.44	1.94
NPMV				
Q1	0	0	0	0 – 1
Q2	0	0	0 – 1	1 – 2
Q3	0	0 - 1	1	2 – 4
Q4	0 – 4	1 - 19	1 – 21	4 – 30
Mean	0.12	0.52	1.04	5.15
NPLV				
Q1	0	0 – 1	0 – 5	7- 25
Q2	0	2	5 – 10	26 – 33
Q3	0- 2	2 – 7	10 – 17	33 – 42
Q4	2 – 13	8 – 61	17 – 72	43 – 130
Mean	1.35	5.06	11.35	41.98
PHV				
Q1	0	0	0	0 – 2
Q2	0	0	0 – 1	2 – 3
Q3	0	1	1 – 2	3 – 4
Q4	0 – 2	2 – 8	2 – 9	4 – 15
Mean	0.10	0.65	1.12	3.83
PMV				
Q1	0	0	0	0 – 2
Q2	0	0	0 – 1	2 – 3
Q3	0	0 -1	1	3 – 4
Q4	0 – 2	1 – 2	1 – 4	4 – 8
Mean	0.13	0.30	0.72	2.91

APPENDIX 4.A CONTINUED

Store Type	**1 mile**	**5 mile**	**10 mile**	**20 mile**
PLV				
Q1	0	0	0 – 4	6 – 18
Q2	0	1 – 2	4 – 5	18 – 22
Q3	0 – 1	2 – 3	5 – 8	22 – 26
Q4	1 – 10	4 – 40	8 – 51	27 – 88
Mean	0.78	3.08	6.73	27.18
Stores with Any Produce				
Q1	0	0 – 1	0 – 5	9 – 23
Q2	0	1 – 3	5 – 6	24 – 27
Q3	0 – 2	3 – 5	6 – 11	27 – 33
Q4	2 – 11	6 – 49	11 – 61	33 – 107
Mean	1.00	4.04	8.57	33.92

APPENDIX 4.B

Average Number of Stores Within One, Five, Ten, and Twenty Miles from a Woman's Home

Store Type	All	Underweight	Normal Weight	Overweight	Obese
Any Store					
1 Mile	2.47	1.41	2.19	2.50	2.16
5 Miles	9.6	5.79	8.31	11.22	9.21
10 Miles	20.97	14.43	19.19	22.75	19.41
20 Miles	81.06	67.60	**73.89**[1*]	**88.27**[*]	79.34
Supermarkets					
1 Mile	0.12	0.17	**0.09**[*]	0.11	**0.19**[*]
5 Miles	0.73	0.47	0.68	0.87	0.66
10 Miles	1.30	1.12	1.24	1.38	1.15
20 Miles	4.57	3.70	**4.22**[*]	**4.95**[*]	4.46
Grocery Stores					
1 Mile					
5 Miles	0.20	0.19	0.16	**0.23**[*]	**0.13**[*]
10 Miles	0.68	**0.25**[†]	**0.51**[*]	**0.83**[† *]	0.67
20 Miles	1.68	1.27	1.47	1.75	1.72
	7.10	7.33	**6.62**[*]	**7.51**[*]	7.14
Supermarkets and Grocery Stores					
1 Mile	0.32	0.36	0.26	0.34	0.32
5 Miles	1.41	0.72	**1.19**[*]	**1.70**[*]	1.33
10 Miles	2.98	2.39	2.71	3.14	2.87
20 Miles	11.68	11.03	**10.85**[*]	**12.47**[*]	11.60
Convenience Stores					
1 Mile	1.31	0.74	1.20	1.26	1.17
5 Miles	4.83	3.67	4.23	5.35	4.72
10 Miles	11.47	8.87	10.65	12.27	10.70
20 Miles	44.85	37.72	**41.35**[†]	**48.18**[†]	43.92
Drug Stores					
1 Mile	0.37	0.13	0.28	0.34	0.36
5 Miles	1.15	0.52	**0.91**[*]	**1.44**[*]	1.13
10 Miles	2.30	1.01	1.98	2.57	2.15
20 Miles	8.53	5.99	**7.29**[*]	**9.63**[*]	8.28
Dollar Stores					
1 Mile	0.15	0.13	0.11	0.19	0.17
5 Miles	0.74	0.23	**0.59**[*]	**0.95**[*]	0.71
10 Miles	1.34	0.71	1.17	1.46	1.20
20 Miles	4.87	3.84	**4.07**[†]	**5.42**[†]	4.89

APPENDIX 4.B CONTINUED

Store Type	All	Underweight	Normal Weight	Overweight	Obese
Discount Stores					
1 Mile	0.02	0.00	0.01	0.02	0.00
5 Miles	0.28	0.15	0.25	**0.37**[*]	**0.21**[*]
10 Miles	0.44	0.19	0.42	0.51	0.34
20 Miles	1.29	0.96	**1.22**[*]	**1.47**[*]	1.25
Natural Food Stores					
1 Mile	0.11	0.07	**0.13**[*]	**0.13**[*]	**0.03**[*, *]
5 Miles	0.32	0.30	**0.38**[*]	0.35	**0.25**[*]
10 Miles	0.60	0.53	**0.64**[*]	0.66	**0.48**[*]
20 Miles	1.83	1.85	1.89	1.89	1.84
General Merchandise Stores					
1 Mile	0.06	0.01	0.08	0.08	0.03
5 Miles	0.20	0.02	0.22	0.24	0.17
10 Miles	0.44	0.24	0.42	0.49	0.35
20 Miles	1.94	1.34	1.79	2.09	1.86
NPMV					
1 Mile	0.12	0.00	**0.07**[†]	0.12	**0.20**[†]
5 Miles	0.52	0.09	**0.31**[*]	**0.72**[*]	0.63
10 Miles	1.04	0.38	**0.80***	**1.30***	1.09
20 Miles	5.15	2.94	**4.21**[*]	**6.19**[*]	4.88
NPLV					
1 Mile	1.35	0.69	1.24	1.31	1.09
5 Miles	5.06	3.54	4.45	5.74	4.76
10 Miles	11.35	8.22	10.55	12.14	10.27
20 Miles	41.98	33.59	**38.49**[*]	**45.43**[*]	41.01
PHV					
1 Mile	0.10	0.19	0.08	0.11	0.14
5 Miles	0.65	0.31	0.60	0.80	0.57
10 Miles	1.12	0.65	1.07	1.25	0.98
20 Miles	3.83	3.03	**3.54**[*]	**4.18**[*]	3.75
PMV					
1 Mile	0.13	0.12	0.12	0.12	0.08
5 Miles	0.30	0.31	0.28	0.31	0.28
10 Miles	0.72	0.69	0.67	0.62	0.65
20 Miles	2.91	2.82	2.79	2.89	2.91
PLV					
1 Mile	0.78	0.43	0.69	0.84	0.64
5 Miles	3.08	1.54	**2.66**[*]	**3.66**[*]	2.97
10 Miles	6.73	4.49	**6.10**[*]	**7.44**[*]	6.42
20 Miles	27.18	25.22	**24.87**[*]	**29.58**[*]	26.78

APPENDIX 4.B CONTINUED

Store Type	**All**	**Underweight**	**Normal Weight**	**Overweight**	**Obese**
Stores with Produce					
1 Mile	1.00	0.73	0.88	1.07	0.87
5 Miles	4.04	2.15	**3.54**[*]	**4.76**[*]	3.82
10 Miles	8.57	5.83	7.84	9.31	8.05
20 Miles	33.92	31.07	**31.19**[*]	**36.66**[*]	33.44

Tests of significance difference adjusted for age, parity, and PCAP status
*: $p < 0.05$
†: $p < 0.01$

APPENDIX 4.C

Odds of Overweight and Obesity by Presence of Specified Store Type within Ten Miles from Home *

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Number of Stores (continuous)	Overweight	1.009	0.998 – 1.020
	Obese	1.001	0.990 – 1.012
	Overweight & Obese	1.005	0.996 – 1.014
Supermarkets (1+ vs 0)	Overweight	0.805	0.520 – 1.247
	Obese	0.678	0.437 – 1.050
	Overweight & Obese	0.737	0.514 – 1.056
Supermarket (continuous)	Overweight	1.067	0.930 – 1.223
	Obese	0.962	0.830 – 1.115
	Overweight & Obese	1.013	0.905 – 1.133
Grocery Stores (1+ vs 0)	Overweight	0.767	0.397 – 1.481
	Obese	0.822	0.415 – 1.629
	Overweight & Obese	0.800	0.459 – 1.397
Grocery Store (continuous)	Overweight	1.074	0.890 – 1.294
	Obese	0.868	0.712 – 1.056
	Overweight & Obese	0.966	0.829 – 1.127
Supermarkets and Grocery (continuous)	Overweight	1.108	0.956 – 1.284
	Obese	1.011	0.869 – 1.177
	Overweight & Obese	1.056	0.936 – 1.192
Convenience Stores (continuous)	Overweight	1.019	0.996 – 1.042
	Obese	1.001	0.978 – 1.025
	Overweight & Obese	1.010	0.991 – 1.029
Drug Stores (1+ vs 0)	Overweight	1.081	0.982 – 1.190
	Obese	1.010	0.913 – 1.118
	Overweight & Obese	1.045	0.965 – 1.132
Drug Stores (continuous)	Overweight	1.054	0.990 – 1.123
	Obese	1.019	0.954 – 1.087
	Overweight & Obese	1.036	0.982 – 1.093
Dollar Stores (1+ vs 0)	Overweight	0.824	0.539 – 1.261
	Obese	**0.596**	**0.388 – 0.915**
	Overweight & Obese	**0.695**	**0.490 – 0.986**
Dollar Stores (continuous)	Overweight	1.077	0.971 – 1.196
	Obese	1.010	0.904 – 1.128
	Overweight & Obese	0.811	0.519 – 1.268
Discount Stores (1+ vs 0)	Overweight	1.364	0.870 – 2.139
	Obese	0.869	0.537 – 1.407
	Overweight & Obese	1.097	0.750 – 1.604

APPENDIX 4.C CONTINUED

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Natural Food Stores (1+ vs 0)	Overweight	0.877	0.574 – 1.338
	Obese	**0.608**	**0.393 – 0.942**
	Overweight & Obese	0.728	0.513 – 1.034
General Merchandise Stores (1+ vs 0)	Overweight	1.127	0.736 – 1.726
	Obese	0.676	0.430 – 1.062
	Overweight & Obese	0.894	0.627 – 1.277
NPMV (1+ vs 0)	Overweight	**1.602**	**1.047 – 2.451**
	Obese	1.040	0.682 – 1.588
	Overweight & Obese	1.304	0.922 – 1.843
NPMV (continuous)	Overweight	1.075	0.990 – 1.168
	Obese	1.044	0.962 – 1.134
	Overweight & Obese	1.063	0.987 – 1.145
NPLV (continuous)	Overweight	1.018	0.986 – 1.052
	Obese	0.982	0.949 – 1.016
	Overweight & Obese	1.000	0.974 – 1.027
PHV (1+ vs 0)	Overweight	0.861	0.563 – 1.314
	Obese	0.658	0.431 – 1.007
	Overweight & Obese	0.748	0.528 – 1.058
PHV (continuous)	Overweight	1.077	0.893 – 1.299
	Obese	0.886	0.726 – 1.082
	Overweight & Obese	0.978	0.838 – 1.143
PMV (1+ vs 0)	Overweight	0.793	0.519 – 1.209
	Obese	0.825	0.538 – 1.267
	Overweight & Obese	0.816	0.576 – 1.157
PMV (continuous)	Overweight	0.885	0.659 – 1.187
	Obese	0.951	0.713 – 1.270
	Overweight & Obese	0.924	0.731 – 1.167
PLV (continuous)	Overweight	**1.032**	**1.000 – 1.066**
	Obese	1.008	0.975 – 1.043
	Overweight & Obese	1.021	0.993 – 1.050
Fresh Produce (continuous)	Overweight	1.045	0.992 – 1.101
	Obese	0.986	0.934 – 1.041
	Overweight & Obese	1.016	0.973 – 1.060

* Tests of significance difference adjusted for age, parity, and PCAP status

APPENDIX 4.D

Odds of Overweight and Obesity by Presence of Specified Store Type within <u>Twenty Miles</u> from Home *

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Number of Stores (continuous)	Overweight	**1.005**	**1.001 – 1.008**
	Obese	1.002	0.998 – 1.008
	Overweight & Obese	**1.003**	**1.000 – 1.007**
Supermarket (continuous)	Overweight	**1.063**	**1.002 – 1.128**
	Obese	1.021	0.956 – 1.090
	Overweight & Obese	1.043	0.991 – 1.098
Grocery Store (continuous)	Overweight	**1.054**	**1.002 – 1.107**
	Obese	1.032	0.978 – 1.088
	Overweight & Obese	**1.044**	**1.000 – 1.089**
Supermarkets and Grocery (continuous)	Overweight	**1.032**	**1.003 – 1.061**
	Obese	1.015	0.984 – 1.047
	Overweight & Obese	1.024	0.999 – 1.050
Number of Convenience Stores (continuous)	Overweight	**1.010**	**1.002 – 1.018**
	Obese	1.004	0.995 – 1.013
	Overweight & Obese	**1.007**	**1.001 – 1.014**
Drug Stores (continuous)	Overweight	**1.025**	**1.004 – 1.047**
	Obese	1.012	0.988 – 1.036
	Overweight & Obese	**1.020**	**1.001 – 1.039**
Dollar Stores (continuous)	Overweight	**1.052**	**1.011 – 1.096**
	Obese	1.037	0.992 – 1.085
	Overweight & Obese	**1.047**	**1.010 – 1.085**
Discount Stores (continuous)	Overweight	**1.202**	**1.005 – 1.437**
	Obese	1.019	0.844 – 1.231
	Overweight & Obese	1.109	0.956 – 1.287
Natural Food Stores (continuous)	Overweight	1.018	0.816 – 1.271
	Obese	0.950	0.759 – 1.189
	Overweight & Obese	0.981	0.816 – 1.180
General Merchandise Stores (continuous)	Overweight	1.107	0.979 – 1.252
	Obese	1.022	0.893 – 1.169
	Overweight & Obese	1.069	0.963 – 1.186
NPMV (continuous)	Overweight	**1.032**	**1.005 – 1.059**
	Obese	1.012	0.983 – 1.041
	Overweight & Obese	**1.023**	**1.000 – 1.047**
NPLV (continuous)	Overweight	**1.009**	**1.002 – 1.017**
	Obese	1.004	0.995 – 1.012
	Overweight & Obese	**1.007**	**1.000 – 1.013**

APPENDIX 4.D CONTINUED

Store Type	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
PHV (continuous)	Overweight	**1.071**	**1.001 – 1.146**
	Obese	1.025	0.952 – 1.103
	Overweight & Obese	1.049	0.990 – 1.112
PMV (continuous)	Overweight	1.056	0.909 – 1.228
	Obese	1.067	0.915 – 1.245
	Overweight & Obese	1.063	0.938 – 1.204
PLV (continuous)	Overweight	**1.016**	**1.004 – 1.028**
	Obese	1.007	0.994 – 1.021
	Overweight & Obese	**1.012**	**1.002 – 1.023**
Fresh Produce (continuous)	Overweight	**1.013**	**1.003 – 1.023**
	Obese	1.006	0.995 – 1.017
	Overweight & Obese	**1.010**	**1.001 – 1.019**

* Tests of significance difference adjusted for age, parity, and PCAP status

APPENDIX 4.E

Average Healthy Food Availability Index (HFAI) for All Stores Within One, Five, Ten, and Twenty Miles of a Woman's Home by Weight Category †

	All	**Underweight**	**Normal Weight**	**Overweight**	**Obese**
One Mile	14.26	16.24	13.81	14.59	14.53
Five Mile	14.11	13.35	13.74*	14.90*	14.07
Ten Mile	14.12	13.98	14.18	14.13	14.03
Twenty Mile	13.96	14.07	13.98	13.89	14.00

† Tests of significance difference adjusted for age, parity, and PCAP status
* Significantly different from each other at $p < 0.05$

APPENDIX 4.F

Odds Ratios for Overweight and Obesity by Average Healthy Food Availability Index (HFAI) Score at Ten and Twenty Miles from a Woman's Home *

	Weight Category (Reference Normal Weight)	**Odds Ratio (95% CI)**
Average HFAI Score at Ten Mile	Overweight	0.981 (0.842 – 1.144)
	Obese	0.935 (0.813 – 1.076)
	Overweight & Obese	0.953 (0.848 – 1.071)
Average HFAI Score at Twenty Mile	Overweight	0.907 (0.716 – 0.149)
	Obese	1.067 (0.836 – 1.360)
	Overweight & Obese	0.971 (0.799 – 1.180)

* Tests of significance difference adjusted for age, parity, and PCAP status

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CHAPTER FIVE

THE RELATIONSHIP AMONG FOOD ENVIRONMENT, FOOD ACQUISITION, DIET AND WEIGHT VARIABLES IN A RURAL SAMPLE OF WOMEN

Introduction

With the alarming growth in the number of overweight and obese people in the United States, researchers and policy makers have increasingly gathered evidence that the changing food and physical activity environments in which we live may be at the root of this epidemic (Larson et al 2009, Booth et al 2001, Popkin et al 2005, Lake and Townshend 2006, Hill et al 2003). This obesogenic environment is hypothesized to include a large number of stores selling high-energy, low-nutrient dense foods, and a dearth of stores selling more nutritious foods like fresh fruits and vegetables, particularly in rural areas and inner city neighborhoods (Powell et al 2007b, Larson et al 2009, United States Department of Agriculture 2009). This environment may inhibit people's ability to make healthful food choices, particularly among those with limited time or financial resources (Glanz et al 2005, Furst et al 1996, Stang and Kossover 2005).

A handful of studies have found a relationship between increased incidence of overweight and obesity among both adults and children and neighborhoods with decreased access to healthier food stores. (Morland et al 2006, Powell et al 2007a, Inagami et al 2006, Sturm and Datar 2005). However, to truly understand the influence of the food environment on health, it is necessary to understand how this environment influences shopping behavior and diet. For instance, some evidence suggests that people who have supermarkets or large grocery stores near their home

(or who have increased access to healthy foods regardless of store type), consume more fruits and vegetables and other healthy foods like low-fat milk (Morland et al 2002b, Rose 2004, Zenk et al 2009a, Moore et al 2008, Bodor et al 2007, Fisher et al 1999, Cheadle et al 1991, Laraia 2004). Even less research is available examining how shopping behavior modifies the influence of the food environment on diet. For instance, a national study of food stamp households found that those residents who reported easy access to a supermarket (a compound variable that included car access and perceived distance to a supermarket), consumed more fruit (Rose and Richards 2004). Another study of African American women in an urban area found that women who reported shopping more often at supermarkets and specialty stores, or who reported more positive perceptions of the produce sold in their chosen store (independent of store type), were more likely to consume more fruits and vegetables (Zenk et al 2005). An additional study in a rural area by Casey et al (2008) found no differences in weight status among rural residents in the Midwest who reported shopping often at supercenters, supermarkets, convenience stores, small grocery stores, bakeries, or fruits and vegetable stores. However, they did find that people with at least a high school education were more likely to shop at a supermarket compared to people with less than a high school education, and that people with less education were more likely to shop at convenience stores.

Studies that have investigated shopping behaviors among low-income individuals reveal that residents have a wide variety of coping mechanisms and strategies by which they overcome challenges in their food environment and maximize their use of limited food dollars (Kempson et al 2003, Stang and Kossover 2005, Smith et al 2009, Clifton 2004). Strategies include creating informal transportation networks to access distant supermarkets, shopping at discount stores, hunting, fishing, gardening, buying in bulk, buying more processed foods and/or lower quality foods,

and making use of emergency food resources like food pantries (Kempson et al 2003, Stang and Kossover 2005, Smith and Morton 2009, Clifton 2004).

It is also possible that people living in nearly identical food environments may be influenced by those environments differently depending on individual level characteristics like income, age, education, and feelings of self-efficacy to achieve a healthful diet. Social Cognitive Theory suggests, for instance, that a people with greater feelings of self-efficacy to successfully engage in a behavior (like to lose or maintain weight) may be able to overcome challenges in their food environment to a greater degree than individuals with less-self-efficacy (Bandura 1977). It may also be that the social environment in which residents live may influence their ability to overcome challenges in the built environment. A qualitative study with residents of "food desserts" in the rural midwest revealed that poorer residents living in communities with greater civic engagement were better able to overcome food access issues because these communities came together to establish greater problem solving networks and fostered more positive social norms towards the poor (Smith and Morton 2009).

Much work is yet to be done in not only characterizing local food environments, but also in understanding how individuals function in these environments. Multifactorial influences from the individual level to the community and national levels play a role in mediating the influence of the built environment on weight and health. This study attempts to understand how the food environment affects low-income women's food shopping behaviors, diet, and weight, and how these relationships are modified by individual-level characteristics such as age, parity, and self-efficacy.

Methods

Women

All women considered for inclusion had registered for obstetric care at Bassett Healthcare, a hospital and set of primary-care clinics serving a 10-county area in Upstate NY. Chart audits were conducted on pregnant women in the first trimester of pregnancy enrolled or screened for enrollment in a parallel study of weight gain during pregnancy to collect data on BMI, age, parity, and enrollment in the Prenatal Care Assistance Program (PCAP). PCAP is a state-supported insurance program for low-income women and has been found to be a good proxy for low-income status in other populations of women from this area (Olson et al 2003a, Olson et al 2003b, Olson et al 2004). Early pregnancy BMIs ($\leq$ 14 weeks gestation) or imputed weights (women whose initial weights were measured in the second trimester were adjusted to the 9 -11 week interval, see Olson and Stawderman 2003a for a description of methods) were categorized into weight categories based on the 1995 World Health Organization classification standards. Data collection for the women was approved by the University Committee on Human Subjects at Cornell University and the Institutional Review Board at Bassett Healthcare Research Institute.

In the parallel study, diet and behavior variables were not assessed in higher income normal weight women. As a result household income was strongly correlated with early pregnancy BMI, and significant differences between weight categories and diet and shopping behaviors could not be attributed to actual differences between weight categories or the effects of the absence of higher income normal weight women. As a result the analysis was limited to lower income women based on their enrollment in PCAP. See Table 5.1 for a description of the women's demographic characteristics.

Table 5.1: Number and Characteristics of Women in Behavioral Subsets

	All	**Normal Weight**	**Overweight**	**Obese**
BMI	NA	18.5 – 24.99	25.00 – 29.99	≥ 30
Subset with diet and self-efficacy variables	131	65	34	32
≤ 30 years	110	57	27	26
Nulliparous	55	31	15	9
< High school education	30	14	8	8
Subset with shopping behavior variables	87	51	17	19
≤ 30 years	71	43	13	15
Nulliparous	38	22	9	7
< High school education	17	10	4	3

Measuring Food Acquisition and Diet

Data on diet, self-efficacy and education level was collected from 219 surveys completed by women enrolled in the parallel study. Among these women 131 were eligible for inclusion in the present study because of their enrollment in PCAP and because they had met the criteria for participation in the earlier study of food environment and weight (Chapter Four). Diet was assessed from three multiple choice questions asking participants what kind of milk they drank (if they drank milk), how many servings of fruits and vegetables they consumed in a day, and how many servings of whole grain foods they consumed in a day. These questions were adapted from similar evaluation questions asked in the National 5-A-Day Campaign. A Diet Index Score was created by averaging responses from these three questions together. Low and high Diet Index Score groups were created based on the women's average response to the three diet questions, with one the low group corresponding to average scores below and equal to the median and the high group corresponding to scores above the median**.** Results of using the continuous Diet Index Score and the binary categorical variable based on the median(with all values corresponding to the median

falling in were compared, with results substantially the same, thus results from using the categorical variable are presented here for ease of interpretation. Self-efficacy was assessed from three questions asking women how confidant they felt, along a Likert scale, in their ability to eat healthfully post-partum. These self-efficacy questions had been previously validated in another study of gestational weight and post-partum weight retention (Kendall et al 2001). Responses were averaged together and a categorical variable created such that women scoring above and below the median were classified as having high and low self-efficacy. As with the Diet Index Scores, results from using the continuous self-efficacy scores and the binary categorical variables were compared with results substantially the same. Thus results from models using the categorical variable are presented here for ease of interpretation.

Data on food acquisition behaviors were collected from a mail survey at 6 months post partum. Of the 219 women enrolled in the parallel survey 172 women returned the survey, and 81 were eligible for the present study based on PCAP status and participation in the previous study on the food environment and weight. Shopping behavior was ascertained from four multiple choice questions asking respondents how often they do their major grocery shopping, where they do their major shopping, how often they do their smaller food shopping trips, and where they do their smaller shopping trips. Additional yes/no questions asked women if they vegetable gardened, if someone in the household hunted or fished, or used a food pantry in the past year.

Food Store Survey

Food stores were surveyed in a rural area of Upstate NY comprising about 8700 square miles and enclosing all or portions of 19 counties and a small piece of northern Pennsylvania. In all 870 stores were surveyed with store names and locations provided by the New York State Department of Agriculture and Markets, which

maintains a database of food stores for state licensure. Surveyed stores included supermarkets and grocery stores, as well as non-traditional places to buy food like convenience stores, drug stores, dollar stores, and general merchandise stores. A full description of the process of surveying and classifying the food stores is provided in Chapter Two.

Foods inside the stores were surveyed using the Nutrition Environment Measurement Survey (NEMS-S) (Glanz et al 2007) with modifications made for local brands and foods of interest to families of childbearing women. The survey assessed the availability and variety of common foods in 14 food categories. See Chapters Two and Three for a fuller description of the food store survey. Data on the availability and variety of these foods were then entered into cluster analysis as an alternative way of analyzing the type of food store, based on the availability and variety of foods, rather than the more traditional system of food store classification (e.g. supermarkets, drug stores etc.) Five different clusters were created, with a forced separation of the food stores into those with and without produce. Two clusters corresponded to stores with no produce – one cluster contained stores with a medium variety of other foods (NPMV) and the other cluster contained store with low variety of other foods (NPLV). The other three clusters corresponded to stores with produce: a cluster with high variety of other foods (PHV), a cluster with medium variety of other foods (PMV), and a cluster with low variety of other foods (PLV). See Chapter Three for a more complete description of the cluster formation and their characteristics.

Measuring the Food Environment

Food store locations and women's homes were geocoded using ArcGIS software (version 9.1, copyright 2001-2004, ESRI, Redlands, CA). The base map used for geocoding containing streets and street numbers was available through the

New York State GIS Clearinghouse and produced by the New York State New York State Office of Cyber Security & Critical Infrastructure Coordination. See Chapter Two for a more complete description of the mapping process. Service areas were created around each woman's home along the street network corresponding to overlapping "discs" of one, five, ten, and twenty miles. In addition a calculation of the distance to the nearest store by type from each woman's home was made using the closest facility analysis layer. This calculation was also made along the street network.

Analysis

The conceptual model guiding this analysis is seen in Figure 5.1. BMI was hypothesized to be influenced by the most proximal variables of age, parity, physical activity and diet. In turn, diet behaviors were hypothesized to be influenced by shopping behaviors, and ultimately shopping behaviors were influenced by the food environment. Self-efficacy was hypothesized to moderate the relationship between the food environment and shopping behaviors and shopping behaviors and diet. Age was also hypothesized to moderate the relationship between diet and weight.

All statistical analysis was conducted with Statistical Analysis Software (version 9.1, 2002-2004, SAS Institute, Inc., Cary, NC). Chi square analyses were used to examine the association between food environment variables and shopping behaviors, as well as, self-efficacy category and diet and food acquisition variables. T-tests of significance were used to analyze the average distance between the nearest store of a specific type and shopping behavior category, as well as, the average number of stores of a given type within a given distance of a woman's home and her score on the individual diet variables.

Logistic regression was used to model the odds of shopping in a supermarket and the frequency of shopping behavior, as well as, modeling the relationship between shopping behaviors and a woman's score on the Diet Index Score. Odds of scoring high on the Diet Index Score were also modeled against the presence and/or number of store types in the food environment at one, five, ten, and twenty miles. Logistic regression models were used to model the odds of being overweight, obese, or overweight and obese combined given the stores in her food environment, her diet, and shopping behavior. Logistic regression analyses were adjusted for age and parity where indicated in individual models. P-Values ≤ 0.05 were considered significant.

Conceptual Model

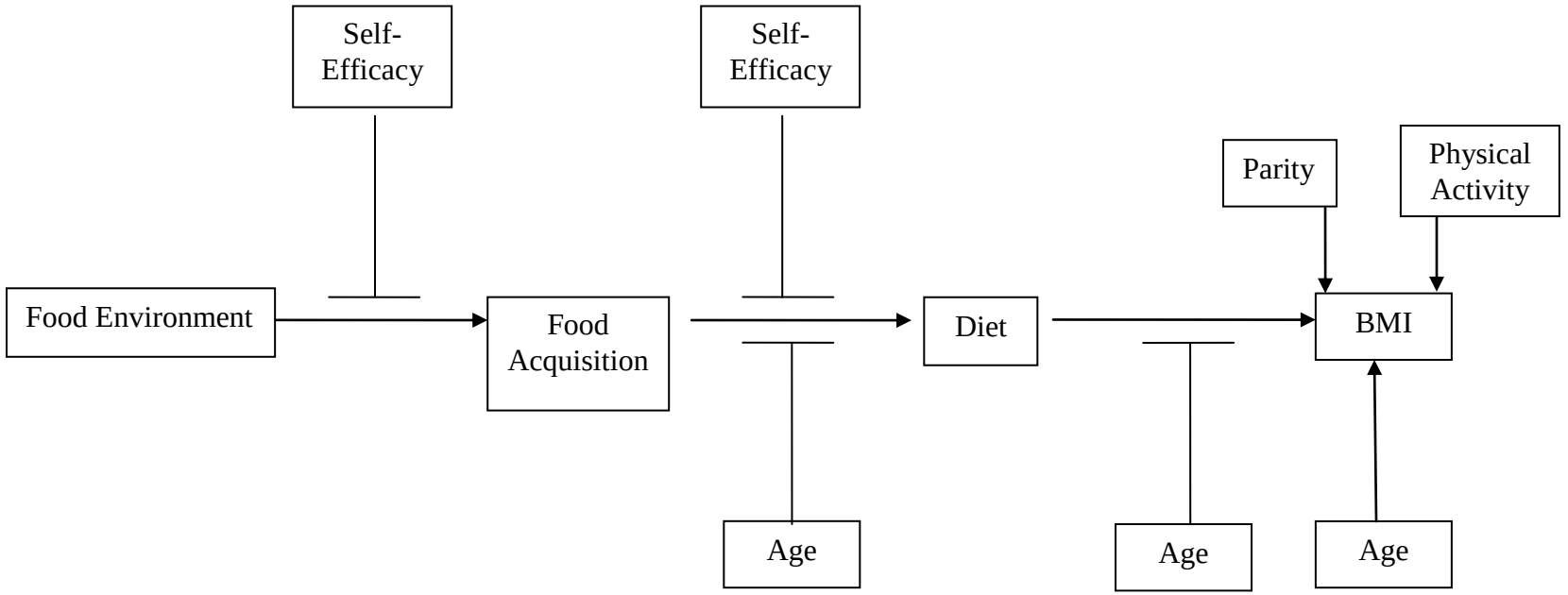
It was hypothesized that the food environment would influence BMI through its action on shopping behavior and diet variables (Figure 5.1). Level of self-efficacy to access and consume fruits and vegetables was thought to moderate the relationship between the food environment and shopping behavior and the relationship between shopping behavior and diet. In addition several demographic and physical activity variables were hypothesized to influence BMI directly.

Results

Food Environment and Shopping Behavior

There was quite a bit of variation in how often women reported someone in the household doing the major food shopping. Nearly half the sample reported doing their major food shopping at least every two weeks, however, about a third also reported doing their food shopping only once a month or less (Table 5.2). No one reported shopping in a convenience store for a major shopping trip. Most of the sample

Figure 5.1: Model of the Hypothesized Relationships between the Food Environment, Food Acquisition, Diet, and BMI


Self-Efficacy
Self-Efficacy
Parity
Physical Activity
Food Environment
Food Acquisition
Diet
BMI
Age
Age
Age

reported making their smaller grocery trips at least once a week. There was no evidence that women who tended to make larger shopping trips less frequently made smaller trips more frequently or that women who make more frequent large shopping trips, made fewer smaller shopping trips. Among those women who made a large shopping trip every two weeks or more often, 40.5% made smaller shopping trips daily or every few days, whereas among those who made big shopping trips less frequently (every 3 weeks or less often) a similar proportion (35.6%) made frequent smaller shopping trips. Most of the major food shopping occurred in a supermarket, although a small minority reported shopping in a smaller local grocery store or discount grocer. By contrast, nearly half the sample reported making smaller shopping trips to smaller grocery stores, convenience stores, and other types of stores.

Table 5.2: Food Shopping Characteristics of the Sample (N = 87)

Variable	Levels	% of Respondents
Frequency of big shopping trips	Once a week or more	20.7
	Every 2 weeks	27.6
	Every 3 weeks	16.1
	Once a month	27.6
	Less than once a month	8.1
Type of store for big shopping trips	Supermarket	88.2
	Small local market or grocery	5.9
	Convenience store	0
	Other	5.9
Frequency of smaller grocery shopping trips	Daily	2.3
	Every few days	34.9
	Once a week	38.4
	Every 2 weeks	14.0
	Every 3-4 days	10.5
Type of store for smaller grocery shopping trips	Supermarket	38.8
	Small local market or grocery	40.0
	Convenience Store	15.3
	Other	5.9

Figure 5.2 models the relationship examined in Tables 5.3 and 5.4. Counter to what might be expected, there was a decreased odds of making more frequent major shopping trips with the presence of a supermarket or grocery store within five miles of a woman's home (Table 5.3). This finding was supported by a marginally significant decreased odds ratio for doing frequent major food shopping and the presence of only a supermarket five miles from home (OR: 0.469; CI: 0.185 – 1.185) and a significantly reduced odds ratio of doing more frequent major shopping with the presence of a supermarket or grocery store five miles from a woman's home (OR: 0.375; CI 0.157 - 0.895**)**. It was not found that doing major shopping trips in a supermarket was related to having a supermarket one, five, or ten miles from a woman's home, but this may have been because the overwhelming majority of the sample (88.2 %) reported doing major shopping in a supermarket regardless of proximity.

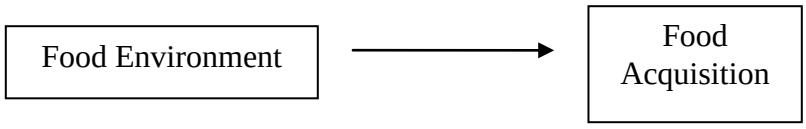


Figure 5.2: Model of the Hypothesized Relationship between Food Environment and Food Acquisition

It was found that the odds of making more frequent smaller shopping trips increased with the presence of a supermarket within five miles of a woman's home (OR: 4.153; CI: 1.605 – 10.751) and the total number of stores within five miles of a woman's home(OR: 1.054; CI: 1.004 – 1.106). Similarly, the odds of doing these smaller shopping trips in a supermarket increased with the presence of a supermarket five (OR: 3.520; CI: 1.376 – 9.004) and ten miles (OR: 2.889; CI: 1.137 – 7.342) from a woman's home and the number of stores at one (OR: 1.163; CI: 1.001 – 1.351), five

Table 5.3: Odds of Exhibiting Shopping Behaviors based on Number of Stores One, Five, and Ten Miles from a Woman's Home (N = 87)

Shopping Behavior	Food Environment Characteristic	OR	95% CI	P-Value
Odds of doing major shopping trips every two weeks or less (versus every 3 weeks or more)	Supermarket within one mile (1+ vs 0)	0.615	0.138 - 2.752	0.53
	Supermarkets within five miles (1+ vs 0)	0.469	0.185 - 1.185	0.11
	Supermarkets within ten miles (1+ vs 0)	0.550	0.231 -1.308	0.18
	Supermarket and grocery store within one mile (1+ vs 0)	1.094	0.403 - 2.970	0.86
	Supermarkets and grocery stores within five miles (1+ vs 0)	**0.375**	**0.157 - 0.895**	**0.03**
	Number of supermarkets and grocery stores within ten miles	0.936	0.703 - 1.246	0.65
	Number of stores within one mile	0.989	0.864 - 1.132	0.88
	Number of stores within five miles	0.964	0.918 - 1.012	0.14
	Number of stores within ten miles	0.985	0.948 - 1.023	0.43
Odds of doing major shopping trips in a supermarket (vs. in a smaller store)	Supermarket within one mile (1+ vs 0)	NA	NA	NA
	Supermarket within five miles (1+ vs 0)	5.062	0.608 - 42.13	0.13
	Supermarkets within ten miles (1+ vs 0)	1.586	0.422 - 5.961	0.49
	Number of stores within one mile	1.154	0.841 - 1.583	0.37
	Number of stores within five miles	1.063	0.959 - 1.179	0.25
	Number of stores within ten miles	1.044	0.972 - 1.121	0.23

Table 5.3 (Continued)

Shopping Behavior	Food Environment Characteristic	OR	95% CI	P-Value
Odds of doing smaller shopping trips every few days or less (vs doing them once a week to every 3-4 weeks)	Supermarkets within one mile (1+ vs 0)	1.014	0.225 - 4.558	0.99
	Supermarkets within five miles (1+ vs 0)	**4.153**	**1.605 - 10.75**	**0.003**
	Supermarkets within ten miles (1+ vs 0)	0.504	0.202 -1.259	0.14
	Supermarkets and grocery store within one mile (1+ vs 0)	1.530	0.554 - 4.225	0.41
	Supermarkets and grocery stores within five miles (1+ vs 0)	1.750	0.720 - 4.251	0.22
	Number of supermarkets and grocery stores within ten miles	1.126	0.839 - 1.510	0.43
	Number of stores within one mile	1.083	0.944 - 1.242	0.26
	Number of stores within five miles	**1.054**	**1.004 - 1.106**	**0. 04**
	Number of stores within ten miles	1.033	0.993 - 1.074	0.10
Odds of doing smaller shopping trips in a supermarket (vs. doing them in a smaller store)	Supermarket within one mile (1+ vs 0)	NA	NA	NA
	Supermarkets within five miles (1+ vs 0)	**3.520**	**1.376 - 9.004**	**0.009**
	Supermarkets within ten miles (1+ vs 0)	**2.889**	**1.137 - 7.342**	**0.03**
	Number of stores within one mile	**1.163**	**1.001 - 1.351**	**0.05**
	Number of stores within five miles	**1.063**	**1.011 - 1.117**	**0.02**
	Number of stores within ten miles	**1.042**	**1.002 - 1.083**	**0.04**

Table 5.4: Shopping Behavior by Average Proximity of Specified Store Types (N = 87)

Food Environment Characteristics	**Shopping Variables**		**P-Value**
	Do major shopping trips every two weeks or less	*Do major shopping trips every 3 weeks or more*	
Nearest supermarket (miles)	9.1	7.3	0.13
Nearest supermarket or grocery store (miles)	4.8	4.2	0.37
Nearest Any Store (miles)	2.0	2.1	0.77
	Do major shopping in a supermarket	*Do major shopping in a smaller store*	
Nearest supermarket (miles)	7.7	10.8	0.10
Nearest Any Store (miles)	1.9	2.9	0.28
	Do smaller shopping every few days or less	*Do smaller shopping once a week to every 3 -4 weeks*	
Nearest supermarket (miles)	**6.6**	**9.1**	**0.05**
Nearest supermarket or grocery store (miles)	3.7	4.9	0.10
Nearest Any Store (miles)	1.9	2.2	0.49
	Do smaller shopping in a supermarket	*Do smaller shopping in a smaller store*	
Nearest supermarket (miles)	**5.9**	**9.6**	**0.003**
Nearest Any Store (miles)	1.6	2.3	0.07

(OR: 1.063, CI: 1.011 – 1.117) , and ten miles (OR: 1.042; CI: 1.002 – 1.083) from a woman's home. This outcome was supported when looking at the relationship of shopping behavior for smaller trips and its relationship to the nearest supermarket. Women who made more frequent smaller shopping trips had the nearest supermarket on average only 6.6.miles from home, whereas women who made less frequent smaller shopping trips had a nearest supermarket on average 9.1 miles from home (Table 5.4). It was hypothesized that perhaps women with a supermarket or grocery store five miles from home made many more small trips (and fewer major trips) because of the relative proximity of these food stores. However, no interaction was found between major shopping trip frequency and smaller shopping trip frequency and the presence of a supermarket five miles from home.

Table 5.5: Diet Index Characteristics of Sample (N = 131)

Variable	Levels	% of Respondents
Type of milk drunk	None	8.4
	Whole	43.5
	2%	28.2
	1% or skim	19.1
Number of fruits and vegetables eaten in a day	<1 serving	21.4
	1 -2 servings	55.0
	3-4 servings	21.4
	5+ servings	2.3
Number of whole grains eaten in a day	None	4.6
	<1 serving	29.8
	1 -2 servings	44.3
	3+ servings	21.4

Food Acquisition and Diet Characteristics

Whole milk was the most common type of milk drunk, followed by 2% and then skim (Table 5.5). Very few people (2.3%) reported eating the minimum recommended 5+ servings of fruits and vegetables a day, and about a fifth reported

consuming less than one serving a day. The majority of the sample reported consuming at least one serving of a whole grain food a day. All three diet variables were correlated with each other, such that people who drank whole milk were more likely to also consume less fruits and vegetables and fewer whole grains. Age was found to be a significant predictor of diet. The average age for those who consumed lower fat milk versus whole fat milk was significantly older (26.0 years versus 23.4 years, $p \leq 0.006$), as was the average age of those who consumed more fruits and vegetables (3+ servings/day) versus fewer fruits and vegetables (< 3 servings/day) (27.3 years versus 24.3 years, $p \leq 0.01$).

Figure 5.3 illustrates the hypothesized relationship between food acquisition behaviors and diet as modified by age. No significant relationships were found between odds of drinking lower fat milk and shopping or other food acquisition behaviors (Table 5.6).

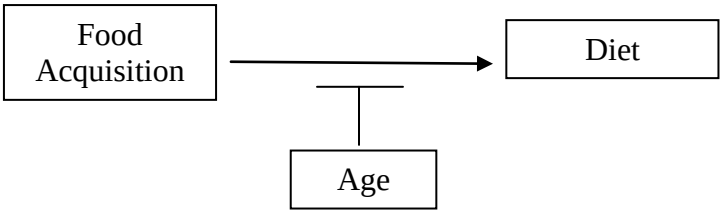


Figure 5.3: Model of the Hypothesized Relationship between Food Acquisition and Diet Characteristics and Age

Table 5.6: Odds of Drinking Lower Fat (2% or less) Milk Based on Food Acquisition Behaviors (N = 87)

Variable	Odds Ratio (Reference: Drinking whole fat milk)	95% CI	P Value
Major shopping frequency (≤2 wks vs. ≥3 wks)	0.921	0.377 - 2.250	0.86
Major shopping place (supermarket vs. smaller store)	1.121	0.260 - 4.844	0.88
Smaller shopping frequency (every few days or less vs. once a week to every 3-4 weeks)	1.747	0.680 - 4.487	0.25
Smaller shopping place (supermarket vs. smaller store)	1.934	0.755 - 4.954	0.17
Do vegetable gardening (Garden vs. Not Garden)	1.389	0.545 - 3.537	0.49
Hunt or Fish (Hunt and fish vs. not hunt and fish)	0.629	0.245 - 1.613	0.33
Food pantry use in past year (Not been to a pantry vs. been to a pantry)	2.263	0.778 - 6.579	0.13

A borderline significant (OR: 0.316; CI: 0.082 – 1.216, P < 0.09) relationship was found between doing major shopping in a supermarket and decreased odds of eating 3+ servings of fruits and vegetables a day, however, the small number of people who reported doing their major shopping anywhere other than a supermarket, makes this estimate unstable (Table 5.7). Among women who reported vegetable gardening, there were significantly increased odds (OR: 6.857; CI: 2.432 – 9.335) that they would consume at least 3 servings of fruits and vegetables a day (Table 5.7). Hunting and fishing appeared to have the opposite effect, with those who lived in households engaged in these activities, significantly less likely to consume more fruits and vegetables (OR: 0.259; CI: 0.079 – 0.848) (Table 5.7). Both the significant relationship with vegetable gardening and with hunting/fishing remained after adjusting for age, however, no significant interaction was found between age and

gardening or age and hunting/fishing on fruit and vegetable consumption (data not shown).

Table 5.7: Odds of Eating 3+ Servings of Fruits and Vegetables Based on Food Acquisition Behaviors (N = 87)

Variable	Odds Ratio (Reference: Eating <3 servings a day)	95% CI	P -Value
Major shopping frequency (≤2 wks vs. ≥3 wks)	1.100	0.429 - 2.818	0.84
Major shopping place (supermarket vs. smaller store)	0.316	0.082 - 1.216	0.09
Smaller shopping frequency (every few days or less vs. once a week to every 3-4 weeks)	0.792	0.294 - 2.132	0.64
Smaller shopping place (supermarket vs. smaller store)	1.667	0.632 - 4.395	0.30
Do vegetable gardening (Garden vs. Not Garden)	**6.857**	**2.432 - 9.335**	**0.003**
Hunt or Fish (Hunt and fish vs. not hunt and fish)	**0.259**	**0.079 - 0.848**	**0.03**
Used a food pantry in past year (Not been to a pantry vs. been to a pantry)	1.322	0.424 - 4.123	0.63

A counterintuitive relationship was found between the odds of consuming one or more servings of whole grains every day and the frequency of major shopping. Women were less likely to consume more servings of whole grains if they shopped more often (OR: 0.381; CI: 0.150 – 0.967) (Table 5.8). This relationship was still significant after adjusting for age, but no interaction between age and large shopping trip frequency on whole grain consumption was found.

Table 5.8: Odds of Consuming < 1 Serving a Day of Whole Grains Based on Food Acquisition Behaviors (N = 87)

Variable	Odds Ratio (Reference: Eating <3 servings a day)	95% CI	P -Value
Major shopping frequency (≤2 wks vs. ≥3 wks)	**0.381**	**0.150 - 0.967**	**0.04**
Major shopping place (supermarket vs. smaller store)	0.471	0.093 - 2.383	0.36
Smaller shopping frequency (every few days or less vs. ≥ once a week)	1.278	0.491 - 3.324	0.62
Smaller shopping place (supermarket vs. smaller store)	0.889	0.350 - 2.260	0.80
Do vegetable gardening (Garden vs. Not Garden)	1.105	0.423 - 2.891	0.84
Hunt or Fish (Hunt and fish vs. not hunt and fish)	0.594	0.233 - 1.513	0.27
Used a food pantry in past year (Not been to a pantry vs. been to a pantry)	0.838	0.285 - 2.468	0.75

The combination of these eating behaviors into a Diet Index Score (as a categorical variable with two levels: high and low) enabled a further look at how diet may be influenced by shopping behaviors (Table 5.9). Overall, food shopping was not found to be related to score on the Diet Index. There was a near significant relationship with women who scored high on the Diet Index somewhat more likely to garden (OR: 2.307, CI: 0.917 – 5.808, P <0.07). When examining the Diet Index Score as a continuous variable, however, the relationship reached significance (p< 0.03) with gardeners more scoring 0.26 points higher (highest score on the Diet Index

Table 5.9: Odds of Scoring Highly on Diet Index Score Based on Food Acquisition Behaviors (N = 87)

Variable	Odds Ratio (Reference: Scoring Low on Diet Index Score)	95% CI	P-Value
Major shopping trip frequency (≤2 wks vs. ≥3 wks)	0.800	0.344 – 1.860	0.60
Major shopping trip place (supermarket vs. smaller store)	1.083	0.289 – 4.055	0.91
Smaller shopping trip frequency (every few days or less vs. once a week to every 3-4 weeks)	0.977	0.407 – 2.347	0.96
Smaller shopping trip place (supermarket vs. smaller store)	2.042	0.835 –4.995	0.12
Do vegetable gardening (Garden vs. Not Garden)	2.307	0.917 – 5.808	0.07
Hunt or Fish (Hunt and fish vs. not hunt and fish)	0.602	0.247 - 1.464	0.26
Used a food pantry in past year (Not been to a pantry vs. been to a pantry)	1.762	0.652 – 4.761	0.26

was four). Older women were more likely to score higher on the Diet Index (when used as both as a categorical and continuous variable), which is not surprising since as stated above they were more likely to eat more fruits and vegetables and drink lower fat milk than the younger women. However, no interaction was found between age and vegetable gardening or other food acquisition variables on the Diet Index Score.

Food Environment and Diet

While some relationships between food environment and shopping behaviors were found, analysis was also conducted to determine the effect of the food environment directly on diet (skipping the influence of food acquisition behaviors) as

modeled in Figure 5.4. No relationships were found between the odds of reporting drinking lower fat milk and the number of stores, the number of stores selling skim or 1% milk, and the number of supermarkets and grocery stores one, five, and ten miles from a woman's home (Table 5.10).

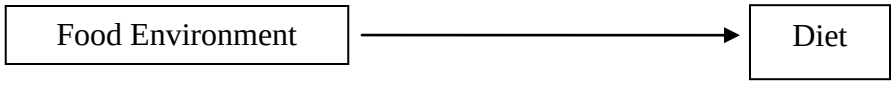


Figure 5.4: Model of the Hypothesized Relationship between the Food Environment and Diet

Table 5.10: Odds of Drinking Skim or 1% Milk Based on Food Environment (N = 131) *

Variable	Odds Ratio (Reference: Higher fat milk drinkers)	95% CI	P Value
Number of stores within one mile	1.078	0.952 - 1.220	0.24
Number of stores within five miles	1.027	0.982 - 1.074	0.25
Number of stores within ten miles	0.995	0.963 - 1.028	0.77
Availability of a store with skim or 1% milk (1+ vs 0) at one mile	1.016	0.418 – 2.470	0.97
Number of stores selling skim or 1% milk (continuous) at five mile	1.034	0.977 - 1.095	0.25
Number of stores selling skim or 1% milk (continuous) at ten mile	0.999	0.955 - 1.045	0.96
Availability of a supermarket within one mile from home (1+ vs 0)	0.935	0.186 – 4.706	0.93
Availability of a supermarket within five miles from home (1+ vs 0)	1.969	0.803 - 4.827	0.14
Number of supermarkets within ten miles from home	1.035	0.714 - 1.500	0.85
Availability of supermarkets or grocery stores within one mile (1+ vs 0)	1.540	0.586 – 4.04	0.38
Availability of supermarkets or grocery stores within five miles (1+ vs 0)	1.989	0.759 - 5.214	0.16
Number of supermarkets and grocery stores within ten miles	0.959	0.742 - 1.240	0.75

* Among those who drink milk

Table 5.11: Odds of Eating 3+ Servings a Day of Fruits and Vegetables Based on Food Environment (N = 131)

Food Environment Characteristic	**Odds Ratio (Reference: eating <3 servings a day)**	**95% CI**	**P-Value**
Number of stores within one mile	1.284	0.564 - 2.921	0.55
Number of stores within five miles	1.035	0.994 - 1.079	0.10
Number of stores within ten miles	1.016	0.989 - 1.044	0.25
Availability of fruits and vegetables (1+ vs 0) at one mile	1.284	0.564 - 2.921	0.55
Number of stores selling fruits and vegetables (continuous) at five miles	1.091	0.989 - 1.204	0.08
Number of stores selling fruits and vegetables (continuous) at ten miles	1.028	0.959 - 1.101	0.43
Availability of a supermarket within one mile from home (1+ vs 0)	0.867	0.226 - 3.329	0.84
Availability of a supermarket within five miles from home (1+ vs 0)	1.992	0.877 - 4.524	0.10
Number of supermarkets within ten miles from home	**1.452**	**1.032 - 2.044**	**0.03**
Availability of a supermarket or grocery store within one mile from home (1+ vs 0)	1.227	0.500 – 3.102	0.65
Availability of a supermarket or grocery store within five miles from home (1+ vs 0)	1.147	0.503 - 2.615	0.75
Number of supermarket or grocery stores within ten miles from home	1.141	0.919 - 1.418	0.23

Table 5.12: Odds of Consuming 1+ Servings a Day of Whole Grains Based on the Food Environment (N = 131)

Food Environment Characteristics	**Odds Ratio (Reference: eating 2+ servings a day)**	**95% CI**	**P - Value**
Number of stores within one mile	1.002	0.902 - 1.113	0.97
Number of stores within five miles	0.993	0.955 - 1.032	0.70
Number of stores within ten miles	1.003	0.977 - 1.030	0.81
Availability of whole grain bread or brown rice (0 vs 1+) at one mile	0.747	0.361 - 1.547	0.43
Number of stores selling whole grain bread or brown rice at five miles	0.982	0.921 - 1.047	0.58
Number of stores selling whole grain bread or brown rice at ten miles	1.006	0.956 - 1.058	0.83
Availability of a supermarket within one mile from home (1+ vs 0)	0.935	0.294 - 2.977	0.91
Availability of a supermarket within five miles from home (1+ vs 0)	0.763	0.362 - 1.608	0.48
Number of supermarkets within ten miles from home	0.982	0.724 - 1.334	0.91
Availability of a supermarket or grocery store within one mile from home (1+ vs 0)	1.639	0.689 - 3.897	0.26
Availability of a supermarket or grocery store within five miles from home (1+ vs 0)	1.614	0.778 - 3.349	0.20
Number of supermarket or grocery stores within ten miles from home	1.038	0.843 - 1.279	0.73

Table 5.13: Odds of Scoring High on Diet Index Score Based on Number of Stores One, Five, and Ten Miles from a Woman's Home (N = 131)

Food Environment Characteristic	Odds Ratio (Reference: Scoring Low on Diet Index Score)	95% CI
One Mile		
Count (Continuous)	1.026	0.928 - 1.134
Supermarket (1+ vs 0)	2.029	0.641 – 6.420
Grocery Stores (1+ vs 0)	0.680	0.268- 1.721
Supermarket & Grocery Stores (1+ vs 0)	1.247	0.570 - 2.727
Convenience Stores (1+ vs 0)	0.618	0.308 – 1.241
Drug Stores (1+ vs 0)	1.271	0.550 - 2.937
Dollar Stores (1+ vs 0)	1.207	0.435 – 3.349
Discount Grocers (1+ vs 0)	0.516	0.046 – 5.833
Natural Food Stores (1+ vs 0)	1.629	0.438 – 6.066
General Merchandise Stores (1+ vs 0)	2.166	0.383 – 12.260
Five Mile		
Count (Continuous)	1.023	0.986 - 1.063
Supermarket (1+ vs 0)	**2.256**	**1.086 - 4.684**
Grocery Stores (1+ vs 0)	1.159	0.583 - 2.303
Supermarket & Grocery Stores (1+ vs 0)	1.745	0.863 - 3.530
Convenience Stores (Continuous)	1.055	0.964 - 1.153
Drug Stores (1+ vs 0)	1.788	0.891 - 3.590
Dollar Stores (1+ vs 0)	1.404	0.683 - 2.885
Discount Grocers (1+ vs 0)	1.403	0.599 – 3.286
Natural Food Stores (1+ vs 0)	1.629	0.438 – 6.066
General Merchandise Stores (1+ vs 0)	1.643	0.648 – 4.161
Ten Mile		
Count (continuous)	0.999	0.974 – 1.024
Supermarket (1+ vs 0)	**2.336**	**1.131 – 4.828**
Grocery Stores (continuous)	0.756	0.545 – 1.050
Supermarket & Grocery Stores (continuous)	0.959	0.789 - 1.165
Convenience Stores (continuous)	0.999	0.947 - 1.054
Drug Stores (continuous)	0.985	0.860 - 1.129
Dollar Stores (1+ vs 0)	1.336	0.669 – 2.669
Discount Grocers (continuous)	1.039	0.655 – 1.646
Natural Food Stores (1+ vs 0)	1.591	0.782 – 3.235
General Merchandise Stores (1+ vs 0)	0.749	0.356 - 1.573

Women who reported consuming more fruits and vegetables (≥3 servings a day compared to <3 servings a day) were significantly more likely to have a supermarket 10 miles from their home (OR: 1.452; CI: 1.032 – 2.044) (Table 5.11). There was also a near significant relationship between higher consumption of fruits and vegetables and number of stores selling fruits and vegetables within five miles from a woman's home (OR: 1.091; CI: 0.989 – 1.204), as well as just having more stores five miles from home (OR: 1.035; CI: 0.994 – 1.079) and more supermarkets five miles from home (OR: 1.992; CI: 0.877 – 4.524). No significant relationships were found between consumption of whole grains and availability of whole wheat bread and brown rice or other food environment variables (Table 5.12).

Table 5.14: Average Distance to the Nearest of a Specified Store Types from a Woman's Home and Her Score on the Diet Index (N = 131)

Food Environment Characteristic	Scoring poorly on diet score index	Scoring highly on diet score index	P-Value
Supermarket (miles)	**8.7**	**6.9**	**0.05**
Grocery Store (miles)	5.4	5.5	0.84
Supermarket or Grocery Store (miles)	4.4	3.9	0.39
Convenience Store (miles)	2.2	2.4	0.63
Drug Stores (miles)	6.6	5.9	0.40
Dollar Stores (miles)	8.1	8.1	0.95
Discount Grocers (miles)	12.1	11.8	0.80
Natural Food Stores (miles)	11.6	10.4	0.23
General Merchandise Stores (miles)	12.5	11.4	0.32
NPMV (miles)	9.8	9.2	0.64
NPLV (miles)	2.4	2.6	0.64
PHV (miles)	9.3	7.9	0.15
PMV (miles)	9.2	9.1	0.97
PLV (miles)	3.3	3.2	0.92

A few significant relationships were found between the odds of scoring high on the Diet Index and the number of stores of a given type within one, five, and ten miles from a woman's home (Table 5.13). At five and ten miles, women with at least one supermarket near their home had increased odds of scoring well on the Diet Index Score (OR: 2.256; CI: 1.086 - 4.684 and OR: 2.336; CI: 1.131 – 4.828). Relatedly, the only significant relationship found between Diet Index Score and distance to the nearest specified store type was for the nearness of supermarkets (Table 5.14). Women who scored higher had a supermarket on average closer to their home than women who scored lower (6.9 miles versus 8.7 miles, $p \leq 0.05$).

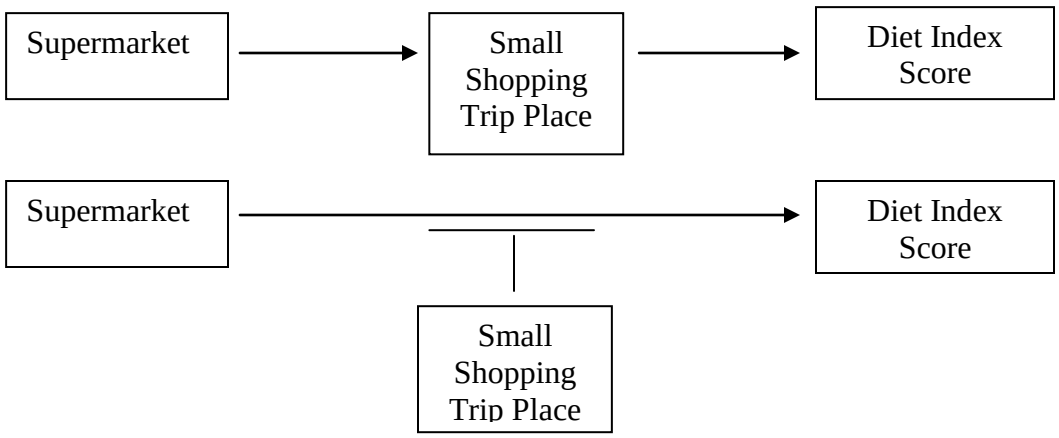


Figure 5.5: Model of the Hypothesized Mediation and Moderation of Small Shopping Trip Place on the Relationship between Supermarket Availability and Diet Index Score

Interactions between Food Environment, Food Acquisition, and Diet Characteristics

Since a significant relationship between supermarket availability at five and ten miles and increased frequency of small shopping trips at a supermarket (Table 5.3) was found, and a marginally significant relationship between making small shopping trips in a supermarket and improved Diet Index Score (Table 5.9), as well as improved Diet Index Score with the availability of at least one supermarket five or ten miles

from a woman's home, multivariate models were run to test the effect of mediation or moderation of small shopping trip place between the relationship of supermarket availability (at five and ten miles) on the Diet Index Score (Figure 5.5). The only significant moderating interaction found that women who had at least one supermarket within 10 miles of their home and who did their smaller shopping trips in a supermarket were more likely to score higher on the Diet Index Score.

Self-Efficacy and Diet and Food Acquisition

It was hypothesized that a woman's level of self-efficacy may affect her ability to make use of the foods in her environment by modifying her shopping or diet behaviors as illustrated in Figure 5.6. Women who reported consuming more fruits and vegetables had significantly higher odds of having higher self-efficacy (Table 5.15), however, self-efficacy was not found to be significantly related to food environment or food acquisition behaviors. A significant interaction was found between self-efficacy and hunting or fishing in predicting diet, such that women who had a hunter and/or fisher in the home and who had high self-efficacy were less likely

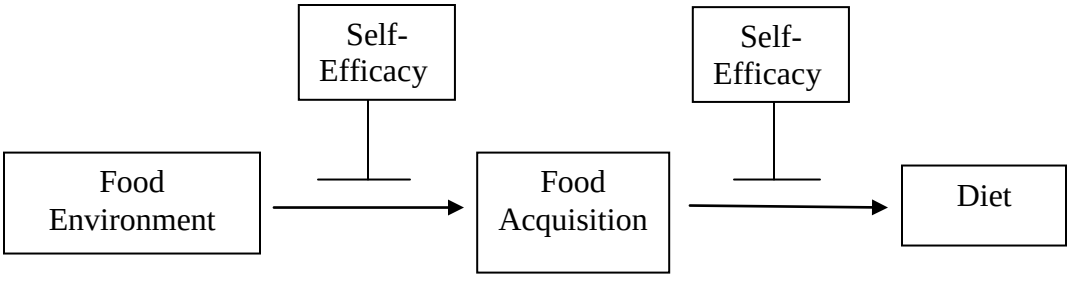


Figure 5.6: Model of the Hypothesized Relationship between Food Environment, Food Acquisition, Diet Characteristics, and Self-Efficacy

to score better on the Diet Index Score ($p < 0.03$ for the interaction). In addition, women who had more supermarkets and grocery stores within one mile of their home and higher self-efficacy were more likely to make frequent large shopping trips ($p < 0.05$ for the interaction).

Table 5.15: Odds of Having High Self-efficacy Based on Diet and Food Acquisition Behaviors* (Diet Variable N = 131; Food Shopping and Acquisition Variables N= 87)

Food Acquisition Behavior	Odds Ratio (Reference: Low self-efficacy)	95% CI
Drink 1% or skim milk vs. Drink whole milk	1.602	0.696 – 3.689
Eat 3+ servings of fruits and vegetables vs. Eat <3 servings of fruits and vegetables	**3.811**	**1.074 - 13.520**
Eat 1+ serving whole grain vs Eat <1 serving whole grains	1.433	0.630 - 3.258
Higher Score on Diet Index Score vs. Lower Score on Diet Index Score	1.111	0.500- 2.468
Major shopping frequency (≤2 wks vs. ≥3 wks)	1.214	0.428 - 3.445
Major shopping place (supermarket vs. smaller store)	NA†	NA
Smaller shopping frequency (every few days or less vs. once a week to every 3-4 weeks)	1.238	0.414 - 3.702
Smaller shopping place (supermarket vs. smaller store)	0.558	0.195 - 1.595
Do vegetable gardening (Garden vs. Not Garden)	1.511	0.482 - 4.740
Hunt or Fish (Hunt and fish vs. not hunt and fish)	0.857	0.294 - 2.499
Used a food pantry in past year (Not been to a pantry vs. been to a pantry)	0.857	0.248 - 2.960

* Chi-square tests of significance

† Not estimable because 0 cell size low self-efficacy and shopping in smaller store

Food Acquisition, Diet, Physical Activity, and Demographic Variables and BMI

Figure 5.7 illustrates the hypothesized influence of food acquisition behaviors, diet, physical activity, and assorted demographic variables on BMI. The Diet variables were not significantly related to the odds of a woman being overweight, obese, or overweight or obese (Table 5.16). The only food acquisition variable found to be significantly related to overweight or overweight/obese was the practice of vegetable gardening. Women who gardened were much more likely to be overweight (Table 5.17). A significant interaction between age (as a continuous variable) and vegetable gardening was found ($p < 0.02$), however, age and vegetable gardening were not significantly related to each other. It appears that younger women who garden are more likely to be overweight compared to young women who do not garden. Among older women there is no significant relationship between gardening and weight status. Parity was also found to significantly predict BMI as a continuous variable such that women with children were more likely to have a higher BMI (Table 5.18). No significant relationships were found between the odds of being overweight or obese and other demographic, self-efficacy, or physical activity variables (Table 5.19).

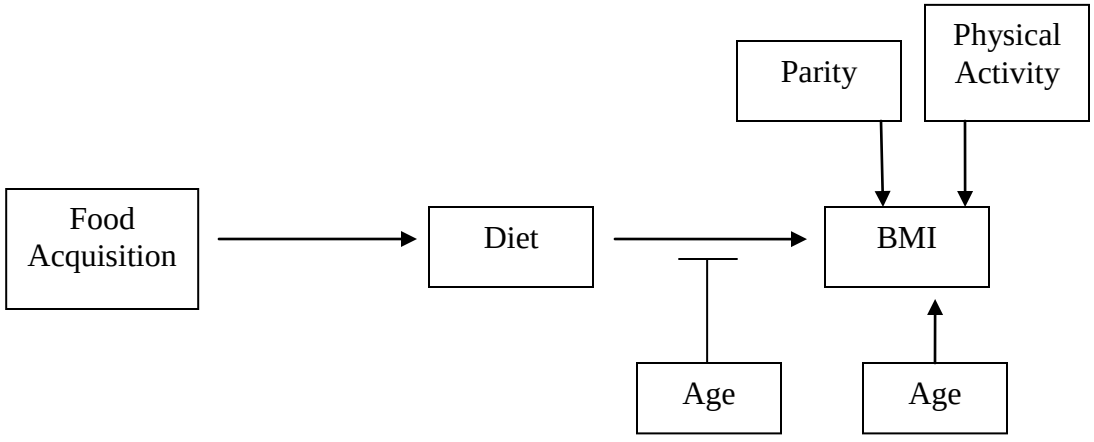


Figure 5.7: Hypothesized Relationships between Food Acquisition, Diet, Physical Activity, Age and Parity on BMI

Table 5.16: Odds of Overweight and Obesity Based on Diet Characteristics

Diet Characteristic	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Drinking skim or 1% milk (vs. drinking higher fat milk)	Overweight	1.675	0.562 - 4.992
	Obese	2.435	0.857 - 6.914
	Overweight &Obese	2.032	0.824 - 5.008
Eating 3+ servings of fruits and vegetables (vs. eating <3)	Overweight	1.840	0.699 - 4.844
	Obese	1.728	0.640 - 4.666
	Overweight &Obese	1.785	0.784 - 4.064
Eating 1+ serving of whole grains (vs. <1 serving)	Overweight	0.782	0.334 - 1.833
	Obese	1.643	0.637 - 4.239
	Overweight &Obese	1.095	0.532 - 2.253
Scoring high on Diet Score Index (vs. scoring low)	Overweight	1.321	0.575 - 3.038
	Obese	1.931	0.818 – 4.561
	Overweight &Obese	1.586	0.796 - 3.161

Table 5.17: Odds of Overweight & Obesity based on Food Acquisition Behaviors

Diet Characteristic	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Major shopping frequency (≤2 wks vs. ≥3 wks)	Overweight	0.865	0.285 - 2.566
	Obese	0.699	0.241 - 2.025
	Overweight &Obese	0.769	0.327 - 1.811
Major shopping place (supermarket vs. smaller store)	Overweight	1.023	0.186 - 5.621
	Obese	1.091	0.199 - 5.969
	Overweight &Obese	1.057	0.275 - 4.060
Smaller shopping frequency (every few days or less vs. ≥ once a week)	Overweight	0.625	0.191 - 2.048
	Obese	0.875	0.294 - 2.604
	Overweight &Obese	0.750	0.307 - 1.835
Smaller shopping place (supermarket vs. smaller store)	Overweight	1.142	0.372 - 3.508
	Obese	1.038	0.343 - 3.139
	Overweight &Obese	1.088	0.449 - 2.636
Do vegetable gardening (Garden vs. Not Garden)	Overweight	**4.066**	**1.282 - 12.89**
	Obese	1.660	0.538 - 5.120
	Overweight &Obese	**2.546**	**1.025 - 6.324**
Hunt or Fish (Hunt and fish vs. not hunt and fish)	Overweight	0.462	0.132 - 1.620
	Obese	0.875	0.294 - 2.604
	Overweight &Obese	0.660	0.266 - 1.635
Not been to a pantry vs. been to a pantry	Overweight	0.458	0.136 - 1.541
	Obese	0.700	0.204 - 2.404
	Overweight &Obese	0.568	0.211 - 1.531

Table 5.18: Relationship between BMI, Age and Parity (N = 131)

Variable	Unit Change in BMI (continuous)	P -Value
Age (continuous)	0.23	0.04
Parity (no live births vs any live births)	-2.36	0.04

Table 5.19: Odds of Overweight and Obesity based Education, Marital Status, Self-efficacy, and Physical Activity Characteristics (N = 131)

	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Education (Less than HS diploma versus HS graduate or more)	Overweight Obese Overweight &Obese	1.121 1.214 1.165	0.417 - 3.013 0.449 - 3.284 0.515 - 2.637
Married (Non-married versus married)	Overweight Obese Overweight &Obese	0.631 0.681 0.654	0.271 - 1.469 0.285 - 1.630 0.323 - .326
Self-efficacy (Most self-efficacy versus least self-efficacy)	Overweight Obese Overweight &Obese	1.440 1.818 1.617	0.543 - 3.816 0.694 - 4.765 0.721 - 3.629
Frequency of regular physical activity (Often/sometimes does regular physical activity versus rarely/hardly ever/never)	Overweight Obese Overweight &Obese	1.205 0.687 0.901	0.437 - 3.321 0.267 - 1.771 0.405 - 2.005
Works Out (Does work out versus does not work out)	Overweight Obese Overweight &Obese	1.562 1.500 1.531	0.509 - 4.796 0.487 - 4.617 0.627 - 3.743
Number of hours of TV (Watches >2 hours of TV versus watches <2 hours of TV)	Overweight Obese Overweight &Obese	1.224 1.102 1.163	0.529 - 2.834 0.470 - 2.583 0.583 - 2.319

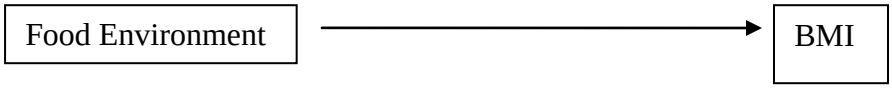


Figure 5.8: Hypothesized Relationship between Food Environment and BMI

The Food Environment and Weight Category

Based on previous studies some significant relationships existed between BMI category and the food environment in the larger sample of women from whom the current sample is drawn (see Chapter Three) as is illustrated in Figure 5.8. In the current smaller sample (n = 131), however, the only significant relationships that still existed between the food environment and BMI category were at five miles (Table 5.20). Women were significantly more likely to be overweight with the presence of discount stores and No-Produce Medium Variety stores (NPMV)(OR: 3.394; CI: 1.255 – 9.180 and OR: 2.631; CI: 1.081 – 6.404). The relationship between these food environment variables and weight category were still significant with the addition of age and parity variables to the model, and were also still significant with the addition of diet variables to the model. The food environment analysis was also run on the smallest subset of women, those for whom shopping behavior information is available (n = 87), and none of the food environment variables were found to be significant (data not shown).

Table 5.20: Odds of Being Overweight or Obese Based on Food Environment at 5 Miles from a Woman's Home (N = 131)

Food Environment Characteristic	Weight Categories (Reference: Normal Weight)	Odds Ratio	95% CI
Discount stores (1+ vs 0)*	Overweight	**3.394**	**1.255 - 9.180**
	Obese	1.256	0.373 - 4.233
	Overweight and Obese	**2.333**	0.960 - 5.671
No-produce medium variety (NPMV) (1+ vs 0)*	Overweight	**2.631**	**1.081 - 6.404**
	Obese	1.515	0.589 - 3.896
	Overweight and Obese	2.032	0.949 - 4.354
Discount stores (1+ vs 0)†	Overweight	**4.320**	**1.476 - 12.650**
	Obese	1.331	0.388 - 4.562
	Overweight and Obese	2.379	0.941 - 6.013
NPMV stores (1+ vs 0)†	Overweight	**3.156**	**1.174 - 8.486**
	Obese	1.101	0.397 - 3.056
	Overweight and Obese	1.863	0.835 - 4.156

* Unadjusted † Adjusted for age, parity, and diet variables

Discussion

This study has attempted to expand understanding of how the food environment may impact shopping behaviors, diet and weight in a low-income sample of women living in a predominantly rural area. A summary of the significant relationships found between these variables are summarized in Figure 5.9. Food acquisition behaviors were related to some elements of the food environment. Women were more likely to do smaller shopping trips more often if there was one supermarket or more or any store within five miles of her home, and these smaller shopping trips were more likely to happen in a supermarket with the presence of a supermarket five and ten miles from her home, or more of any food store one, five, or ten miles from home. The odds of more frequent larger shopping trips actually decreased with the presence of one or more supermarkets or grocery stores five miles from home.

Women who practiced vegetable gardening were more likely to eat more fruits and vegetables and were almost significantly more likely to score high on the Diet Index Score. Contrary to what might be expected, women who vegetable gardened were also more likely to be overweight. This relationship seems to be driven by the observation that younger women who gardened were more likely to be overweight than their non-gardening peers. The opposite relationship was found among women who reported household hunting and fishing, with these women less likely to consume fruits and vegetables. It is difficult to determine why this relationship may have existed. Perhaps these women were more food insecure, choosing to live off of household acquired meat and fish, and so had fewer resources to buy fruits and

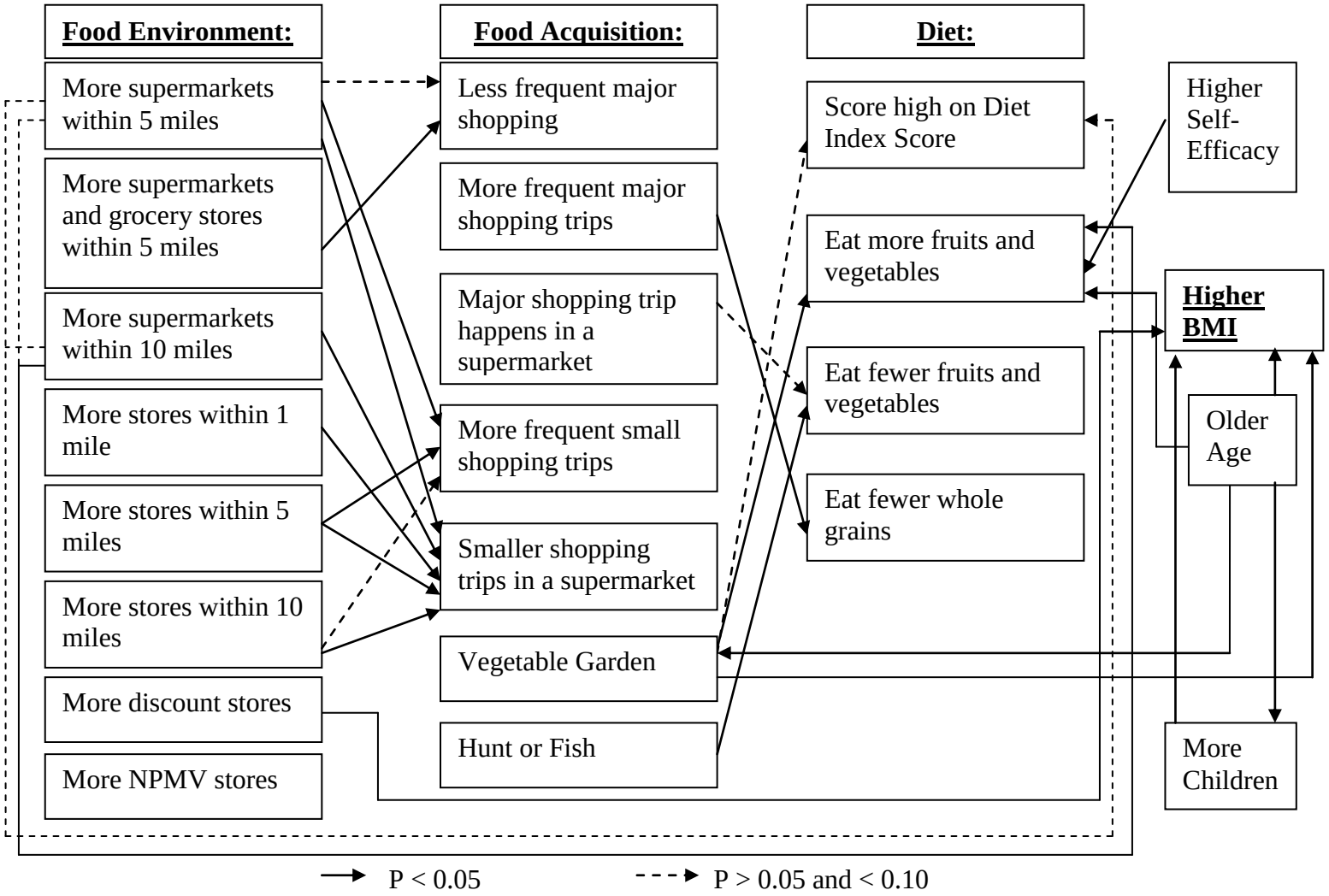


Figure 5.9: Model of the Significant Relationships between the Food Environment, Food Acquisition, Diet, & BMI

vegetables. Of note, women who reported hunting and fishing were not more likely to report gardening. Women who reported household hunting and/or fishing and also scored higher for self-efficacy to eat well, were also less likely to achieve a higher Diet Index Scores. Perhaps households with hunters and/or fishers view eating well differently than those without hunters and/or fishers. Finally, women who did more frequent major shopping were also less likely to report eating more whole grains. This relationship is also difficult to interpret. One possibility is that with more frequent major shopping women were buying fresh baked bread, which more often than not, is white bread.

The food environment was found to impact some diet choices of the low-income women. No food environment variables were found to correlate with type of milk consumed. This may be because most food stores sold milk (both skim and whole milk), so that the availability of food stores may not be requisite to choosing one type of milk over another. The availability of more stores, stores selling produce five miles from home, or the availability of more supermarkets five and ten miles form a woman's home were either marginally or significantly predictive of eating more servings of fruits and vegetables. In addition, the closer the nearest supermarket was to a woman's home, the more likely she was to consume more fruits and vegetables. Putting the diet variables together in a Diet Index Score, also supported that more supermarkets within five and ten miles of a woman's home increased the chance that she would score highly on the Diet Index Score. This relationship is consistent with the association seen between the food environment and consumption of more fruits and vegetables, suggesting that women who have a relatively abundant food environment five or ten miles from their home have better diets. Analysis of the interaction between frequent small shopping, availability of supermarkets five and ten miles from home, and diet suggests that these women may live just close enough to

supermarkets to make regular small trips that keep healthy foods in stock at their home. In addition, while no significant association was found between women who make more frequent small shopping trips and taking these trips most often to a supermarket, the direction of the correlation would suggest these more frequent trips occurred in supermarkets. The less consistent association between diet variables and stores one mile from home may be because only 14 (of 131 women) low-income women had a supermarket this distance from home, and only 60 has any stores a mile from their home, making predictions difficult.

While diet and shopping behavior were somewhat predicted by food environment, diet and shopping behavior were not in turn predictive of weight of these low-income women (with the exception of vegetable gardening). Furthermore, the food environment was largely not predictive of weight in this analysis compared to the analysis in Chapter Three. It may be that the overall smaller sample size in this analysis compared to the analysis in Chapter Three made it more difficult to detect the associations between food environment and weight. The two associations between the food environment and weight that did appear in this analysis, were also significant among lower income women in Chapter Three. Having more discount grocers and more NPMV stores (a group largely composed of larger convenience stores and drug stores) at five miles increased the odds of being overweight. At the same time more NPMV stores increased the odds of scoring highly on the diet index, a finding that is potentially counterintuitive because of the quality of foods typically sold in these stores. If a larger sample size had been available it is possible that more associations would have been found between the food environment and weight, and it may have been more possible to explore how this association was moderated by diet.

The association between eating more fruits and vegetables and higher diet self-efficacy is consistent with what would be expected. The lack of an association

between self-efficacy and shopping behaviors does not necessarily mean that personal beliefs and capacities are not playing a role in how a woman makes these decisions. It may be that the present self-efficacy variables, geared toward diet-related behaviors, are not the appropriate measure of self-efficacy when a woman is shopping and attempting to make healthy food choices. Similarly, the physical activity variables were not found to be associated with weight. This may be because the two questions about exercise, and one question about hours of television viewing, may not be adequate to accurately assess levels of physical activity. It may also be that both larger and smaller women exercise at similar levels, and that other variables are having a greater influence on differentiating their weight status.

Strengths and Weaknesses

This analysis was able to compare multiple potential mechanisms by which the food environment may affect weight, namely shopping behavior and diet. In addition the study made use of a thorough ground-truthed evaluation of the food environment. Unfortunately, the study had to be limited to lower income women, so it is not possible to compare how lower income women interact with their environment versus higher income women. However, in an earlier study (See Chapter Four), several of the significant associations between the food environment and weight were driven by the lower income subset of women.

Also the measures of shopping behavior and diet were somewhat limited. Both sets of these variables were self-reported with the clear possibility of measurement error. Additionally, it would have been helpful to know exactly where a woman shops (not just the store type) to realistically map her interaction with her food environment. Women may choose to shop at stores further from home for a variety of reasons including shopping near work, school, where other errands are run, or perceived

higher quality and/or lower prices. It would be helpful to know in future studies: why one location is chosen over another, what kinds of foods are bought on different trips or in different store types, and how choices are made in a given store among multiple food options. Some initial work examining the perceived food environment versus the objective food environment has shown that resident's perceptions of the same neighborhood can be affected by income and education, and that store density and average store size can interact to create different perceptions of healthy food availability (Zenk et al 2009b, Moore et al 2008). As a result, understanding the perception of food environment, as well as its objective reality, may be necessary to validly evaluate the food environment and how it influences the people who live within it.

In the same way, it would have been helpful to have more information about each woman's diet and how they make these eating decisions. Availability of healthy foods is a necessary, but not sufficient, element in making healthy food choices, and clearly many other factors go into a woman's food choices for herself and her family (Glanz et al 1998, Devine et al 1998, Connors et al 2001).

Conclusions

This analysis showed a relationship between the food environment and shopping behaviors for small shopping trips, such that women were more likely to make more trips and make these trips to a supermarket when a supermarket was within five miles of her home. Likewise women were more likely to score better on the diet score index when a supermarket was within five or ten miles of her home. However, no relationship was found between shopping behaviors and weight category or diet and weight category, possibly because of the relatively small sample size. While much work is yet to be done on understanding the nature of the food environment,

even more work stands to be done on understanding how individuals and families function within these environments. There is a robust literature on food choice, and some of these elements should be incorporated into future studies to better connect the elements of the food environment with diet and health (Devine et al 1999, Furst et al 1996, Glanz et al 1998). Individuals with different backgrounds, resources, values, motivations and expectations may adapt to these environments in different ways. Understanding how these individual level influences interact with the food environment will be necessary as communities work to ensure all individuals have access to the resources, support, and education they need to make healthy food decisions.

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CHAPTER SIX

EVALUATION OF PUBLIC HEALTH PROFESSIONALS' CAPACITY TO IMPLEMENT ENVIRONMENTAL CHANGES SUPPORTIVE OF HEALTHY WEIGHT

Abstract

Community-based interventions to promote healthy weights by making environmental changes in the community are likely an important strategy in reversing the obesity epidemic. For instance, community-based interventions to develop local parks, or local efforts to encourage neighborhood stores to offer healthier snacks are environmental initiatives discussed in the public health literature. However, the challenges faced by local nutrition and public health professionals in making or facilitating effective environmental change need to be better understood and addressed, if these local professionals are to become community leaders in this approach. In order to better understand the process of partnering at a local level to make environmental change, the study authors evaluated the efforts of the Healthy Start Partnership, a university-community project to promote healthy weights in childbearing women and their infants in a rural eight-county area of upstate New York. Qualitative interviews were conducted with 21 key public health partners (30 interviews in all) over three years to better understand the challenges faced by members as they attempted to design and implement local strategies to create more supportive environments for physical activity, eating, and breastfeeding. Interviews were transcribed and coded according to the constant comparative method, and major themes were identified. Challenges faced by partners significantly slowed progress of

environmental interventions in some of these communities. First, many partners did not feel that their "regular" jobs afforded them the time, responsibility, or resources to work so extensively with the community in this way. Second, taking an environmental approach required partners to involve themselves in local political and business dealings, which either made them uncomfortable or for which they felt a lack of efficacy. Third, facilitating environmental change was a major shift in the way partners worked, and partners felt they lacked the needed information and skills (e.g. they struggled with how to switch from an educational to an environmental approach). If local public health professionals are to become community leaders in building environments that promote healthy weight, these challenges need to be acknowledged and addressed.

Introduction

It is increasingly hypothesized that physical and social environments have a significant impact on body weight and health (Papas et al 2007, Drewnowski et al 2007, Black et al 2008). For instance, the availability of and access to healthy foods (Morland et al 2006, Laraia et al 2004, Bodor et al 2007, Inagami et al 2006, Maddock et al 2004, Sturm and Datar 2005, Mobley 2006), as well as safe and accessible places to be physically active (Giles-Corti et al 2003, Saelens et al 2003, Frank et al 2004, Gordon-Larson et al 2006, Doyle et al 2006) are examples of community-specific characteristics that have been found to correlate with healthy eating and physical activity and/or weight. Interventions to create environments that support healthy behaviors on a community-wide basis are also of heightened community and research interest (Economos et al 2007, Cummins et al 2005, Pothukuchi K 2005, Wang et al 2007, Prevention Institute 2004).

In this paper, "environment" is defined as everything external to the individual (CDC 2007). Specifically of interest are the influences of the built (e.g. number of fast food outlets in a neighborhood), social (e.g. social norms and social networks), and policy environments (e.g. local laws and workplaces policies) on weight gain and weight retention in childbearing women and their infants. Environmental influences are also considered to have an effect at the home or individual level (i.e. the micro-environment) and at the community level (i.e. the macro-environment) (Faith et al 2007).

Recent frameworks emphasize the multi-sectoral or ecological nature of the obesity problem. These frameworks depict the embedded nature of the obesity epidemic within home, school, workplace, and broader community settings, while not forgetting the influence of personal factors like genetics and physiology (Wells and Olson 2006, Kumanyika et al 2002, Haire and Nanney 2002, French et al 2001, Papas et al 2007, Black et al 2008). This ecological view of the causes of obesity presumes that changes in all or many of these settings may be necessary to create environments that are conducive to healthy lifestyles. These changes could occur from the local to international levels and involve policy change as well as physical and social changes in communities (Nestle and Jacobsen 2000, French et al 2001, Hill and Peters 2001, Jeffrey 2001).

Members of the public health community are gradually building evidence that the environment in which we live has direct and indirect affects on health-related behavior and outcomes like overweight and obesity. Many of the studies show associations between the availability and accessibility of places to be physically active and healthy foods, but suffer from the possibility of self-selection bias common in cross-sectional studies (Sallis and Glanz 2006, Papas et al 2007). Randomized control trials are all but impossible to conduct in the community context, but studies

examining change in behavior over time as a result of documented changes in the environment will help answer many questions.

As the evidence base is built, many in the public health community feel the role of the environment in promoting overweight and obesity is too large and too common-sensical to ignore. Recognizing the multi-sectoral or ecological nature of a complicated problem like obesity, community-based coalitions seem like an apt mechanism to initiate these environmental changes in local communities. Community-based partnerships offer a way to bring people together in the community with different skills, access to resources, and the ability to work at different levels in society from the intrapersonal to the community and public policy level while taking into consideration the local context of communities (Butterfoss 2007; McLeroy et al 1988). However, the efficacy of partnerships and coalitions to bring about health changes in a community is far from insured, particularly when those coalitions are challenged to address issues of higher-level environmental changes like altering community structures or creating new public policy. Kreuter et al (2000) have found in their review of community-based coalitions for health promotion that the majority of activities accomplished by community-based coalitions are focused on awareness raising and education, as opposed to broader system or policy change. Likewise Kadushin et al (2005) have found that coalitions are more often than not ineffective mechanisms to achieve broad health goals. Specifically, in their analysis of the Robert Wood Johnson Foundation Fighting Back Initiative, the researchers found that coalitions often broke down because of an inability of organizations to successfully work together due to poor definition of coalition objectives and decades of organizational and community "baggage" that results in initiatives being thrown together more out of happenstance than through a clear tie to community assessment and need. Coalitions that did create successful initiatives tended to work on specific,

more narrowly defined projects that lacked a community or population-wide focus, and did not change the way prevention and treatment programs were structured.

Consequently, the effectiveness of coalitions to create system-wide or broader environmental changes are not well-supported in the literature. However, the problems faced by coalitions and partnerships may be surmountable, and given the current political climate for decentralization of public health programs, the need to understand and develop strategies to overcome these challenges is paramount. It is also important to recognize that environmental interventions currently being tested in the academic and scientific communities, need the well-trained support and resources of community-based practitioners to bring interventions based in theory to scale and really begin to make differences in communities. If local partnerships are to be a major public health mechanism in curtailing the obesity epidemic, and if curtailing the epidemic requires environmental change, then there needs to be a better understanding the readiness and capacity of community-based public health practitioners to plan and implement environmental changes in their community. Efforts to build the capacity of these community-based practitioners is an important part of developing effective strategies to combat the obesity epidemic.

Hawe et al (2000) has defined three major components for building strong public health capacity in health promotion. First, is the need to for health infrastructure and service development. Public health promotion program require that practitioners have the knowledge, skills, resources to conduct health promotion programs, and that their organizations demonstrate support for these approaches through appropriate policies and expectations. Second, is the need to develop program maintenance and sustainability. Partnerships and organizational environments need to be built so that programs are sustained (along with their health effects), whether or not the original initiating organization continues to support the

effort. Third, is the need to develop problem-solving capacity in public health practitioners and their communities. Health practitioners need to develop abilities that are transferable over time and across issues, so that as new public health issues arise they can be addressed.

Capacity for public health promotion can, therefore, be developed in a number of issue areas, but because skills and resources are transferable to other problems, many public health practitioners may already have some of the skills needed to work on emergent public health initiatives like environmental approaches to obesity prevention, while others may require more efforts at capacity-building. Another important element of Hawe's definition is that capacity-building very much occurs as practitioners work through new problems, and in so doing learn from each other. While technical assistance programs can be a part of capacity-building, working directly on problem-solving in a community or organization is a major mechanism of capacity development. This framework also emphasizes the work of partnerships, particularly in level two. Not only do practitioners learn from each other, but having a network of agencies working together builds support for a program in the community and helps ensure that it continues even if one or several agencies can no longer support it.

For many public health practitioners working at the broader community level to make environmental changes is a new undertaking, for which the capacity of the public health system may not be high. As research continues to point to the ecological nature of the obesity epidemic, the need to develop public health capacity to address obesity at all levels in the ecological framework is crucial. Understanding the challenges faced by public health practitioners as they work to develop and implement environmental changes, is an important part of understanding how capacity for this approach can be built. In order to do so, the study authors evaluated the efforts of the

Healthy Start Partnership, a university-community project to promote healthy weights in childbearing women and their infants in a rural eight-county area of upstate New York.

The Healthy Start Project (HSP) aimed to promote healthy weight gain during pregnancy and appropriate weight loss post-partum in a population-based sample of women living in a rural area of upstate New York served by a large centralized health care system. Childbearing has been shown to be positively associated with weight gain in women, and can lead to higher weights several years postpartum, particularly among women who gain more than the Institute of Medicine's Guidelines (Olson and Stawderman 2003, Schieve et al 1998, Gunderson et al 2003). Appropriate weight gains during pregnancy may also have long-term benefits for the offspring's childhood and adult weight and health (Srinivasan et al 2006, Oken 2003, Silverman et al 1998). Thus, interventions that increase the number of women who gain an appropriate amount of weight during pregnancy, and those that support women in weight loss efforts after pregnancy can aid in nationwide efforts to curb the obesity epidemic. For this reason, the university invited community organizations with an interest in women's and children's health to become part of the HSP in order to develop community-based environmental interventions to promote healthy weights. Community partners were encouraged to develop interventions in the areas of nutrition, physical activity, or breastfeeding, so long as the interventions could theoretically be linked to promoting healthy weights. While region-wide initiatives were encouraged, county-based partnerships tended to develop with most of the work to-date accomplished at this level. In order to evaluate the success of the HSP data on the weight gain and weight retention of childbearing women before and after the period of intervention were collected. Results of this outcome evaluation are published elsewhere.

Methods

Partnership formation began in the summer of 2005, with the first regional kick-off meeting occurring in December of that year. While partners from all eight counties participated in some way, HSP projects were only implemented in six of the counties. The authors attended all the regional HSP meetings, and the first author attended many of the local county HSP meetings either in-person or through conference call. This enabled the research team to observe first-hand the interactions of partners and follow the development of interventions from initial brainstorming through evaluation. Fieldnotes of observed meetings were maintained, along with meeting minutes. The first author carried the status of participant-observer in all community meetings and correspondence. This allowed the first author to attend and contribute resources and ideas to meetings as needed, but efforts were made to not direct the course of the partnership in any significant way. All partners were made aware of the first author's role.

In addition to attending meetings, 30 semi-structured interviews were conducted with 21 partners in the HSP. Eight of the most involved partners (e.g. county-level HSP leaders) were interviewed two to three times over the course of the project. At least 2 partners in each of the 6 counties that implemented projects were interviewed. Interview questions were designed using guidance provided in Patton (1990) to ensure questions were open-ended and appropriate to qualitative analysis. Partners were interviewed on two major topics: partnerships and environmental interventions. Questions about partnerships focused on the nature and depth of past partnership experiences, perceived strengths and weaknesses of the partnership approach, and the functioning of the current HSP. Questions about environmental

interventions focused on past experiences with this kind of approach, current interest in pursuing the environmental approach to promote healthy weights, and reactions to environmental interventions implemented by the HSP. Partners were also asked about the perceived causes of overweight and obesity in their community and explained how they would spend $20,000 on any intervention related to health and well-being.

Interviews were transcribed verbatim and analyzed using the constant-comparative method (Glaser and Straus 1967, Glazer and Corbin 1990). Interviews were coded for major and minor themes. As new themes emerged they were tested for validity in later interviews. Early in the interview process questions focused on understanding the interviewees' current capacity to build successful partnerships and their interest and current ability to implement environmental interventions. As the partnership progressed interviewees were probed further on how particular projects were chosen to be the focus of their local partnership activities with an emphasis on understanding the interviewees' understanding of what projects were considered possible and why.

In addition to the qualitative data, several surveys were administered to partners focusing on the functioning of the partnership and the partners' perceived changes in their own knowledge and beliefs about implementing environmental interventions (i.e. their capacity to do environmental interventions). At the first regional meeting 31 partners filled out a pre-survey, and after 2.5 years of partnership participation 20 people completed the post-survey. The intent was to match surveys over time to the same partner to observe changes in knowledge and beliefs. However, only 11 of the responders to the post-survey could be matched to the pre-survey. For this reason, and because of the overall small sample size, most analyses were done with and without matching, and results were generally found not to differ (when responses do differ they are noted below). For analyses using matched partners

Wilcoxan Paired T-tests were used to compare pre and post survey results, and independent sample T-tests were used to compare the whole pre sample to the whole post sample (Statistical Analysis Software 9.1; Cary, NC).

Surveys were not matched to individual qualitative interviews, so that surveyees would feel comfortable giving candid feedback on the functioning of the partnership and their knowledge and interests. However, county affiliation was used in some analysis to better understand how partnership conditions varied by county. Data collection for the process evaluation was approved by the University Committee on Human Subjects at Cornell University.

Results

The Partnership

Models of the ecological or "upstream" determinants of obesity suggest that multiple sectors from local to national and international levels have contributed to the current obesity epidemic. The degree to which each of these sectors needs to be involved in the solutions likely varies from community to community. However, it is generally felt that the problem of obesity is too large for one organization in the community to tackle on its own. Over forty different partners from eight contiguous counties were involved with the HSP over the course of the project. Community-based organizations working in public health, nutrition, and maternal and child health were well-represented, as were representatives of area hospitals and people working for community-based organizations to improve health care delivery.

The partnership governing structure was made-up of a Coordinating Committee (CC) composed of university partners, two "sparkplugs," and representatives from most of the counties. At the start of the partnership the

sparkplugs (chosen by the project leader as leaders within their county and in their respective organizations) along with the university partners, nominated people to be members of the CC so as to build a broadly representative governing structure. Every year CC members were asked if they wanted to continue and nominations were accepted to fill in vacated slots or to fill in identified holes in representation. The CC helped shape the direction of the partnership, identify agenda items for the regional meetings, and make funding decisions about projects submitted for HSP funds.

Partners in the HSP were encouraged to work in local (i.e. county-wide), as well as in a regional partnership. Early on brainstorming for several region-wide initiatives was attempted, however, as the partnership progressed it was difficult to develop and maintain region-wide initiatives for a variety of reasons. Partners within counties often already had a history of working together, but were less experienced in working across county boundaries, particularly on intersectoral work. It was difficult to designate region-wide leaders who had the resources or interest to work across eight-counties. There was also a good deal of county variation at the environmental level (e.g. some counties were more rural than others). For this reason, approximately a year after the first regional kick-off meeting, county-level meetings were facilitated by the university partners to focus attention on possible useful and feasible interventions in each county. After these sessions, several counties initiated local interventions as discussed below. Nonetheless, partners commented that had more resources been available to organize region-wide activities, that regional efforts could have been a source of energy for "bigger" change. For instance, working with upper level management in a convenience store chain that had stores in several counties may have had more impact than working with a local manager of one or two stores.

The partnership building literature discusses many factors that likely contribute to partnership success (Butterfoss 2007, Zakocs et al 2006). While the objective of

this paper is not to explore the structure of partnerships and how that affects partnership functioning per se, the ability and interest of partners to come together in a partnership with a shared goal certainly had an effect on the functioning of the HSP. Most HSP partners had had experience working in partnerships in their community, although the objectives of these other partnerships varied. Some partners had primarily been involved in information-sharing partnerships that functioned to network community resources, whereas others had more experience in partnerships that had tried to bring about a broader community change (e.g. working to make healthy changes in schools). These past experiences in partnerships positively related to partners current involvement in the HSP. In a couple of the counties where organizations had had little or no experience working together on a common goal or objective, local partnership formation was slow and little cohesion of effort was observed. An additional dynamic affecting participation was the extent to which partners felt working in collaborations was a crucial part of their job. Those who perceived partnerships to be a strong component were more likely to get significantly involved in the HSP, as well as in other partnerships in their community. The perception that working in partnerships was a crucial part of one's job varied among individuals holding similar positions in the same organization across counties.

Dynamics between local agencies also played a role in HSP success. In some counties the agencies that got involved with the HSP had had a history of successful collaboration and were able to combine resources and ideas with little concern over turf, competition, or sharing of credit. Strong local leadership was critical in bringing these partners together. In other counties partners had trouble forming active groups. In these counties local leadership on the issues of interest to the HSP did not emerge. Reasons for this are discussed later in this paper, but are specifically related to a perceived lack of interest and capacity among partners to develop environmental

interventions, uncertainty about partner roles and responsibilities, and a lack of resources (e.g. staff time) to develop partnerships and local leaders.

Core partners in the HSP were generally from "traditional" public health fields related to maternal and child health. The HSP originally set out to involve partners from fields less commonly involved in public health work, for instance transportation planners, parks and recreation officials, grocery store managers, and the like. However, it was perceived by many of the most-involved partners that because these potential partners did not have a public health focus, they would have less time and less interest to devote to regular partnership meetings. As the partnership evolved HSP partners explained that many of these "less traditional" partners could be brought into the partnership on an "as needed basis."

The Interventions

Five of the six counties participated in one or more interventions. A brief description of each follows. In county A, a series of breastfeeding social marketing campaigns were conducted involving billboards, television and radio PSAs, posters, mailing to businesses, doctors offices and schools, and a breastfeeding forum attended mostly by public health nurses. The objective was to create a more supportive social environment for breastfeeding moms, as opposed to targeting breastfeeding women alone. A limited number of partners also worked with two convenience stores to encourage the purchase of fruits and vegetables, with the objective of increasing sales of these items. In County B, partners worked to improve the social and physical environment of doctor's offices by encouraging every doctor's office that has some contact with childbearing women or infants to appoint a "Champion" to attend a special training and follow-up sessions on how to create a more breastfeeding supportive atmosphere. Their objective was to improve the office environment in

support of breastfeeding. In County C, a map of all the physical activity opportunities was developed and approximately 3500 were disseminated to area families. The objective of this map distribution was to improve local residents' knowledge of area physical activity opportunities and their use of them. County D created a social marketing campaign to promote breastfeeding, as well, and their intervention included billboards and a breastfeeding walk. The partners in this county also worked extensively with area hospitals to develop better connections that would support breastfeeding women and refer them to help as needed. The objectives in this county were to improve the community social environment regarding breastfeeding and also create a professional system that better aligned women with breastfeeding and nutrition services. County E also worked on breastfeeding promotion by bringing together partners in the community who worked with breastfeeding moms to improve training opportunities. Process evaluations for most of the activities listed above were carried out by the research team to understand the extent of the intervention effect and coverage in the population. In general the interventions were successfully implemented and in some cases had small but significant effects on the target population.

Capacity-Building for the Environmental Approach

One of the major objectives of the HSP was to build the capacity of local public health practitioners to plan and implement environmental interventions to prevent or reduce overweight and obesity in childbearing women. One major mechanism for building this capacity were the regional partnerships meetings held about 2 times a year and organized by the university partners. They functioned as a forum for information sharing, knowledge-building, and skill development, often with invited speakers who were experts in their fields (e.g. weight gain in childbearing

women, community design, and convenience stores). The initial regional meetings focused on orienting everyone to the problems associated with excessive gestational weight gain and its prevalence in the local population, as well as orienting partners to the environmental approach and some of the most recent research suggesting a connection between the environment and overweight and obesity. Later meetings focused on building knowledge and skills in particular areas of environmental intervention like building bike paths, working with managers of retail food stores, and creating breastfeeding friendly workplaces. Partners were also encouraged to share their intervention experiences and resources with each other at these meetings. Many of these materials were posted on the HSP website. Details on the agendas in these regional meetings can be found in Appendix 6.A.

Partners did not feel that involvement in the HSP had drastically changed the way they thought about the causes of overweight and obesity (most felt they had a pretty good understanding to begin with). Indeed, in early interviews all partners were able to list a litany of causes of overweight and obesity in their community, ranging from lack of education on how to prepare healthy foods to proliferation of fast food, reliance on the car, fear of letting children out to play, and lack of time for healthy habits. Where there was more opportunity for growth was in gaining an understanding of how to address some of the broader ecological causes, and how to integrate these interventions into their ongoing work. To this end partners reflected that the regional meetings were very useful learning opportunities and that they were effective in raising awareness about how to work in an environmental context. One partner reflected on her experience,

> I really appreciate the presentation of research on the topic [of environmental interventions] because 1) it gives us a good background for what we are planning to do in the future and 2) just as a professional in the field, it is good to know these things. So that combination of

> information you can use with the discussion sessions of what can we do now in light of that information, I think is a really good combination.

Another partner reflected that one of the later regional meetings with representatives from supermarkets and convenience stores (an area of intervention of high interest to her) were very useful in aiding her understanding of how to work with these potential partners. She says,

> But I found the last regional meeting, you know the most recent one, extremely useful and I thought one of the guest speakers had some awesome data, and I am a data junky so if you give me data I will salivate over anything. But I think he had some very good insight. I really appreciated his candid comments after the other presenters had left. I think being given examples like that in terms of real environmental interventions and what they look like is incredibly useful.

On an organizational level the HSP also appears to have had some success in building capacity among and between organizations to better support healthy lifestyles in childbearing women and their families. A survey administered about 2.5 years into the Partnership showed that as a result of participating in the HSP, partners generally had high knowledge, interest, and ability in interventions related to breastfeeding and creating better connections between doctors and other health care professionals, where most counties focused their efforts (Figure 6.1). Partners gave lower ratings to interventions that were either not attempted or were attempted on a limited basis, for instance working with restaurants to create healthy menu labels, or working with convenience stores to introduce healthier meal options. This shows that partners either focused their energy on interventions where they had high knowledge, interest, and ability, or as a result of participating in and hearing about interventions related to breastfeeding, their knowledge, interests and ability increased. Based on the qualitative interviews it appears that both of these scenarios occurred. Key partners in

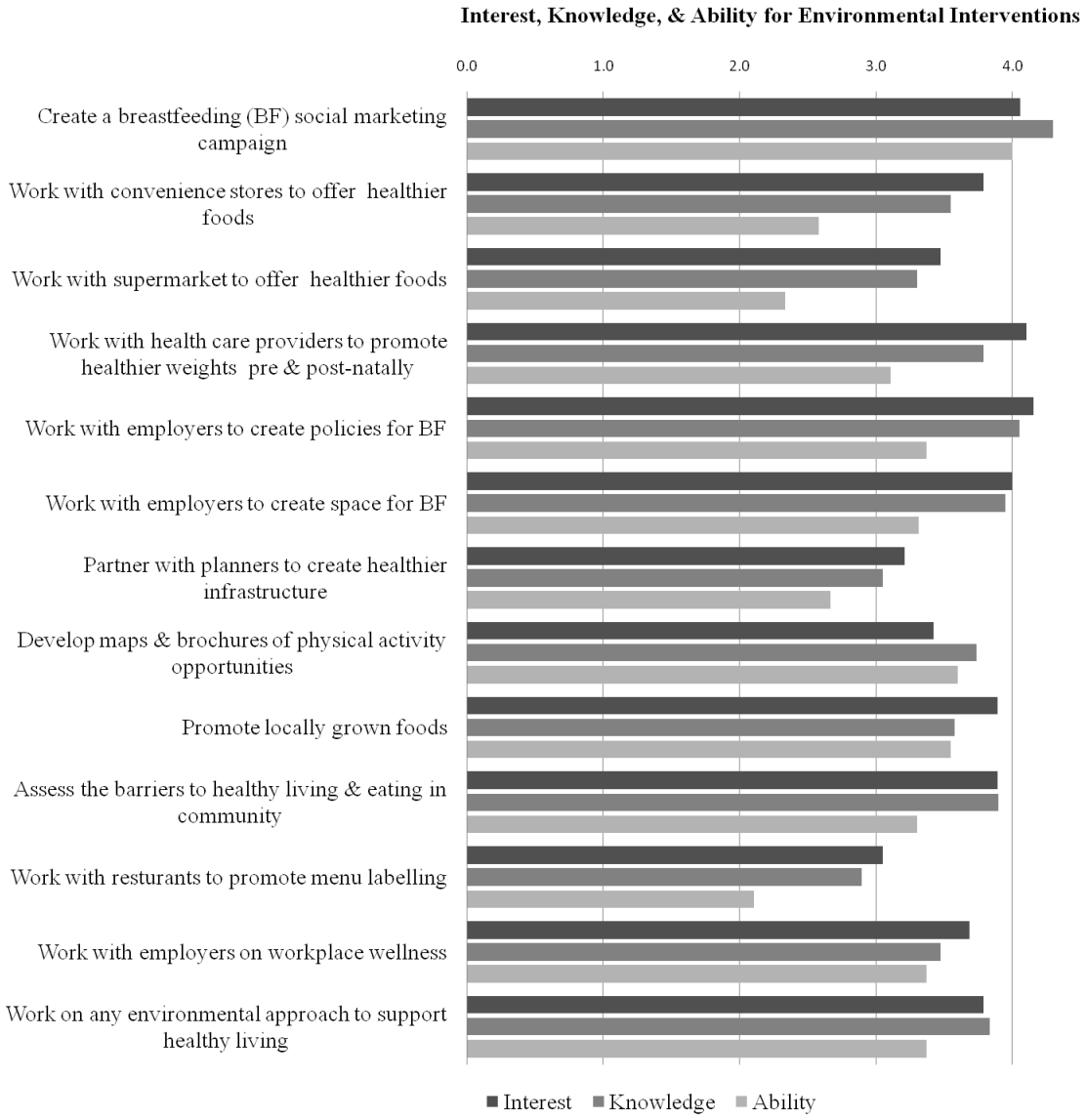


Figure 6.1: Interest, Knowledge, & Ability for Environmental Interventions among Healthy Start Partnership Partners

all the counties that implemented breastfeeding interventions discussed their interest in breastfeeding promotion in early interviews. As will be discussed below, many partners had a strong interest in breastfeeding and many (though not all) had jobs where breastfeeding promotion or education were strong components, so they were

attracted to working on this issue because it supported their personal interests and was supported by their professional role.

In addition, partners in counties who had successfully implemented the breastfeeding programs, felt that they had learned a great deal about local partnering organizations, and about the mechanics of the intervention itself, resulting in new organizational and community capacity. One county after a successful breastfeeding social marketing campaign, has gone on to repeat and expand the campaign the following year with plans to maintain and extend the intervention over time. Several partners in this county explained that this was the first time partners in their community had ever come together in such a comprehensive way to promote breastfeeding, and this in and of itself was a great accomplishment. In another county partners were working to develop additional local capacity for breastfeeding support after an initial campaign to bolster support for women in doctor's offices. In this county, as well, this was the first time partners had come together in such a comprehensive way to support breastfeeding, and the partnership is currently reaching out for new resources to expand its efforts. In still another county, partners explain for the first time, as a result of their efforts in the HSP, connections between local health professionals and other valuable service providers in the community were being made to better connect moms with breastfeeding and nutrition support. This represented a significant systems shift in this community to build a more supportive organizational and community environment for promoting healthy lifestyles among families. Clearly these examples demonstrate that capacity to make environmental change had been built in these communities.

To further measure change in capacity for the environmental approach over the course of the project, the partners were asked to rate the degree to which they felt a series of example environmental interventions were useful or feasible at the start of the

HSP and after 2.5 years of involvement. The example interventions were chosen from examples in the literature and were selected to represent a broad range of interventions points (e.g. interventions involving businesses, municipal infrastructure, and social and policy environments). Examples interventions were grouped into nutrition, physical activity, breastfeeding, and "mixed" categories. After 2.5 years of the project, partners generally reported decreased perceptions that the example environmental interventions were useful or feasible.

Of the 32 example interventions, partners' perceptions of usefulness increased in 12 examples and decreased in 17 examples. The feasibility of environmental interventions showed the most change pre to post. Partners' perception of feasibility increased for only eight examples and decreased in 22 examples. Example interventions showing a significant change are shown in Table 6.1, however because of the small sample sizes some significant differences may have been hard to detect. Notably, the example intervention related to creating a more accepting societal attitude toward breastfeeding showed increased feasibility, as might be expected given the partner's experience with that intervention. The other significant interventions showed a decrease in feasibility, and were generally for projects that were not attempted by the HSP. The one example intervention showing increased usefulness was increasing food stamp enrollment for eligible families. The reasons for this are unclear, but may be related to the downturn in the economy that occurred between the pre and post surveys.

Just looking at the size of the change in usefulness and feasibility scores pre to post also gives some insight. Example interventions showing the greatest fall in perceived feasibility (half a point or more on a scale of one to five, five being the most useful or feasible) were generally interventions that the partnership did not work on, whereas the breastfeeding example interventions showed generally negligible or

Table 6.1: Selected Pre and Post Scores for Usefulness and Feasibility for Example Interventions as Rated by HSP Partners

Example Intervention	Pre* Score	Post* Score	Change	P Value
Feasible:				
Increase local media promotion of healthy foods and quick and healthy recipes (radio, local cable TV).	3.9	3.2	Decrease 0.7	0.09
Provide nutrition information and/or other kinds of healthy meal cues on restaurant menus.	3.3	2.6	Decrease 0.7	0.06
Place signs and other cues in buildings to promote the use of the stairs.	4.3	3.2	Decrease 1.1	0.03
Create public policies that promote walking as a means of transport and recreation.	3.2	2.4	Decrease 0.08	0.09
Initiate a program that encourages walking and other forms of exercise in public buildings like school gymnasiums.	3.7	2.0	Decrease 1.7	0.08
Increase local media promotion of breastfeeding to encourage a more accepting societal attitude.	3.3	4.4	Increase 1.1	0.06
Useful:				
Initiate a public campaign to increase enrollment in Food Stamps for eligible individuals and families.	3.4	4.3	Increase 0.9	0.13

* Scale 1 to 5 with 1 being the least useful or feasible and 5 being the most.

positive changes pre to post. Example interventions that had the lowest overall ratings (< 2) in both the pre and post surveys for feasibility had to do with large structural changes (implementing a tax on junk foods, increasing the number of supermarkets in rural areas, improving public transportation, and increasing the economic viability of the area). On average partners felt that nearly all of the example interventions could be moderately or very useful in decreasing obesity in childbearing women both pre and post, with only the example intervention of implementing a local tax on junk food

receiving a score less than three for usefulness in the pre-surveys. Feasibility scores were generally much lower than usefulness scores both pre and post. Results of all the usefulness and feasibility surveys are found in Appendix 6.B.

Capacity development, however, was not even across or within counties. A major factor that would be hypothesized to affect the degree to which the HSP could have influenced capacity-building for the environmental approach is the extent to which partners were actually involved in designing and implementing environmental interventions. One county, as of writing, never got an intervention off the ground or even successfully built a local county coalition. Two other counties implemented interventions to some degree, but were challenged in finding local leadership and building a coherent local partnership. Within counties that did successfully implement interventions, there were clearly some partners who were much more involved than others, which is not surprising or inconsistent with the partnership literature (Butterfoss 2007). A survey of the partners showed that on average partners spent 53.5 hours in HSP activities in the past year or about 2.6% of work time assuming a 40 hour work week. But some partners were considerably more involved than others (Table 6.2). Fifteen partners reported being involved in 50 or fewer hours in the past year, whereas five others reported being involved more than 100 hours. The amount of time spent in meetings was slightly higher in the most involved group, but the amount of time spent working on project implementation was considerably higher among the most involved. Partners with the least amount of involvement on average spent about the same amount of time in meetings as on implementation, whereas those with more overall involvement spent the majority of their time involved in the implementation of actual HSP interventions (more than six times the amount of time they spent in meetings). The four counties engaged in some kind of breastfeeding

intervention had at least one person falling into the "most involved" category, probably representing the county leader.

Among the most involved partners, the pattern of responses to the interest, knowledge, and ability questions discussed above were similar to the sample as a whole, except that on average the most involved expressed a much higher degree of knowledge for developing initiatives to promote local foods, and generally higher ability to initiate programs related to breastfeeding than the less involved. This latter point may be due to the fact that the most involved partners were generally successfully working on breastfeeding interventions, and consequently felt high ability to continue these efforts. Graphs illustrating the interest, knowledge and ability of the most involved partners are shown in Appendix C.

Table 6.2: Time Spent HSP Activities as Reported by Partnership Members

Least Involved (<50 hours in past year)		**Most Involved (> 100 hours in past year)**	
Average Time in Meetings (hours)	Average Time in Implementation (hours)	Average Time in Meetings (hours)	Average Time in Implementation (hours)
12.3	12.0	19.2	121.6

Interviews with partners who were both significantly and less involved revealed a number of issues that affected their capacity to participate and consequently to develop further knowledge, skills, and organizational connections related to environmental interventions. These challenges are detailed in the following section. Nonetheless, even limited involvement seems to have had the affect of raising awareness of environmental interventions. One woman in a county where they did not implement an environmental intervention explained that she had not really been

familiar with the idea before getting involved with the HSP, but when prompted in the interview could now successfully define it based on ideas and examples she had learned from the regional meetings.

There were also several partners who had been significantly involved in implementing environmental interventions before getting involved with the HSP. While the evaluation evidence does not suggest that involvement in the HSP significantly increased the degree of their involvement in environmental interventions (other than adding on an HSP project), or their interest in the approach, involvement in the HSP continued to grow these partners commitment to making environmental changes in their work. Several of these partners were able to fold the activities of the HSP into activities and programs they were already engaged in and sustainability of the objectives of the HSP (an element of capacity-building) appeared strong. However, one partner who had been involved in environmental approaches in the past, struggled to become involved in the HSP, not for lack of interest, but because her job no longer supported her involvement in this kind of community work. She also felt that the focus of the HSP on childbearing women may not be of interest to many of her previous partners and so she felt she could not easily transition the old partnership into one supporting the objectives of the HSP. These challenges of organizational support and interests of partners will be discussed in the next section.

Challenges of the Environmental Approach

Partners clearly agreed that overweight and obesity were problems in their community among childbearing women and all other sub-populations. They also felt that the causes of overweight and obesity were at least partially ecological in nature and in interviews listed both macro and micro-level causes of overweight and obesity in their communities. Among the ecological causes for overweight and obesity given

were: the prevalence of fast food and junk food, the lack of time busy families have for making healthy meals, the difficulty of accessing safe places for physical activity, the prevalence of sedentary jobs, and the reliance on the automobile.

Generally partners felt that working on the environmental causes of overweight and obesity was an effective approach and worth pursuing, however, many of the partners did not prioritize environmental interventions in their work. When asked how they would spend a hypothetical $20,000 on any health intervention of their choice, most partners discussed projects with a strong educational or service delivery focus (many, but not all, focused on the obesity issue). In many cases these programs were extensions or expansions of programs they were already involved in. While partners certainly felt that the causes of overweight went beyond *only* a need for more education or more services, their professional interests were often educationally focused.

A reason for this disconnect may be that not all partners felt that they were the appropriate person to make environmental changes in their community. Three major reasons were given: a lack of personal interest in the environmental approach, a lack of organizational support from their employer to spend time on these activities, and not feeling empowered to make environmental changes in the community.

Interest

On average interest in the environmental approach was moderate among the participating partners, and increased slightly over three years. One a scale from one to six with one representing the least amount of interest, partners average interest increased from 2.9 to 4.2 ($p < 0.001$), while they also projected that the interest level of their organization to increase in the future (3.7 now to 4.5, $p < 0.05$).

Among the partners who felt that personally they did not have high interest in the approach, one issue discussed was that they did not feel they had enough energy to put into this kind of work. One explains,

> My focus would not be to say "how can we make convenience stores more accessible to the public to sell the foods they need." I think it is a worthwhile agenda, but it is not something on the top of my list that I would say I wish I had time to do that.

She goes on to explain that you have to have a real "passion" for wanting to make environmental change in your community and she is much more interested in working on nutrition education,

> You really have to have an interest, a passion, an energy level to work on that, be consistent, plan it, carry it through, get other people involved. And unless that is your area of passion, I just don't think that it is going to happen.

Nonetheless, most partners were interested in the environmental approach, but felt other constraints prevented them from getting fully involved.

Organizational Support

For many organizations a substantial shift would be required to move from an educational or service delivery approach focused on individual behaviors, to one incorporating initiatives working more broadly on community supports for healthy lifestyles. While only one partner faced outright criticism from her organization for her work on environmental changes, many partners explained that working on environmental change was not a core part of their job description. Some partners felt that they were not well supported in their organization to work on environmental initiatives, and that was a major impediment for getting involved in certain projects.

One partner explained why she felt she could not get involved in several projects happening in her county because they were not closely aligned enough with the mission of her organization,

> If our whole group were to say ok now we are going to work on the convenience stores, I would really have to pick and choose and say ok, yes this important, yes I want to be involved, but I will take less of this one. […] Other people are taking care of it because it is much more closely aligned to their mission.

Another partner explained that she personally had a great deal of interest in creating environments more supportive of healthy eating and exercise, but that her job really called her to work on other issues,

> In my job capacity now, I would not get bigger wins in heaven or a pat on the back or a promotion or anything like that for making an environmental change happen. Primarily because it is not seen as what I do.

Nonetheless, many partners felt it was important enough to work on environmental change, because they truly believed it needed to be a part of the solution, to frame their current jobs to allow for strong participation. One partner explains,

> I mean some people could say that [working on environmental interventions] is not part of my job, but what we have found is through this kind of work we have done a lot of networking and some real positive things are happening, spin-offs for trainings and other things. […] I mean those are the kinds of things that are really important. I think the potential is there. We still have to do some of the basic things that the expectations of the grant streams are already telling us we have got to do. But the opportunity is there for even more funding of these kinds of environmental approaches.

Partners were asked in a survey to rate the extent they felt they had the authority to change the direction or priorities of their organization. While about half (n=10) indicated that they had fairly high authority (score seven to nine out of 10, with 10 being high authority), four out of the 10 respondents felt they had low authority (scoring one), with the others (n=5) falling somewhere in between. Of those with expressing high authority only two were among the most involved partners discussed earlier, indicating that high involvement in environmental interventions is not necessarily dependent on feeling that you have the authority to change your organization.

The extent that a staff member can work on environmental approaches to prevent overweight and obesity may depend to large degree on the extent to which a staff member's job encourages community-wide work generally. While only one partner in the HSP said that community work was outright discouraged in their job, many partners explained that community work was not a major focus of their jobs, or was permitted after all the other duties of their job had been completed. One partner explained that her job lacked "community time" defined as "time that you are allowed to not be in the office that you could work in the community like on collaboration and stuff like that." She explained how this lack of community time can affect potential partners' ability to collaborate and how the insertion of "community time" into her job affects her ability to get core parts of her job accomplished,

> One of the big problems is that most people who are in this kind of work, don't have "community time." My boss has allowed me community time as part of my work always, but you know that is not typical of a lot of agencies like mine. So when do you get this time? When I am not here, I am not seeing clients. That is what I am supposed to be doing, it is not the only thing, I mean these other things are big because they really do affect our clients. All those people who don't get community time, and they need it because the community needs it, you know?

The partner below echoes these sentiments when she reflects on her efforts in past collaborations in her community,

> I guess the whole thing with a coalition, and especially when it is a totally voluntary coalition, is that people are just so busy in "their own jobs" that it is hard for them to eke out the time and energy to do something else. Something in addition. And I think like our members have been very happy to do things, but they can not give as much as maybe would be nice to ask for, just because of their other commitments. And a lot of what we have done has not even been during work time, it is like weekends, if you are going to have an event for a family, you are going to do it on a weekend or something like that.

This led some partners who were interested in pursuing some kinds of community or environmental level work to explain that they often worked after hours to make-up for time spent in community meetings, for instance the partner below explains,

> I am really busy right now and I end up doing some of it on my own personal time. My kids are grown and my youngest started college this year, so I have a little bit more time in the evenings to be able to throw some things together. So that is where I am. What I am not doing at work is carrying over into home.

Given that working on the environmental determinants of obesity really necessitates collaboration and partnerships within the community, potential partners with skills and resources critical to the success of this work need to have the ability to contribute. Without a core groups of leaders in public health, nutrition, and physical activity arenas with the authority, in addition to the interest and skills, to address the environmental determinants of overweight and obesity, the challenges of moving research on the etiology of overweight and obesity into the public health domain where it can have an impact is significant.

Power and Politics

Another challenge faced by partners was feeling that they did not have the power in their citizen or professional roles to make environmental change happen in their community. One partner explained her feelings,

> I have huge potholes on my road. I can't even get the potholes filled. How am I going to work with that town to do something better to improve a walking path or create something like that [laughs]? You know what I am saying? And I have gone to some of the town meetings, and it is like, well we may eventually get to it, but the politics of it all is really really difficult.

This sentiment was echoed by the following partner,

> And I think that it is probably in most people's minds, the hardest thing to imagine, having the influence over the community to the extent that new sidewalks would be built or whatever. I think that people just stay within the health profession or the service organizations that we seem to attract. I don't know if they get it. I am just not sure. And if they get it they just think oh I could not do that. I am just working on this program or I am just working on that program or whatever it is. And what influence would I possibly have? And I see that reluctance.

Some partners also felt constrained from working on certain kinds of environmental interventions, or community-based work more generally, because of local political ramifications. However, this was regarded more often as an indirect constraint, than something that was actively confronted on a regular basis. One partner explained that she had never felt such constraints when working on environmental changes to promote physical activity, but that she had also never endeavored to work on a project that pushed the boundaries too far. She explains,

> I have always had good luck. Well actually anyone in the county agencies, if they could do whatever it was we were asking, they did it, and actually I never thought of the politics involved. But I do know, for example, in [another issue] area where [another county agency] was

> trying to [do some work], there were some strong feelings in county government, and I can just remember some scuttle, again, nothing from my real personal experience, it was just hearing about some of these things. They did not take a really strong stance and it is probably because of some strong leaders within our governmental agencies. But I have found people to be very cooperative in all the areas, but I have probably not asked them to do the hard things that other people have asked.

The effects of local politics were more often manifested in agencies reliant on local tax dollars. For instance, one partner received a lot of push-back for her participation in the partnership because it was not considered a priority by local government. Another partner explained that financially her county was "barely breaking even" and as a result she observed,

> So I know [county employees] would have a lot of difficulty doing anything that could be seen in anyway as costing county dollars, it is just the parameters of their job. […] It just depends on where your county government is at with regards to their support of these kinds of things.

Some agencies receiving only partial funding from local tax dollars, while having more lee-way, still felt they needed to justify their work within broader government goals.

In other cases partners were able to maneuver around some of these local political pressures as a result of their decades of experience of working within these counties and apt political skills. These partners were particularly active in interventions in their community to change the environment (as part of the HSP and as part of other projects). One partner explained,

> I worked for the county for 33 years, so I have had 33 years to learn how to work within that system. So being on the outside of that […] has put me at an advantage, dealing with the county government because I know how they think. I know what is important to them and I

> know how to sell to them what we are doing. […] I think I am not intimidated by government because I worked in the bureaucracy for so long. So I don't give up so easily.

Another partner explained how this political capacity to work with government officials is something she has learned over time,

> But another part is our knowledge base, it is our comfort level with working with that audience. I was not comfortable with that 15 years ago, but now I interface with legislators and do other things because of where I have been and what I have done. But if you have new people, that may not be a place that they are comfortable with.

In addition to gaining the capacity to maneuver within the political system, one partner explained how she works through other organizations with broader connections in the community when she needs to reach out for certain kinds of projects. She says,

> [Agency X] is part of county government in our county and sits in the county office building. And they are linked very well to our county administrators. They are linked to the planning department. All those pieces are there. So when they come to our group, they bring that connection. We got access to that right away and that taps us right into you know other things.

While not all partners were disinterested in the environmental approach or felt unempowered in to make it happen, and certainly some local organizations were very supportive of this work, the combination of these factors weakened the ability of many counties to pull together a core of committed partners. Problems in pulling together a motivated local partnership group, likely contributed to the uneven success of projects across the target area.

Long Time Frame

Like a lot of community-based projects, the environmental interventions of the HSP took a long time to plan and develop. For at least the first couple of years of the HSP (and in some counties even longer than that), partners were engaged in developing their partnerships and figuring out what their interventions would be. As has been discussed, many partners had limited time for the HSP because of other job responsibilities and so planning grew over time. And again, as with many community-based projects, funding for the HSP was coming to a close just as some counties were beginning to develop some momentum for action. Likewise once counties implemented an environmental change, the change process and its ultimate affect on weight and health also takes a long time. As one partner explains,

> And to tell you the truth it is a very long process. Change is such a long process. You can put out a safe exercise place and maybe 5 people show up the first year and then they tell their friends about it and they get 15 the second year. But it has to be out there in front of the public for a long time before people really internalize it and say "this is what I want, and this is here for me and I am going to use it, and oh boy, I am so glad we have this." We have to be very patient and willing over a long period of time to keep plugging away at making it work. It is not s short-term kind of thing.

Unfortunately, community-based projects time-out before many of these major impacts (e.g. outcomes) and minor impacts (e.g. relationships built, policies enacted) take effect.

Working outside of traditional role

One major area where this project demonstrated a need to increase the capacity of local public health stakeholders was in creating and implementing interventions in arenas outside those of "traditional" public health initiatives. For instance, working

closely with business leaders to change food environments, or working closely with municipalities to create new physical activity opportunities. As discussed earlier, most of the projects planned and implemented in the HSP had a strong breastfeeding focus. There were a couple successful efforts at creating physical activity maps and some efforts were made to work with local food stores, but these received much less attention and involvement from partnership members. Partners explained that they felt more comfortable working on breastfeeding promotion because breastfeeding was an issue that more closely aligned with their experience and the mission of their organization (many but not all organizations had at least a minor interest in maternal and child health). One partner explained,

> So breastfeeding promotion is one of those approaches that I think just makes a lot of sense for many of us for various reason. And maybe did not seem as hard. I mean when I think about getting a convenience store to carry more fruits and vegetables and move them up to the front, that seems hard. I think why would they want to do that for me? You know what I mean? Whereas with this breastfeeding stuff, we can do it and we can get other people that we know want to promote breastfeeding on board with it.

They also felt that they lacked knowledge about how to pursue initiatives with local businesses or with government departments outside of public health. Many lacked significant experience working with these kinds of partners and were unsure of their ability "to talk the language" of the potential partner. There was also a sense that people working in these other fields would not be sufficiently motivated by anything the partnership had to offer (e.g. businesses would be more motivated by profit versus a more general public good). Generally, partners expressed a lack of professional efficacy to partner with organizations outside of traditional public health partners. One partner explained,

> And quite frankly even that corporate arena is challenging to me. I don't know how to handle that one. They don't operate the same. The bottom line is the whole thing, and I don't know if I have enough training and understanding. I am just thinking "Hmm…I am not sure we had enough to offer." I mean we had some things we thought we could offer, but I don't know if that is of any value to them. […] It is taking people from an educational background and trying to put them in an arena they may not be comfortable in or don't even know how to facilitate.

The hesitation to partner seemed to work both ways. One partner related her experience trying to start a collaboration to improve opportunities for physical activity between her organization and local municipal organizations. She says,

> We did mass mailings and phone calls and so far we have had one municipality interested. But that was how we started with the schools. We got very little interest at first, but over time it has grown. Now we know who to contact. […] We built on some of our past stuff we had done with them. So I think it is going to be a similar experience with the municipalities: trying to get them to start thinking differently, to think more collaboratively, and that they can reach out to non-profits and other entities to partner and do things.

Gradually building new relationships with "non-traditional" partners, and building off of these relationships to try newer and broader initiatives is a strategy several partners discussed as a way to create capacity in the community for broader environmental change.

> So it takes a lot of opening of doors, I think, and getting to know people. And I found that once I got into the hospital doing [an earlier local] project, that people were so open and they recruited so many people and they were so interested in actually making changes at the worksite, that they now know that there is a big connection in terms of what [my agency] is doing to try to impact the health of people, and they know that we are committed.

The importance of directing future efforts to network with people outside of traditional public health professions was underscored by another partner who saw her profession moving increasingly in the direction of working on environmental change. She explains,

> I am not saying I am an expert even working on this project, on environmental intervention. All I think I have is a better understanding of what could be done. I am not saying I even have the answers of how to do it. You need to spend a lot of time on committees. I spend a lot of time on networking in all these groups, because it just allows you to start to see how these things can come together. That is very important as you look at potential funding streams for the future. I think there is a lot of potential. [My organization] has the most opportunity because of the way we have developed programming and the way we deliver it. We can make the biggest change in order to have that kind of thing happen.

In addition to building the capacity of public health practitioners to work with less traditional partners, one of the biggest challenges partners expressed was building the frameworks, knowledge and skills required to actually make the changes in their community to create healthier environments. Most of the partners had been working in educational and service delivery fields for the better part of their careers. The following partners explains how she feels it will require significant training and practice for these individuals to redirect their efforts.

> I think the local partnership is struggling to develop a concept of environmental interventions. And then what I see happening is that through this struggle the partnership members returning to their comfort zone which is education and outreach. So I see that as a barrier within our local partnership that will take quite a bit of time to overcome because this is sort of a quantum leap in thinking. When you are talking about people who have been doing things the same for 20 or 30 years and it is hard for people, you know, to change certain of their constructs in a relatively short period of time.

Some partners also talked of the need to know about, and a desire to enact, environmental interventions that had proven efficacy through scientific research. They wanted more examples of what had tested been and evaluated in other locations to use as templates for local action. One partner explains,

> I am rally intrigued about the whole environmental/social intervention thing so maybe some more research and presentation on that would be helpful to me, or just interesting to me. We have talked a lot about the basic principals of environmental intervention, but not as much about places that have tried to implement something like this and what has happened because of it now. They don't exist yet…so…

Presentations by academic researchers and other invited speakers at regional partnership meetings helped inform what is known about environmental approaches to overweight and obesity management, but as will be explored in the discussion, the scientific community has yet to test and validate significant community-wide interventions applicable to these kinds of community-based interventions. While public health practitioners may be in need of new knowledge and skills to build their capacity for the environmental approach, the scientific community also has an ongoing role to play to bolster the evidence base for effective environmental approaches.

However, despite the focus in this project on making environmental changes in communities, many partners emphasized not losing sight of the ongoing need for education about healthy lifestyles. Some partners explained that ideally environmental changes and education would work hand-in-hand. For instance, continuing to educate people about the benefits of eating fruits and vegetables (i.e. work on demand), while also working to increase their prevalence in community stores (i.e. work on supply).

Discussion

Generally, partners in the HSP were enthusiastic about the environmental approach and some were already experienced working in this way before the HSP. Nonetheless among the interested partners many expressed a lack of efficacy for producing broad environmental change within their communities because of underdeveloped professional skills to carry-out this approach, an unsupportive organizational environment, or because of local political constraints. It was also acknowledged that creating environmental changes will take the building of multiple, and often new, relationships with other stakeholders in the community, and that any change is likely to take a long time to implement, and even longer to have an impact. This paper examined an attempt at creating environmental interventions in several rural communities to understand some of the challenges that public health practitioners face in implementing this approach to curb overweight and obesity in childbearing women and their families.

The infrastructure for public health nutrition in the communities targeted in the HSP consisted largely of education and service delivery programs, with some notable exceptions. While these organizations are well-designed to deliver information and services, the availability of time and other resources for additional activities varied a great deal from one organization to another. To some degree the lack of resources and time constrained not only the implementation of environmental interventions, but community work in general. This challenge of community work is well-documented in the partnership literature (Butterfoss 2007). While personal interest and motivation can overcome some of these organizational constraints, as was evidenced by some enthusiastic partners in the HSP, long-term consideration of the ability of the current public health infrastructure to adopt this approach must be considered.

Partners also requested more resources to teach them the knowledge and skills needed to successfully carry-out environmental interventions. The interesting finding that partners actually felt the majority of example interventions were less feasible after participating in the HSP may indicate that partners came to realize just how difficult many of the changes are once they had some experience thinking and talking about them. Shiriki Kumanyika (2001) describes the state of current public health practitioners for addressing the obesity epidemic from an ecological perspective using the transtheoretical model. For many of the reasons described above, she projects that practitioners are in the stage of precontemplation where they may feel inefficacious about their likelihood of having a significant impact on the causes of obesity, or in the contemplation stage where they want to have a greater impact but are unsure of how to proceed. To move practitioners into the next stage where they prepare for action, they need to develop a plan for action. Online programs like the Cornell Nutritionworks Course "Preventing Childhood Obesity: An Ecological Approach" may be one such tool to move practitioners from precontemplation to contemplation and then into action planning. This Course has been shown to increase the knowledge, skills and confidence of participants in environmental interventions (Stark et al 2008). In addition participants in the course are permitted to work in small local teams as they develop context appropriate strategies to prevent obesity, potentially finishing the course with a small partnership and a workable action plan. Some partners in the HSP participated in this online course over the course of the project and found that it was very useful in increasing their understanding.

Increasing interest in the health promotion community of the environmental determinants of overweight and obesity are leading to many new theories of how the environments in which we live may be affecting our health. While there is still much to be learned about the etiology of overweight and obesity, there is also significant

work to be done in understanding how and to what extent change at the community level can create observable outcomes in population health and weight. Examination of the literature on environmental approaches to prevent overweight and obesity show few community-based interventions with proven efficacy to prevent or reduce excess weight in any population (Faith et al 2007, Economos et al 2007, Cummins et al 2005, Wang et al 2007, Kahn et al 2002). Evidence from school-based environmental interventions shows some positive models, but the evidence has been mixed (Cullen et al 2008, Lytle et al 2004, Leupker RV et al 1996, Foster et al 2007, French et al 2004). Given the considerable challenges faced by community organizations in partnering to create any change in their community, particularly at the environmental level, the public health community needs to be informed of the extent to which local strategies can be successful in changing outcomes, and if so, which strategies are the most successful. Most of the partners in the HSP were hopeful that local strategies (in general) could improve the health and weight of local residents, but were unsure of which strategies would best achieve that goal.

It is also worth considering how many of the current hypothesized causes of overweight and obesity in the population emanate from sources within local community control. Partners within the HSP expressed clear feelings of lack of power and control over certain parts of their environment, like the kinds of foods sold in chain supermarkets and convenience stores (i.e. "Corporate America"). However, several partners mentioned that they felt greater control over physical activity opportunities, since the placement, building and upkeep of these structures were often local political or bureaucratic decisions. Partners also felt some efficacy for working on the social environment in their communities, by creating social marketing campaigns to change opinions on the acceptability of breastfeeding, for instance. These are likely places where local communities have opportunities to successfully

implement initiatives, but just because they are places where local public health practitioners feel some degree of efficacy to function, does not necessarily make them the right places for intervention to have an ultimate impact on outcomes. Relatedly, to what extent can capacity be built in local public health practitioners such that they can tackle broader issues in the environment that may have a greater impact on health?

Put another way, is the local level the right place to concentrate our efforts for changing the environment? While most models of the ecological nature of obesity point to causes occurring at all levels in society from the individual to the national and international level, there is very little evidence that local causes (or causes under the control of local practitioners) have greater weight. While certainly organizational changes and education need to occur among local practitioners so that they can successfully carry-out local environmental interventions, understanding what we can reasonably expect from well-executed locally focused interventions is needed. We must also question the extent to which resources should be dedicated to creating environmental change in thousands of local communities over and over, and to what extent changes at higher levels in society might be more efficacious.

Perhaps one of the long-term consequences of raising the awareness of local public health practitioners about the ecological nature of obesity (and other health issues), is that the extent to which they engage in local efforts to create a healthier community, they become more supportive of social movements to make broader environmental and policy changes at the state, national, and international levels. As local practitioners and other interested partners form partnerships at the local level, assess their community, deliberate strategies, and execute interventions, they are in fact engaging in a deliberative process that can have real consequences. Participation in a deliberative process has been shown to increase knowledge of the problem and participants' feelings of internal political efficacy (i.e. feelings of personal capacity to

participate and get your voice heard) (Morrell 1999, Morrell 2005). As participants become more engaged in the issue of obesity and come to see its etiology framed from an environmental perspective, the number of voices calling for change may increase, and gradually put pressure on higher social institutions to make changes.

Strengths and Weaknesses

The HSP is the only project the authors are aware of that has focused its efforts to make environmental changes to promote healthy weights among childbearing women and in a rural population. Data on the process of community partnering was collected in several ways - through qualitative interviews, participant observation, and surveys – to try to capture as thoroughly as possible the actions taken, challenges faced, and changes in capacity as a result of the partnership. The researchers allowed many of the projects to develop organically in the communities, and since only a relatively small amount of funding was available, the interventions developed likely reflected more closely what rural communities might be expected to develop "on their own." An outcome evaluation, running in parallel to the interventions, was collecting data on behavior change and weight to determine if the environmental interventions had any affect. Results of this outcome evaluation are published elsewhere.

However, the HSP was a relatively small project, only focusing on 8 counties, and consequently the results may not be fully generalizable to all partnerships working on environmental change. Since the HSP generally allowed local partners to pick the interventions they would be involved in, the efficacy of certain kinds of environmental interventions could not be as clearly tested since the researchers had less control over the interventions chosen and the way they were implemented. Rather the HSP was better able to assess the ability of local partners to plan and develop environmental interventions, and the motivations that led them to certain interventions over others.

Conclusion

While more information is needed on potentially efficacious public health models to reduce overweight and obesity, attention must also be paid to the capacity of local public health professionals to implement local interventions, particularly as many public health practitioners work in organizational environments not as supportive of community-work as may be needed to make broader changes in the community. Future research should work to understand the most efficacious points in the ecology of obesity to act and which strategies will be most effective at those levels. Building the environmental capacity of public health practitioners will be a pre-requisite to any environmental strategy aimed at the community level.

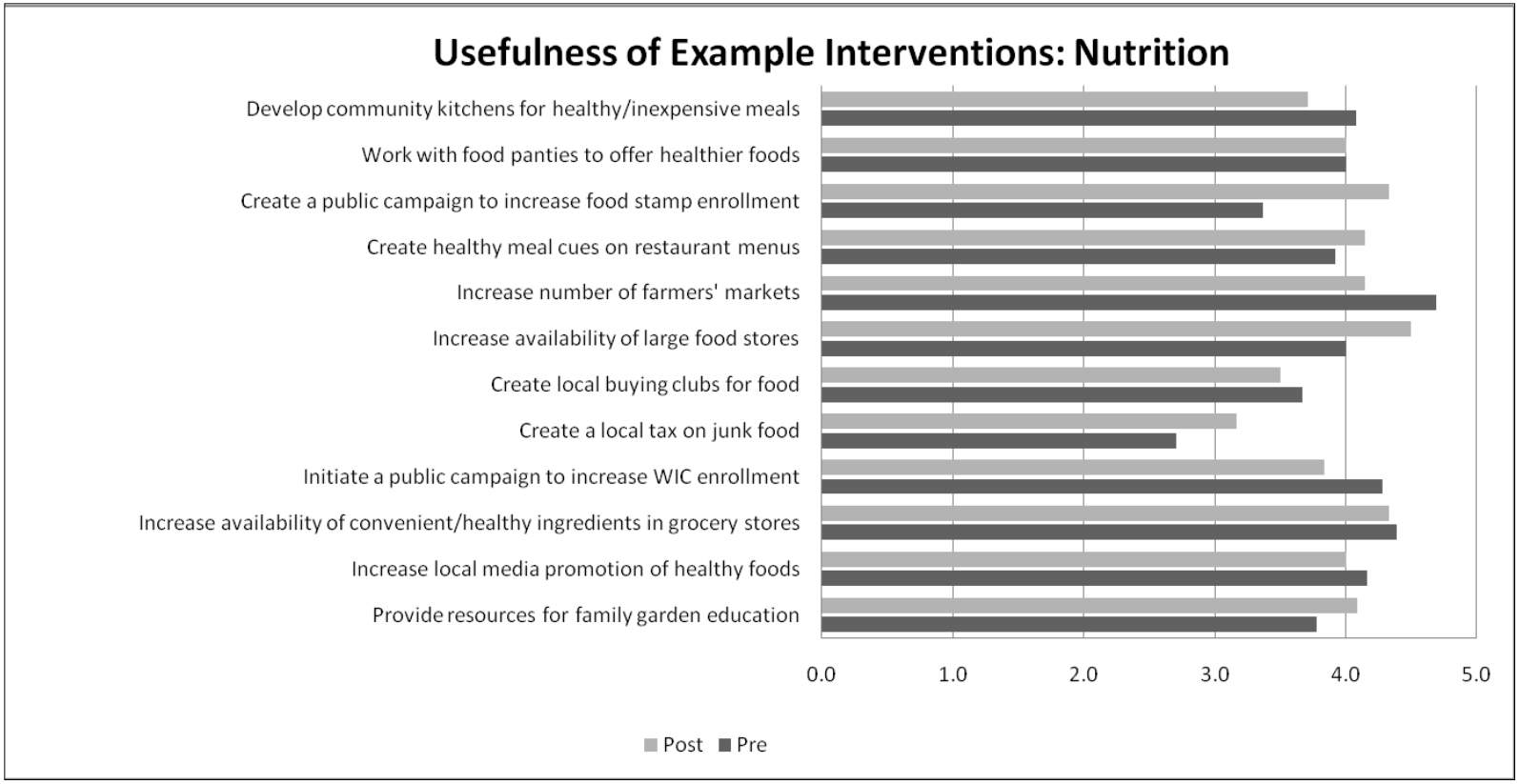
APPENDIX 6.A

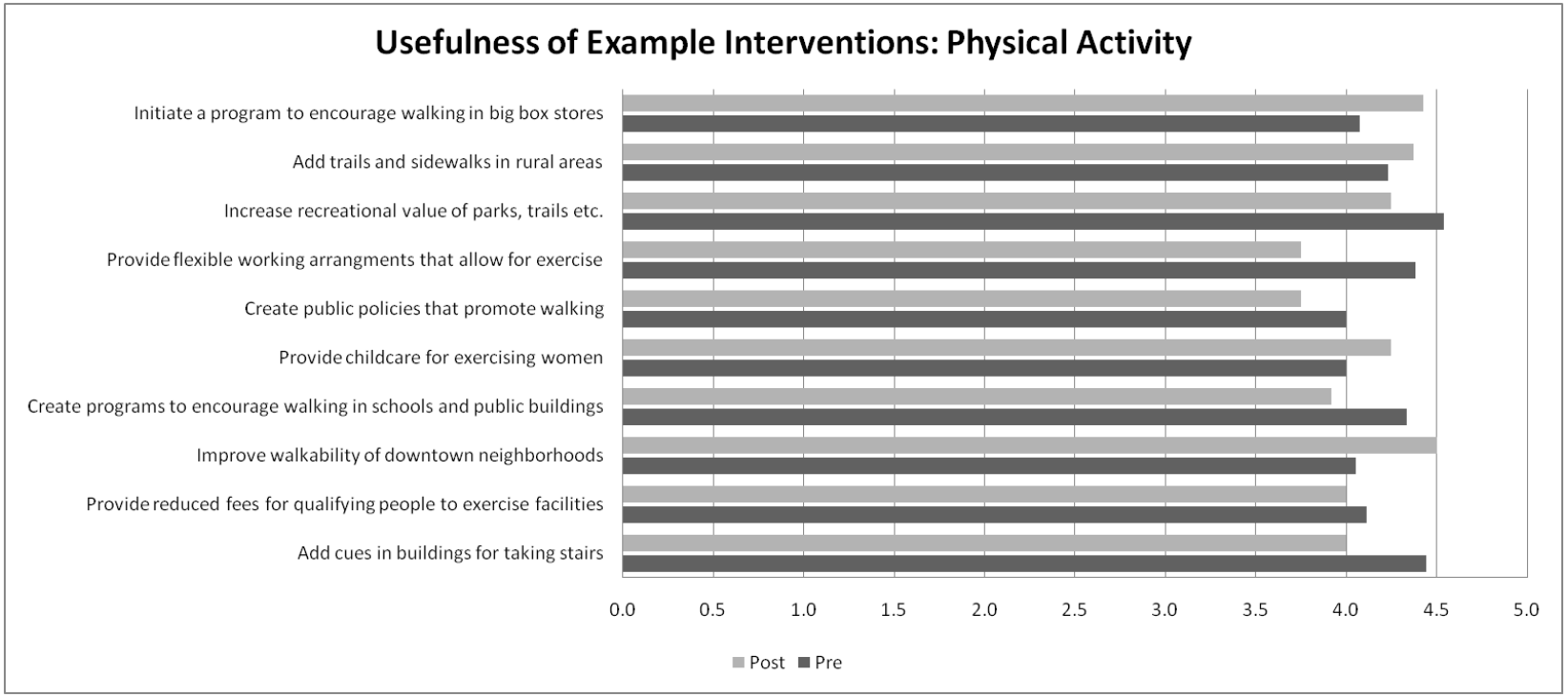
Major Agenda Items for Regional Partnership Meetings

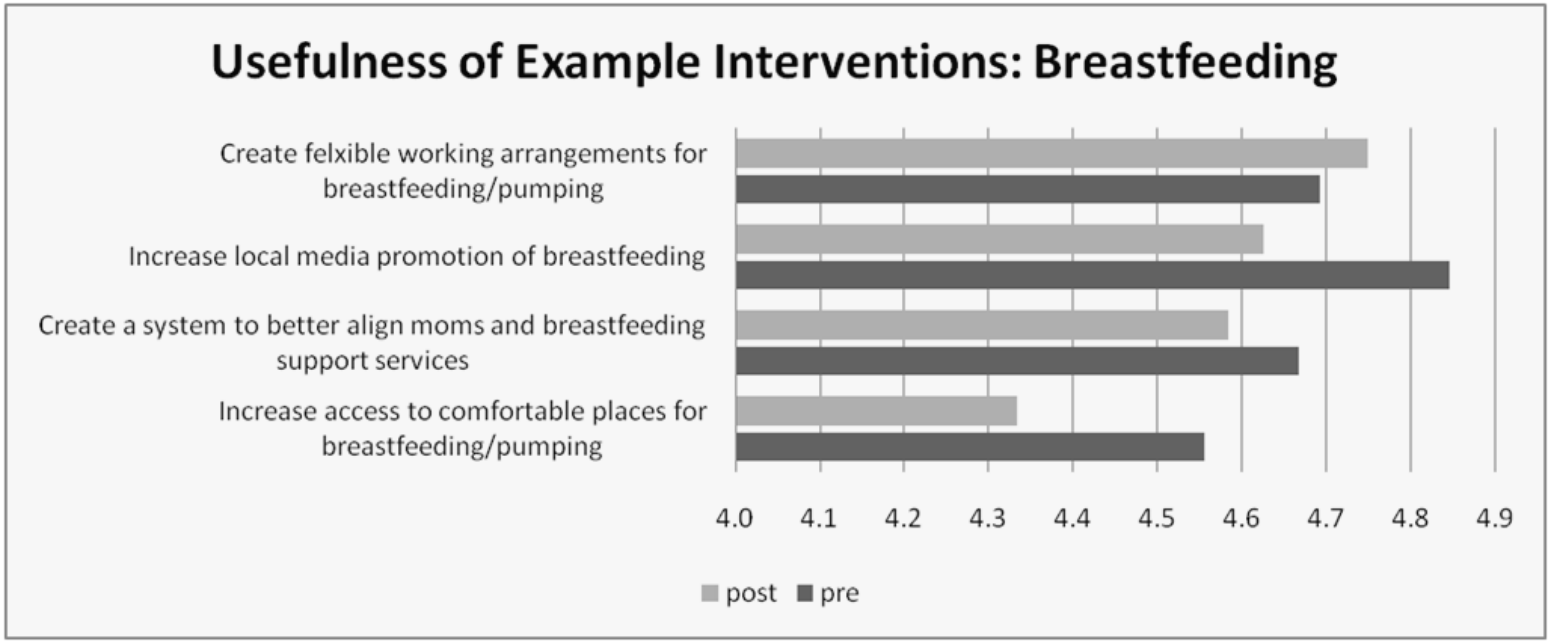
Date	Agenda Items
December 1, 2005	• Introduction to the HSP • Introduction to the problem of excessive gestational weight gain in childbearing women and its repercussions • Introduction to environmental determinants of weight • Consideration of how this information applies to local communities • Interest level of participants involvement collected
May 5, 2006	• Introduction to the HSP for those not previously involved • Example environmental intervention occurring in local area presented • Results of usefulness and feasibility survey presented • Partnership name brainstorming • Small group work on special topic related to potential environmental interventions
March 20, 2007	• Introduction to the HSP • Presentations on working with doctors • Results of process evaluation from one county breastfeeding intervention • County sharing of intervention activities and plans • Small group work on developing region-wide environmental interventions
September 28, 2007	• Presentations on environmental determinants of overweight and obesity, including an historical perspective • Presentation by a local planner on how to work with your planner • Presentation by a local bike path advocate on how "he did it" • Introduction to convenience store operations • County sharing of intervention activities and plans
April 4, 2008	• Presentations on creating workplace friendly breastfeeding policies • Presentation on convenience store operations • Presentation on the healthy steps being taken by a local convenience store chain • Presentation on the healthy food labeling system taken by a local Supermarket Chain • County sharing of intervention activities and plans • Thoughts on future directions for the HSP

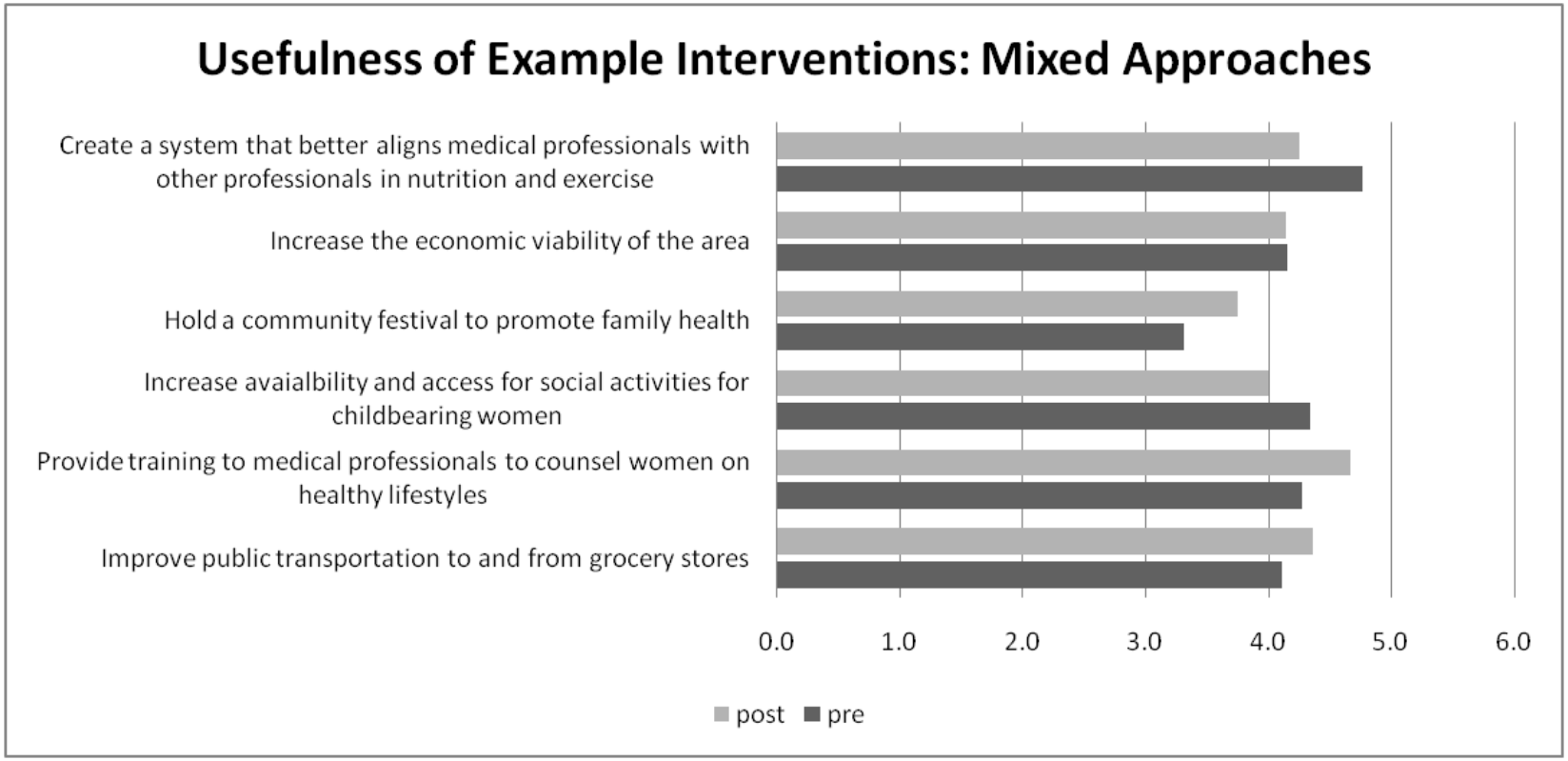
APPENDIX 6.B

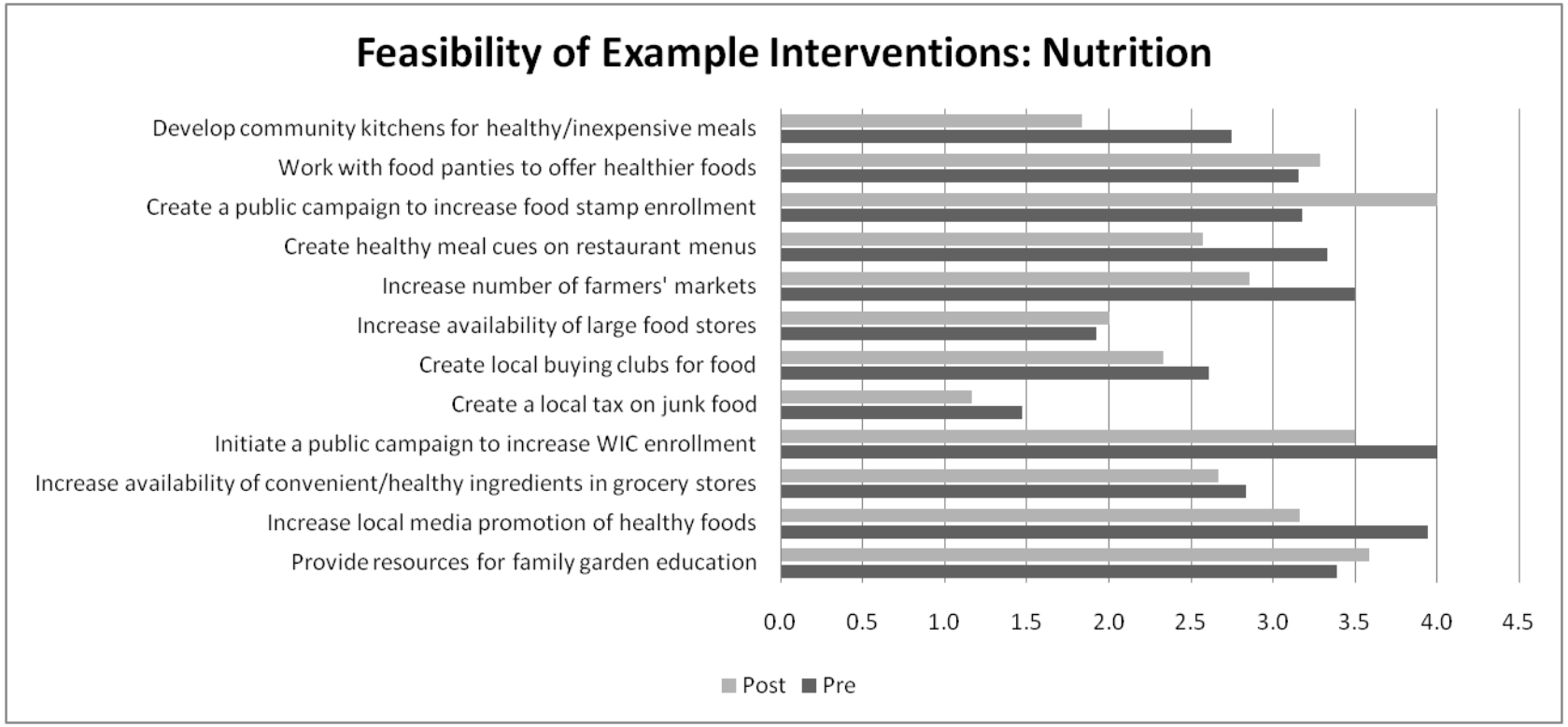
Usefulness and Feasibility of Example Environmental Interventions as Rated by HSP Partners (Pre and Post)



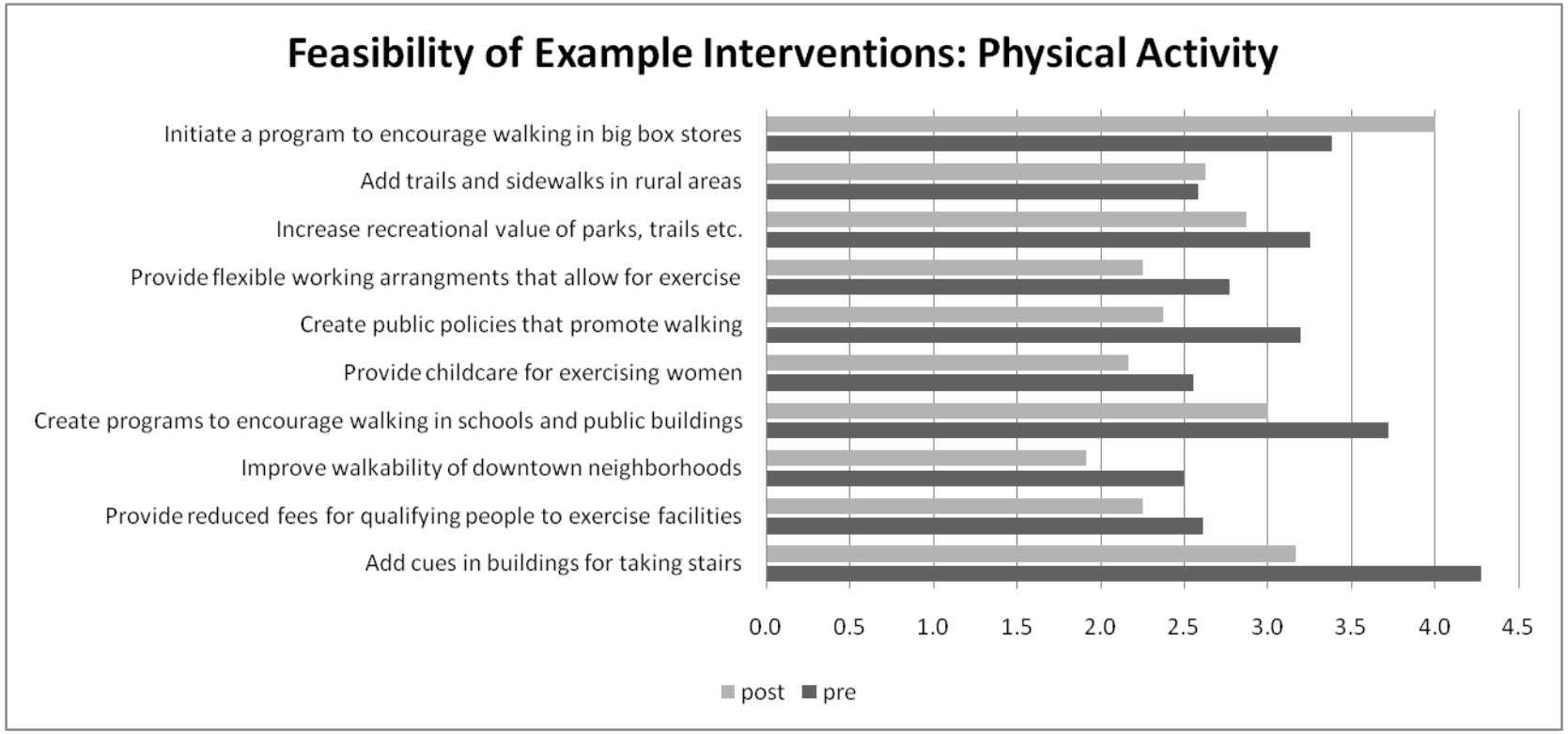

Usefulness of Example Interventions: Physical Activity
Initiate a program to encourage walking in big box stores
Add trails and sidewalks in rural areas
Increase recreational value of parks, trails etc.
Provide flexible working arrangments that allow for exercise
Create public policies that promote walking
Provide childcare for exercising women
Create programs to encourage walking in schools and public buildings
Improve walkability of downtown neighborhoods
Provide reduced fees for qualifying people to exercise facilities
Add cues in buildings for taking stairs
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Post
Pre

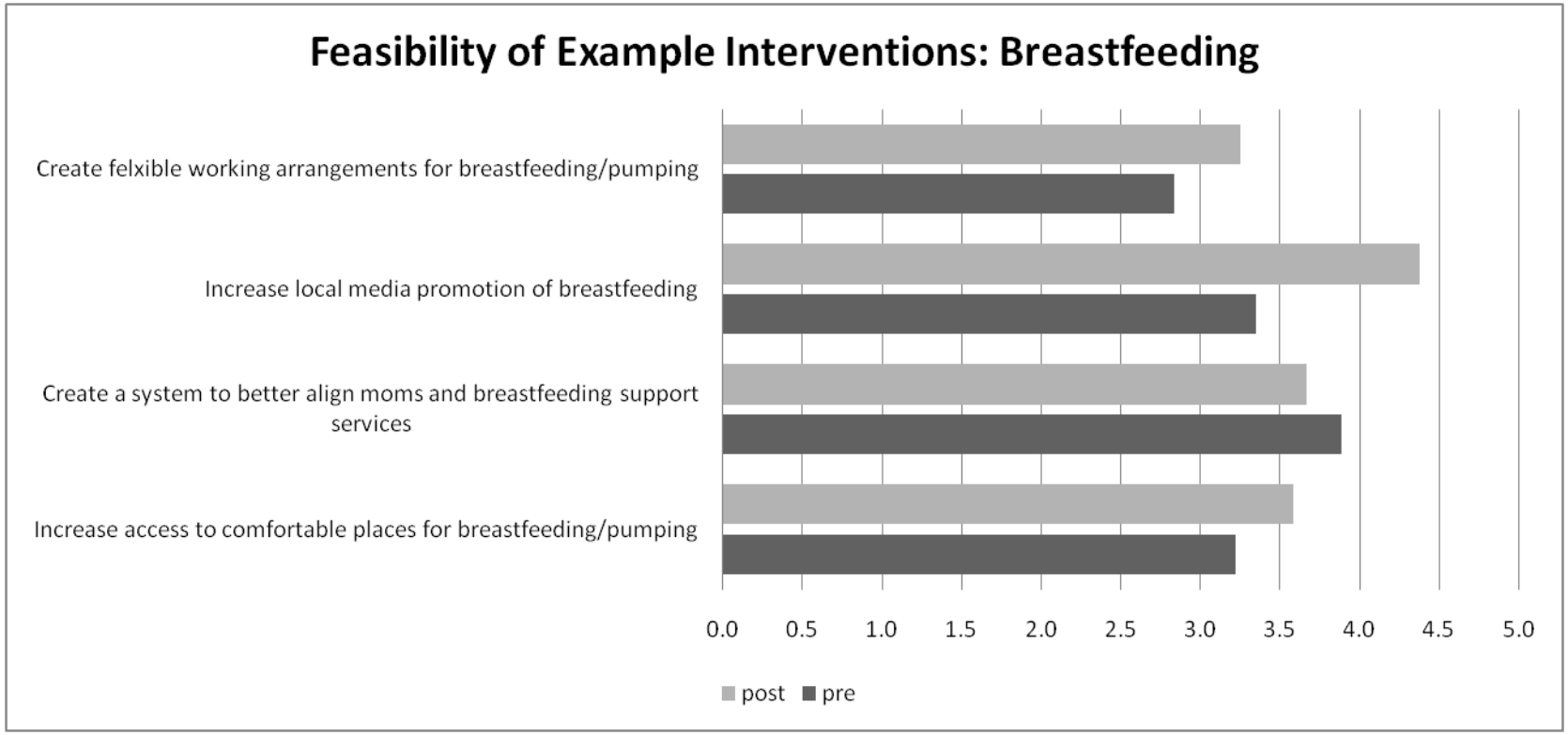

Usefulness of Example Interventions: Breastfeeding
Create felxible working arrangements for breastfeeding/pumping
Increase local media promotion of breastfeeding
Create a system to better align moms and breastfeeding support services
Increase access to comfortable places for breastfeeding/pumping
4.0
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
post
pre

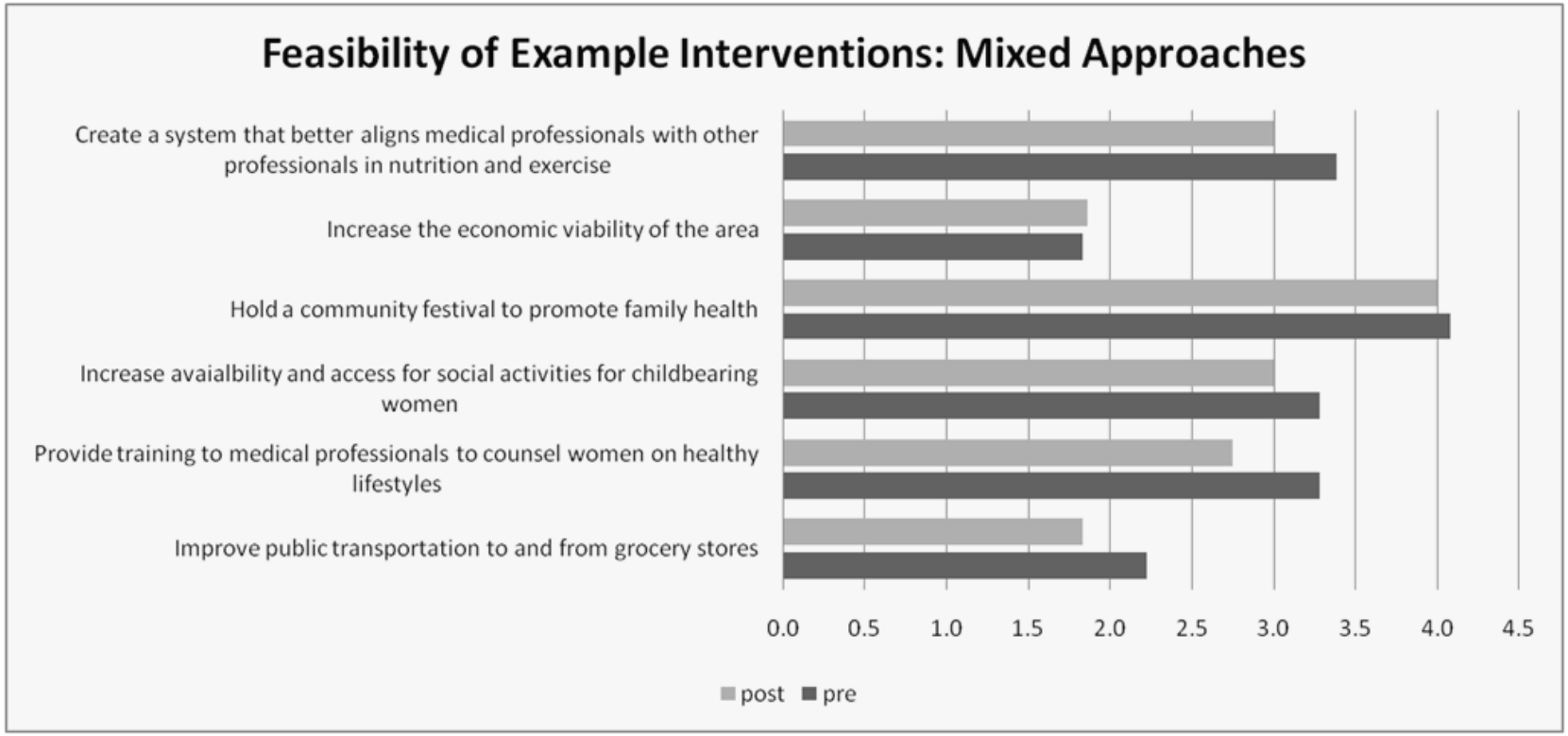

Usefulness of Example Interventions: Mixed Approaches
Create a system that better aligns medical professionals with other professionals in nutrition and exercise
Increase the economic viability of the area
Hold a community festival to promote family health
Increase avaialbility and access for social activities for childbearing women
Provide training to medical professionals to counsel women on healthy lifestyles
Improve public transportation to and from grocery stores
0.0
1.0
2.0
3.0
4.0
5.0
6.0
post
pre


Feasibility of Example Interventions: Nutrition
Develop community kitchens for healthy/inexpensive meals
Work with food panties to offer healthier foods
Create a public campaign to increase food stamp enrollment
Create healthy meal cues on restaurant menus
Increase number of farmers' markets
Increase availability of large food stores
Create local buying clubs for food
Create a local tax on junk food
Initiate a public campaign to increase WIC enrollment
Increase availability of convenient/healthy ingredients in grocery stores
Increase local media promotion of healthy foods
Provide resources for family garden education
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Post
Pre

APPENDIX 6.B CONTINUED

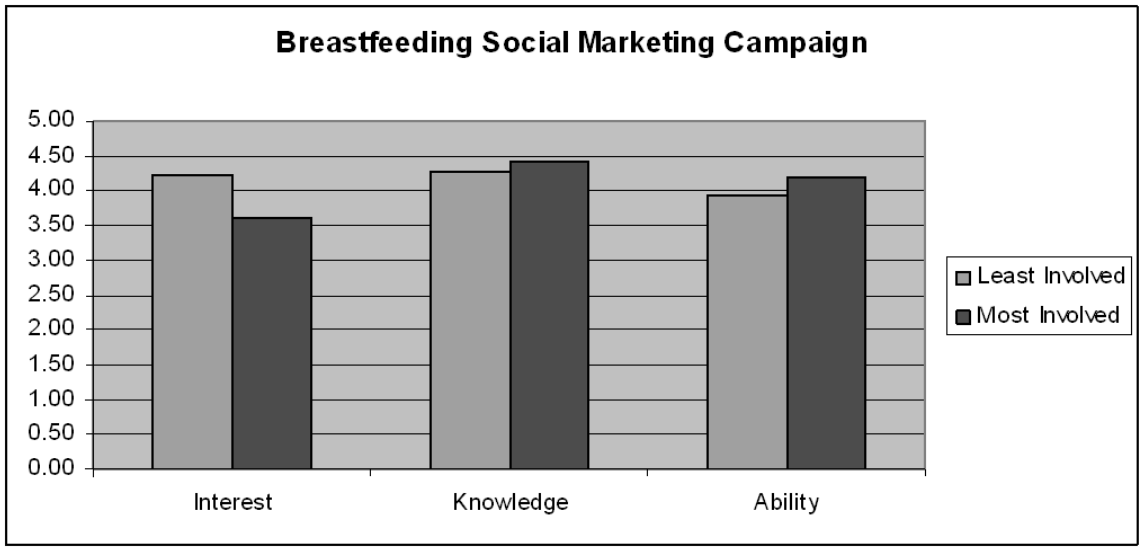


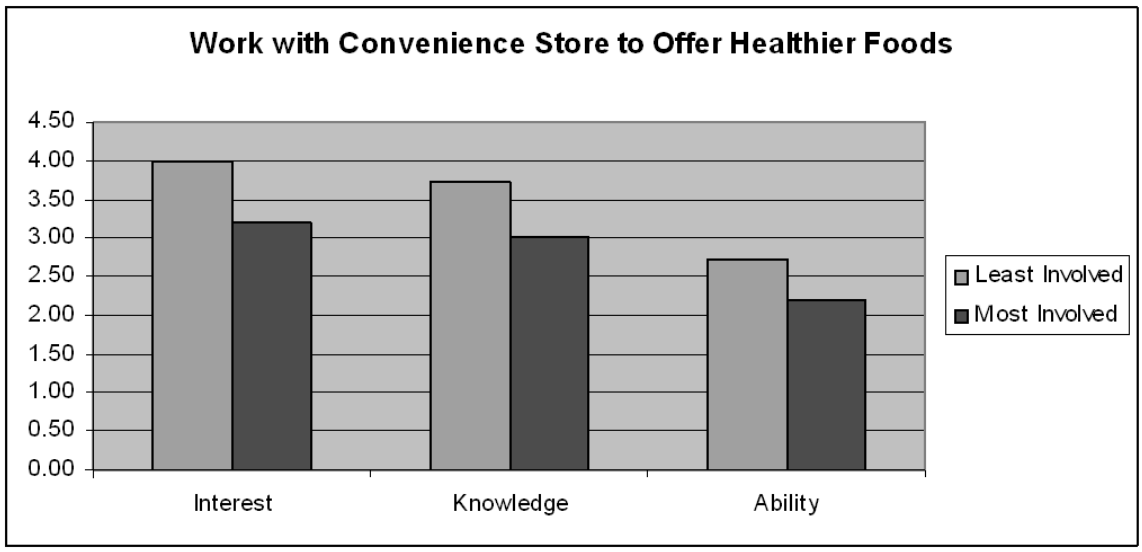

Feasibility of Example Interventions: Breastfeeding
Create felxible working arrangements for breastfeeding/pumping
Increase local media promotion of breastfeeding
Create a system to better align moms and breastfeeding support services
Increase access to comfortable places for breastfeeding/pumping
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
post
pre

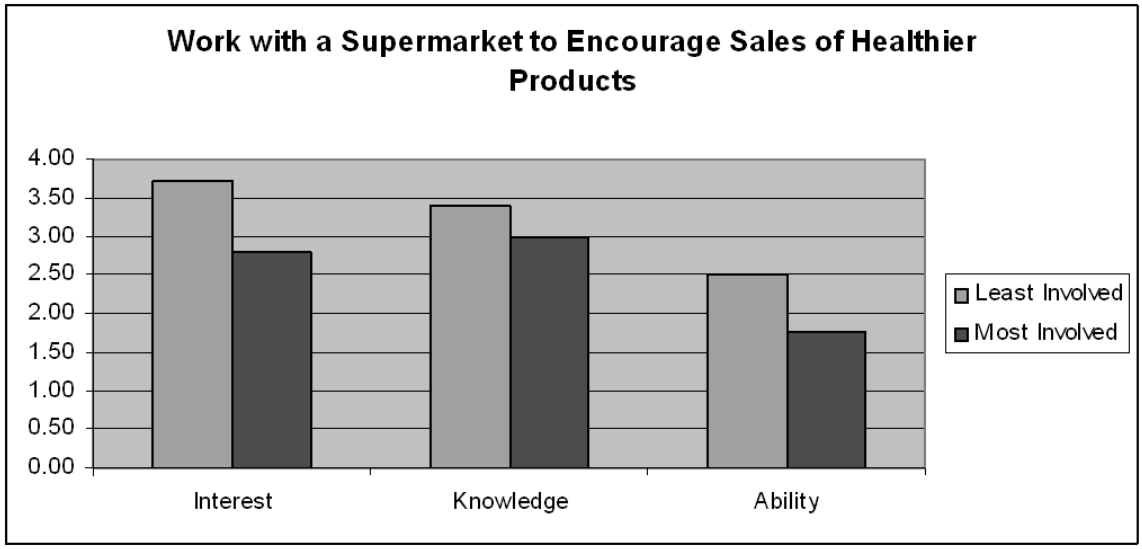

Feasibility of Example Interventions: Mixed Approaches
Create a system that better aligns medical professionals with other professionals in nutrition and exercise
Increase the economic viability of the area
Hold a community festival to promote family health
Increase avaialbility and access for social activities for childbearing women
Provide training to medical professionals to counsel women on healthy lifestyles
Improve public transportation to and from grocery stores
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
post
pre

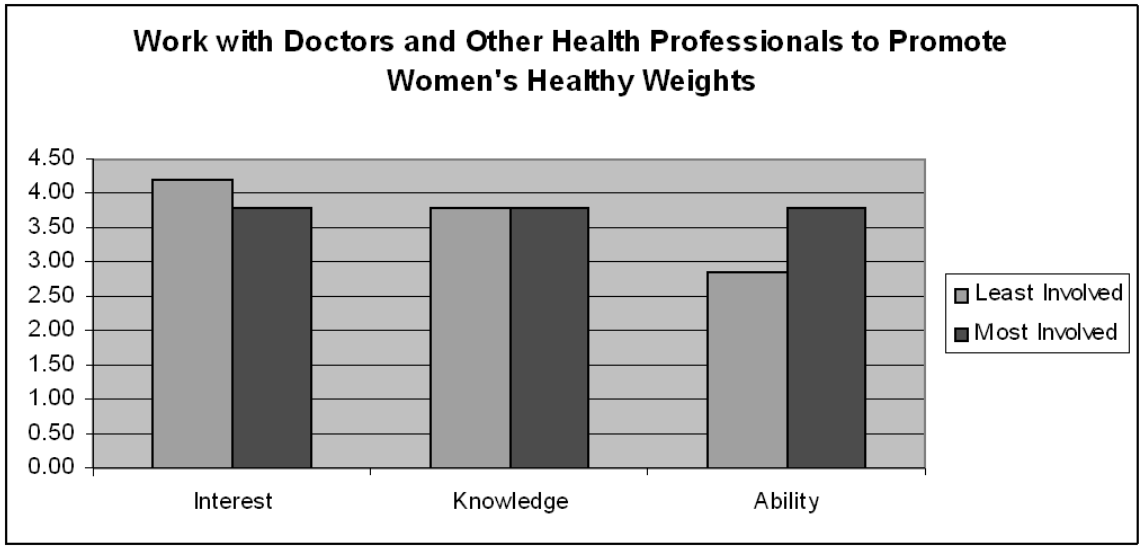
APPENDIX 6.C

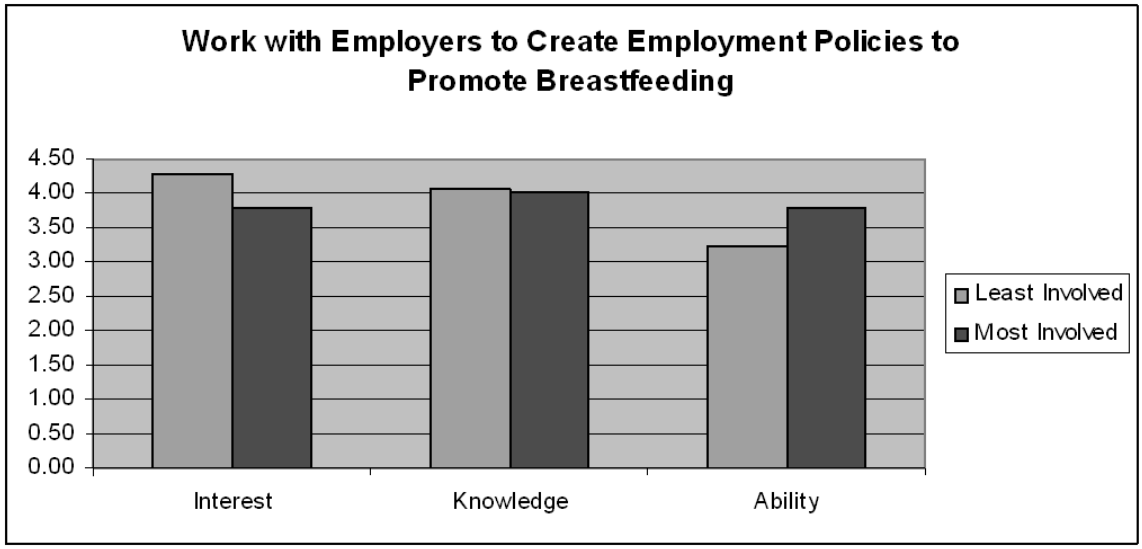
Interest, Knowledge, and Ability of the Most Involved Partners versus the Least Involved in Various Environmental Interventions

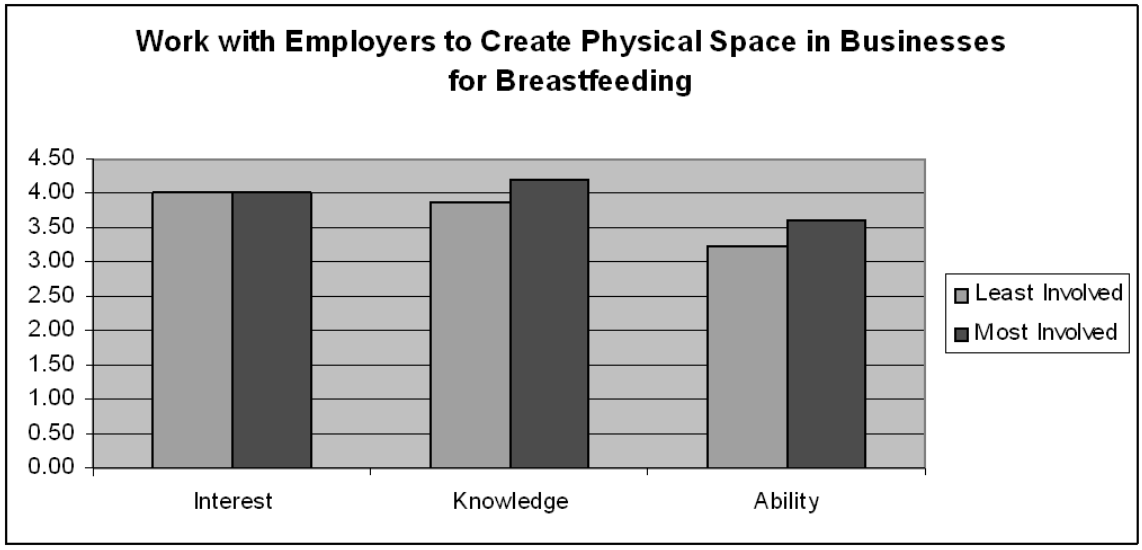


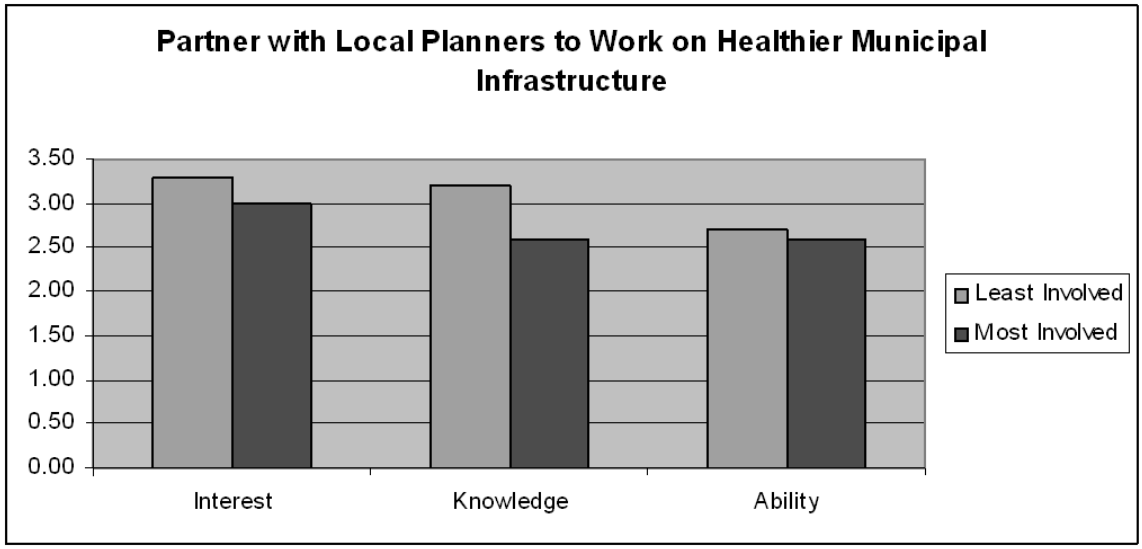


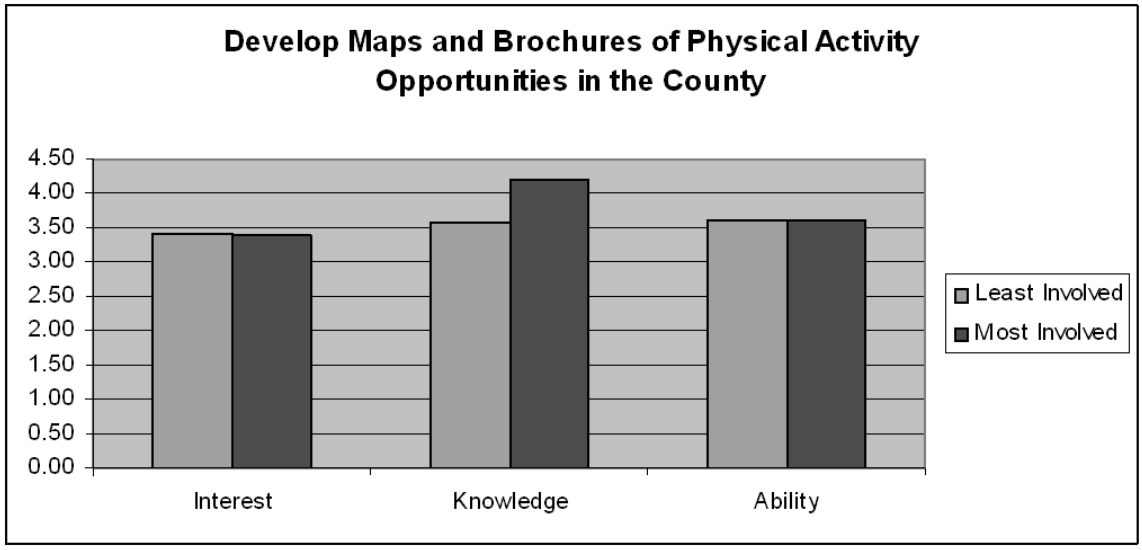

Work with a Supermarket to Encourage Sales of Healthier Products
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved

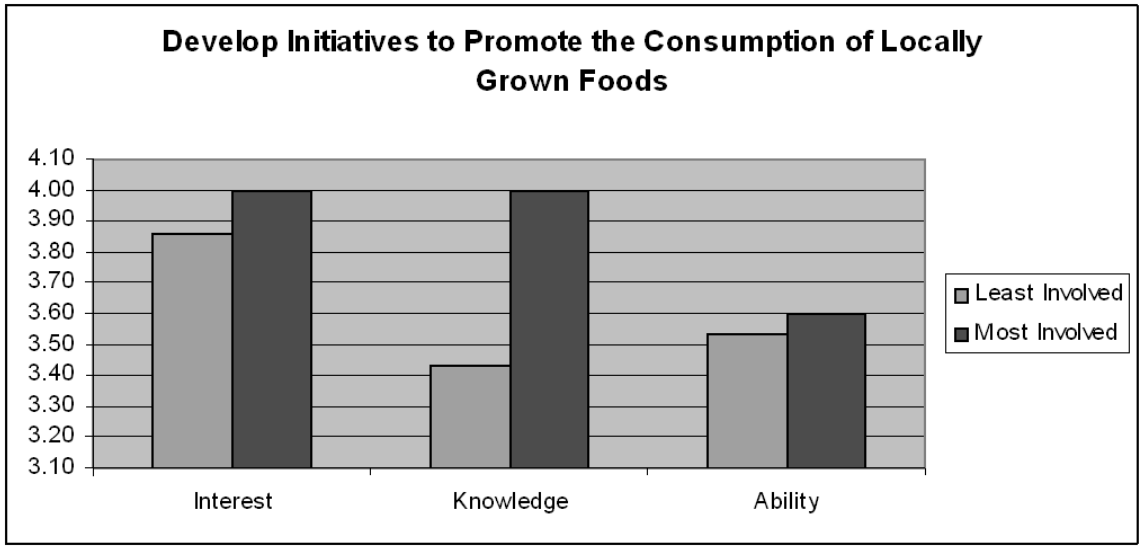

Work with Doctors and Other Health Professionals to Promote Women's Healthy Weights
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved

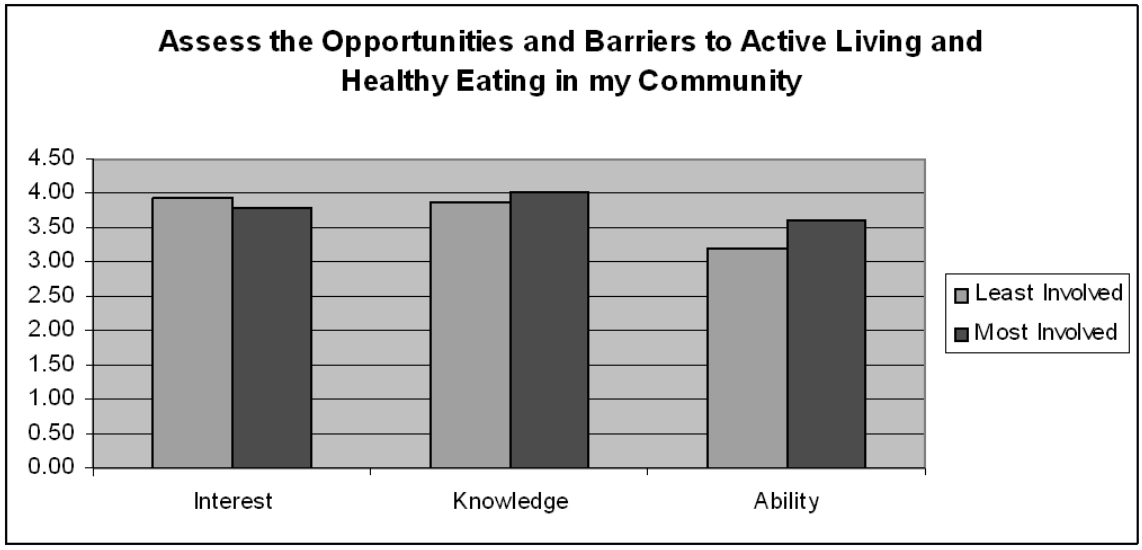

Work with Employers to Create Employment Policies to Promote Breastfeeding
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved

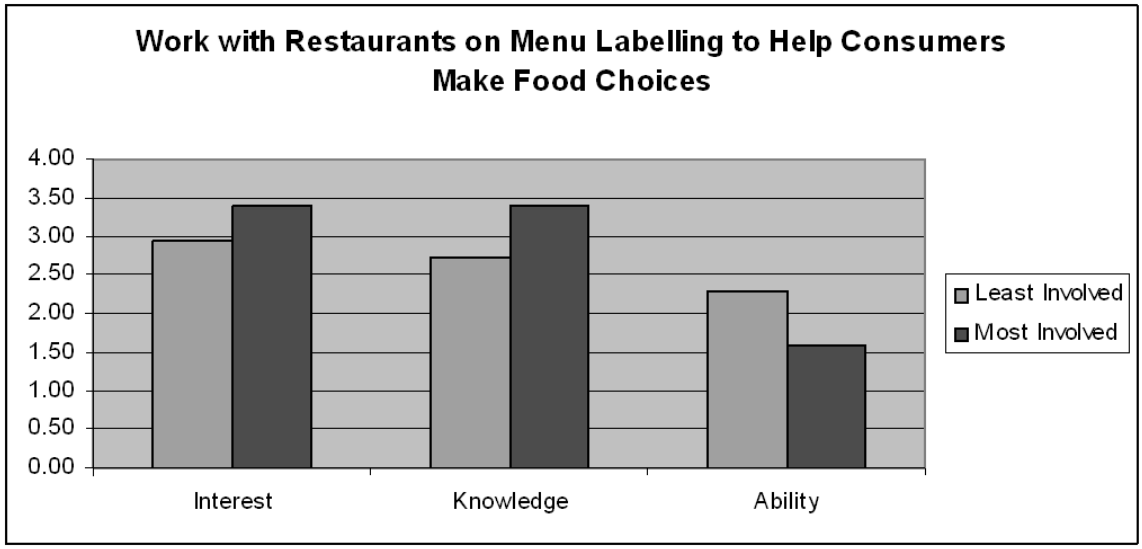

Work with Employers to Create Physical Space in Businesses for Breastfeeding
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved

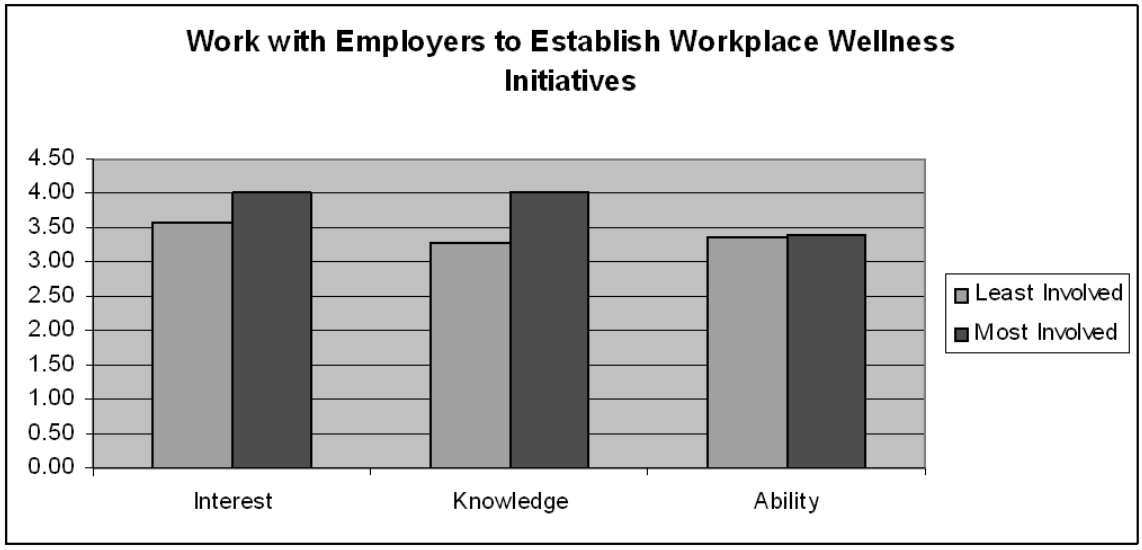

Partner with Local Planners to Work on Healthier Municipal Infrastructure
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved

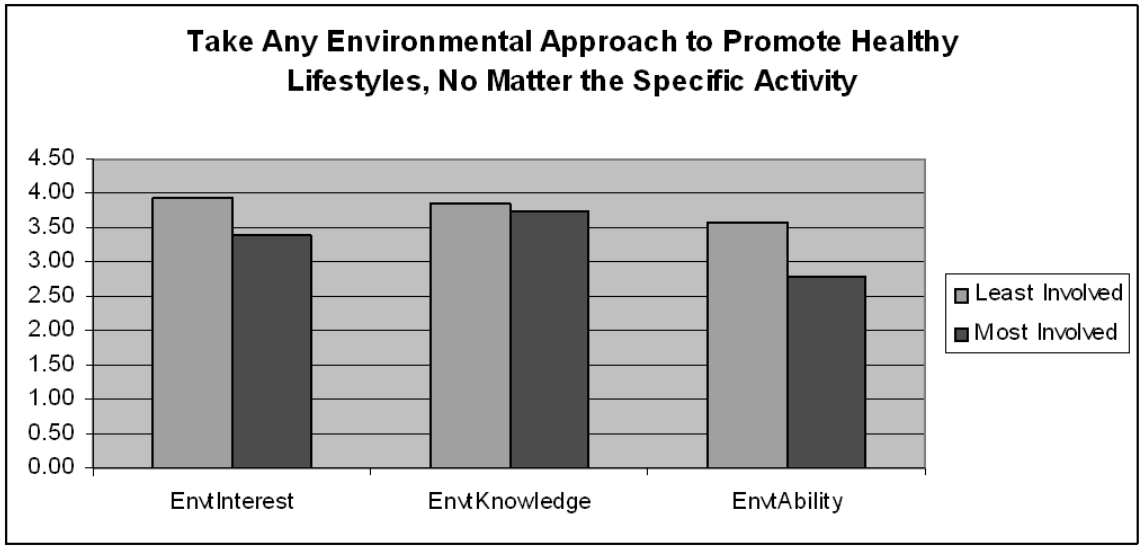

Develop Maps and Brochures of Physical Activity Opportunities in the County
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved


Develop Initiatives to Promote the Consumption of Locally Grown Foods
4.10
4.00
3.90
3.80
3.70
3.60
3.50
3.40
3.30
3.20
3.10
Interest
Knowledge
Ability
Least Involved
Most Involved


Assess the Opportunities and Barriers to Active Living and Healthy Eating in my Community
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved


Work with Restaurants on Menu Labelling to Help Consumers Make Food Choices
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved

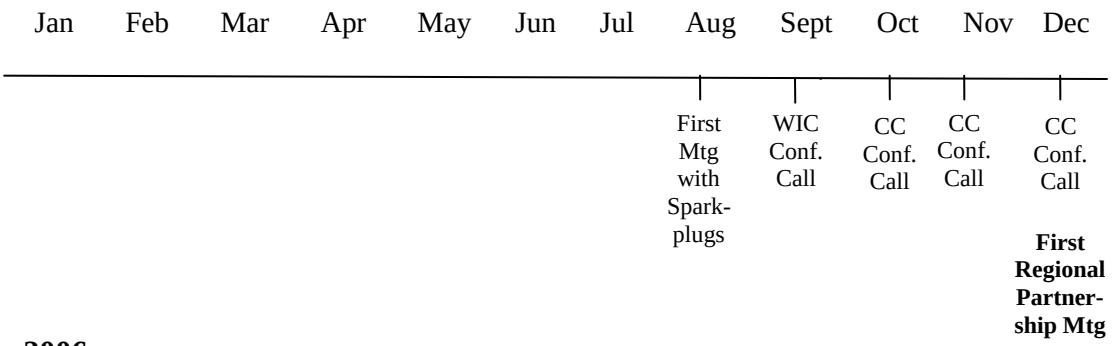

Work with Employers to Establish Workplace Wellness Initiatives
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Interest
Knowledge
Ability
Least Involved
Most Involved


Take Any Environmental Approach to Promote Healthy Lifestyles, No Matter the Specific Activity
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
EnvtInterest
EnvtKnowledge
EnvtAbility
Least Involved
Most Involved

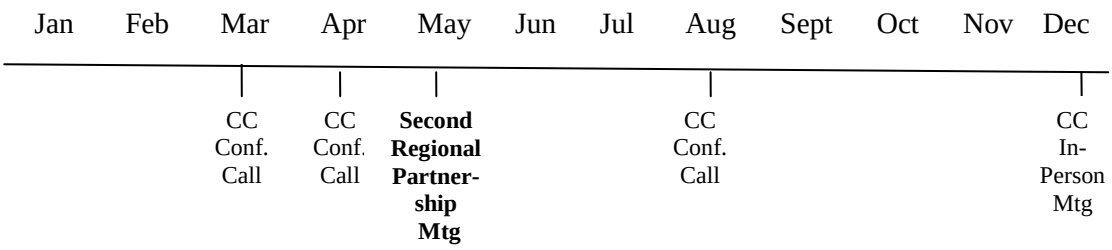
APPENDIX 6.D

Timeline of Healthy Start Partnership Activities

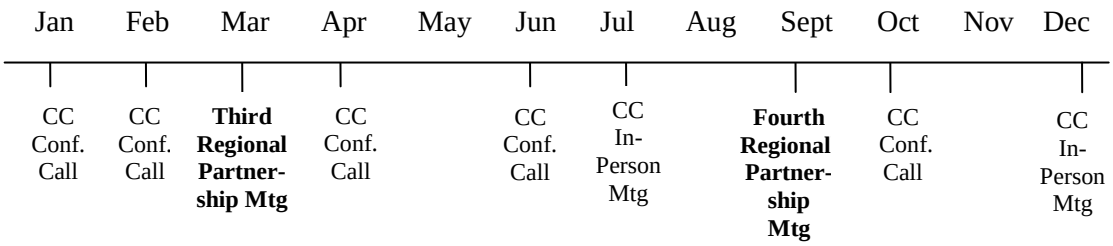
2005



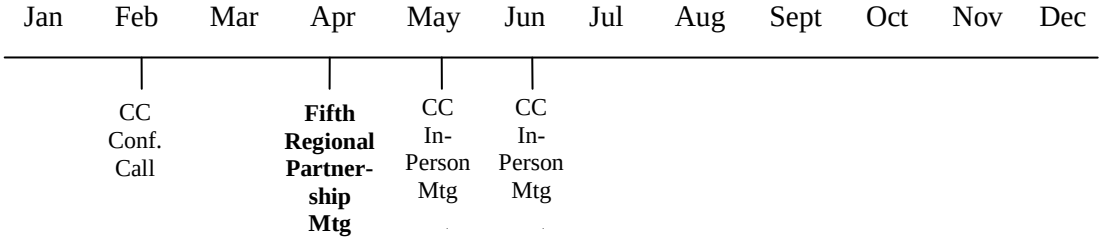
2006



2007



2008



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CHAPTER SEVEN

CONCLUSION

Research Conclusions

The food environment in a rural 8700 square mile are of Upstate NY was investigated with the aim to describe the kinds of foods available, the distribution of these foods in the environment, and how the types of stores and the food sold within them correlate with women's food related behaviors and weight in a sample of 555 women in early pregnancy (≤ 14 weeks gestation). Also investigated were the challenges faced a public health practitioners as members of a local community-based partnership (The Healthy Start Partnership) to create environmental interventions to support healthy weights in women and their children in this same area of Upstate NY.

Results in Chapter Second demonstrated that a wide variety of stores sell food, including many "non-traditional" food stores like drug stores, dollars stores, and general merchandise stores. While supermarkets and most grocery stores still offered the widest variety of all surveyed foods, several of the smaller stores and "non-traditional" stores also sold some healthier items (e.g. skim milk, whole grain bread). Fresh produce was only available in 43% of the surveyed stores (mainly supermarkets and grocery stores, although approximately a third of convenience stores also sold some fresh produce). Less healthful foods like soda and potato chips were sold in nearly all stores. Of the surveyed stores 54.3% were convenience stores, and this store type was on average the closest type of store to the participant women. Women were also much more likely to be within two miles of foods like soda and chips, than more healthful foods like apples and tomatoes (average nearest distance 3.2 miles).

Chapter Three examined two ways of collating food store data: cluster analysis and Healthy Food Availability Index. The advantage of cluster analysis was that it reduced the number of "store types" to five (as opposed to 14) based on the availability of produce and the number of varieties of other food types. Generally, the largest supermarkets sorted into one cluster, and smaller supermarkets and larger grocery stores sorted into a second cluster. The remaining store types were distributed among the three remaining clusters. The Healthy Food Availability Index reduced all the food variety variation to a single statistic that summarized every store along a continuum from 0 to 37. Supermarkets, grocery stores, and discount grocers generally scored high, but the remaining store types showed quite a bit of variation in scores (although generally this variation was among values lower than those scored by supermarkets and grocery stores). Ongoing consideration of how to characterize and summarize information from the food environment is needed, particularly as non-traditional food stores increasingly sell more food and even begin to sell fresh groceries.

Chapter Four examined the relationship between the food environment and weight in a sample of 555 women. Generally, the more stores in a woman's near food environment (one and five miles) the higher her odds for being overweight or obese. Of particular interest, women with a supermarket within one mile from her home or a supermarket or grocery store five miles from her home were at higher risk for being obese or overweight, respectively. In addition proximity to a natural food store reduced odds of being obese. Modification by household income did not reveal many additional significant relationships, although lower income women were more likely to be closer to a discount grocer or a dollar store compared to higher income women, and higher income were more likely to live closer to a grocery store and a general merchandise store. Lower income women were more likely to be overweight if they

lived within five miles of a grocery store, and higher income women were less likely to be obese if they lived near a natural food store. These results differ from many studies in urban areas where proximity to a supermarket or larger grocer decreased the odds of overweight and obesity (Morland et al 2006, Powell et al 2007a, Inagami et al 2006, Sturm and Datar 2005). It may be that rural food environments differ in significant ways from urban food environments including more "non-traditional" food stores (Bustillos et al 2009, Liese et al 2007), less segregation by income and race (in the northeast), and generally increased travel distance to food stores for all residents (Sharkey 2009, Blanchard and Lyson 2005, Morton and Blanchard 2007, Powell et al 2007b).

Chapter Five examined the affects of mediating variables between the food environment and BMI, specifically shopping and diet behaviors and feelings of self-efficacy to eat a health diet among lower income women. It was found that more supermarkets five and ten miles from a woman's home and more stores one and five miles from a home predicted more smaller shopping trips made in a supermarket. In addition more supermarkets within five miles predicted more frequent smaller shopping trips. Vegetable gardening was associated with higher fruits and vegetable consumption, but hunting and fishing was associated with decreased consumption. Putting three diet variables (type of milk drunk, average number of servings a day of fruits and vegetables, and average servings a day of whole grains) together in a Diet Index Score suggested that more supermarkets within five and ten miles of a woman's home increased the chance that she would score highly on the Diet Index Score. This relationship is consistent with the association seen between availability of a supermarket or more food stores five and ten miles from a woman's home and consumption of more fruits and vegetables, suggesting that women who have a relatively abundant food environment five or ten miles from their home have better

diets. Analysis of the interaction between frequent small shopping, availability of supermarkets five and ten miles from home, and diet suggests that women who had at least one supermarket within 10 miles of their home and who did their smaller shopping trips in a supermarket were more likely to score higher on the Diet Index Score. Women who had higher self-efficacy to eat healthier were found to consume more fruits and vegetables. No relationships were found between diet or shopping behaviors and weight. While much work is yet to be done on understanding the nature of the food environment, even more work stands to be done on understanding how individuals and families function within these environments. There is a robust literature on individual elements that contribute to food choice (e.g. family traditions, values, household resources, knowledge and skills), and some of these elements should be incorporated into future studies to better connect the elements of the food environment with diet and health (Devine et al 1999, Connors et al 2001, Furst et al 1996, Glanz et al 1998).

Chapter Six took a very different approach from the previous chapters, and examined the process by which public health practitioners discussed, planned and implemented environmental interventions. It was found that practitioners generally viewed the causes of overweight and obesity from an ecological perspective, but among those that were interested in addressing these environmental determinants, there were significant challenges. Many partners were trained for education and service delivery, and so felt they lacked the skills to work on environmental change. It was also felt among some practitioners that working on environmental determinants of overweight and obesity required a passion that the practitioners did not have, suggesting many public health jobs in nutrition and health selectively attract practitioner more interested in education and service delivery. Organizational support for environmental approaches was also lacking according to many practitioners (for

instance, environmental approaches were not part of the job description, or practitioners lacked "community time" to be extensively involved in any partnership). There were also concerns that practitioners lacked power to influence decision-makers who had more control over the environment and that practitioners lacked the skills and the language to negotiate effectively with these non-traditional partners. As a result of these challenges, practitioners chose projects that more closely aligned with their traditional way of working (i.e. education and social marketing), and likely had less of an impact on the broader environmental determinants of obesity. As the evidence base grows that the social, policy, and built environments in which we live are important predictors of weight and health, approaches to prevent and treat obesity through environmental interventions will become more popular. Consideration must be given to the capacity-building needs of public health practitioners who will be on the front lines and are tasked with improving public health. However, there is still a tremendous need for evidence-based practice suggesting promising interventions likely to have a major impact on weight and health. Development of pubic health practitioner capacity must go hand-in-hand with the development of this research base.

Future Areas of Research

The author outlines 4 major areas for future research:

1) More research needs to explore how the food environment affects food choice and weight in different geographic areas of the country. There is already evidence that the relationship between less healthy food environments and less healthy diets observed in some urban areas of the United States is not observed in urban areas of England and Australia, potentially owing to the different ways these communities are built and settled (Lake and Townshend 2006). Even within rural areas of this country, the

historical settlement patterns associated with segregation and discrimination against African Americans in rural areas of the south may have contributed to different community built and food environments compared to rural areas of the north (Kaufmann. 1998).

2) More research needs to examine the "black box" between the food environment and weight, by collecting more information on shopping behavior, food choice, and additional individual-level variables that would be expected to intervene and mediate the relationship between the built environment and the food that is ultimately consumed (Devine et al 1999, Connors 2001, Furst et al 1996, Glanz et al 1998).

3) Research on the food environment also needs to go beyond cross-sectional analysis. For instance, more extensive research needs to be conducted on how food beliefs, shopping behaviors, diet, and weight change after the introduction of healthier foods or larger food stores in a community (or the removal of healthier foods or food stores). Opportunities for these kinds of natural experiments are cropping up around the country in a variety of settings and on different scales from school classrooms to entire cities, sometimes as a result of the work of advocacy organizations (e.g., The Food Trust 2009). In some cases these interventions may lend themselves well to randomized control trials, and in other cases pre and post-testing of changes in the outcome variables of interest (e.g. beliefs, perception, food choices, weight etc.) may be adequate.

4) Finally, researchers and interested community members need to build on the evidence gathered from point #3 above to explore workable mechanisms to modify the built environment to support healthier lifestyles. Potential leverage points and points

for intervention are almost as numerous as there are communities. While clearly more work needs to be done to build the capacity of local organizations and local public health practitioners to assess, design and implement these environmental changes, a great amount of work is also yet to be done to investigate the most effective points of intervention and how they should be targeted. Evidence on the relative efficacy of different potential interventions is also needed, taking into consideration the relative short and long-term differences in cost, political acceptability, timeframe, and the portion of the population that is impacted. University-community partnerships may be an effective mechanism to not only build local public health capacity to understand and implement environmental interventions, but also ensure that these interventions are grounded in local knowledge and sound science.

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