Exploring the Food and Physical Activity Environments and Their Influence on Healthy Behaviors

Clarice Nhat-Hien Waters

Dissertation submitted to the faculty of Virginia Polytechnic Institute and State University in partial fulfillment of the requirement for the degree of

Doctor of Philosophy
In
Human Nutrition, Foods, and Exercise

Jennie L. Hill
Korine N. Kolivras
Paul A. Estabrooks
Jamie M. Zoellner

October 25, 2013
Blacksburg, Virginia

Keywords: community-based participatory research, environment, fruit and vegetable intake, physical activity, health disparate

Exploring the Food and Physical Activity Environments and Their Influence on Healthy Behaviors

Clarice Nhat-Hien Waters

ABSTRACT

Using a community-based participatory research (CBPR) approach, community members, community stakeholders, and academic researchers from Virginia Tech formed a community-academic partnership in 2009. In the formative months, the coalition decided to focus on reducing obesity in the region. The coalition adopted the name of The Dan River Partnership for a Healthy Community (DRPHC) with a mission to "foster community partnerships to combat obesity in the Dan River Region through healthy lifestyle initiative". During a planning workshop, the DRPHC created six causal models for the root causes of obesity in the region. Two causal models that focused on geographic and environmental influences for obesity are the foundation for this series of research.

The focus of this dissertation is at the intersection of the food and physical activity environments and their characteristics that contribute to meeting fruit and vegetable intake and minutes of physical activity recommendations. The food environment is one aspect of built environment research that examines food locations for procurement and the variety, availability, and quality of different food options. To date, the vast majority of research on the food environment is based in urban, suburban, and metropolitan areas with high residential densities and populations. Rural areas are often understudied because of their dispersed and hard-to-reach populations; yet these individuals experience some of the worst health outcomes in the nation. This is due, in part, to the large overlaps of rural regions and food deserts, resulting in poor food choices and poor diets. The overall objective of this dissertation is to examine the associations of the food and physical activity environments with individual healthy behaviors.

Three studies were conducted within the broader research plan to meet the overall objective. The first study systematically examined the food environment using the Nutrition Environment Measures Survey (NEMS) for all food outlets in Danville, VA, a small regional city within the health disparate region, to compare differences in healthy available food options by block group race and income. The second study expanded NEMS methodology to encompass all food outlets in the three-county Dan River region to examine if food environment and availability of healthy options was predictive of meeting fruit and vegetable intake recommendations. The last study examined the objective and perceived distance individuals must travel to reach a physical activity outlet and whether or not distance was a predictive factor of individual weekly minutes of moderate to vigorous physical activity and meeting physical activity recommendations.

DEDICATION

Annalette, as you wished.

ACKNOWLEDGEMENTS

Thank you to my family, for all the love and support throughout all my life endeavors. To Jimmy, I am indebted to you for the countless hours of editing manuscripts, late nights and weekends working in the lab, and long car rides for data collection. Thank you for always knowing when to make me laugh during my most stressful times and for always believeing in me; this would not have been possible without you. To Faustine and Andrew, thank you for patience and understanding while I was away from home on conducting research. And to my second parents, Hank and Leslie Jo, thank you for loving me as your daughter.

To my faculty advisor, Jennie, thank you for the past three years. You have challenged me to be a better researcher, taught me invaluable life lessons, and have been a great role model for balancing life with an academic career. I enjoyed the experience (the good, bad, and ugly!) and your guidance through the process. Thank you to Jamie, Paul, and Korine for sharing your expertise and input towards this research. It was a pleasure to work and learn fro you. To the GCH faculty at GMU, especially Kathryn, for making me a better writer and never letting me give up. Thank you, Lisa, for giving me the opportunities to travel and teach. To Curtiss, who has inspired me to be a worldly traveler, thank you for your wit and continued correspondence; and to Lorraine, who took a chance on me and accepted me into the GCH graduate program to start my academic career, I thank you.

To my dear friends, thank you for continuing to encourage me. Special thanks to Esther, the duck to my swan. To my HNFE labmates with whom I commiserate the pains of graduate school, I am grateful for our time working together and challenging each other to always be better. To my NEMS and PARA research teams, without you I would still be collecting data; thank you for all the fun road trips.

A special thanks to the DRPHC community members who have allowed me to continue my research and to all the business owners in the DRR who allowed us to collect our data.

ATTRIBUTIONS

Manuscript 1:

Jamie M. Zoellner is an associate professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. She was a co-investigator that received funding for this project and assisted by editing this manuscript.

Jennie L. Hill is an assistant professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. She was the principal investigator that received funding for this project and assisted in the conceptualization of this manuscript, helped develop the protocol for data collection, guide the data anylses, and assisted by editing this manuscript.

Manuscript 2:

Jamie M. Zoellner is an associate professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. She was a co-investigator that received funding for this project and assisted by editing this manuscript.

Paul A. Estabrooks is a professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. He assisted by editing this manuscript.

Jennie L. Hill is an assistant professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. She was the principal investigator that received funding for this project, and assisted by editing this manuscript.

Manuscript 3:

Jamie M. Zoellner is an associate professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. She was a co-investigator that received funding for this project and assisted by editing this manuscript.

Korine N. Kolivras is an associate professor in the Department of Geography at Virginia Tech. She assisted by editing the manuscript.

Paul A. Estabrooks is a professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. He assisted by conceptualizing and editing this manuscript.

Eileen F. O'Connor was an undergraduate student in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech during preparation of this manuscript. She assisted with the enumeration and collection of data and writing the introduction and discussion sections.

Jennie L. Hill is an assistant professor in the Department of Human Nutrition, Foods, and Exercise at Virginia Tech. She was the principal investigator that received funding for this project, and assisted by editing this manuscript.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

Using a community-based participatory research (CBPR) approach, community members, community stakeholders, and academic researchers from Virginia Tech formed a community-academic partnership in 2009. In the formative months, the coalition decided to focus on reducing obesity in the region. The coalition adopted the name of The Dan River Partnership for a Healthy Community (DRPHC) with a mission to "foster community partnerships to combat obesity in the Dan River Region through healthy lifestyle initiative". During a planning workshop, the DRPHC created six causal models for the root causes of obesity in the region. The series of projects presented here evolved from two causal models that focused on geographic and environmental influences for obesity (Appendix A). As such, this is a community-based participatory research project and all findings will be disseminated back to the DRPHC and community members to inform future intervention and action-items.

This dissertation is grounded in the social ecological framework focused on the intersection of the food and physical activity environments and their characteristics that contribute to meeting fruit and vegetable intake and minutes of moderate-vigorous physical activity recommendations. The food environment is one aspect of built environment research that examines food locations for procurement and the variety, availability, and quality of different food options. To date, the vast majority of research on the food environment is based in urban, suburban, and metropolitan areas with high residential densities and populations. Rural areas are often understudied because of their dispersed and hard-to-reach populations; yet these individuals experience some of the worse health outcomes compared to the nation. The negative outcomes are due, in part, to the lack of resources in these areas resulting in poor health behaviors. These different research interest areas are combined in the following three distinct, but related studies. The overall objective of this dissertation is to examine the relationship of the food and physical activity environments with individual behaviors in a rural health disparate region.

The aim of the first study was to enumerate and describe the food environment in a rural, health disparate region. The distribution of healthy food availability was spatially analyzed. Low-income and predominantly minority neighborhoods had fewer food outlets and lower healthy food availability. This study was completed in 2011 and has been published in the *Journal of Hunger and Environmental Nutrition.*

The purpose of the second study is to expand on the first food environment study and to perform spatial analysis of the food environment and to determine if proximity to food outlets influences individual's ability to meet fruit and vegetables recommendations. It was found that residents of the DRR are not meeting current USDA recommendations for fruit and vegetable intake. Further, there was low healthy food availability throughout the region. The results of this study are currently under review at a peer-reviewed journal.

In addition to the food environment mentioned in the previous two studies, the third study focused on the physical activity environment. The study assessed how objective and subjective proximity to resources influences weekly minutes of moderate-vigorous physical activity (MVPA) and meeting PA recommendations. The self-reported average weekly MVPA minutes were lower than the current national recommendations. There was no signicant relationship between proximity to an outlet and PA behaviors.

CHAPTER 2: LITERATURE REVIEW

Built Environment and Health

Built environments can be defined as any human-made physical structure in the environment and may include: buildings, streets, designated space for physical activity (parks, trails, and gyms), food outlets (restaurants, grocery stores), neighborhood design and aesthetic appeal (Brownson, Baker, Housemann, Brennan, & Bacak, 2001; Saelens, Sallis, Black, & Chen, 2003). These features of the built environment may promote or hinder healthy lifestyles. There is growing evidence that supports the relationship between obesity and built environments (Booth et al., 2005; Elinder & Jansson, 2009; Papas et al., 2007). Specific to obesity, "obesogenic environments" is a term used to describe how environmental factors influence obesity (Booth et al., 2005; Papas et al., 2007). Characteristics of obesogenic environments include food and physical activity resources, neighborhood environments, the level of walkability, sidewalks, perceived safety from crime and traffic, and neighborhood aesthetics (Booth et al., 2005; Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; Diez Roux & Mair, 2010; Elinder & Jansson, 2009; Feng et al., 2010; Kaczynski & Henderson, 2008; Saelens & Handy, 2008). Two important aspects of obesogenic environments are the food and physical activity environments. Individuals are more likely to engage in physical activity and meet the recommendations for physical activity when outlets are closer to their homes (Diez Roux et al., 2007; Evenson, Scott, Cohen, & Voorhees, 2007; Giles-Corti & Donovan, 2002a; Kaczynski & Henderson, 2008). Alternately, individuals who live in areas with a high density of fast food restaurants tend to be obese and eat away from the home more frequently (Feng et al., 2010; Giskes, van Lenthe, Avendano-Pabon, & Brug, 2011; Li, Harmer, Cardinal, Bosworth, & Johnson-Shelton, 2009).

These environmental correlates differ across geographic regions and mirror race, ethnic and income disparities. In the United States, suburbanites have a higher health status than residents of urban or rural areas (Hartley, 2004). While urban areas have a higher density of resources, they may not be accessible to residents and the high presence of traffic and low aesthetics may negatively affect utilization of the resources (Giles-Corti & Donovan, 2002b). Compounding to the rural geographies, there is a higher prevalence of Blacks in the rural South and more Hispanics in the rural Southwest (Probst et al., 2004). These minority populations are at a greater disadvantage with lower number of resources and environmental barriers to health care (Eberhardt & Pamuk, 2004; Probst et al., 2004). Living in economically deprived areas increases one's risk of chronic conditions (Freedman, Grafova, & Rogowski, 2011). Low socioeconomic neighborhoods have fewer food and physical activity outlets available, which may explain, in part, disparities in health status (Black & Macinko, 2008; Ford & Dzewaltowski, 2010; Franco, Diez Roux, Glass, Caballero, & Brancati, 2008; Giskes et al., 2011; Zenk et al., 2011).

Unclear in the built environment literature related to obesity is the extent to which individual characteristics or area characteristics contribute to poor health outcomes such as physical inactivity, poor diet and obesity (Kawachi & Berkman, 2003). Compositional explanations focus on individuals that live in one area and attribute health outcomes to the individual's features, characteristics, and behaviors. Research on composition has a "people make the place" perspective (Kawachi & Berkman, 2003). However, contextual explanations seek to determine the extent to which poor environments, such as those with an overall lack of resources (Kawachi & Berkman, 2003; Lovasi, Hutson, Guerra, & Neckerman, 2009) contribute to obesity. In the systematic review of environmental characteristics in disadvantaged areas, Lovasi and colleagues concludes that vulnerable individuals live in environments with poor access to supermarkets and space for PA (Lovasi et al., 2009). Low supermarket accessibility is positively associated with the high prevalence of obesity in disadvantaged areas (Lovasi et al., 2009). Attempts to untangle compositional or contextual effects are artificial in that they ignore the interrelated nature of places and people (Macintyre, 2007; Macintyre, Ellaway, & Cummins, 2002).

Deprivation amplification encompasses both compositional and contextual effects by hypothesizing that poor and vulnerable populations, already at risk for poor health outcomes, experience additional and sustained exposures by living in unhealthy environments which compounds these individual level risks (Macintyre, 2007; Macintyre et al., 2002). Related to obesity, deprivation amplification is supported by findings such as an unequal density and distribution of food and PA outlets by socioeconomic status and racial/ethnic minority populations (Boone-Heinonen et al., 2011; Franco et al., 2009; Gordon-Larsen, Nelson, Page, & Popkin, 2006; Moore, Diez Roux, & Brines, 2008; Shishehbor, Gordon-Larsen, Kiefe, & Litaker, 2008). Low-income and minority populations have fewer supermarkets, less access to fresh produce, and live farther from physical activity outlets and open-space than other populations (Boslaugh, Luke, Brownson, Naleid, & Kreuter, 2004; Franco et al., 2009; Franco et al., 2008; Wilson, Kirtland, Ainsworth, & Addy, 2004).

However, these findings are not consistent. For example, Estabrooks and colleagues found an equal number of physical activity resources in low-income, minority neighborhoods compared to White and higher income areas (Estabrooks, Lee, & Gyurcsik, 2003); while Giles-Corti and colleagues found that low-socioeconomic neighborhoods had higher accessibility to sports and recreational centers (Giles-Corti & Donovan, 2002b). These inconsistencies are noted by McIntyre's 2007 article, in which she highlights several shortcomings of the deprivation amplification hypothesis. The spatial distribution of environmental resources may not be patterned by area-level deprivation and varies greatly by type of resource. Yet, the quality of these resources is less important than the presence or absence of the resource and perceptions of the availability and accessibility. This inconsistency is supported in multiple literature reviews of built environment and health research in which the authors conclude that there is still a great deal of variability in measurement and standard definition of neighborhood area (buffer or other geographic boundaries), making it difficult to generalize across studies (Feng et al., 2010; Giskes et al., 2011; Lovasi et al., 2009).

Environment is only one level of influence contributing to the obesity epidemic in the United States. There are many facets of the environment, but this dissertation is focused to the food and physical activity environments and the availability of resources as it relates to individual behaviors. As the prevalence of obesity and related chronic conditions continue to rise, it is imperative that there is a holistic approach to any behavior-based intervention.

Obesity

Obesity is a known risk factor for many chronic diseases, which include but are not limited to, cardiovascular disease, hypertension, and type 2 diabetes (Flegal, Carroll, Ogden, & Curtin, 2010; Ogden et al., 2006; Ogden, Yanovski, Carroll, & Flegal, 2007; Pender & Pories, 2005). Overweight increases one's risk of becoming obese and developing related chronic health conditions (Ogden et al., 2006; Pender & Pories, 2005). For a two decade period (1960-1980), trends of overweight and obesity had been stable in the United States (Flegal, 2005), but in the late 1980's, the prevalence rate of obesity in adults began to increase (Flegal, 2005; Flegal et al., 2010; Ogden et al., 2007). This trend of obesity became alarming as the prevalence in adults doubled in a short amount of time (Flegal, 2005; Flegal et al., 2010). National surveys throughout the 1990s and early 2000s show an upward trend in both overweight and obesity for the total population (Flegal et al., 2010; Ogden et al., 2006; Ogden et al., 2007).

Although prevalence of obesity is increasing in all groups in the United States, there are disparities in which some sectors of the population are disproportionately burdened. For example, non-Hispanic Blacks have the highest rates of both overweight and obese and Asian Americans have the lowest rates among all racial groups in the United States (Wang & Beydoun, 2007). Across gender, women had higher rates of obesity than men, and among all females, non-Hispanic Black had higher rates than non-Hispanic white females (Baskin, Ard, Franklin, & Allison, 2005). Beyond disparities by gender and race or ethnicity, factors including education, income, and place of residence also influence obesity (Flegal et al., 2010; "Healthy People 2020"; Jackson, Doescher, Jerant, & Hart, 2005; Phillips & McLeroy, 2004; Wang & Beydoun, 2007). Low socioeconomic groups are at an increased risk of obesity (Ogden et al., 2006; Wang & Beydoun, 2007). The prevalence of obesity is highest among individuals with less than a high school diploma compared to individuals who have a high school degree or some level of post-secondary education (Wang & Beydoun, 2007). Obesity prevalence is lowest in suburban areas compared to urban or rural regions (Jackson et al., 2005; Patterson, Moore, Probst, & Shinogle, 2004; Probst, Moore, Glover, & Samuels, 2004). As many past studies have looked at the disparities in non-modifiable risk factors, other studies have shifted focus to modifiable risk factors, such as individual level behavior changes as well as environmental and policy level changes.

The key in maintaining a healthy weight status is energy balance. Achieved through a neutral balance, the energy (e.g., calories) consumed equals the energy expended (e.g., through exercise) (Spiegelman & Flier, 2001). Weight gain is a product of positive energy balance when caloric intake is greater than calories expended. Therefore, research has focused on individual behavior changes for weight loss and weight maintenance. There has been much success of obese individuals reducing their weights and lowering their body mass index through individually focused behavioral interventions for lowering caloric intake or increasing physical activity (Anderson, Konz, Frederich, & Wood, 2001; Anderson, Vichitbandra, Qian, & Kryscio, 1999; Daly et al., 2000; Lutes et al., 2008). However, sustainability and long-term maintenance of weight status varies (Anderson et al., 2001; Brownell & Jeffrey, 1987; Sherwood et al., 2011). While it was believed that obesity and weight status was a factor of only genetic disposition, current research has shown that in recent years that obesity is the result of changes in the environment, specifically the availability and composition of foods and the lower demand of physical exertion (Booth, Pinkston, & Poston, 2005; Feng, Glass, Curriero, Stewart, & Schwartz, 2010; Spiegelman & Flier, 2001). However, it is still unclear whether an interaction effect of genes and environments is leading to this weight gain.

Given limited results from individual behavior change interventions, recent research has begun to take an ecological perspective to population-based approaches. Under the ecological model, individual and environmental factors are equal contributors to obesity and consequently have multiple levels and points for interventions (Brownson & Jones, 2009; Harper, 2006; Sallis, Owen, & Fisher, 2003; Spence & Lee, 2003). Individual behavior changes are most effective and sustainable when accompanied by environmental and policy changes (Sallis et al., 2003). Therefore, population-based strategies for reducing weight should account for individual behaviors in the environmental context. Moving away from individual-based interventions, research is now focusing on built environmental factors and their influence on behaviors.

Phsysical Activity Environment

The built environment for physical activity includes resources or features that promote or enable physical activity or active transport such as land use and design, sidewalks, parks and recreational settings, private gyms and fitness centers, or other open space for activity (e.g., fields, black tops, neighborhood cul-de-sac). Cities with a grid-pattern, sidewalks, and high street connectivity and number of destinations, have higher walkability indices that promote walking behavior and active transport than cities wihout those characteristics (Brownson et al., 2001; Giles-Corti & Donovan, 2002b; Saelens & Handy, 2008). Available parks and recreational space increases the potential for physical activity by planned exercise and walking (Kaczynski & Henderson, 2008). Resources with a high number of features were more likely to increase physical activity behaviors (Kaczynski, Potwarka, & Saelens, 2008).

In exploring the neighborhood differences in physical activity behaviors, there are known disparities (Brownson et al., 2001; Diez Roux et al., 2007; Giles-Corti & Donovan, 2002a, 2002b; Giles-Corti, Timperio, Bull, & Pikora, 2005). High socioeconomic status is generally perceived as providing better access to resources and these residents reported higher minutes of physical activity than there lower socioeconomic status counterparts (Brownson et al., 2001; Brownson et al., 2004; Giles-Corti & Donovan, 2002b; Romero et al., 2001; Wilson et al., 2004). Further, low socioeconomic status individuals reported higher perceptions of crime and traffic, low neighborhood aesthetics, and less perceived accessibility to recreational facilities, which are all barriers to physical activity behaviors (Brownson et al., 2001; Giles-Corti & Donovan, 2002b; Wilson et al., 2004). Aside from socioeconomic disparities, there are environmental disparities in perception and physical activity. Residents from highly walkable neighborhoods perceived their neighborhoods to have better street connectivity and engaged in more minutes of physical activity than individuals from low walkable areas (Leslie et al., 2005; Saelens et al., 2003). Across race and gender, Blacks reported low perceptions of neighborhood attributes for physical activity (Boslaugh et al., 2004), while men reported more physical activity resources than women (Brownson et al., 2001). As these several studies address environmental determinants of physical activity, other studies that follow within the decade have examined both objective and subjective measures of the physical environment as they relate to behaviors.

The actual presence of available physical activity resources and physical activity behavior is well-documented (Boone-Heinonen, Evenson, Song, & Gordon-Larsen, 2010; Diez Roux et al., 2007; Giles-Corti & Donovan, 2002a; Hoehner, Brennan Ramirez, Elliott, Handy, & Brownson, 2005; Kaczynski & Henderson, 2008; Kaczynski et al., 2008; Parra et al., 2010; Saelens & Handy, 2008). Physically active individuals reported that the outlet for most, or all, physical activity was close to their home (<1 mile) (Boone-Heinonen, Evenson, et al., 2010; Boone-Heinonen, Popkin, Song, & Gordon-Larsen, 2010; Diez Roux et al., 2007; Giles-Corti & Donovan, 2002a). Researchers also found that individuals were more likely to engage in physical activity behaviors if their neighborhoods had a higher density of resources than those who lived in areas with a lower density of resources (Diez Roux et al., 2007; Saelens et al., 2003). Among environmental-based factors, neighborhood streets/sidewalks and shopping malls were the highest reported places for physical activity (Brownson et al., 2001). Increased physical activity was associated with better access to parks and indoor recreational centers, as well as pleasant neighborhood aesthetics (Brownson et al., 2001; Brownson et al., 2004). In a literature review that combines two fields (transportation planning and public health), researchers found that increased walking behavior was positively associated with the accessibility and proximity of destinations, as well as the neighborhood aesthetics (Saelens & Handy, 2008). Again, those who lived in areas with high densities of destinations were likely to walk more than those who lived in low-density destination communities (Saelens & Handy, 2008).

Developed in Kansas City by Lee and colleagues, the Physical Activity Resource Assessment (PARA) is a tool to objectively and systematically measure public physical activity outlets (Lee, Booth, Reese-Smith, Regan, & Howard, 2005). The one-page PARA objectively assesses the number of features, amenities and incivilities present at each outlet (Appendix F). The features category evaluates 13 items that include baseball field, basketball field, soccer field, bike rack, exercise stations, play equipment, pool > 3 feet deep, sandbox, sidewalk, tennis courts, trails, volleyball courts and wading pool < 3 feet. Features are rated on quality from 0 to 3 (0 = not present, 1= poor, 2= mediocre, 3=good). Twelve amenities are rated including access points, bathrooms, benches, drinking fountains, decorative fountains, landscaping efforts, lighting, picnic tables with and without shade, shelters, shower/locker room and trash containers. Amenities are rated on the same scale as features. The incivilities section rates 12 items including, auditory annoyance, broken glass, dog refuse, dogs unattended, evidence of alcohol use, evidence of substance use, graffiti/tagging, litter, no grass, overgrown grass, sex paraphernalia and vandalism. Scores range from zero to three (0=none, 1=a little, 2=some, 3=a lot). Average scores are calculated by summing the scores for each category and dividing by the total number of items in the category.

Since its development, PARA has been utilized primarily in urban areas with most studies focusing on adult populations in public housing neighborhoods. While the findings have been varied, incivilities were consistently higher at outlets located in lower socioeconomic areas. In the development of the PARA tool, Lee et al. found that outlets in housing developments of Kansas City had more amenities and incivilities per resource (Lee et al., 2005). However, in 2008 Warren found that lower socioeconomic areas had more physical activity outlets but fewer amenities per resource.

Although there is growing support for access, proximity and availability of resources and increased physical activity through active transport or exercise, there is still limited understanding about the role of perceptions about the environment and the extent to which that influences or interacts with objective measures. Examining the relationship of an available physical activity resource is one pathway in determining physical activity behavior; however, perceived availability of resources may be a greater influence in predicting individual behaviors (Macintyre, 2007). Even if a resource is present, it may not be perceived as accessible by individuals, and thus may not be utilized to the full potential (Estabrooks et al., 2003). Findings showed that factors including unfamiliarity, distance and safety concerns were all factors not reflected in PARA that could potentially be a barrier to physical activity resource use (Findholt, Michael, Jerofke, & Brogoitti, 2011). Numerous studies have shown the relationship of physically inactive, overweight and obese individuals perceiving their neighborhood environments to have low availability and accessibility to PA outlets (Boehmer, Hoehner, Deshpande, Brennan Ramirez,

& Brownson, 2007; Boehmer, Lovegreen, Haire-Joshu, & Brownson, 2006; Catlin, Simoes, & Brownson, 2003; Joshu, Boehmer, Brownson, & Ewing, 2008). Low neighborhood environment perception for PA was also related to neighborhoods from low socioeconomic status and high minority populations (Boslaugh et al., 2004; Giles-Corti & Donovan, 2002b; Romero et al., 2001; Wilson et al., 2004). As the pathway between perceived physical activity environment and behavior is strong, there is potential for this relationship to be a mediator between the objective measure of the physical activity environment and behavior.

While there is evidence to support objective and subjective indicators of the environment as influential to physical activity, most of these studies consider environments that are urban or suburban (Boehmer et al., 2007; Boslaugh et al., 2004; Catlin et al., 2003; Eberhardt & Pamuk, 2004; Frank et al., 2010; Hoehner et al., 2005; Joshu et al., 2008; Leslie et al., 2007; Saelens et al., 2003). Only a handful of studies have examined the built environments as they relate to rural environments (Boehmer et al., 2006; Casey et al., 2008; Dunton, Kaplan, Wolch, Jerrett, & Reynolds, 2009; Fein, Plotnikoff, Wild, & Spence, 2004; Patterson et al., 2004; Wilson et al., 2004). Rural environments differ from urban ones with a lack of grid-pattern, low street connectivity, an absence of sidewalks and other neighborhood environmental features (Casey et al., 2008; Eberhardt & Pamuk, 2004; Sharkey, 2009; Smith et al., 2010). In these rural areas, the most common barrier to physical inactivity is the lack of available and accessible resources (Boehmer et al., 2006; Dunton et al., 2009; Patterson et al., 2004). Negative neighborhood rural environment perceptions (e.g., unpleasant neighborhood aesthetics, absence of sidewalks, lack of destinations) were equally important in contributing to inactivity (Boehmer et al., 2006; Casey et al., 2008; Fein et al., 2004; Wilson et al., 2004). However, Wilson and colleagues used a Geographic Information System (GIS) to identify objective sources of PA in communities (presence of sidewalks, available recreation facilities, and low crime rates) that do not support the difference in environmental perception and physical inactivity (Wilson et al., 2004). The low number of studies in rural areas and the inconsistency in findings highlight an important gap in our understanding of rural environments (Dunton et al., 2009; Patterson et al., 2004).

Food Environment and Dietary Intake

Another aspect of the built environment that relates to obesity is the food environment. Food environments are places where food is available for purchase or for consumption (e.g. stores, restaurants, homes, schools, worksites) (Glanz, Sallis, Saelens, & Frank, 2007; McKinnon, Reedy, Morrissette, Lytle, & Yaroch, 2009; Saelens, Glanz, Sallis, & Frank, 2007). There are four levels of the food environment (organizational, informational, community, and consumer) of which an individual may acquire food (Ohri-Vachaspati & Leviton, 2010). The organizational food environment affects large groups of people such as in schools and workplaces. Informational food environment describes the media outlets for food advertisements. The community food environments are the types and locations of stores and restaurants that are found within one's community and include the accessibility of these outlests (i.e., hours of operation, presence of a drive-through, etc.). Last, the consumer food environment is concerned with the availability of food items and the pricing, placement, and promotion of certain food items where food is available for purchase (Ohri-Vachaspati & Leviton, 2010).

Multiple reviews have examined the relationship of the food environment and weight status across gender, race/ethnicity, and varying socioeconomic status (Black & Macinko, 2008; Ford & Dzewaltowski, 2008; Larson, Story, & Nelson, 2009; Laska, Hearst, Forsyth, Pasch, & Lytle, 2010). Low socioeconomic neighborhoods with high densities of racial and ethnic minorities were more likely to experience poor food environments (i.e., high density of fast food restaurants, low availability of fresh produce), influencing unhealthy diets and leading to lower health statuses (Ford & Dzewaltowski, 2010; Franco et al., 2009; Franco et al., 2008; Krukowski, West, Harvey-Berino, & Elaine Prewitt, 2010). Despite the higher walkability in several low-income areas (i.e., more sidewalks due to high population density), there was a significantly higher overweight and obesity prevalence in these areas (Oreskovic, Kuhlthau, Romm, & Perrin, 2009). Neighborhoods with higher availability and accessibility of fresh produce were associated with individuals with better diet quality and a lower prevalence of obesity (Bodor, Rice, Farley, Swalm, & Rose, 2010; Gittelsohn & Sharma, 2009; Larson et al., 2009; Laska, Borradaile, Tester, Foster, & Gittelsohn, 2010; Sharkey, Johnson, & Dean, 2010; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). The density of fast food restaurants and other restaurants that promote unhealthy eating (e.g., buffet-style restaurants) is positively associated with obesity prevalence, increased caloric intake, and poor diet quality (Casey et al., 2008; Li et al., 2009; Macdonald, Cummins, & Macintyre, 2007).

When considering the evidence linking food environments to obesity, methods to measure the food environment must be considered. Recently, Ohri-Vachaspati and Leviton identified 48 assessment tools to measure the food environment, of which only 39% were tested for reliability and validity (Ohri-Vachaspati & Leviton, 2010). Furthermore, there is no systematic methodology for any the instruments, thus only few generalized statements can be made about the food environment and diet quality. While there are no current measurement standards for the food environment, Ohri-Vachaspati and colleagues identify the Nutrition Environment Measures Survey as the most comprehensive and detailed to all environmental influences that is also highly valid and reliable (Ohri-Vachaspati & Leviton, 2010).

Glanz and colleagues developed the Nutrition Environment Measures Survey (NEMS) with the objective of providing highly reliable and valid measures on the community and consumer level of the food environment (Glanz et al., 2007; Saelens et al., 2007). Currently, of the four food environment levels, the community and consumer level are less studied (Ohri-Vachaspati & Leviton, 2010). The community food environment is described by the type and location of a food outlet and how accessible it is to the community and the consumer food environment is described by the availability of healthy food options and any facilitators that aid in the choice (Ohri-Vachaspati & Leviton, 2010). Two different tools were created for food stores (NEMS-S) and restaurants (NEMS-R) (Glanz et al., 2007; Saelens et al., 2007). Both instruments have been validated with high inter-rater reliability and test-retest validity (Glanz et al., 2007; Ohri-Vachaspati & Leviton, 2010; Saelens et al., 2007).

Food stores, which are defined as grocery stores, convenience stores, specialty stores, and supermarkets, are measured with NEMS-S for their pricing, availability and quality in healthy foods (Glanz et al., 2007). There are 11 indicator food items: milk, fresh fruits (10 types), fresh vegetables (10 types), ground beef, hot dog, frozen dinner entrees, baked goods, beverages, bread, baked chips and cereal (Glanz et al., 2007). NEMS-S rates each food item separately in each store. Comparisons were made between grocery and convenience stores with findings supporting the idea that grocery stores have a higher availability and variety of healthy food choices, grocery stores prices were lower for the health choice than convenience stores (Glanz et al., 2007). When comparing the stores by SES by neighborhoods, it was found that higher income areas had a greater availability of fresh produce compared to lower income areas (Ford & Dzewaltowski, 2008; Ford & Dzewaltowski, 2010; Glanz et al., 2007; Larson et al., 2009; Laska, Hearst, et al., 2010).

In restaurants, NEMS-R measures menu options, healthy food availability, and healthy promotion (Saelens et al., 2007). Restaurants were categorized as “fast food” characterized by minimal service and food supplied quickly after ordering, “fast casual” characterized by similarities to fast food with no table service but higher quality of food, or “sit-down” that include a full table service and wait staff (Saelens et al., 2007). Information on menu options and pricing can be obtained through the internet or by direct observation of the establishment (Saelens et al., 2007). However, to fully observe all on-site facilitators and/or barriers to healthy options, direct observations are most necessary (Saelens et al., 2007). Results from NEMS-R suggest a mixed environment for restaurants. While fast food establishments typically displayed nutrition information, there was a high rate of advertisement and promotion of unhealthy options, such as sweet desserts, combination meals, or upgrading to a larger portion (Saelens et al., 2007). Sit-down restaurants had better indicators of healthy choices, but often lacked nutritional information (Saelens et al., 2007).

Utilizing either NEMS-S or NEMS-R, a composite score is given to each establishment indicating the availability of healthy foods; a higher score indicates a higher percentage of availability (Glanz et al., 2007; Saelens et al., 2007). On this scale, the environment is assessed objectively and there is a standard for measurement. Another characteristic of NEMS is that the tool can be adapted for the environment to accommodate for regional influences (Glanz et al., 2007; Saelens et al., 2007). While NEMS was developed in Atlanta, GA in four different neighborhoods (high SES/high walkability, high SES/low walkability, low SES/high walkability, low SES/low walkability) it has been adopted to measure the nutrition environment in different urban and rural areas around the United States (Andreyeva, Blumenthal, Schwartz, Long, & Brownell, 2008; Dale, 2009; Franco et al., 2009; Franco et al., 2008; Gittelsohn et al., 2008; Glanz et al., 2007; Gloria & Steinhardt, 2010; Havens & Martin, 2010; Krukowski et al., 2010; Lasley & Litchfield, 2007; Lucan, Karpyn, & Sherman, 2010; Saelens et al., 2007). In Baltimore, NEMS-S was used as a foundation for calculating the Health Food Availability Index (HFAI) across neighborhoods (Franco et al., 2009; Franco et al., 2008) and was simplified to create the Food Source Assessment (FSA) for a quick observational assessment of corner and convenience stores (Gittelsohn et al., 2008; Gittelsohn & Sharma, 2009). Food availability in Vermont and Arkansas was assessed to determine its impact on food purchasing behavior of the communities (Krukowski et al., 2010). Other adaptations to NEMS include modifying items on the checklist to accommodate for regional influences on types of available food and the typical diets of their communities (Andreyeva et al., 2008; Gloria & Steinhardt, 2010; Lasley & Litchfield, 2007), the development of a vending machine assessment tool (NEMS-V) (Lasley & Litchfield, 2007) and a variety of other adaptations to meet the community's needs (Lee et al., 2010; Zenk, Grigsby-Toussaint, Curry, Berbaum, & Schneider, 2010). Because of the flexibility of NEMS, it is a tool utilized not only by academic researchers, but also by community activist and advocacy groups or by health practitioners. Apart from understanding the food environment, the implications and findings from NEMS can be used to target behavioral and policy interventions.

While systematic audit tools, such as the NEMS, provide an objective rating of the food environment by a trained person, it does not capture the perceptions of persons who shop or dine at these outlets. Another method for understanding how the food environment influences dietary patterns is by measuring individual perceptions. Perceptions may be more influential in actually determining behavior, as they give more insight to what the individual believes to be present in their community as opposed to an objective measure (Macintyre, 2007). In one study, the association between socioeconomic status and diet quality were weak and non-significant, suggesting that differences in diet quality can be explained by individual's food environment perceptions of availability, accessibility, and affordability (Inglis, Ball, & Crawford, 2008). Residents living in areas with lower densities or an absence of supermarkets, perceived lower availabilities of healthy food, especially those in rural areas, which may influence their poor diets (Jilcott, Laraia, Evenson, & Ammerman, 2009; Moore et al., 2008; Sharkey et al., 2010). Therefore, objective measurements of the food environment maybe insufficient in determining the interaction of the environmental level influence and individuals perception of that food environment.

While our understanding of the influence of the built environment, particularly food and physical activity environments, on obesity is growing, the vast majority of the aforementioned studies have been conducted in urban or suburban settings. There is sparse research on the food environment with a rural focus (Feng et al., 2010). The built environments in rural areas are often considered difficult to study due to low population densities and low number of available resources. While only a small percentage of all built environment studies focus on rural regions (Feng et al., 2010), there is ample evidence to support environmental influence on individual behaviors with a focus to these health disparate populations (Booth et al., 2005; Ding & Gebel, 2012; Gordon-Larsen et al., 2006; C. Lee, Moudon, & Courbois, 2006; Lovasi et al., 2009; Papas et al., 2007). It is crucial to further research the built environments in these areas to determine if there truly is a deprivation-amplification effect experience by the residents (Macintyre, 2007). Further, novel research is beginning to explore whether objective measures of resources or the perception of resources has a great influence on healthy behaviors. As we move forward in built environment research, it is necessary to focus on rural areas so that we may provide the future groundwork for interventions and policies and to reduce the gaps in disparities.

Rural Health

As obesity in this nation continues to rise, there is a disproportionate distribution on where this increase in prevalence is occurring. Those who live in regions that are more rural experience a greater disparity in health status, with higher rates of obesity and greater mortality due to cardiovascular disease, coronary heart disease, diabetes, hypertension, and stroke (Berkowitz, 2004; Eberhardt & Pamuk, 2004; Hartley, 2004). Historically, rural areas centered on agrarian lifestyles have had lower incidence of overweight and obesity compared to urban and metropolitan areas. Lifestyle and occupation demanded higher physical exertion. However, as agriculture industrialized, there has been a shift, with rural regions experiencing higher rates of obesity and type 2 diabetes (Jackson et al., 2005; Patterson et al., 2004; Tai-Seale & Chandler, 2003). Behavioral risk factors such as higher rates of tobacco use, less PA, and poorer diet quality are positively associate with the increase in obesity in rural areas (Doescher, Jackson, Jerant, & Gary Hart, 2006; Eberhardt & Pamuk, 2004; Patterson et al., 2004; Tai-Seale & Chandler, 2003). Rural populations may still follow an agrarian lifestyle, which influences these individual health behaviors and decisions; however when compared to the rest of the nation, rural areas are generally poorer and less educated (Hartley, 2004; Patterson et al., 2004; Probst et al., 2004). These socioeconomic factors may also play a role in health decision making and the overall poor health outcomes.

Evident that rural areas are experiencing lower health outcomes, the government's latest agenda on improving the nation's health, Healthy People 2020, prioritizes reducing the gap in health disparities across the nation, especially reducing obesity in adults and children ("Healthy People 2020"). While there are distinct differences in the health of individuals based on place of residence, rural regions have poorer infrastructurs and a lack of access to health care services which compounds health disparities experienced by these regions (Berkowitz, 2004; Hartley, 2004; Patterson et al., 2004; Phillips &

McLeroy, 2004; Probst et al., 2004). Although, our government has passed legislation to mandate equitable access to primary health care, differences in health outcome still exist for rural populations (Eberhardt & Pamuk, 2004; Hartley, 2004).

Related to obesity and the built environment, rural, socioeconomically deprived areas have the lowest access and availability to resources (PA and food outlets) (Boehmer et al., 2006; Casey et al., 2008; Phillips & McLeroy, 2004). With respenct to the food environment, rural regions are often categorized as "food deserts", defined by the USDA as low-income census tracts with low access to a supermarket or grocery store with the availability of healthy foods (Service, 2010). Rural areas have low population densities and a greater dispersion of food resources that contribute to their food desert status (Sharkey, 2009). Environments that promote health and well-being (e.g., available resources for PA, availability of fresh produce in grocery stores) lead to better health outcomes (Booth et al., 2005; Brownson et al., 2001; Gordon-Larsen et al., 2006; Lopez-Zetina, Lee, & Friis, 2006). A culturally relevant, population-based public health strategy aimed at environmental and behavioral changes is necessary to reduce obesogenic risk factors (Hartley, 2004; Phillips & McLeroy, 2004). Healthy People 2020 calls to create social and physical environments that promote good health to achieve health equity, reducing disparities, and to improve the health of all population groups ("Healthy People 2020").

Community-based Participatory Research

While vulnerable, low-income, minority and/or rural populations are hard-to-reach due in part to geographic dispersion, the low population densities and cultural or social norms may also be barriers. Community-based participatory research (CBPR) can be an effective method in reaching these populations. Successful CBPR initiatives build upon the collective knowledge, resources, assets and expertise from the community members and academic partners (Greenwood & Levin, 2007; Israel, Eng, Schulz, & Parker, 2005). This process ensures community participation in all aspects of the research, from designing and implementation to evaluation effectiveness, and allows trust to be gained and sustainable programs in vulnerable communities (Israel et al., 2005).

In the Dan River Region, obesity is a regional health priority as it is associated with many co-morbidities including cardiovascular disease, diabetes, stroke (MDC, 2008). The Dan River Partnership for a Healthy Community (DRPHC) is a coalition formed by community members, key stakeholders and academic researchers from Virginia Tech to address the obesity problem in the Dan River region (Zoellner, Motley, Wilkinson, Jackman, Barlow, & Hill, 2012). The mission of the DRPHC is "to foster community partnerships to combat obesity in the Dan River Region through healthy lifestyle initiatives" and a vision "to promote an environment that supports opportunities for all Dan River Region residents to make healthy food choices and to be physically active in order to achieve or maintain a healthy weight" (DRPHC, 2012).

During the formative months of the DRPHC, a 2-day intensive comprehensive participatory and planning evaluation (CPPE) workshop was held to identify root causes of obesity and prioritize areas for intervention (Zoellner, Motley, Wilkinson, Jackman, Barlow, & Hill, 2012). Six causal models were identified as possible target areas; these included geographic planning, nutrition, environment, social norms, physical activity, and education. Of the six causal models, three were chosen for immediate action and a variety of interventions and programs have been initiated to address these causal model (Zanko, Reese, MacAuley, Hill, & Zoellner, 2012; Zoellner, Hill, Grier, Chau, Kopec, Pryce, & Dunn, 2012; Zoellner, Zanko, Pryce, Bonner, & Hill, 2012).

Geographic planning and environment models were not prioritized for immediate action, but contained key ideas and concepts that crossed several causal models (Appendix A). Therefore, the research team advanced a series of studies to begin to gather baseline geographic and environmental data that could be used across all DRPHC activities (Chau, Luebbering, Kolivras, Zoellner, & Hill, 2011; Chau, Zoellner, & Hill, 2012; Hill, Chau, Luebbering, Kolivras, & Zoellner, 2012). Data from these research projects provide contextual information about built environment in the Dan River Region to be used as the foundation for future interventions across all causal models. Further, honoring the principles of CBPR, all results and information will be disseminated back to the community members of the DRPHC so that the coalition may take ownership and decide on all future intervention programs and policies.

Contributions of this Study

In summary, this dissertation will focus on two aspects of the built environment, the PA environment and the food environment in this rural, health disparate region. The foundation of this project is the ecological framework; the multi-level approach to the research design that will target different levels of influence for behavioral change. The studies contribute to several gaps in the current scientific literature. While many built environment studies to date are conducted in urban and metropolitan settings with little attention to rural regions, this project will solely focus on a rural, health disparate area. Since health outcomes of rural populations are lower than national averages, it is necessary to focus public health research and initiatives to these areas. This project will use a CBPR approach to reach vulnerable, rural areas, as this is a novel methodology. Utilizing CBPR allows for the development and implementation of culturally and socially relevant, sustainable programs by gaining the trust of community stakeholders. Lastly, evident by the current review of literature, both objective and subjective measures of the physical and food environment influence physical activity and diet.

Specific Aims

The overall objective of this study is to examine the relationship of the food and physical activity environments with individual behaviors. The specific aims are to:

1. To enumerate and conduct systematic audits of the food and physical activity environments in the Dan River Region to describe availability and determine if spatial differences exist within the region.
2. To examine how the relationship of proximity to food outlets influences meeting fruit and vegetable intake recommendations.
3. To compare objectively measured proximity of physical activity outlets and perceived proximity of outlets and how they differ in predicting minutes of moderate-vigorous physical and meeting recommendations.

Theoretical Framework

Conceptual Background

Ecological models focus on environments, specific to social, physical, and cultural contexts, while integrating individual behaviors. The core of all ecological models is that there are multiple levels (e.g., intrapersonal, interpersonal, organizational, community and public policy) of influence on individual behavior (Sallis et al., 2003). These levels provide a comprehensive framework for understanding behaviors and outline the levels for intervention for behavior change. While many studies have been successful at modifying individual level behaviors for obesity prevention, many lack sustainability (Harper, 2006). Therefore, researchers are moving towards changing behaviors in the context or environments in which the individuals live in.

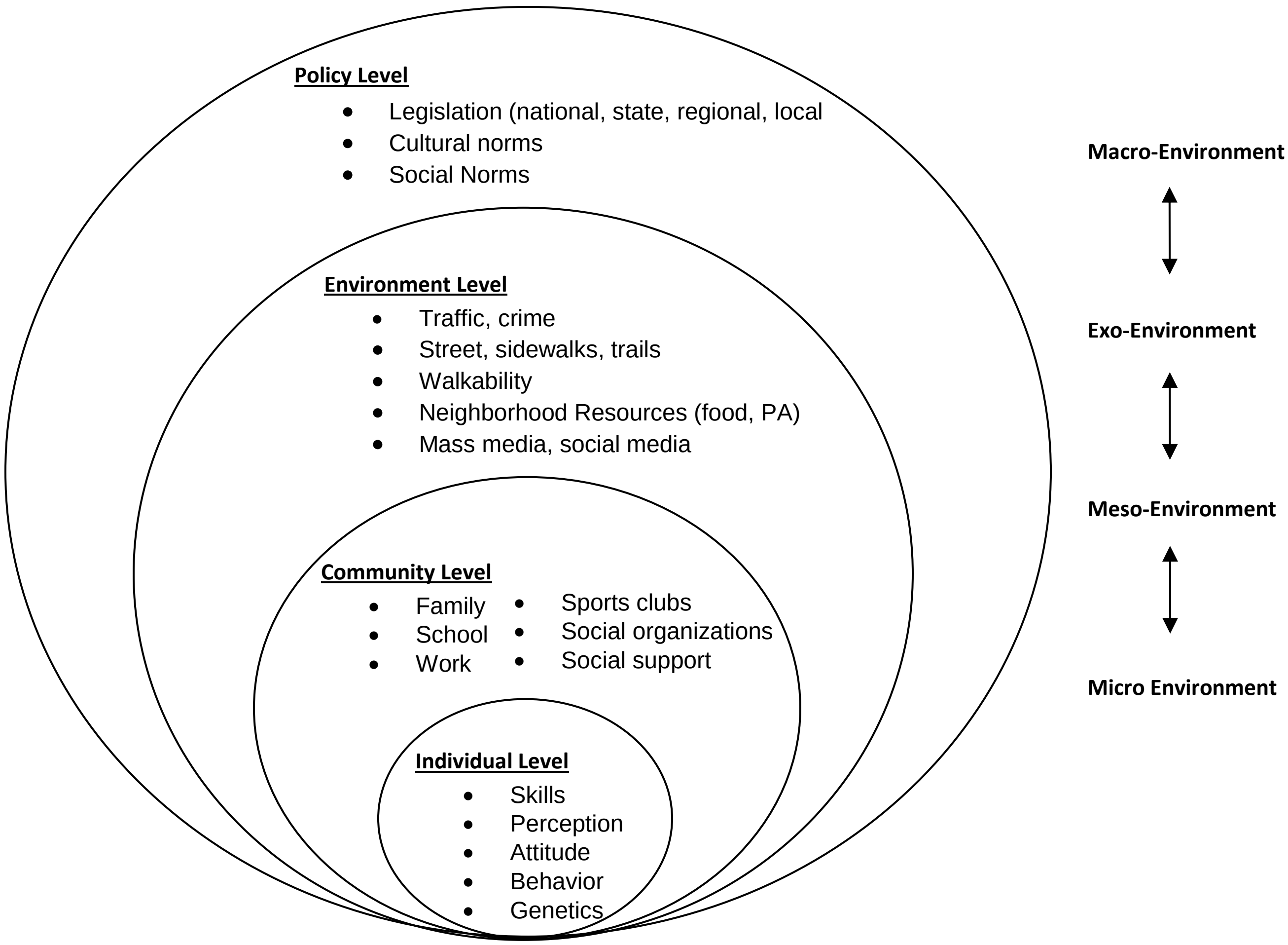
One of the principles of the ecological model is that effective interventions target all levels of influence (Glanz, Rimer, & Viswanath, 2008; Harper, 2006; Sallis et al., 2003). Healthy behaviors are maximized when environmental and public policies promote healthy choices and individuals are educated and encouraged to make these choices (Glanz et al., 2008; Sallis et al., 2003). Another key component of the ecological model is the varying environments and their influences. The ecological model proposes that the environment can directly influence behaviors. This unique attribute of an ecological framework distinguishes itself from other theories, like the Social Cognitive Theory, which theorizes that environmental characteristics do not directly influence behaviors, but rather indirectly, through the perception of an individual (Bandura, 1989).

Multi-level Framework

To effectively describe the varying level of influences on individual behaviors, Bronfenbrenner differentiates between intra-individual (e.g., beliefs, attitudes, and perception) and extra-individual (e.g., geographic topography, social and cultural context, policy) characteristic (Bronfenbrenner, 1979). Both are interdependent in producing behavior change. For example, intra-individual level influence might include a positive attitude towards increasing PA, thereby increasing the probability of engaging in PA. Alternately, changes at the extra-individual level might include providing available and accessible space for PA, thus also increasing the likelihood of PA engagement (Spence & Lee, 2003). Further, the different levels of environment settings, referred to as "systems", also influence our behaviors (Bronfenbrenner, 1979). The micro-system is the most proximal setting to the individual, which the macro-system is the most distal setting (Bronfenbrenner, 1979). To further elaborate on Bronfenbrenner's systems theory, Spence and Lee developed a model of the environment that would comprehensively and explicitly show the varying levels of influence on physical activity behaviors (Spence & Lee, 2003). The structural model of the environment is multi-dimensional to include the micro-environment, the meso-environment, the exo-environment, and the macro-environment; all of which play a key part in individual behavior. Each level has bi-directional influence to the other levels; and because of this, more proximal levels of the environment can influence distal environments. Proximal environments exert the most influence on behaviors, and change is immediate; whereas environments that are more distal exert broader influences and cause change over time. Since these environments are dynamic, individuals adapt by changing their behaviors (Bronfenbrenner, 1979; Spence & Lee, 2003).

Figure 2-1 graphically represents the ecological model. At the very core is the individual. There, the intra-individual characteristics (skill, knowledge, attitude, perception) influence individual behaviors. However, at this individual core are genetic factors that also affect health outcomes. For example, racial and ethnic disparities exist with higher rates of both overweight and obesity in non-Hispanic blacks and lower rates amount Asian Americans (Wang & Beydoun, 2007). Across gender, women had higher rates of obesity than men, and among all females, those of non-Hispanic blacks and Mexican had higher rates than non-Hispanic white females (Baskin et al., 2005). As the key in maintaining weight status is energy balance, weight gain is a product of positive energy balance when caloric intake is greater than calories expended (Spiegelman & Flier, 2001). Our society has long believed that obesity and weight status was a factor of genetic disposition; however, current research has shown that in recent years obesity is the result of changes in the environment, specifically the availability and composition of foods and the lower demand of physical exertion (Booth et al., 2005; Spiegelman & Flier, 2001). Yet it is unclear whether an interaction exists between genetics and the environment, furthering the need to research in an ecological perspective.

Figure 2-1. Conceptual framework of the ecological model.



The micro-environment is the most proximal setting to the individual. It is the behavioral setting at which the individual interacts. Micro-environments can include workplaces, schools, grocery stores most frequented, other religious, social, or sports organizations.

The meso-environment comprises of multiple micro-environment and the process in which they are connected to one another. These can be the physical presence of connectors or linkages, such as streets and sidewalks, but also the degree of relationships between and within each micro-environment.

The exo-environment includes other micro-environments that indirectly affect the individual behavior. These environments are present in the individual's neighborhoods and communities, but there is no interaction by the individual. For example, there may be a large industrial manufacturing plant about hour outside of the neighborhood of an individual. While neither the individual nor their spouse work at this manufacturing company, the plant is expelling sulfur dioxide smoke as a by-product. This smoke is causing an unpleasant odor and underlying respiratory conditions in the individual. While this particular micro-environment (the manufacturing plant) is not an environment the individual interacts with, their by-product does affect the individual leading to it becoming an exo-environment to the individual.

Lastly, the macro-environment is the larger and broader social, cultural, political context that houses the other environments. This environmental level is non-specific to the individual, yet the influence is great on individual behavior. Cultural and social norms towards eating influence individual diets and diet behaviors; while policy and legislative may mandate availability of certain food options in stores.

Framework for Dissertation Project

The ecological framework guides the research design and methodology of this dissertation. Given the hierarchical approach of the framework, this dissertation proposes to determine the multi-level influence to healthy behaviors (Glanz et al., 2008; Harper, 2006). Individuals, educated in making healthy decisions, are more likely to engage in healthy behaviors when they live in an environment that also promotes healthy living through media and policy (Glanz et al., 2008). Therefore, this dissertation will examine factors of the food and physical activity environments and its relationship to meeting recommendations for fruits and vegetable consumption and minutes of physical activity.

REFERENCES

Anderson, J. W., Konz, E. C., Frederich, R. C., & Wood, C. L. (2001). Long-term weight-loss maintenance: a meta-analysis of US studies. Am J Clin Nutr, 74(5), 579-584.

Anderson, J. W., Vichitbandra, S., Qian, W., & Kryscio, R. J. (1999). Long-term weight maintenance after an intensive weight-loss program. J Am Coll Nutr, 18(6), 620-627.

Andreyeva, T., Blumenthal, D. M., Schwartz, M. B., Long, M. W., & Brownell, K. D. (2008). Availability and prices of foods across stores and neighborhoods: the case of New Haven, Connecticut. Health Aff (Millwood), 27(5), 1381-1388. doi: 10.1377/hlthaff.27.5.1381

Bandura, A. (1989). Human agency in social cognitive theory. Am Psychol, 44(9), 1175-1184.

Baskin, M. L., Ard, J., Franklin, F., & Allison, D. B. (2005). Prevalence of obesity in the United States. Obes Rev, 6(1), 5-7. doi 10.1111/j.1467-789X.2005.00165.x

Berkowitz, B. (2004). Rural public health service delivery: promising new directions. Am J Public Health, 94(10), 1678-1681.

Black, J. L., & Macinko, J. (2008). Neighborhoods and obesity. Nutr Rev, 66(1), 2-20. doi: 10.1111/j.1753-4887.2007.00001.x

Bodor, J. N., Rice, J. C., Farley, T. A., Swalm, C. M., & Rose, D. (2010). The Association between Obesity and Urban Food Environments. J Urban Health, 87(5), 771-781. doi: 10.1007/s11524-010-9460-6

Boehmer, T. K., Hoehner, C. M., Deshpande, A. D., Brennan Ramirez, L. K., & Brownson, R. C. (2007). Perceived and observed neighborhood indicators of obesity among urban adults. Int J Obes (Lond), 31(6), 968-977. doi: 10.1038/sj.ijo.0803531

Boehmer, T. K., Lovegreen, S. L., Haire-Joshu, D., & Brownson, R. C. (2006). What constitutes an obesogenic environment in rural communities? Am J Health Promot, 20(6), 411-421.

Boone-Heinonen, J., Diez Roux, A. V., Kiefe, C. I., Lewis, C. E., Guilkey, D. K., & Gordon-Larsen, P. (2011). Neighborhood socioeconomic status predictors of physical activity through young to middle adulthood: The CARDIA study. Soc Sci Med. doi:10.1016/j.socscimed.2010.12.013

Boone-Heinonen, J., Evenson, K. R., Song, Y., & Gordon-Larsen, P. (2010). Built and socioeconomic environments: patterning and associations with physical activity in U.S. adolescents. Int J Behav Nutr Phys Act, 7, 45. doi:10.1186/1479-5868-7-45

Boone-Heinonen, J., Popkin, B. M., Song, Y., & Gordon-Larsen, P. (2010). What neighborhood area captures built environment features related to adolescent physical activity? Health Place, 16(6), 1280-1286. doi: 10.1016/j.healthplace.2010.06.015

Booth, K. M., Pinkston, M. M., & Poston, W. S. (2005). Obesity and the built environment. J Am Diet Assoc, 105(5 Suppl 1), S110-117. doi:10.1016/j.jada.2005.02.045

Boslaugh, S. E., Luke, D. A., Brownson, R. C., Naleid, K. S., & Kreuter, M. W. (2004). Perceptions of neighborhood environment for physical activity: is it "who you are" or "where you live"? J Urban Health, 81(4), 671-681. doi:10.1093/jurban/jth150

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

Brownell, K. D., & Jeffrey, R. W. (1987). Improving long-term weight loss: Pushing the limits of treatment. Behavior Therapy, 18(4), 353-374.

Brownson, R. C., Baker, E. A., Housemann, R. A., Brennan, L. K., & Bacak, S. J. (2001). Environmental and policy determinants of physical activity in the United States. Am J Public Health, 91(12), 1995-2003.

Brownson, R. C., Chang, J. J., Eyler, A. A., Ainsworth, B. E., Kirtland, K. A., Saelens, B. E., & Sallis, J. F. (2004). Measuring the environment for friendliness toward physical activity: a comparison of the reliability of 3 questionnaires. Am J Public Health, 94(3), 473-483.

Brownson, R. C., Hoehner, C. M., Day, K., Forsyth, A., & Sallis, J. F. (2009). Measuring the built environment for physical activity: state of the science. Am J Prev Med, 36(4 Suppl), S99-123 e112. doi:10.1016/j.amepre.2009.01.005

Brownson, R. C., & Jones, E. (2009). Bridging the gap: translating research into policy and practice. Prev Med, 49(4), 313-315. doi:10.1016/j.ypmed.2009.06.008

Casey, A. A., Elliott, M., Glanz, K., Haire-Joshu, D., Lovegreen, S. L., Saelens, B. E., . . . Brownson, R. C. (2008). Impact of the food environment and physical activity environment on behaviors and weight status in rural U.S. communities. Prev Med, 47(6), 600-604. doi: 10.1016/j.ypmed.2008.10.001

Catlin, T. K., Simoes, E. J., & Brownson, R. C. (2003). Environmental and policy factors associated with overweight among adults in Missouri. Am J Health Promot, 17(4), 249-258.

Chau, C. N., Luebbering, C. R., Kolivras, K. N., Zoellner, J. M., & Hill, J. L. (2011). Using GIS to determine environmental factors related to obesity in a health disparate region. Paper presented at the International Society for Behavioral Nutrition and Physical Activity, Melbourne, Australia.

Chau, C., Zoellner, J., & Hill, J. (2012). Community-based approach to assessing the nutrition environment in a health disparate region. Paper presented at the Society of Behavioral Medicine, New Orleans, Louisiana.

Dale, D. (2009). Comparison of the availability of health foods in low income and high income neighborhoods in Philadelphia. Ethn Dis, 19(S3), 82-83.

Daly, A., Konz, E. C., Soler, N., Anderson, J. W., Yergler, C., & Carpenter, P. (2000). Successful long-term maintenance of substantial weight loss: one program's experience. J Am Diet Assoc, 100(12), 1456.

Diez Roux, A. V., Evenson, K. R., McGinn, A. P., Brown, D. G., Moore, L., Brines, S., & Jacobs, D. R., Jr. (2007). Availability of recreational resources and physical activity in adults. Am J Public Health, 97(3), 493-499. doi:10.2105/AJPH.2006.087734

Diez Roux, A. V., & Mair, C. (2010). Neighborhoods and health. Ann N Y Acad Sci, 1186, 125-145. doi: 10.1111/j.1749-6632.2009.05333.x

Ding, D., & Gebel, K. (2012). Built environment, physical activity, and obesity: What have we learned from reviewing the literature? Health Place, 18(1), 100-105. doi: 10.1016/j.healthplace.2011.08.021

Doescher, M. P., Jackson, J. E., Jerant, A., & Gary Hart, L. (2006). Prevalence and trends in smoking: a national rural study. J Rural Health, 22(2), 112-118. doi: 10.1111/j.1748-0361.2006.00018.x

DRPHC. (2012). Dan River Partnership for a Healthy Community.   Retrieved March 29, 2012

Dunton, G. F., Kaplan, J., Wolch, J., Jerrett, M., & Reynolds, K. D. (2009). Physical environmental correlates of childhood obesity: a systematic review. Obes Rev, 10(4), 393-402. doi: 10.1111/j.1467-789X.2009.00572.x

Eberhardt, M. S., & Pamuk, E. R. (2004). The importance of place of residence: examining health in rural and nonrural areas. Am J Public Health, 94(10), 1682-1686.

Economic Research Service. (2010, July 6, 2012). Food Desert Locator.   Retrieved July 15, 2011, from http://www.ers.usda.gov/data-products/food-desert-locator.aspx

Elinder, L. S., & Jansson, M. (2009). Obesogenic environments--aspects on measurement and indicators. Public Health Nutr, 12(3), 307-315. doi: 10.1017/S1368980008002450

Estabrooks, P. A., Lee, R. E., & Gyurcsik, N. C. (2003). Resources for physical activity participation: does availability and accessibility differ by neighborhood socioeconomic status? Ann Behav Med, 25(2), 100-104.

Evenson, K. R., Scott, M. M., Cohen, D. A., & Voorhees, C. C. (2007). Girls' perception of neighborhood factors on physical activity, sedentary behavior, and BMI. Obesity (Silver Spring), 15(2), 430-445. doi: 10.1038/oby.2007.502

Fein, A. J., Plotnikoff, R. C., Wild, T. C., & Spence, J. C. (2004). Perceived environment and physical activity in youth. Int J Behav Med, 11(3), 135-142. doi: 10.1207/s15327558ijbm1103_2

Feng, J., Glass, T. A., Curriero, F. C., Stewart, W. F., & Schwartz, B. S. (2010). The built environment and obesity: a systematic review of the epidemiologic evidence. Health Place, 16(2), 175-190. doi: 10.1016/j.healthplace.2009.09.008

Findholt, N. E., Michael, Y. L., Jerofke, L. J., & Brogoitti, V. W. (2011). Environmental influences on children's physical activity and eating habits in a rural Oregon County. Am J Health Promot, 26(2), e74-85. doi: 10.4278/ajhp.100622-QUAL-210

Flegal, K. M. (2005). Epidemiologic aspects of overweight and obesity in the United States. Physiol Behav, 86(5), 599-602. doi: 10.1016/j.physbeh.2005.08.050

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. JAMA, 303(3), 235-241. doi: 10.1001/jama.2009.2014

Ford, P. B., & Dzewaltowski, D. A. (2008). Disparities in obesity prevalence due to variation in the retail food environment: three testable hypotheses. Nutr Rev, 66(4), 216-228. doi: 10.1111/j.1753-4887.2008.00026.x

Ford, P.B., & Dzewaltowski, D.A. (2010). Geographical, racial, ethnic, and socioeconomic disparities in the availability of grocery stores and supermarkets among low-income women across the urban-rural continuum. J Hunger Environ Nutr, 5(5), 216-233. doi: 10.1080/19320241003800276

Franco, M., Diez-Roux, A. V., Nettleton, J. A., Lazo, M., Brancati, F., Caballero, B., . . . Moore, L. V. (2009). Availability of healthy foods and dietary patterns: the Multi-Ethnic Study of Atherosclerosis. Am J Clin Nutr, 89(3), 897-904. doi: 10.3945/ajcn.2008.26434

Franco, M., Diez Roux, A. V., Glass, T. A., Caballero, B., & Brancati, F. L. (2008). Neighborhood characteristics and availability of healthy foods in Baltimore. Am J Prev Med, 35(6), 561-567. doi: 10.1016/j.amepre.2008.07.003

Frank, L. D., Sallis, J. F., Saelens, B. E., Leary, L., Cain, K., Conway, T. L., & Hess, P. M. (2010). The development of a walkability index: application to the Neighborhood Quality of Life Study. Br J Sports Med, 44(13), 924-933. doi: 10.1136/bjsm.2009.058701

Freedman, V. A., Grafova, I. B., & Rogowski, J. (2011). Neighborhoods and chronic disease onset in later life. Am J Public Health, 101(1), 79-86. doi:10.2105/AJPH.2009.178640

Giles-Corti, B., & Donovan, R. J. (2002a). The relative influence of individual, social and physical environment determinants of physical activity. Soc Sci Med, 54(12), 1793-1812.

Giles-Corti, B., & Donovan, R. J. (2002b). Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. Prev Med, 35(6), 601-611.

Giles-Corti, B., Timperio, A., Bull, F., & Pikora, T. (2005). Understanding physical activity environmental correlates: increased specificity for ecological models. Exerc Sport Sci Rev, 33(4), 175-181.

Giskes, K., van Lenthe, F., Avendano-Pabon, M., & Brug, J. (2011). A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments? Obes Rev, 12(5), e95-e106. doi: 10.1111/j.1467-789X.2010.00769.x

Gittelsohn, J., Franceschini, M.C.T., Rasooly, I.R., Ries, A. V., Ho, L.S., Pavlovich, W., . . . Frick, K.D. (2008). Understanding the food environment in a low income urban setting, implications for food store interventions. J Hunger Environ Nutr, 2(2), 33-50. doi: 10.1080/19320240801891438

Gittelsohn, J., & Sharma, S. (2009). Physical, consumer, and social aspects of measuring the food environment among diverse low-income populations. Am J Prev Med, 36(4 Suppl), S161-165. doi: 10.1016/j.amepre.2009.01.007

Glanz, K., Rimer, B. K., & Viswanath, K. (Eds.). (2008). Health Behavior and Health Education: theory, research, and practice (4th ed.). San Francisco, CA: Jossey-Bass.

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2007). Nutrition Environment Measures Survey in stores (NEMS-S): development and evaluation. Am J Prev Med, 32(4), 282-289. doi: 10.1016/j.amepre.2006.12.019

Gloria, C. T., & Steinhardt, M. A. (2010). Texas nutrition environment assessment of retail food stores (TxNEA-S): development and evaluation. Public Health Nutr, 1-9.

Gordon-Larsen, P., Nelson, M. C., Page, P., & Popkin, B. M. (2006). Inequality in the built environment underlies key health disparities in physical activity and obesity. Pediatrics, 117(2), 417-424. doi: 10.1542/peds.2005-0058

Greenwood, D.J., & Levin, M. (2007). Introduction to Action Research: Social Research for Social Change (2 ed.). Thousand Oaks, CA: Sage Publications.

Harper, M. G. (2006). Childhood obesity: strategies for prevention. Fam Community Health, 29(4), 288-298.

Hartley, D. (2004). Rural health disparities, population health, and rural culture. Am J Public Health, 94(10), 1675-1678.

Havens, E., & Martin, K. (2010). Store WIC Authorization and Availability of Healthy Food in Corner Markets (C. f. P. H. a. H. Policy, Trans.) (Vol. March): University of Connecticut.

Healthy People 2020. Retrieved June 30, 2011, from http://www.healthypeople.gov

Hill, J. L. , Chau, C. N., Luebbering, C. R., Kolivras, K. N., & Zoellner, J. M. (2012). Does availability of physical activity and food outlets differ by race and income? Findings from an enumeration study in a rural health disparate region. Int J Behav Nutr and Phys Act, 9:105. doi: 10.1186/1479-5868-9-105

Hoehner, C. M., Brennan Ramirez, L. K., Elliott, M. B., Handy, S. L., & Brownson, R. C. (2005). Perceived and objective environmental measures and physical activity among urban adults. Am J Prev Med, 28(2 Suppl 2), 105-116. doi: 10.1016/j.amepre.2004.10.023

Inglis, V., Ball, K., & Crawford, D. (2008). Socioeconomic variations in women's diets: what is the role of perceptions of the local food environment? J Epidemiol Community Health, 62(3), 191-197. doi: 10.1136/jech.2006.059253

Israel, B.A., Eng, E., Schulz, A.J., & Parker, E.A. (Eds.). (2005). Methods in Community-Based Participatory Research for Health (1 ed.). San Francisco, CA: Josey-Bass.

Jackson, J. E., Doescher, M. P., Jerant, A. F., & Hart, L. G. (2005). A national study of obesity prevalence and trends by type of rural county. J Rural Health, 21(2), 140-148.

Jilcott, S. B., Laraia, B. A., Evenson, K. R., & Ammerman, A. S. (2009). Perceptions of the community food environment and related influences on food choice among midlife women residing in rural and urban areas: a qualitative analysis. Women Health, 49(2-3), 164-180. doi: 10.1080/03630240902915085

Joshu, C. E., Boehmer, T. K., Brownson, R. C., & Ewing, R. (2008). Personal, neighbourhood and urban factors associated with obesity in the United States. J Epidemiol Community Health, 62(3), 202-208. doi: 10.1136/jech.2006.058321

Kaczynski, A. T., & Henderson, K. A. (2008). Parks and recreation settings and active living: a review of associations with physical activity function and intensity. J Phys Act Health, 5(4), 619-632.

Kaczynski, A. T., Potwarka, L. R., & Saelens, B. E. (2008). Association of park size, distance, and features with physical activity in neighborhood parks. Am J Public Health, 98(8), 1451-1456. doi: 10.2105/AJPH.2007.129064

Kawachi, I., & Berkman, L. F. (Eds.). (2003). Neighborhoods and Health (1 ed.). New York, NY: Oxford University Press.

Krukowski, R. A., West, D. S., Harvey-Berino, J., & Elaine Prewitt, T. (2010). Neighborhood impact on healthy food availability and pricing in food stores. J Community Health, 35(3), 315-320. doi: 10.1007/s10900-010-9224-y

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments: disparities in access to healthy foods in the U.S. Am J Prev Med, 36(1), 74-81. doi: 10.1016/j.amepre.2008.09.025

Laska, M. N., Borradaile, K. E., Tester, J., Foster, G. D., & Gittelsohn, J. (2010). Healthy food availability in small urban food stores: a comparison of four US cities. Public Health Nutr, 13(7), 1031-1035. doi: 10.1017/S1368980009992771

Laska, M. N., Hearst, M. O., Forsyth, A., Pasch, K. E., & Lytle, L. (2010). Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status? Public Health Nutr, 1-7. doi: 10.1017/S1368980010001564

Lasley, Emily C.K., & Litchfield, Ruth E. (2007). Fresh produce in rural Iowa: Availability and Accessibility. J Hunger Environ Nutr, 2(2), 5-17. doi: 10.1080/19320240801891404

Lee, C., Moudon, A. V., & Courbois, J. Y. (2006). Built environment and behavior: spatial sampling using parcel data. Ann Epidemiol, 16(5), 387-394. doi:10.1016/j.annepidem.2005.03.003

Lee, R. E., Booth, K. M., Reese-Smith, J. Y., Regan, G., & Howard, H. H. (2005). The Physical Activity Resource Assessment (PARA) instrument: evaluating features, amenities and incivilities of physical activity resources in urban neighborhoods. Int J Behav Nutr Phys Act, 2, 13. doi: 10.1186/1479-5868-2-13

Lee, R. E., Heinrich, K. M., Medina, A. V., Regan, G. R., Reese-Smith, J. Y., Jokura, Y., & Maddock, J. E. (2010). A picture of the healthful food environment in two diverse urban cities. Environ Health Insights, 4, 49-60.

Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., & Hugo, G. (2007). Walkability of local communities: using geographic information systems to objectively assess relevant environmental attributes. Health Place, 13(1), 111-122. doi: 10.1016/j.healthplace.2005.11.001

Leslie, E., Saelens, B., Frank, L., Owen, N., Bauman, A., Coffee, N., & Hugo, G. (2005). Residents' perceptions of walkability attributes in objectively different neighbourhoods: a pilot study. Health Place, 11(3), 227-236. doi: 10.1016/j.healthplace.2004.05.005

Li, F., Harmer, P., Cardinal, B. J., Bosworth, M., & Johnson-Shelton, D. (2009). Obesity and the built environment: does the density of neighborhood fast-food outlets matter? Am J Health Promot, 23(3), 203-209. doi: 10.4278/ajhp.071214133

Lopez-Zetina, J., Lee, H., & Friis, R. (2006). The link between obesity and the built environment. Evidence from an ecological analysis of obesity and vehicle miles of travel in California. Health Place, 12(4), 656-664. doi: 10.1016/j.healthplace.2005.09.001

Lovasi, G. S., Hutson, M. A., Guerra, M., & Neckerman, K. M. (2009). Built environments and obesity in disadvantaged populations. Epidemiol Rev, 31, 7-20. doi: 10.1093/epirev/mxp005

Lucan, S. C., Karpyn, A., & Sherman, S. (2010). Storing empty calories and chronic disease risk: snack-food products, nutritive content, and manufacturers in Philadelphia corner stores. J Urban Health, 87(3), 394-409. doi: 10.1007/s11524-010-9453-5

Lutes, L. D., Winett, R. A., Barger, S. D., Wojcik, J. R., Herbert, W. G., Nickols-Richardson, S. M., & Anderson, E. S. (2008). Small changes in nutrition and physical activity promote weight loss and maintenance: 3-month evidence from the ASPIRE randomized trial. Ann Behav Med, 35(3), 351-357. doi: 10.1007/s12160-008-9033-z

Macdonald, L., Cummins, S., & Macintyre, S. (2007). Neighbourhood fast food environment and area deprivation-substitution or concentration? Appetite, 49(1), 251-254. doi: 10.1016/j.appet.2006.11.004

Macintyre, S. (2007). Deprivation amplification revisited; or, is it always true that poorer places have poorer access to resources for healthy diets and physical activity? Int J Behav Nutr Phys Act, 4, 32. doi: 10.1186/1479-5868-4-32

Macintyre, S., Ellaway, A., & Cummins, S. (2002). Place effects on health: how can we conceptualise, operationalise and measure them? Soc Sci Med, 55(1), 125-139.

McKinnon, R. A., Reedy, J., Morrissette, M. A., Lytle, L. A., & Yaroch, A. L. (2009). Measures of the food environment: a compilation of the literature, 1990-2007. Am J Prev Med, 36(4 Suppl), S124-133. doi: 10.1016/j.amepre.2009.01.012

MDC. (2008). Dan River Region Health Assessment Chapel Hill, NC.

Moore, L. V., Diez Roux, A. V., & Brines, S. (2008). Comparing Perception-Based and Geographic Information System (GIS)-based characterizations of the local food environment. J Urban Health, 85(2), 206-216. doi: 10.1007/s11524-008-9259-x

Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. JAMA, 295(13), 1549-1555. doi: 10.1001/jama.295.13.1549

Ogden, C. L., Yanovski, S. Z., Carroll, M. D., & Flegal, K. M. (2007). The epidemiology of obesity. Gastroenterology, 132(6), 2087-2102. doi: 10.1053/j.gastro.2007.03.052

Ohri-Vachaspati, P., & Leviton, L. C. (2010). Measuring food environments: a guide to available instruments. Am J Health Promot, 24(6), 410-426. doi: 10.4278/ajhp.080909-LIT-190

Oreskovic, N. M., Kuhlthau, K. A., Romm, D., & Perrin, J. M. (2009). Built environment and weight disparities among children in high- and low-income towns. Acad Pediatr, 9(5), 315-321. doi: 10.1016/j.acap.2009.02.009

Papas, M. A., Alberg, A. J., Ewing, R., Helzlsouer, K. J., Gary, T. L., & Klassen, A. C. (2007). The built environment and obesity. Epidemiol Rev, 29, 129-143. doi: 10.1093/epirev/mxm009

Parra, D. C., Gomez, L. F., Sarmiento, O. L., Buchner, D., Brownson, R., Schimd, T., . . . Lobelo, F. (2010). Perceived and objective neighborhood environment attributes and health related quality of life among the elderly in Bogota, Colombia. Soc Sci Med, 70(7), 1070-1076. doi: 10.1016/j.socscimed.2009.12.024

Patterson, P. D., Moore, C. G., Probst, J. C., & Shinogle, J. A. (2004). Obesity and physical inactivity in rural America. J Rural Health, 20(2), 151-159.

Pender, J. R., & Pories, W. J. (2005). Epidemiology of obesity in the United States. Gastroenterol Clin North Am, 34(1), 1-7. doi: 10.1016/j.gtc.2004.12.010

Phillips, C. D., & McLeroy, K. R. (2004). Health in rural America: remembering the importance of place. Am J Public Health, 94(10), 1661-1663.

Probst, J. C., Moore, C. G., Glover, S. H., & Samuels, M. E. (2004). Person and place: the compounding effects of race/ethnicity and rurality on health. Am J Public Health, 94(10), 1695-1703.

Romero, A. J., Robinson, T. N., Kraemer, H. C., Erickson, S. J., Haydel, K. F., Mendoza, F., & Killen, J. D. (2001). Are perceived neighborhood hazards a barrier to physical activity in children? Arch Pediatr Adolesc Med, 155(10), 1143-1148.

Saelens, B. E., Glanz, K., Sallis, J. F., & Frank, L. D. (2007). Nutrition Environment Measures Study in restaurants (NEMS-R): development and evaluation. Am J Prev Med, 32(4), 273-281. doi: 10.1016/j.amepre.2006.12.022

Saelens, B. E., & Handy, S. L. (2008). Built environment correlates of walking: a review. Med Sci Sports Exerc, 40(7 Suppl), S550-566.

Saelens, B. E., Sallis, J. F., Black, J. B., & Chen, D. (2003). Neighborhood-based differences in physical activity: an environment scale evaluation. Am J Public Health, 93(9), 1552-1558.

Sallis, J.F., Owen, N., & Fisher, E. D. (2003). Ecological Models of Health Behavior. In K. Glanz, B. K. Rimer & K. Viswanath (Eds.), Health Behavior and Health Education (4 ed., pp. 465-485). San Francisco, CA: Jossey-Bass.

Sharkey, J. R. (2009). Measuring potential access to food stores and food-service places in rural areas in the U.S. Am J Prev Med, 36(4 Suppl), S151-155. doi: 10.1016/j.amepre.2009.01.004

Sharkey, J. R., Johnson, C. M., & Dean, W. R. (2010). Food access and perceptions of the community and household food environment as correlates of fruit and vegetable intake among rural seniors. BMC Geriatr, 10, 32. doi: 10.1186/1471-2318-10-32

Sherwood, N. E., Crain, A. L., Martinson, B. C., Hayes, M. G., Anderson, J. D., Clausen, J. M., . . . Jeffery, R. W. (2011). Keep it off: a phone-based intervention for long-term weight-loss maintenance. Contemp Clin Trials, 32(4), 551-560. doi: 10.1016/j.cct.2011.03.011

Shishehbor, M. H., Gordon-Larsen, P., Kiefe, C. I., & Litaker, D. (2008). Association of neighborhood socioeconomic status with physical fitness in healthy young adults: the Coronary Artery Risk Development in Young Adults (CARDIA) study. Am Heart J, 155(4), 699-705. doi: 10.1016/j.ahj.2007.07.055

Smith, D. M., Cummins, S., Taylor, M., Dawson, J., Marshall, D., Sparks, L., & Anderson, A. S. (2010). Neighbourhood food environment and area deprivation: spatial accessibility to grocery stores selling fresh fruit and vegetables in urban and rural settings. Int J Epidemiol, 39(1), 277-284. doi: 10.1093/ije/dyp221

Spence, J., & Lee, R.E. (2003). Towards a comprehensive model of physical activity. Psychol Sport Exerc, 4(1), 7-24.

Spiegelman, B. M., & Flier, J. S. (2001). Obesity and the regulation of energy balance. Cell, 104(4), 531-543.

Story, M., Kaphingst, K. M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: policy and environmental approaches. Annu Rev Public Health, 29, 253-272. doi: 10.1146/annurev.publhealth.29.020907.090926

Tai-Seale, T., & Chandler, C. (2003). Nutrition and Overweight Concerns in Rural Areas: A Literature Review. Rural Healthy People: A companion document to Healthy People 2010, 115-130.

Wang, Y., & Beydoun, M. A. (2007). The obesity epidemic in the United States--gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. Epidemiol Rev, 29, 6-28. doi: 10.1093/epirev/mxm007

Wilson, D. K., Kirtland, K. A., Ainsworth, B. E., & Addy, C. L. (2004). Socioeconomic status and perceptions of access and safety for physical activity. Ann Behav Med, 28(1), 20-28. doi: 10.1207/s15324796abm2801_4

Zanko, A., Reese, F., MacAuley, L., Hill, J. L., & Zoellner, J. . (2012). Evaluating the public health of community gardens in a health disparate region. Paper presented at the Virginia Dietetic Association, Blacksburg, Virginia.

Zenk, S. N., Grigsby-Toussaint, D. S., Curry, S. J., Berbaum, M., & Schneider, L. (2010). Short-term temporal stability in observed retail food characteristics. J Nutr Educ Behav, 42(1), 26-32. doi: 10.1016/j.jneb.2009.01.005

Zenk, S. N., Schulz, A. J., Matthews, S. A., Odoms-Young, A., Wilbur, J., Wegrzyn, L., . . . Stokes, C. (2011). Activity space environment and dietary and physical activity behaviors: A pilot study. Health Place, 17(5), 1150-1161. doi: 10.1016/j.healthplace.2011.05.001

Zoellner, J., Hill, J., Grier, K., Chau, C., Kopec, D., Pryce, B. & Dunn, C. (2012). Better Together: Healthy Caswell County- Findings from a randomized controlled trial targeting obesity-related behaviors. Prev Chron Dis, 10:120296. doi:10.5888/pcd10.120296

Zoellner, J. M., Motley, M., Wilkinson, M., Jackman, B., Barlow, M. L., & Hill, J. L. (2012). Engaging the Dan River Region to Reduce Obesity: Application of the Comprehensive Participatory Planning and Evaluation Process. Fam Community Health, 35(1), 44-56.

Zoellner, J., Zanko, A., Pryce, B., Bonner, J., & Hill, J. L. (2012). Exploring community gardens in a health disparate population: Findings from a mixed methods pilot study. Prog Community Health Partnersh, 6(2), 153-165.

CHAPTER 3: MANUSCRIPT 1

Availability of Healthy Food: Does Block Group Race and Income Matter?

Authors: Chau CN[1], Zoellner JM[1], Hill JL[1]

Affiliations: [1]Virginia Tech, Human Nutrition, Foods, and Exercise, Blacksburg, Virginia

Introduction

In the United States, obesity is a major public health concern (Flegal, 2005; Flegal, Carroll, Ogden, & Curtin, 2010; Ogden, Yanovski, Carroll, & Flegal, 2007). As the prevalence of obesity and its related chronic conditions (e.g., diabetes, cardiovascular disease, and hypertension) is increasing throughout the entire American population, low-income, minority and rural populations bear a disproportionate burden (Flegal et al., 2010; Hartley, 2004). When compared to White, urban, higher socio-economic status peers, low-income, minority and rural populations are at increased risk for obesity (Cooper et al., 2000; Wang & Beydoun, 2007; Woolf et al., 2010).

Numerous epidemiological studies have explored relationships and root causes of obesity, including a variety of individual, social, community, environmental, and policy level factors (Ogden et al., 2007; Wang & Beydoun, 2007). Despite this range of multifaceted observational data, intervention efforts to address obesity have largely focused on changing individual level behaviors and findings indicate that biological, behavioral, psychological, and social factors seem only to explain weight gain in individuals and do not fully explain weight gain across groups of people (Giskes, van Lenthe, Avendano-Pabon, & Brug, 2011; Harper, 2006; Wang & Beydoun, 2007). For these reasons, there has been increased emphasis on understanding the role of the built environment in obesity (Black & Macinko, 2008; Booth, Pinkston, & Poston, 2005). In fact, for the first time in 2020, Healthy People has a national objective that targets the built environment (i.e., “to create social and physical environments that promote good health for all”) ("Healthy People 2020"). These environmental factors include but are not limited to: physical activity resources (e.g., presence of sidewalks/trails, recreational facilities, public parks, private gyms), food outlets (e.g., restaurants, stores, vending machines), modes of transportation (e.g., bicycle, automobile, bus), designated land-use (e.g., residential, retail, industrial, agricultural), traffic, crime rates, and aesthetic appeal (Brownson, Baker, Housemann, Brennan, & Bacak, 2001; Saelens, Sallis, Black, & Chen, 2003). While each has potentially important implications to obesity, the food environment is the focus of this research.

The “food environment” includes places where food is available for purchase or for consumption (e.g., stores, restaurants, homes, schools, worksites) (Glanz, Sallis, Saelens, & Frank, 2007; Gustafson, Hankins, & Jilcott, 2011; McKinnon, Reedy, Morrissette, Lytle, & Yaroch, 2009; Saelens, Glanz, Sallis, & Frank, 2007). ‘Poor’ food environments are typically characterized as having too few ‘healthy’ options (e.g., outlets that carry fresh fruits or vegetables, whole grain products), too few outlets (e.g., food deserts), or too many outlets that would encourage unhealthy food choice (e.g., density of fast food)(Booth et al., 2005; Ding & Gebel, 2012; Elinder & Jansson, 2009; Feng, Glass, Curriero, Stewart, & Schwartz, 2010; Giskes et al., 2011; Li, Harmer, Cardinal, Bosworth, & Johnson-Shelton, 2009). These poor food environments often coincide with low-income areas and a significantly higher proportion of overweight and obese residents (Booth et al., 2005; Elinder & Jansson, 2009; Feng et al., 2010; Ford & Dzewaltowski, 2010; Giskes et al., 2011; Larson, Story, & Nelson, 2009; Oreskovic, Kuhlthau, Romm, & Perrin, 2009; Raja, Ma, & Yadav, 2008). Numerous studies show that low-income areas have higher densities of fast food restaurants and a lower fresh produce selection in grocery stores and markets (Andreyeva, Blumenthal, Schwartz, Long, & Brownell, 2008; Franco et al., 2009; Franco, Diez Roux, Glass, Caballero, & Brancati, 2008; Gustafson et al., 2011; Krukowski, West, Harvey-Berino, & Elaine Prewitt, 2010; Larson et al., 2009; Moore, Diez Roux, & Franco, 2012; Moore, Diez Roux, Nettleton, Jacobs, & Franco, 2009; Oreskovic et al., 2009; Raja et al., 2008). Indeed, many of these neighborhoods or regions can be classified as 'food deserts', having limited accessibility and availability to fresh produce and other healthy food options (ERS, 2010). To date, the body of literature on food environments and health outcomes has predominately focused on urban areas with high population densities(Andreyeva et al., 2008; Casagrande et al., 2011; Franco et al., 2009; Franco et al., 2008; Jilcott, McGuirt, Imai, & Evenson, 2010; Laska, Borradaile, Tester, Foster, & Gittelsohn, 2010; Laska, Hearst, Forsyth, Pasch, & Lytle, 2010; Moore et al., 2009; Zenk et al., 2009); therefore the extent to which these findings are true in non-metropolitan and rural areas are still inconclusive (Boehmer, Lovegreen, Haire-Joshu, & Brownson, 2006; Bustillos, Sharkey, Anding, & McIntosh, 2009; Casey et al., 2008; Creel, Sharkey, McIntosh, Anding, & Huber, 2008; A. A. Gustafson et al., 2011; Hermstad, Swan, Kegler, Barnette, & Glanz, 2010; Lasley & Litchfield, 2007; Liese, Weis, Pluto, Smith, & Lawson, 2007; Sharkey, 2009). Studies that do focus on rural environments provide conflicting results. For example, Boehmer and colleagues found that the distance to the nearest supermarket influences the dietary habits of individuals in rural areas (Boehmer et al., 2006), but Hermstad and colleagues found that there is no relationship between the neighborhood food environment and dietary intake(Hermstad et al., 2010). There is a need for continued research in rural areas to better understand how it may be similar or different from urban and suburban areas.

The inclusion of communities members in built environment assessment research have only recently begun to emerge in the peer-reviewed literature(Buman et al., 2012; Nykiforuk et al., 2012; Ohri-Vachaspati et al., 2012; Zoellner, Hill, Zynda, Sample, & Yadrick, 2012). Community-based participatory research (CBPR) may be an effective method for gaining access to hard-to-reach and vulnerable populations. CBPR approaches aim to leverage local expertise and resources to meet project objectives and move health outcomes (Israel, Eng, Schulz, & Parker, 2005; Minkler, 2008). Further, a CBPR-approach allows for collaborative conceptualization of the project, a mechanism to disseminate results to the community and a forum for feedback from the community (Israel et al., 2005; Minkler, 2008). The Dan River Partnership for a Healthy Community (DRPHC), established in 2009 as a community-academic partnership, has a mission to reduce and prevent obesity in the region and operates under CBPR principles(Motley, Holmes, Hill, Plumb, & Zoellner, 2012; J. M. Zoellner et al., 2012). In 2010, using the

CPPE process (Zoellner et al., 2012), the community created causal models for obesity in the region (Zoellner et al., 2012). Of the six created models, two causal models focused on environmental and geographical factors driving obesity in the region (Hill et al., 2012; Zoellner et al., 2012). To address the geographic and environmental causal models, a series of built environment studies were developed to provide environmental and contextual data for the region and the DRPHC (Hill et al., 2012). This study is part of those ongoing efforts, occurring as part of the DRPHC and adheres to the CBPR process that guides this community-academic partnership.

The overall objective is to advance the community created causal models for geographic and environmental influences by focusing on the food environment (Hill et al., 2012; Zoellner et al., 2012). This paper describes the enumeration and systematic audits of the food environment using the Nutrition Environment Measures Surveys (NEMS) (Glanz et al., 2007; Saelens et al., 2007) to determine the availability of healthy food options. Further, this study seeks to determine if the availability of healthy food options differ by block group race and income and between store and restaurant types. It is hypothesized that low income and high minority block groups will have lower healthy food availability.

Methods

Study Area

The Dan River Region is a predominately rural, health disparate and medically underserved region covering almost 1,800 square miles located in south-central Virginia and north-central North Carolina (Bureau, 2012; "Find Shortage Areas: MUA/P by State and County,"). This large region is anchored by a small regional city (Danville, VA) of approximately 45,000 residents (Bureau, 2012). The city suffers from high unemployment, low educational attainment and high rates of chronic disease, including obesity ("Local Area Unemployment Statistics: Unemployment Rates for Metropolitan Areas," 2012; MDC, 2008). Danville currently ranks 118th out of 131 for health outcomes by county or city in the Commonwealth of Virginia ("County Health Rankings," 2012). Through the CBPR process, community members assisted in defining the study area. Given the higher concentration of resources (e.g., food outlets, healthcare services) within Danville, and that many county-based residents travel into the city for work or shopping, the study area for this initial project is defined by the city limits.

Block Group Measures

<u>Race and Income</u>

Detailed 2010 United States Census data is currently not available for this region, therefore 2000 Census data was utilized to obtain block group level economic and socio-demographic characteristics for the city. Census data is hierarchical and divides a selected area, from largest to smallest, into states, counties, census tracts, block groups, and blocks ("Standard Hierarchy of Census Geographic Entities," 2010). Data at the block group level is a proportional sample of all blocks within the census tract. Block group-level data is often used in the food environment literature and it provides a smaller-scale representation of what may be available immediately or nearby to residents compared to census tract or county-level data (Li et al., 2009; Zenk et al., 2009; Sharkey et al., 2011b). The 2000 Census divides Danville into 39 block groups (Bureau, 2012). Several studies on the food environment use block group as the neighborhood indicator (Li et al., 2009; Sharkey, Johnson, Dean, & Horel, 2011b; Zenk et al., 2009). Based on census data, just over 95% of the population in the city is Black or White with nearly even distribution between the two. To eliminate empty cells at the block group level for race, the other race categories were dropped and block groups were categorized as predominantly Black, predominantly White or Mixed. To determine the appropriate cut points for block group race classification, a sensitivity analysis was conducted and found 55% sufficient (Hill et al., 2012). A block group with >55% of a single race, was classified as predominantly "White" or "Black". Out of 39 total block groups, 33 had distributions >60/40% for race, 11 of which have distributions >75/25%. Therefore, it was a conservative approach in using >55% in categorizing block groups. Only six of the total 39 block groups did not have an overwhelming percentage of either White or Black (e.g., both race percentages are >45% but <55%), and are classified as "Mixed". Aligning with other published research utilizing similar methods, income by block group was categorized using tertiles based on median family income distribution: low income (≤$22,000), middle income ($22,000-$49,999), high income (≥$50,000) (Franco et al., 2009; Franco et al., 2008).

<u>Enumeration of food outlets</u>

In the Commonwealth of Virginia, all food outlets must hold an active permit to sell food ("Food Safety ") and the research team obtained a current list of the food establishments from a searchable database from the Virginia's Department of Health ("Danville Food Establishments," 2012). Food outlets that served a worksite (e.g., cafeteria in a hospital, office building), school or do not serve the public (e.g., hotel breakfast only open to hotel patrons; catering companies) were excluded from the original list. Outlets on this reduced list were matched against a business directory list from the City of Danville Office of Economic Development. Researchers further verified all outlets through an online business directory and outlets that were found through the internet searches and verified to be open were included in the final data sample.

From these data sources, outlets were divided into stores and restaurants and then further categorized according to NEMS classifications (Glanz et al., 2007; Saelens et al., 2007). Stores are divided into two main categories (i.e., grocery stores, convenience stores) and restaurants into three main categories (i.e., fast casual, fast food, sit-down). A fourth "specialty" category was also included under restaurants to encompass food outlets that serve hot entrees as a secondary function (e.g., a coffee house that primarily serves specialty coffee to its patrons but also has a menu for hot entrees). In total, 209 outlets (49 stores, 160 restaurants) were identified, enumerated, and sorted by census tract (Table 3-1). Each outlet was given a unique three-digit identification (ID) number and subsequently mapped in ArcGIS™ 9.3 to their corresponding census tract and block group.

Nutrition Environment Measures Survey

Glanz and colleagues developed the Nutrition Environment Measures Survey (NEMS) with the objective of providing highly reliable and valid measures of the food environment(Glanz et al., 2007; Saelens et al., 2007) Store and restaurants are measured separately by two different tools (i.e., NEMS-S for stores and NEMS-R for restaurants) (Glanz et al., 2007; Saelens et al., 2007). The primary outcome of NEMS-S is to assess the availability of healthy options, price and quality within a retail food store (Glanz et al., 2007), while NEMS-R assesses factors in the restaurant environment and on the menu that contribute to food choices, such as availability of more healthy options, facilitators and barriers to healthy eating, pricing, and signage and promotions of healthy and unhealthy choices (Saelens et al., 2007). Both instruments have been validated with high inter-rater reliability and test-retest validity (Glanz et al., 2007; Ohri-Vachaspati & Leviton, 2010; Saelens et al., 2007).

Food stores are categorized into two main categories: grocery stores and convenience stores, which include all gas station mini-marts (Glanz et al., 2007). The NEMS-S reviews each store on 11 indicator items (i.e., milk, fresh fruits, fresh vegetables, ground beef, hot dogs, frozen dinner entrees, baked goods, beverages, bread, chips, and cereal), and the number of varieties (e.g., healthy or not healthy) offered (Glanz et al., 2007). The criteria to determine if an item is healthy was based on government recommendations for intakes (e.g., fat-free milk or 1% milk compared to 2% or whole milk) (Glanz et al., 2007).

Restaurants categorized as “fast food” have minimal service and food is supplied quickly after ordering, “fast casual” characterized by similarities to fast food with no table service but higher quality of food, or “sit-down” that include a full table service and wait staff (Saelens et al., 2007). The NEMS-R instrument includes a review of menu items, rating of the signage and promotion and facilitators and barriers to healthy choices (Saelens et al., 2007). According to NEMS-R protocol, healthy options are determined by the ratio of total grams of fats and saturated fats compared to total calories based on government recommendations for intake (Saelens et al., 2007). If full nutrition information is not available, a healthfulness score cannot be accurately determined, and by default receive a zero score for healthy availability of entrée options (Saelens et al., 2007).

Healthy Food Availability

The NEMS is scored to provide a composite score for the different subscales (healthy availability, pricing, and quality) (Glanz et al., 2007; Saelens et al., 2007). For this research project, only the subscale score of healthy availability was used across stores and restaurants. Both NEMS tools were scored according to published protocol (Glanz et al., 2007; Saelens et al., 2007). The scores for healthy availability in the NEMS-S and NEMS-R can range from 0-30, with a higher score indicating better availability of healthy food options.

The four categories of restaurants (fast casual, fast food, sit down, specialty) were collapsed into three categories with the "specialty" being re-categorized as "fast casual" since there were too few "specialty" outlets (n=4) for adequate analyses and they met the criteria of a "fast causal" outlet. Through the DRPHC, community members gave input during the enumeration and audit process that many residents in the region shopped at these 'other' non-traditional stores for grocery items. Therefore, an additional 'others' category was added to encompass dollar stores and convenience store pharmacies (e.g. CVS, Walgreens, Rite-Aid) (Bustillos et al., 2009; Sharkey, 2009; Sharkey, Horel, & Dean, 2010).

Training and Fieldwork for NEMS

Prior to the initiation of this study, the principle investigator (PI) completed NEMS training in person with NEMS staff and the project coordinator completed training online. Research assistants, which included graduate and undergraduate research assistants, completed the NEMS online training module and an intensive two-day didactic training that included experiential field practice led by the PI and project coordinator (Appendix D). An *a priori* kappa coefficient of >0.60 was set for inter-rater reliability. Kappa coefficients were computed for all data collected in field practice and trainees were certified for fieldwork once they consistently reached the threshold. In sum, eight graduate and undergraduate research assistants completed the online modules for NEMS, seven completed didactic sessions and field work and six reached certification for fieldwork.

After certification through training, two auditors rated every outlet to ensure data quality. Beginning with the restaurants, auditors traveled in pairs to assigned block groups for audits. Upon entering a restaurant, the auditor first observes the restaurant environment for facilitators and barriers to healthy eating. Following the NEMS-R protocol, auditors then systematically review the menu to determine availability of healthy entrées (Saelens et al., 2007). For stores, auditors followed the NEMS-S protocol and determined if the 11 indicator items are available. If the item is available for sale, they would find the healthy alternative and compare to the regular alternative (e.g., for bread, comparing whole wheat bread to while bread) for price and quality. If no healthy alternative option is available, the regular option was noted (Glanz et al., 2007).

If the auditors came across an outlet that was not on the original enumerated data list and it met the inclusion criteria, an audit was performed and the outlet was added to the sample. An extra 26 outlets were identified during fieldwork and audited. Figure 3-1 provides detailed information on the audit process. For any outlets not audited, the auditors made comments as to why they failed to perform the audit (N=30). The two main reasons for not conducting an audit were the business was closed or could not be found at or near published address (N=25) and the manager/owner did not approve of the audits (N=5) (Figure 3-1).

Inter-Rater Reliability

A kappa coefficient was calculated for each food outlet to test inter-rater reliability (Appendix E). Kappa coefficients ranged from 0.75-0.95, with means of 0.846 and 0.883, in restaurants and stores, respectively. Inter-rater reliability was high across both restaurants and stores (Fleiss & Cohen, 1973). An independent sample t-test was computed for all possible pairs of auditors to test for consistency in rating and there were no systematic differences across auditors in scoring (Appendix E). Given the high inter-rater reliability and consistency among auditors, a random-delete strategy was used to eliminate one audit for each outlet to create a final data set for scoring.

Analysis

All completed audits were coded and entered into Statistical Package for Social Sciences (SPSS®) 20.0. All entered data was double-checked for errors by another research assistant and through descriptive measures such as range, mean and percentages. One-way analysis of variance (ANOVA) tested for mean differences in healthy availability scores by block group race and income and within all store types and restaurant types.

Results

In total, the research team audited 60 stores and 124 restaurants. Stores included 37 convenience stores, 12 other stores, and 11 grocery stores; while restaurants included 61 sit down, 44 fast food, and 19 fast casual. Table 3-2 summarizes the healthy availability subtotal scores for both stores and restaurants audited by block group race and income. The mean (SD) healthy food availability scores for all stores by type are: convenience stores, 4.2 (4.1); other stores, 6.8 (2.5); grocery stores, 22.3 (5.7). For restaurants, the availability of healthy menu option subtotal scores for all restaurants by types are: sit down, 4.2 (2.8); fast food, 5.7 (3.8); fast casual, 8.6 (7.1). Within all stores (n=60, F= 79.5, p=0.000) and all restaurants (n=124, F=8.6, p=0.000), there is a significant difference of healthy available options by type of outlet.

Table 3-2 provides the number of audits completed and their mean healthy availability scores by block group race and income. In general, healthy food availability scores were low (M=8.0, SD=8.0) across all block groups, incomes, and outlet types. The predominately White block groups are higher income and have higher number of outlets (n=115) while the predominately Black block groups were low-to middle income, with no high income Black block groups, and fewer total number of outlets (n=32). Across the 19 White block groups, there are seven grocery stores with a mean (SD) healthy availability score of 24.3 (4.8). In contrast, across 14 Black block groups, only one grocery store is present with a healthy availability score of 13.0 (Table 3-2).

In addition to describing the food environment by block group race and income, one-way ANOVAs tested for significant differences in availability of healthy options (Table 3-3). There were no significant differences in the healthy availability scores by block group race or income (Table 3-3). Despite the relatively large mean difference, the low variability in healthy availability scores limit the ability to detect statistically significant differences.

Discussion

The food environment in this study lacks availability of healthy options for residents. Although, not statistically significant, block groups of lower income and higher minority populations had fewer food outlets which is consistent with research in urban or metropolitan areas(Andreyeva et al., 2008; Black & Macinko, 2008; Franco et al., 2009; Franco et al., 2008; Krukowski et al., 2010; Larson et al., 2009; Lee et al., 2010; Raja et al., 2008). Andreyeva and colleagues found predominantly White, high-income neighborhoods have a more even distribution of stores with better healthy food options (Andreyeva et al., 2008). In other studies, low-income neighborhoods had three times the number of conveniences stores with only half the number of grocery stores (Gloria & Steinhardt, 2010; Lee et al., 2010). Krukowski and colleagues found that the availability of healthy foods varies by neighborhood median income (Krukowski et al., 2010). Although the definition of a "neighborhood" varies across studies (i.e., census block groups or census tracts), it is consistent that there is a relationship between store and restaurant types and the racial or economic composition of neighborhoods (Franco et al., 2008; Gittelsohn et al., 2008; Krukowski et al., 2010; Larson et al., 2009; Lee et al., 2010). Consistent with other literature, grocery stores had the highest availability of healthy foods while convenience and other stores varied in their availability (Andreyeva et al., 2008; Black & Macinko, 2008; Ford & Dzewaltowski, 2010; Krukowski et al., 2010; Laska, Borradaile, et al., 2010; Liese et al., 2007).

For the restaurants, few had healthy alternatives on the menu. Fast casual restaurants had the highest availability of healthy menu options, compared to fast food or sit down restaurants. The protocol for NEMS-R is based on availability of nutrition facts for entrée options to determine healthfulness. Most of the fast casual and fast food restaurants are national or regional chains, which may have more support for or requirements from the national office to provide nutritional facts and information. By comparison, many of the sit-down restaurants were independent diners and cafes that did not provide nutritional information, therefore making it difficult to determine the healthfulness of menu options.

Through the CBPR process, DRPHC members provided critical feedback on the study area and adaptations to the measurement of food outlets. In addition to the typical NEMS definitions for stores, this study includes non-typical food outlets such as Family Dollar or CVS Pharmacy. The community indicated that these are common places to purchase groceries for many local residents; therefore, they were enumerated and audited as part of the food environment. Further, as part of the participatory process, results from this study were disseminated to the DRPHC. Currently, the DRPHC is considering expansion of these efforts into the outlying counties and options for additional dissemination and 'action items' that could be considered at the local level based on these findings.

This study is not without limitations. This study focuses on a small city that anchors a predominately rural, health disparate region that may limit the generalizability of these findings. However, given that the majority of food environment and NEMS research has focused on urban settings(Andreyeva et al., 2008; Franco et al., 2009; Gittelsohn et al., 2008; Laska, Borradaile, et al., 2010; Lee et al., 2010; Ohri-Vachaspati & Leviton, 2010), this study contributes to the small body of literature focusing on assessment of non-metropolitan and rural food environments(Ford & Dzewaltowski, 2010; Hermstad et al., 2010; Lasley & Litchfield, 2007; Sharkey, Johnson, Dean, & Horel, 2011a). Statistical power may also be viewed as a study limitation, yet it is important to recognize that rural environments and small cities yield fewer census tracts and block groups than would be typical of an urban-based studies. Importantly, the data presented is not a sample of the food outlets available to residents. Our data collection included all food outlets; therefore, this is what is available for residents.

Conclusions

This study adds to the body of literature that supports disparities in access and availability of healthy food options for low income and minority populations. It also contributes to the much smaller knowledge base of non-metropolitan and rural food environments and the research literature on the NEMS tools for measuring the food environment. Importantly, this study of food environments occurs within a CBPR framework and as part of an ongoing community-academic partnership. The study was designed and conducted specifically to advance community-created causal models on environmental and geographic factors related to obesity. It has accomplished this by identifying and auditing 184 publically available stores and restaurants within Danville. Further, based on the NEMS healthy availability score, it is clear that there is low availability of healthy options for residents. This data is available for use by DRPHC members and local stakeholders. Working collaboratively, research staff and community stakeholders in the DRPHC will make decisions for the dissemination of these results to the community and the next steps for this research. Use of this data by the DRPHC may lead to more sustainable interventions or programs in the region, including those that extend beyond individual level approaches to address complex obesity related problems. Likewise, this data may also be used to inform the creation of contextually and locally relevant policy aimed at creating a healthier food environment for residents of this health disparate region.

Table 3-1. Enumerated food outlets by block group.

	Restaurants				Stores	
CT-BG	FC	FF	SD	SP	GS	CS
CT 1 BG 1	1	4	2	0	0	2
CT 1 BG 2	2	2	0	0	0	1
CT 1 BG 3	0	0	1	0	0	0
CT 1 BG 4	0	0	0	0	0	0
CT 2 BG 1	1	10	6	0	0	1
CT 2 BG 2	0	4	0	0	0	1
CT 2 BG 3	1	2	7	0	1	1
CT 3 BG 1	0	0	0	0	0	0
CT 3 BG 2	0	1	0	0	1	0
CT 3 BG 3	0	1	1	0	0	1
CT 4 BG 1	0	0	0	0	1	2
CT 4 BG 2	0	0	0	0	1	0
CT 4 BG 3	0	0	0	0	1	0
CT 4 BG 4	1	0	1	0	0	0
CT 5 BG 1	1	1	1	1	2	0
CT 5 BG 2	0	1	1	0	0	2
CT 6 BG 1	2	0	0	0	0	0
CT 6 BG 2	0	0	1	0	0	0
CT 6 BG 3	0	0	0	0	0	1
CT 6 BG 4	0	0	0	0	1	1
CT 7 BG 1	0	0	0	0	0	0
CT 7 BG 2	1	1	1	0	0	0
CT 7 BG 3	2	3	3	0	0	0
CT 8 BG 1	9	16	26	3	3	3
CT 8 BG 2	1	3	3	1	0	2
CT 8 BG 3	1	0	1	0	0	0
CT 9 BG 1	0	1	1	0	1	3
CT 9 BG 2	0	0	2	0	0	2
CT 9 BG 3	0	0	0	0	1	1
CT 10 BG 1	0	0	2	0	1	1
CT 10 BG 2	0	0	0	0	0	0
CT 11 BG 1	0	0	0	0	0	0
CT 11 BG 2	1	1	0	0	0	0
CT 11 BG 3	0	0	1	0	0	0
CT 12 BG 1	0	1	2	0	0	0
CT 12 BG 2	0	0	0	0	0	0
CT 13 BG 1	2	8	5	0	2	5
CT 14 BG 1	0	0	0	0	1	1
CT 14 BG 2	0	0	1	0	0	1

FC, Fast Casual; FF, Fast Food; SD, Sit-Down; SP, Specialty; GS, Grocery Store; CS, Convenience Store; CT, Census Tract; BG, Block Group

Figure 3-1. Consort diagram for audits performed.

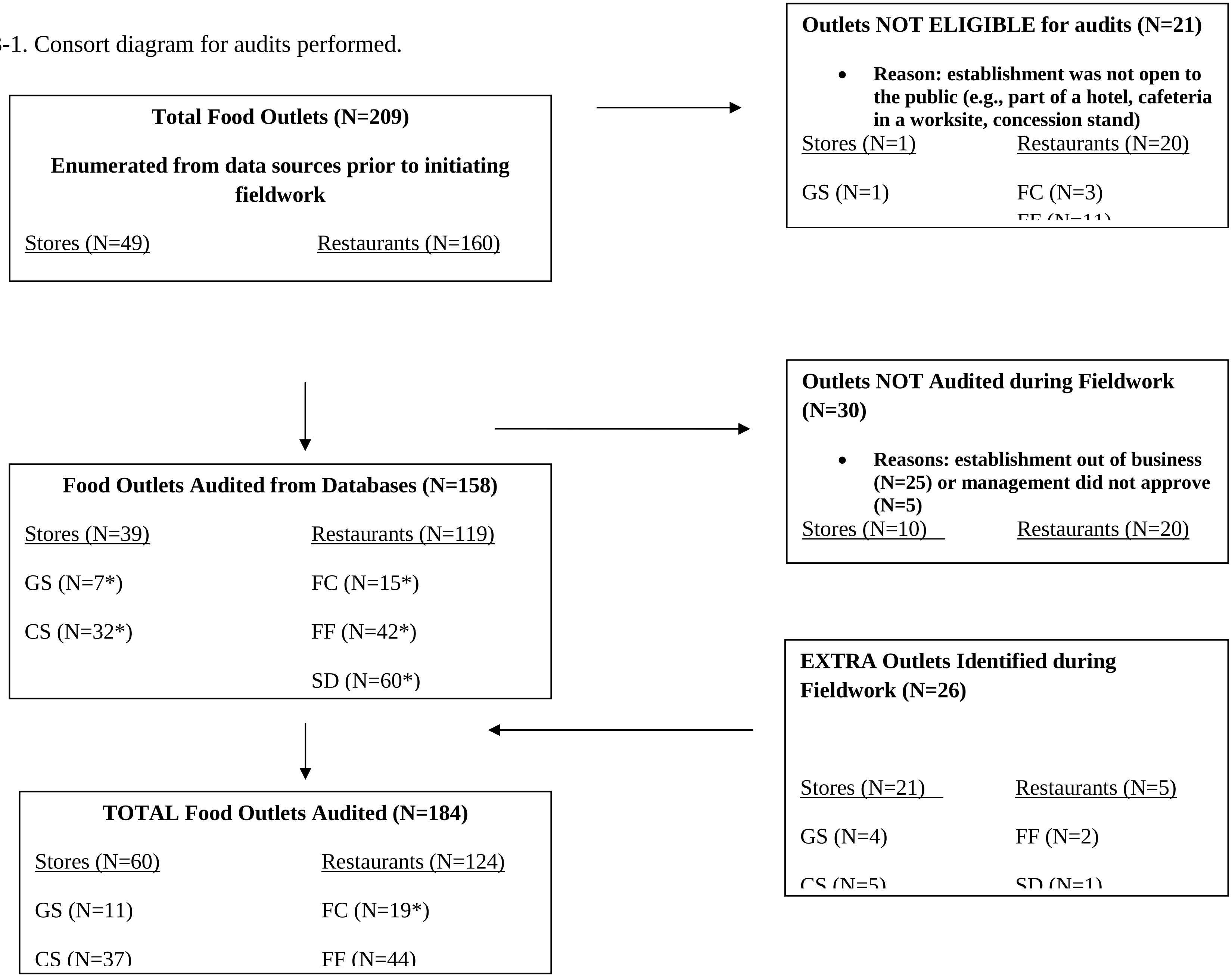


Table 3-2. Mean(SD) of healthy food availability by block group race and income.

Race	Income	Type	N(%)[†]	Healthy Food Availability[¤]
White (19 BG[‡§])	Middle (6BG)	Fast Casual	8(6.5)	7.2(8.2)
		Fast Food	19(15.3)	6.4(4.8)
		Sit Down	37(29.8)	4.3(2.9)
		Grocery Store	4(6.7)	23.8(5.7)
		Convenience Store	8(13.3)	3.1(1.7)
		Other non-traditional Store	2(3.3)	7.0(5.7)
	High (12BG)	Fast Casual	3(2.4)	13.3(4.5)
		Fast Food	8(6.5)	4.4(2.9)
		Sit Down	8(6.5)	4.1(2.7)
		Grocery Store	3(5.0)	25.0(4.4)
		Convenience Store	9(15.0)	6.9(7.7)
		Other non-traditional Store	6(10.0)	6.2(2.0)
Black (14 BG)	Low (12 BG)	Fast Casual	3(2.4)	6.0(7.9)
		Fast Food	4(3.2)	6.5(2.6)
		Sit Down	4(3.2)	6.8(3.8)
		Grocery Store	1(1.7)	13.0*
		Convenience Store	7(3.4)	3.4(1.1)
		Other non-traditional Store	0	
	Middle (2 BG)	Fast Casual	2(1.6)	6.0(0.0)
		Fast Food	5(4.0)	4.6(1.1)
		Sit Down	4(3.2)	3.8(1.5)
		Grocery Store	0	
		Convenience Store	2(3.3)	3.0(1.4)
		Other non-traditional Store	0	
Mixed (6 BG)	Low (2 BG)	Fast Casual	1(0.8)	3.0*
		Fast Food	0	
		Sit Down	1(0.8)	7.0*
		Grocery Store	1(1.7)	17.0*
		Convenience Store	1(1.7)	4.0*
		Other non-traditional Store	1(1.7)	7.0*
	Middle (1 BG)	Fast Casual	1(0.8)	16.0*
		Fast Food	6(4.8)	6(4.1)
		Sit Down	5(4.0)	3(2.1)
		Grocery Store	2(5.0)	22.5(6.4)
		Convenience Store	5(8.3)	3.0(1.4)
		Other non-traditional Store	2(5.0)	7.5(3.5)
	High (3 BG)	Fast Casual	1(0.8)	17.0*
		Fast Food	2(1.6)	4.5(2.1)
		Sit Down	2(1.6)	1.5(2.1)
		Grocery Store	0	
		Convenience Store	5(8.3)	3.6(1.5)
		Other non-traditional Store	1	8.0*

BG = Block Group
[†]Total Restaurants (N=124), Total Stores (N=60)
[¤]Healthy Food Availability Score range 0-30; 0=least healthy options, 30=more healthy options
[‡]Total block groups present in specified category
[§]Missing 1 White, low-income block group; no outlets identified in area
*Only one outlet, no standard deviation

Table 3-3. One-way ANOVA of healthy availability score for all restaurant types and all store types by block group race and income.

	All Restaurant Types				All Store Types			
	n	M (SD)	F	Sig.	n	M(SD)	F	Sig.
By Race			0.024	0.976			1.864	0.164
White	83	5.4 (4.5)			32	9.6 (9.3)		
Black	22	5.5 (3.3)			10	4.3 (3.2)		
Mixed	19	5.6 (4.9)			18	7.2 (6.9)		
By Income			0.338	0.714			0.4554	0.637
Low	13	6.2 (4.1)			11	5.9 (4.8)		
Middle	87	5.2 (4.2)			25	8.6 (9.1)		
High	24	5.7 (4.8)			24	8.3 (8.2)		

REFERENCES

Andreyeva, T., Blumenthal, D. M., Schwartz, M. B., Long, M. W., & Brownell, K. D. (2008). Availability and prices of foods across stores and neighborhoods: the case of New Haven, Connecticut. Health Aff (Millwood), 27(5), 1381-1388. doi: 10.1377/hlthaff.27.5.1381

Black, J. L., & Macinko, J. (2008). Neighborhoods and obesity. Nutr Rev, 66(1), 2-20. doi: 10.1111/j.1753-4887.2007.00001.x

Boehmer, T. K., Lovegreen, S. L., Haire-Joshu, D., & Brownson, R. C. (2006). What constitutes an obesogenic environment in rural communities? Am J Health Promot, 20(6), 411-421.

Booth, K. M., Pinkston, M. M., & Poston, W. S. (2005). Obesity and the built environment. J Am Diet Assoc, 105(5 Suppl 1), S110-117. doi: 10.1016/j.jada.2005.02.045

Brownson, R. C., Baker, E. A., Housemann, R. A., Brennan, L. K., & Bacak, S. J. (2001). Environmental and policy determinants of physical activity in the United States. Am J Public Health, 91(12), 1995-2003.

Buman, M. P., Winter, S. J., Baker, C. S., Hekler, E. B., Otten, J. J., & King, A. C. (2012). Neighborhood Eating and Activity Advocacy Teams (NEAAT): engaging older adults in policy activities to improve food and physical activity environments. Transl Behav Med, 2(2), 249-253.

Bureau, U.S. Census. (2012). State and County QuickFacts. Retrieved July 9, 2012, from http://quickfacts.census.gov/qfd/states/51/5121344.html

Bustillos, B., Sharkey, J. R., Anding, J., & McIntosh, A. (2009). Availability of more healthful food alternatives in traditional, convenience, and nontraditional types of food stores in two rural Texas counties. J Am Diet Assoc, 109(5), 883-889. doi: 10.1016/j.jada.2009.02.011

Casagrande, S. S., Franco, M., Gittelsohn, J., Zonderman, A. B., Evans, M. K., Fanelli Kuczmarski, M., & Gary-Webb, T. L. (2011). Healthy food availability and the association with BMI in Baltimore, Maryland. Public Health Nutr, 14(6), 1001-1007. doi: 10.1017/S1368980010003812

Casey, A. A., Elliott, M., Glanz, K., Haire-Joshu, D., Lovegreen, S. L., Saelens, B. E., . . . Brownson, R. C. (2008). Impact of the food environment and physical activity environment on behaviors and weight status in rural U.S. communities. Prev Med, 47(6), 600-604. doi:10.1016/j.ypmed.2008.10.001

Cooper, R., Cutler, J., Desvigne-Nickens, P., Fortmann, S. P., Friedman, L., Havlik, R., . . . Thom, T. (2000). Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention. Circulation, 102(25), 3137-3147.

County Health Rankings. (2012). Retrieved August 18, 2012, from http://www.countyhealthrankings.org/app/virginia/2012/rankings/outcomes/overall

Creel, J. S., Sharkey, J. R., McIntosh, A., Anding, J., & Huber, J. C., Jr. (2008). Availability of healthier options in traditional and nontraditional rural fast-food outlets. BMC Public Health, 8, 395. doi: 10.1186/1471-2458-8-395

Danville Food Establishments. (2012, August 19, 2012). Retrieved August 19, 2012, from http://www.healthspace.com/Clients/VDH/PDanville/PDanville_Website.nsf

Ding, D., & Gebel, K. (2012). Built environment, physical activity, and obesity: What have we learned from reviewing the literature? Health Place, 18(1), 100-105. doi: 10.1016/j.healthplace.2011.08.021

Elinder, L. S., & Jansson, M. (2009). Obesogenic environments--aspects on measurement and indicators. Public Health Nutr, 12(3), 307-315. doi: 10.1017/S1368980008002450

Feng, J., Glass, T. A., Curriero, F. C., Stewart, W. F., & Schwartz, B. S. (2010). The built environment and obesity: a systematic review of the epidemiologic evidence. Health Place, 16(2), 175-190. doi: 10.1016/j.healthplace.2009.09.008

Find Shortage Areas: MUA/P by State and County. Retrieved August 9, 2012, from http://muafind.hrsa.gov/index.aspx

Flegal, K. M. (2005). Epidemiologic aspects of overweight and obesity in the United States. Physiol Behav, 86(5), 599-602. doi: 10.1016/j.physbeh.2005.08.050

Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. JAMA, 303(3), 235-241. doi: 10.1001/jama.2009.2014

Fleiss, J., & Cohen, J. (1973). The Equivalence of Weighted Kappa and the Intraclass Correlation Coefficient as Measures of Realiability. Educ Psychol Meas, 33, 613-619.

Food Safety (2010, December 2, 2010). Retrieved January 17, 2011, from http://www.vdh.state.va.us/

Ford, P.B., & Dzewaltowski, D.A. (2010). Geographical, racial, ethnic, and socioeconomic disparities in the availability of grocery stores and supermarkets among low-income women across the urban-rural continuum. J Hunger Environ Nutr, 5(5), 216-233. doi: 10.1080/19320241003800276

Franco, M., Diez-Roux, A. V., Nettleton, J. A., Lazo, M., Brancati, F., Caballero, B., . . . Moore, L. V. (2009). Availability of healthy foods and dietary patterns: the Multi-Ethnic Study of Atherosclerosis. Am J Clin Nutr, 89(3), 897-904. doi: 10.3945/ajcn.2008.26434

Franco, M., Diez Roux, A. V., Glass, T. A., Caballero, B., & Brancati, F. L. (2008). Neighborhood characteristics and availability of healthy foods in Baltimore. Am J Prev Med, 35(6), 561-567. doi: 10.1016/j.amepre.2008.07.003

Giskes, K., van Lenthe, F., Avendano-Pabon, M., & Brug, J. (2011). A systematic review of environmental factors and obesogenic dietary intakes among adults: are we getting closer to understanding obesogenic environments? Obes Rev, 12(5), e95-e106.

Gittelsohn, J., Franceschini, M.C.T., Rasooly, I.R., Ries, A. V., Ho, L.S., Pavlovich, W., . . . Frick, K.D. (2008). Understanding the food environment in a low income urban setting, implications for food store interventions. J Hunger Environ Nutr, 2(2), 33-50. doi: 10.1080/19320240801891438

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2007). Nutrition Environment Measures Survey in stores (NEMS-S): development and evaluation. Am J Prev Med, 32(4), 282-289. doi: 10.1016/j.amepre.2006.12.019

Gloria, C. T., & Steinhardt, M. A. (2010). Texas nutrition environment assessment of retail food stores (TxNEA-S): development and evaluation. Public Health Nutr, 1-9. doi: 10.1017/S1368980010001588

Gustafson, A. A., Sharkey, J., Samuel-Hodge, C. D., Jones-Smith, J., Folds, M. C., Cai, J., & Ammerman, A. S. (2011). Perceived and objective measures of the food store environment and the association with weight and diet among low-income women in North Carolina. Public Health Nutr, 14(6), 1032-1038. doi: 10.1017/S1368980011000115

Gustafson, A., Hankins, S., & Jilcott, S. (2011). Measures of the Consumer Food Store Environment: A Systematic Review of the Evidence 2000-2011. J Community Health. doi: 10.1007/s10900-011-9524-x

Harper, M. G. (2006). Childhood obesity: strategies for prevention. Fam Community Health, 29(4), 288-298.

Hartley, D. (2004). Rural health disparities, population health, and rural culture. Am J Public Health, 94(10), 1675-1678.

Healthy People 2020. Retrieved June 30, 2011, from http://www.healthypeople.gov

Hermstad, A. K., Swan, D. W., Kegler, M. C., Barnette, J. K., & Glanz, K. (2010). Individual and environmental correlates of dietary fat intake in rural communities: a structural equation model analysis. Soc Sci Med, 71(1), 93-101. doi: 10.1016/j.socscimed.2010.03.028

Hill, J. L., Chau, C., Luebbering, C. R., Kolivras, K. K., & Zoellner, J. (2012). Does availability of physical activity and food outlets differ by race and income? Findings from an enumeration study in a health disparate region. Int J Behav Nutr Phys Act, 9, 105. doi: 10.1186/1479-5868-9-105

Israel, B.A., Eng, E., Schulz, A.J., & Parker, E.A. (Eds.). (2005). Methods in Community-Based Participatory Research for Health (1 ed.). San Francisco, CA: Josey-Bass.

Jilcott, S. B., McGuirt, J. T., Imai, S., & Evenson, K. R. (2010). Measuring the retail food environment in rural and urban North Carolina counties. J Public Health Manag Pract, 16(5), 432-440.

Krukowski, R. A., West, D. S., Harvey-Berino, J., & Elaine Prewitt, T. (2010). Neighborhood impact on healthy food availability and pricing in food stores. J Community Health, 35(3), 315-320. doi: 10.1007/s10900-010-9224-y

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments: disparities in access to healthy foods in the U.S. Am J Prev Med, 36(1), 74-81. doi: 10.1016/j.amepre.2008.09.025

Laska, M. N., Borradaile, K. E., Tester, J., Foster, G. D., & Gittelsohn, J. (2010). Healthy food availability in small urban food stores: a comparison of four US cities. Public Health Nutr, 13(7), 1031-1035. doi: 10.1017/S1368980009992771

Laska, M. N., Hearst, M. O., Forsyth, A., Pasch, K. E., & Lytle, L. (2010). Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status? Public Health Nutr, 1-7. doi: 10.1017/S1368980010001564

Lasley, Emily C.K., & Litchfield, Ruth E. (2007). Fresh produce in rural Iowa: Availability and Accessibility. J Hunger Environ Nutr, 2(2), 5-17. doi: 10.1080/19320240801891404

Lee, R. E., Heinrich, K. M., Medina, A. V., Regan, G. R., Reese-Smith, J. Y., Jokura, Y., & Maddock, J. E. (2010). A picture of the healthful food environment in two diverse urban cities. Environ Health Insights, 4, 49-60.

Li, F., Harmer, P., Cardinal, B. J., Bosworth, M., & Johnson-Shelton, D. (2009). Obesity and the built environment: does the density of neighborhood fast-food outlets matter? Am J Health Promot, 23(3), 203-209. doi: 10.4278/ajhp.071214133

Liese, A. D., Weis, K. E., Pluto, D., Smith, E., & Lawson, A. (2007). Food store types, availability, and cost of foods in a rural environment. J Am Diet Assoc, 107(11), 1916-1923. doi: 10.1016/j.jada.2007.08.012

Local Area Unemployment Statistics: Unemployment Rates for Metropolitan Areas. (2012, November 1, 2012). Retrieved December 26, 2012, from http://www.bls.gov/lau/

McKinnon, R. A., Reedy, J., Morrissette, M. A., Lytle, L. A., & Yaroch, A. L. (2009). Measures of the food environment: a compilation of the literature, 1990-2007. Am J Prev Med, 36(4 Suppl), S124-133. doi: 10.1016/j.amepre.2009.01.012

MDC. (2008). Dan River Region Health Assessment Chapel Hill, NC.

Minkler, M. (2008). Community-based participatory research for health. San Francisco, CA: Jossey-Bass.

Moore, L. V., Diez Roux, A. V., & Franco, M. (2012). Measuring Availability of Healthy Foods: Agreement Between Directly Measured and Self-reported Data. Am J Epidemiol, 175(10), 1037-1044. doi: 10.1093/aje/kwr445

Moore, L. V., Diez Roux, A. V., Nettleton, J. A., Jacobs, D. R., & Franco, M. (2009). Fast-food consumption, diet quality, and neighborhood exposure to fast food: the multi-ethnic study of atherosclerosis. Am J Epidemiol, 170(1), 29-36. doi: 10.1093/aje/kwp090

Motley, M., Holmes, A., Hill, J., Plumb, K. , & Zoellner, J. (2012). Evaluating Community Capacity to Reduce Obesity in the Dan River Region: A Case Study. Am J Health Behav, 37(2):207-216.

Nykiforuk, C. I., Schopflocher, D., Vallianatos, H., Spence, J. C., Raine, K. D., Plotnikoff, R. C., . . . Nieuwendyk, L. (2012). Community Health and the Built Environment: examining place in a Canadian chronic disease prevention project. Health Promot Int. doi: 10.1093/heapro/dar093

Ogden, C. L., Yanovski, S. Z., Carroll, M. D., & Flegal, K. M. (2007). The epidemiology of obesity. Gastroenterology, 132(6), 2087-2102. doi: 10.1053/j.gastro.2007.03.052

Ohri-Vachaspati, P., Leviton, L., Bors, P., Brennan, L. K., Brownson, R. C., & Strunk, S. (2012). Strategies proposed by Healthy Kids, Healthy Communities partnerships to prevent childhood obesity. Prev Chronic Dis, 9, E11.

Ohri-Vachaspati, P., & Leviton, L. C. (2010). Measuring food environments: a guide to available instruments. Am J Health Promot, 24(6), 410-426. doi: 10.4278/ajhp.080909-LIT-190

Oreskovic, N. M., Kuhlthau, K. A., Romm, D., & Perrin, J. M. (2009). Built environment and weight disparities among children in high- and low-income towns. Acad Pediatr, 9(5), 315-321. doi: 10.1016/j.acap.2009.02.009

Raja, S., Ma, C. X., & Yadav, P. (2008). Beyond food deserts - Measuring and mapping racial disparities in neighborhood food environments. Journal of Planning Education and Research, 27(4), 469-482. doi: 10.1177/0739456x08317461

Saelens, B. E., Glanz, K., Sallis, J. F., & Frank, L. D. (2007). Nutrition Environment Measures Study in restaurants (NEMS-R): development and evaluation. Am J Prev Med, 32(4), 273-281. doi: 10.1016/j.amepre.2006.12.022

Saelens, B. E., Sallis, J. F., Black, J. B., & Chen, D. (2003). Neighborhood-based differences in physical activity: an environment scale evaluation. Am J Public Health, 93(9), 1552-1558.

Service, Economic Research. (2010, July 6, 2012). Food Desert Locator.   Retrieved July 15, 2011, from http://www.ers.usda.gov/data-products/food-desert-locator.aspx

Sharkey, J. R. (2009). Measuring potential access to food stores and food-service places in rural areas in the U.S. Am J Prev Med, 36(4 Suppl), S151-155. doi: 10.1016/j.amepre.2009.01.004

Sharkey, J. R., Horel, S., & Dean, W. R. (2010). Neighborhood deprivation, vehicle ownership, and potential spatial access to a variety of fruits and vegetables in a large rural area in Texas. Int J Health Geogr, 9, 26. doi: 10.1186/1476-072X-9-26

Sharkey, J. R., Johnson, C. M., Dean, W. R., & Horel, S. A. (2011a). Association between proximity to and coverage of traditional fast-food restaurants and non-traditional fast-food outlets and fast-food consumption among rural adults. Int J Health Geogr, 10, 37. doi: 10.1186/1476-072X-10-37

Sharkey, J. R., Johnson, C. M., Dean, W. R., & Horel, S. A. (2011b). Focusing on fast food restaurants alone underestimates the relationship between neighborhood deprivation and exposure to fast food in a large rural area. Nutr J, 10, 10. doi: 10.1186/1475-2891-10-10

Standard Hierarchy of Census Geographic Entities. (2010, October 27, 2010). Retrieved November 21, 2012, from http://www.census.gov/geo/reference/pdfs/geodiagram.pdf

Wang, Y., & Beydoun, M. A. (2007). The obesity epidemic in the United States--gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. Epidemiol Rev, 29, 6-28. doi: 10.1093/epirev/mxm007

Woolf, S. H., Jones, R. M., Johnson, R. E., Phillips, R. L., Jr., Oliver, M. N., Bazemore, A., & Vichare, A. (2010). Avertable deaths associated with household income in Virginia. Am J Public Health, 100(4), 750-755. doi: 10.2105/AJPH.2009.165142

Zenk, S. N., Lachance, L. L., Schulz, A. J., Mentz, G., Kannan, S., & Ridella, W. (2009). Neighborhood retail food environment and fruit and vegetable intake in a multiethnic urban population. Am J Health Promot, 23(4), 255-264. doi: 10.4278/ajhp.071204127

Zoellner, J., Hill, J. L., Zynda, K., Sample, A. D., & Yadrick, K. (2012). Environmental perceptions and objective walking trail audits inform a community-based participatory research walking intervention. Int J Behav Nutr Phys Act, 9, 6. doi: 10.1186/1479-5868-9-6

Zoellner, J. M. , Motley, M. , Wilkinson, M. , Jackman, B. , Barlow, M. L., & Hill, J. L. (2012). Engaging the Dan River Region to Reduce Obesity: Application of the Comprehensive Participatory Planning and Evaluation Process. Fam Community Health, 35(1), 44-56.

CHAPTER 4: MANUSCRIPT 2

Is the availability of healthy foods related to fruit and vegetable consumption in a rural, health disparate region?

Authors: Waters CN[1], Zoellner JM[1], Estabrooks PA[1], Hill JL[1]

Affiliations: [1]Virginia Tech, Human Nutrition, Foods, and Exercise, Blacksburg, Virginia

Introduction

Consuming more than five cups of fruits and vegetables (FV) a day is important for overall health and management of several chronic health conditions such as diabetes, some types of cancer, heart disease, and obesity(Bazzano, 2006; Blanck, Gillespie, Kimmons, Seymour, & Serdula, 2008; Dietary Guidelines for Americans 2010, 2010; Ford & Mokdad, 2001; He, Nowson, & MacGregor, 2006). Further, incorporating fresh FV into a daily diet is an important strategy for weight management (Bazzano, 2006; He et al., 2006). The current USDA recommendation for FV is 2-6.5 cups per day based on caloric need, yet less than a quarter of all Americans meet this recommendation (Dietary Guidelines for Americans 2010, 2010; Lutfiyya, Chang, & Lipsky, 2012).

While FV consumption is low nationally with a mean of 2.7 cups (NCI, 2010), meeting recommendations for FV intake varies by race, income, and education (Baker, Schootman, Barnidge, & Kelly, 2006; Dubowitz et al., 2008; Lutfiyya et al., 2012; Middaugh, Fisk, Brunt, & Rhee, 2012). In rural areas, residents are less likely to meet FV recommendation (Lutfiyya et al., 2012). This may be due in part to differences in the food environment and access to fresh produce (Larson, Story, & Nelson, 2009; Sharkey, Johnson, & Dean, 2010; C. Smith & Morton, 2009; D. M. Smith et al., 2010). A growing body of literature considers the influence of the food environment on choice and consumption (Boyington, Schoster, Remmes Martin, Shreffler, & Callahan, 2009; Guillaumie, Godin, & Vezina-Im, 2010; Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008). In general, low-income areas have poorer food environments, with less availability of healthy options and often higher densities of fast food restaurants (Baker et al., 2006; Dubowitz et al., 2008; Larson et al., 2009; Sloane et al., 2003). Neighborhoods with higher racial and ethnic minority populations and low socioeconomic statuses often have limited access to healthy foods resulting in poorer overall diets and less consumption of FV (Baker et al., 2006; Larson et al., 2009; Sloane et al., 2003). Sloane and colleagues found that residents living in a census tract with at least one supermarket are more likely to meet recommendations for FV and that individual consumption of FV increased as proximity to supermarkets and fresh produce increased (Sloane et al., 2003). Another study found fresh vegetable availability within 100 meters to a residence is a positive predictor of higher vegetable intake (Bodor, Rose, Farley, Swalm, & Scott, 2008). Mixed-race and White high poverty areas and all Black areas regardless of income, are less likely to have access to healthier food options than White, higher-income areas(Baker et al., 2006). It is evident that the food environment plays a significant role to influence diet and consumption.

While the body of literature that supports food environment and dietary behavior is expanding, the majority of studies have been completed urban areas with high population densities while the food environment in less populated and rural areas has received far less attention(Boehmer, Lovegreen, Haire-Joshu, & Brownson, 2006; Casey et al., 2008; Gustafson et al., 2011; Sharkey, 2009). Those studies that have focused on rural food environments indicate that these areas are characterized by low number of widely dispersed outlets, increasing the distance residents must travel to reach an outlet such as a supermarket or grocery store (Larson et al., 2009; Sharkey, 2009; Sharkey, Horel, Han, & Huber, 2009; Smith & Morton, 2009; Smith et al., 2010). However, the finding that healthy eating and environmental availability of healthy foods has not been consistent in studies of rural environments (Boehmer et al., 2006; Bustillos, Sharkey, Anding, & McIntosh, 2009; Ford & Dzewaltowski, 2010; Hermstad, Swan, Kegler, Barnette, & Glanz, 2010; Hosler, Rajulu, Fredrick, & Ronsani, 2008; Lutfiyya et al., 2012) and mechanisms of the disparities in FV intake are unclear.

Community-based participatory research (CBPR) is one approach to generate locally relevant information that could be related to reducing health disparities such as those related to FV intake(Greenwood & Levin, 2007; Israel, Eng, Schulz, & Parker, 2005). Through this process, community residents, organizations, and researchers, together identify priority areas, propose potential causal maps that result in specific disparities, collect data to test causal maps and inform the design and implement interventions (Israel et al., 2005). The collaboration is focused on equal partnership of all key members and builds upon the strengths and assets of the community (Greenwood & Levin, 2007; Israel et al., 2005). The research presented here is part of a larger ongoing community-academic partnership, the Dan River Partnership for a Healthy Community (DRPHC), which operates under CBPR principles.

In a predominantly rural health disparate region of south-central Virginia and north-central North Carolina, the DRPHC(Motley, Holmes, Hill, Plumb, & Zoellner, 2012; Zoellner et al., 2012) conducted a 2-day, comprehensive participatory planning and evaluation workshop that resulted in a variety of priority areas to address obesity in the region(Zoellner et al., 2012; Zanko, Reese, MacAuley, Hill, & Zoellner, 2012; Zoellner et al., 2012; Zoellner, Zanko, Price, Bonner, & Hill, 2012). Of note, one priority area was to examine a number of aspects of the local built environment to determine local availability of resources for healthy food and FV options with an ultimate goal to determine the need and opportunities for interventions to eliminate disparities in healthful eating, physical activity, and obesity in the region(Chau, Luebbering, Kolivras, Zoellner, & Hill, 2011; Chau, Sams, Kolivras, & Hill, 2012a, 2012b; Chau, Zoellner, & Hill, 2012; Chau, Zoellner, & Hill, 2012; Hill, Chau, Luebbering, Kolivras, & Zoellner, 2012).

This study reports on some of the initial DRPHC activities that occurred in response to the high need for research in rural regions and small population communities, the lack of consensus regarding the role of the food environment on FV intake, and the local priority to understand current rates of FV intake and environmental availability of healthy food options as the basis for intervention development. Thus, the primary objective of this study was to describe the food environment in the Dan River Region, a predominately rural, health disparate area, by objectively measuring and reporting on the availability of healthy food options. A secondary goal was to provide information on the relationship between the food environment and individual FV intake by testing the following hypotheses. First, individuals who live in census block groups with higher availability of healthy options consume significantly higher amounts of FV. Second, individuals who lived near food outlets with higher healthy food availabilities will report higher FV intake and are more likely to meet recommendations.

Methods

The Virginia Tech Institutional Review Board approved the study protocol and all participants provided verbal consent before completing the survey.

Study Area

The Dan River Region (DRR) consists of 3 large rural counties spanning more than 1800 mi^2 across south-central Virginia and north-central North Carolina, anchored by the mid-size city of Danville (44 mi^2, population of 45,000)(Bureau, 2012). The DRR suffers from high unemployment, with unemployment rates between 12-19%, compared to state's 5.6% and nation's 7.7% average ("Local Area Unemployment Statistics: Unemployment Rates for Metropolitan Areas," 2012). Designated as a medically underserved area, residents also suffer from high rates of chronic conditions (i.e., diabetes, obesity) ("Find Shortage Areas: MUA/P by State and County"; Woolf et al., 2010). The combination of these factors makes this one of the most health disparate regions in the country ("Unequal Health Across the Commonwealth," 2008; Woolf et al., 2010).

Measures

Telephone Survey Sampling and Individual Fruit and Vegetable Intake

A professional telephone survey unit sampled the area by random digit dialing. Counties and cities were sampled based on population density. The random sample response rate of the telephone survey was 74%. In addition as part of a related DRPHC project, a non-random sample from residents living in public housing was recruited to complete the survey. The housing residents make up 16% of the overall sample with a response rate of 98%. Expectedly, the socio-demographics of the housing sample differed from the random sample in terms of education, income and race. However there were no differences in the outcomes of FV intake, therefore the housing sample is included in the analyses. All participants received a $20 gift card for completing the survey.

Modeled after the BRFSS survey, the telephone survey comprised of ten modules that included questions on health behaviors, food security, neighborhood perception, social support and social networks, and sociodemographic data (CDC, 2011; Cerin, Saelens, Sallis, & Frank, 2006; Sampson, 1997; USDA, 2000). Individual self-reported FV intake was assessed using the National Cancer Institute's FV short screener (Thompson et al., 2002). This short screener asks participants to report on the frequency and portion size for nine different food items. In comparison to the full food frequency questionnaires and 24-hr diet recalls, the short FV screener had better estimates of median FV intake with high reliability and validity of constructs (Thompson et al., 2002). Therefore using the short screener is more desirable in larger population studies, especially when administration is through a telephone survey. Consumption can be computed as the total daily cups of fruits and vegetables per individual respondent and categorically as either meeting or not meeting FV recommendations (Thompson et al., 2002).

Systematic Audits of the Food Environment

The Nutrition Environment Measures Survey (NEMS) is a highly reliable tool to objectively assess the food environment and to quantify the availability, quality, and price of healthy food options in stores and restaurants (Glanz, Sallis, Saelens, & Frank, 2007; Saelens, Glanz, Sallis, & Frank, 2007). All food outlets in the three counties were enumerated from Virginia's Department of Health website and the North Carolina Caswell County, Office of Environmental Health (Hill, Chau, Luebbering, Kolivras, & Zoellner, 2012). Details of the enumeration process for the regional city are outlined in Chau, et al. and were replicated in the outlying rural areas for this study (Chau, Zoellner, & Hill, 2013). Once enumerated, food outlets were categorized using the NEMS definitions for stores and restaurants (Glanz et al., 2007; Saelens et al., 2007). Stores included grocery stores, convenience stores, or other stores which included dollar stores and pharmacies that carried grocery items (Chau et al., 2013). Restaurants included fast-food (e.g., food is usually pre-made and supplied quickly to consumer with minimal service), fast-casual (e.g., similar to fast food with no table service, but food is made to order with higher quality), and sit-down restaurants (e.g., full table service and wait staff and all food is made to order)(Saelens et al., 2007).

Trained auditors conducted systematic assessments of all identified food outlets using the NEMS for either stores (NEMS-S) or restaurants (NEMS-R) (Glanz et al., 2007; Saelens et al., 2007). To ensure data quality, auditors were trained according to NEMS procedures and protocols (Chau et al., 2013). Pairs of auditors visited each food outlet to conduct independent audits and inter-rater reliability assessed by computing kappa coefficient for each outlet ($k= 0.89\pm.15$). Given the high inter-rater reliability, a random delete strategy was used to eliminate one audit for each outlet to create a final data set.

Healthy Food Availability Score

Using the NEMS protocol, a score was computed for the subscale of healthy food availability (Glanz et al., 2007; Saelens et al., 2007). This healthy food availability score can range from 0-30 and a higher score indicates a higher availability of healthy food options at that outlet (Glanz et al., 2007; Saelens et al., 2007). Healthy food availability scores can be treated as continuous and categorical, dependent on analyses type. For categorical data, healthy food availability scores were organized into tertiles (low, middle, or high healthy availability) based on the distribution of scores.

Measures of Proximity

All food outlets were geocoded and mapped in ArcGIS™ 10.0. U.S Census divides a geographical area, from largest to smallest, into states, counties, census tracts, block groups, and blocks ("Standard Hierarchy of Census Geographic Entities," 2010). Data were presented at the block group level, a proportional sample of all blocks, rather than at the census tract level, to provide a smaller-scale representation of resources nearby residents (Li et al., 2009; Zenk et al., 2009; Sharkey et al., 2011). Therefore, all participants were associated with the mean block group healthy food availability score based on their home address for analyses that explore the influence of food environment on FV intake. A healthy food availability score (0-30) was calculated from the mean across blocks in each block group.

To determine proximity of food outlets from participants' addresses, road network information was downloaded from the 2010 US Census TIGER® database ("2012 TIGER/Line Shapefiles,"). In ArcGIS™ 10.0, the nearest grocery store, nearest five stores, and nearest five food outlets of any type were determined for each of the participants (Block, Christakis, O'Malley, & Subramanian, 2011).

Analyses

All food environment data were entered into Statistical Package for Social Science (SPSS® 20.0) for analyses. Data were double-checked for errors by pairs of research assistants. Telephone survey data was collected and cleaned by the professional survey unit and imported into SPSS® 20.0 prior to analyses. One-way ANOVA tested for mean differences of healthy food availability by store and restaurant type. Healthy food availability score of the nearest grocery, along with means of the nearest five stores and nearest five outlets of any type were used to determine if proximity and healthy food availability is predictive of individual FV consumption.

Linear regression tested the predictability of continuous block group healthy food availability scores and the availabilities of the proximal food environment on FV intake. Subsequently, healthy food availability scores were categorized as low, middle, and high and ANOVAs was used to test for mean differences in total cups of FV consumed by healthy food availability (i.e., mean block group healthy food availability, nearest grocery store healthy food availability, nearest five store mean healthy food availability, nearest five outlets any type mean healthy food availability; see Table 4-3).

The degree to which residents in the DRR meet the public health recommendations for FV recommendations was also identified as an outcome of interest by the DRPHC and other researchers (Blanck et al., 2008; Institute; "State-specific trends in fruit and vegetable consumption among adults --- United States, 2000-2009," 2010). Therefore, logistic regression models were used to test if residents were more likely to meet FV recommendations by the continuous healthy food availability score in their food environment and their proximal food environments. Chi-square tests were also used to examine the relationship between healthy food availability score categories (low, middle, high) and if residents were meeting or not meeting FV recommendations.

Results

Individual Fruit and Vegetable Intake

In total, 930 individuals completed the regional surveillance survey; of which 813 (87%) could be geocoded and included in this analysis. The other 117 (13%) lived outside the geographic boundaries of the region (N=22), did not provide complete addresses (N=46), or provided a post office box for an address (N=49). As can be seen in Table 4-1, women were somewhat over represented in the responses, but the racial and sociodemographic characteristics of the sample aligned with the distribution in the broader regional population. The mean FV consumption is 2.8±2.5 cups with less than 10% of the sample meeting FV recommendations.

Description of the Food Environment

There are 483 (295 restaurants, 188 stores) food outlets in the DRR. Mean healthy food availability across outlets was quite low (M=6.2±6.0). Descriptive statistics by outlet type are provided in Table 4-2. By type of store (F=117.21, p=0.00), grocery stores had the highest healthy food availability (M=19.6±8.6); and for restaurants (F=17.41, p=0.00), fast-causal (M=8.7±7.2) had the highest healthy food availability.

Grocery stores (N=38) only make up about 8% of all food outlets in this region. Supermarkets and chain grocery stores were generally concentrated to the cities of Danville and Martinsville. In the outlying rural region, smaller independent grocers were more common. The healthy food availability was higher in larger supermarkets and chain grocery stores (n=20; M=26.2±5.5) compared to smaller independent grocers (n=18; M=12.3±5.7) across the region (F=58.4, p=0.00).

Figure 4-1 illustrates the distribution of food outlets by type for the DRR. In the city, national chain sit-down (17% of all sit-down) and fast-food (75.9% of all fast-food) restaurants were most prevalent. Outside city limits, chain fast-food restaurants account for 57% of all fast-food restaurants, while only about 2% of sit-down restaurants were national chains restaurants. In the outlying counties, independent diners were the most prevalent type of restaurant (74%). Because these diners were small, independently owned, no nutrition information was given on the menu; as a result, the healthfulness of entrée options could not be determined based on NEMS protocol (Saelens et al., 2007).

It is also evident from Figure 4-1 that residents in the cities do not have to travel as far to reach a food outlet, compared to residents in the outlying counties. Although 73.8% of the residents live within 5-miles of a grocery store, the mean distance varies. City residents only have to travel a mean of 1.2±0.81 miles compared to county residents who must travel further (5.2±4.1 miles). This holds true for the nearest five stores and nearest five any food outlets. County residents live further from stores (4.3±2.6

miles) and food outlets (3.4±2.2 miles) in general, than do residents within city limits (1.0±0.5 miles for stores, 0.74±0.44 miles for any food outlets).

Predictability of Fruit and Vegetable Intake and Meeting Recommendations

Contrary to hypotheses, when examining the degree to which healthy food availability was related to FV consumption, there were no significant relationships (Table 4-3). Further, relationships between resident likelihood of meeting FV recommendations and the healthy food availability by block group based on nearest grocery store, nearest five stores, and nearest five outlets of any type were not significant (β =0.05, p=0.36 for mean block group healthy food availability; β =-0.01, p=0.44 for nearest grocery store; β =-0.06, p=0.25 for nearest five stores any type; β =-0.03, p=0.62 for nearest five outlets any type).

Mean differences in Fruit and Vegetable Intake and Meeting Recommendations

For each of the four healthy food availability indicators of the food environment, tertile means and standard deviations are presented in Table 4-4. As illustrated, there was no statistical significance in mean differences for cups of FV intake by healthy food availability. Furthermore, chi-squared tests indicate the relationship of the healthy food availability tertiles for each food environment is not significant in meeting FV recommendations (χ^2=3.10, p=0.21 for mean block group healthy food availability; χ^2=1.34, p=0.53 for nearest GS; χ^2=0.53, p=0.79 for nearest five stores any type; χ^2=0.06, p=0.97 for nearest five food outlets).

Discussion

The research presented here was conducted under the larger community-based participatory research partnership, the DRPHC. The findings from this study are an integral foundation piece for DRPHC interventions and programs aimed at addressing obesity through nutrition or dietary changes. The mean daily cups of FV intake is very low (2.8±2.5), with only 10% of the sample meeting FV recommendations. This is considerably lower than national and state prevalence for meeting recommendations of FV of 24% and 27%, respectively (CDC, 2010). Epidemiologic studies demonstrate that FV intake is overall low across the nation(NCI, 2010), and lower in rural and health disparate populations(Bazzano, 2006; Blanck et al., 2008; Dietary Guidelines for Americans 2010, 2010; Lutfiyya et al., 2012). Congruent to previous research, this current study supports the conclusion that residents in rural regions have low FV intake (Lutfiyya et al., 2012). Other studies have demonstrated an association between neighborhood socioeconomic status and race as influences on FV intake and meeting FV recommendations (Baker et al., 2006; Dubowitz et al., 2008; Middaugh et al., 2012). While disparities in FV intake may be a factor of race, education, and income, the food environment in rural regions may be one explanation to low FV consumption.

The results demonstrate that the overall healthy food availability in the region is very low (M=6.2±6.0, range 0-30). Not surprisingly, grocery stores and large supermarkets had the highest availabilities of healthy food, yet they only account for about 8% of the entire food environment. The majority of food outlets were small, independent diners and convenience stores. In rural areas, the most common food outlets were convenience stores. The healthy food availability score at these outlets are the lowest within the region (convenience store M=5.3±3.2; sit-down restaurants M=3.7±2.5). These findings align with a number of other studies that have demonstrated that healthy food availability in rural or health disparate regions is low(Baker et al., 2006; Casey et al., 2008; Hermstad et al., 2010; Larson et al., 2009;Smith et al., 2010). Low-income areas with high minority populations have poorer food environments and limited accessibility and availability of healthy foods that results in poor diet quality and low FV consumption (Baker et al., 2006; Dubowitz et al., 2008; Larson et al., 2009; Sloane et al., 2003).

While there is low FV intake throughout the region, and overall low healthy food availability, there is no significant relationship between the food environment and FV intake. Examining the healthy food availabilities at the nearest stores and food outlets did not predict individual FV intake. The results of this study support previous research, yet, it also contradicts others. For example, our findings align with a number of other studies that document a lack of association between healthy food availability and dietary intake (Hermstad et al., 2010; Sharkey et al., 2010). Sharkey and colleagues found lower fruit and vegetable intake was associated with living a greater distance to grocery stores and supermarkets with higher healthy food availabilities (Sharkey et al., 2010). However, our findings contradict a study by Boehmer and colleagues that reported the distance to the nearest supermarket influenced dietary intake(Boehmer et al., 2006) and residents with at least one supermarket located in their census tract were more likely to meet FV recommendations(Sloane et al., 2003). Based upon the current differences, there is a continued need to study the contextual effects of FV intake and meeting dietary guidelines beyond a measure of healthy food availability.

The low mean score and overall lack of healthy food options in the region leads to a left-skew distribution for the healthy food availability score. This low mean compresses the variability in the healthy food availability score, which may influence our statistical outcomes. Importantly, in the context of the DRPHC community-academic partnership, the purpose of this study was to provide comprehensive data on the food environment in the region. The data presented is not a sample of the food outlets, but all outlets available to residents living within the region. Congruent with the DRPHC's vision to "promote an environment that supports opportunities for all Dan River Region residents to make healthy food choice" (DRPHC, 2012), the results of this study provides an overview of the current food environment for residents. As part of a community-academic partnership, these results have been shared with the DRPHC and community members. The DRPHC is currently working towards action-items and interventions aimed at increasing FV intake within the region and focusing on creating healthier food environments. Therefore, the findings from this study provide important local context to address availability of healthy foods that may influence FV intake.

Although these findings may have limited generalizability beyond the Dan River Region, the conceptual approach and scientific methodology has broad application for nutrition and dietetic practitioners and researchers. Historically, the nutrition and dietetics literature has been primarily comprised of individual level factors that influence dietary behaviors and less is known about how the food environment influences dietary intake. Our study illustrates the importance of considering the food environment and highlights issues related to low healthy food availability and access to fresh produce. Dietetic practitioners and researchers should consider information about other regional food environments and healthy food availability when conducting dietary interventions for healthier behaviors. For example, individual-level intervention designs should consider the geographic context of the food environment and account for the low availabilities in stores and restaurants. Furthermore, future nutrition research should actively engage local decision and policy makers to effectively target environmental- and policy-level strategies aimed at impacting the availability of healthy food options, especially in health disparate regions.

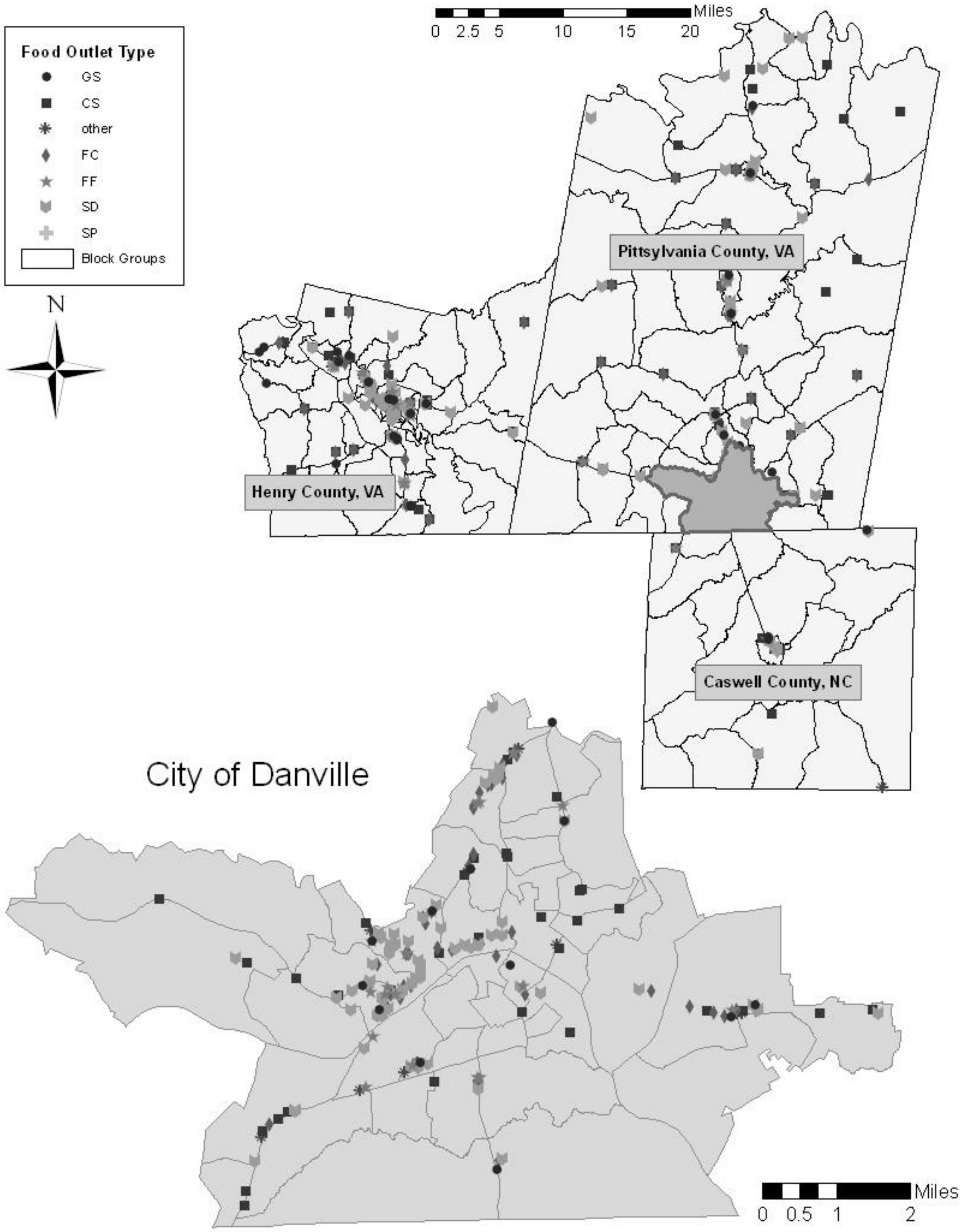
Table 4-1. Individual characteristics of telephone survey respondents (N=813)

	N(%)
Gender	
Male	194(23.9)
Female	619(76.1)
Mean(SD) Age in years	55.9(17.2)
Race	
White	492(61.7)
Black	283(35.5)
Other and Multi-Racial	22(2.8)
Education	
<HS	141(17.4)
HS or GED	292(36.0)
1-3 years college	250(30.8)
≥4 years college	129(15.9)
Total Annual Household Income	
<$20,000	318(45.4)
$20,000-$50,000	236(33.7)
>$50,000	147(21.0)
Fruit and Vegetable Consumption	
Mean(SD) in Cups	2.8(2.5)
Meeting Recommendations	74(9.1)
Not Meeting Recommendations	739(90.9)

Table 4-2. One-way ANOVA of NEMS healthy availability score by store and restaurant types (N=483)

	N(%)	Mean(SD)	F	Sig
Stores			117.21	0.00
Grocery Store	38(7.9)	19.6(8.6)		
Convenience Store	106(21.9)	5.3(3.2)		
Other Stores (Dollar Stores, Pharmacies)	44(9.1)	7.8(3.5)		
Restaurants			17.41	0.00
Fast Casual	39(8.1)	8.7(7.2)		
Fast Food	119(24.6)	4.1(3.6)		
Sit Down	135(28.0)	3.7(2.5)		
Specialty	2(0.4)	4.5(6.4)		

Figure 4-1. All food outlets with complete NEMS audit information in the Dan River Region*



*Total area of Dan River Region is 1800 mi^2 and total area of the City of Danville is $44mi^2$

Table 4-3. Linear Regression statistics for total cups of fruit and vegetable intake by healthy availability in the food environment

Spatial Food Environment Healthy Availability	F	Standardized Beta	Sig.
Mean Block Group	.008	-.004	.928
Nearest Grocery Store	.693	.029	.406
Nearest 5 Store	.204	-.016	.652
Nearest 5 Outlets	.188	-.015	.665

Table 4-4. One-way ANOVA of total cups of fruit and vegetable intake by healthy availability of the food environment

Spatial Food Environment	Mean (SD) and Range of Availability Scores*	N individuals	Mean (SD) cups of FV	F	Sig.
Mean BG Availability	5.7(3.0)		2.81(2.53)	1.07	.344
Low	0-3.00	286	2.76(2.95)		
Middle	3.01-6.00	272	2.99(2.36)		
High	>6.00	255	2.69(2.16)		
Nearest Grocery Store Mean Availability	21.5(7.8)		2.81(2.53)	1.47	.231
Low	0-17.00	311	2.63(1.91)		
Middle	17.01-28.00	365	2.96(3.01)		
High	>28.00	137	2.82(2.29)		
Nearest 5 Stores Mean Availability	8.8(2.5)		2.81(2.53)	.466	.628
Low	0-7.80	331	2.74(2.34)		
Middle	7.81-9.80	218	2.95(3.11)		
High	>9.80	264	2.79(2.21)		
Nearest 5 Outlets (Stores and/or Restaurants) Mean Availability	6.0(2.5)		2.81(2.53)	.144	.866
Low	0-4.20	286	2.81(2.41)		
Middle	4.21-7.25	261	2.76(2.38)		
High	>7.25	266	2.87(2.90)		

*NEMS healthy availability score were categorized into tertiles based on distribution of the data.

REFERENCES

2012 TIGER/Line Shapefiles. Retrieved October 17, 2012, from http://www.census.gov/cgi-bin/geo/shapefiles2012/main

Baker, E. A., Schootman, M., Barnidge, E., & Kelly, C. (2006). The role of race and poverty in access to foods that enable individuals to adhere to dietary guidelines. Prev Chronic Dis, 3(3), A76.

Bazzano, L. A. (2006). The high cost of not consuming fruits and vegetables. J Am Diet Assoc, 106(9), 1364-1368. doi: 10.1016/j.jada.2006.06.021

Blanck, H. M., Gillespie, C., Kimmons, J. E., Seymour, J. D., & Serdula, M. K. (2008). Trends in fruit and vegetable consumption among U.S. men and women, 1994-2005. Prev Chronic Dis, 5(2), A35.

Block, J. P., Christakis, N. A., O'Malley, A. J., & Subramanian, S. V. (2011). Proximity to food establishments and body mass index in the Framingham Heart Study offspring cohort over 30 years. Am J Epidemiol, 174(10), 1108-1114. doi: 10.1093/aje/kwr244

Bodor, J. N., Rose, D., Farley, T. A., Swalm, C., & Scott, S. K. (2008). Neighbourhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment. Public Health Nutr, 11(4), 413-420. doi: 10.1017/S1368980007000493

Boehmer, T. K., Lovegreen, S. L., Haire-Joshu, D., & Brownson, R. C. (2006). What constitutes an obesogenic environment in rural communities? Am J Health Promot, 20(6), 411-421.

Boyington, J. E., Schoster, B., Remmes Martin, K., Shreffler, J., & Callahan, L. F. (2009). Perceptions of individual and community environmental influences on fruit and vegetable intake, North Carolina, 2004. Prev Chronic Dis, 6(1), A04.

Bureau, U.S. Census. (2012). State and County QuickFacts. Retrieved July 9, 2012, from http://quickfacts.census.gov/qfd/states/51/5121344.html

Bustillos, B., Sharkey, J. R., Anding, J., & McIntosh, A. (2009). Availability of more healthful food alternatives in traditional, convenience, and nontraditional types of food stores in two rural Texas counties. J Am Diet Assoc, 109(5), 883-889. doi: 10.1016/j.jada.2009.02.011

Casey, A. A., Elliott, M., Glanz, K., Haire-Joshu, D., Lovegreen, S. L., Saelens, B. E., . . . Brownson, R. C. (2008). Impact of the food environment and physical activity environment on behaviors and weight status in rural U.S. communities. Prev Med, 47(6), 600-604. doi: 10.1016/j.ypmed.2008.10.001

CDC. (2011). Behavioral Risk Factor Surveillance System Survey Data. 2012, from http://www.cdc.gov/brfss/

CDC. (2010). State-specific trends in fruit and vegetable consumption among adults --- United States, 2000-2009. MMWR Morb Mortal Wkly Rep, 59(35), 1125-1130.

Cerin, E., Saelens, B. E., Sallis, J. F., & Frank, L. D. (2006). Neighborhood Environment Walkability Scale: validity and development of a short form. Med Sci Sports Exerc, 38(9), 1682-1691.

Chau, C. N., Luebbering, C. R., Kolivras, K. N., Zoellner, J. M., & Hill, J. L. (2011). Using GIS to determine environmental factors related to obesity in a health disparate region. Paper presented at the International Society for Behavioral Nutrition and Physical Activity, Melbourne, Australia.

Chau, C. N., Sams, L., Kolivras, K., & Hill, J. L. (2012a). Contextual overview of physical activity resources in a health disparate region. Paper presented at the International Society for Behavioral Nutrition and Physical Activity Annual Meeting, Austin, Texas.

Chau, C. N., Sams, L., Kolivras, K., & Hill, J. L. (2012b). Does walking proximity to resources predict physical activity in a health disparate region? . Paper presented at the International Society for Behavioral Nutrition and Physical Activity Austin, Texas.

Chau, C., Zoellner, J., & Hill, J. (2012). Community-based approach to assessing the nutrition environment in a health disparate region. Paper presented at the Society of Behavioral Medicine, New Orleans, Louisiana.

Chau, C.N., Zoellner, J.M., & Hill, J.L. (2013). Availability of Healthy Food: Does Block Group Race and Income Matter? J Hunger Environ Nutr, 8, 22-38.

. Dietary Guidelines for Americans 2010. (2010). Washington, DC: U.S. Department of Agriculture and U.S. Department of Health and Human Services Retrieved from http://www.dietaryguidelines.org.

DRPHC. (2012). Dan River Partnership for a Healthy Community.   Retrieved March 29, 2012

Dubowitz, T., Heron, M., Bird, C. E., Lurie, N., Finch, B. K., Basurto-Davila, R., . . . Escarce, J. J. (2008). Neighborhood socioeconomic status and fruit and vegetable intake among whites, blacks, and Mexican Americans in the United States. Am J Clin Nutr, 87(6), 1883-1891.

Find Shortage Areas: MUA/P by State and County. Retrieved August 9, 2012, from http://muafind.hrsa.gov/index.aspx

Ford, E. S., & Mokdad, A. H. (2001). Fruit and vegetable consumption and diabetes mellitus incidence among U.S. adults. Prev Med, 32(1), 33-39.

Ford, P.B., & Dzewaltowski, D.A. (2010). Geographical, racial, ethnic, and socioeconomic disparities in the availability of grocery stores and supermarkets among low-income women across the urban-rural continuum. J Hunger Environ Nutr, 5(5), 216-233. doi: 10.1080/19320241003800276

Glanz, K., Sallis, J. F., Saelens, B. E., & Frank, L. D. (2007). Nutrition Environment Measures Survey in stores (NEMS-S): development and evaluation. Am J Prev Med, 32(4), 282-289. doi: 10.1016/j.amepre.2006.12.019

Greenwood, D.J., & Levin, M. (2007). Introduction to Action Research: Social Research for Social Change (2 ed.). Thousand Oaks, CA: Sage Publications.

Guillaumie, L., Godin, G., & Vezina-Im, L. A. (2010). Psychosocial determinants of fruit and vegetable intake in adult population: a systematic review. Int J Behav Nutr Phys Act, 7, 12. doi: 10.1186/1479-5868-7-12

Gustafson, A. A., Sharkey, J., Samuel-Hodge, C. D., Jones-Smith, J., Folds, M. C., Cai, J., & Ammerman, A. S. (2011). Perceived and objective measures of the food store environment and the association with weight and diet among low-income women in North Carolina. Public Health Nutr, 14(6), 1032-1038. doi: 10.1017/S1368980011000115

He, F. J., Nowson, C. A., & MacGregor, G. A. (2006). Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. Lancet, 367(9507), 320-326. doi: 10.1016/S0140-6736(06)68069-0

Hermstad, A. K., Swan, D. W., Kegler, M. C., Barnette, J. K., & Glanz, K. (2010). Individual and environmental correlates of dietary fat intake in rural communities: a structural equation model analysis. Soc Sci Med, 71(1), 93-101. doi: 10.1016/j.socscimed.2010.03.028

Hill, J. L., Chau, C., Luebbering, C. R., Kolivras, K. K., & Zoellner, J. (2012). Does availability of physical activity and food outlets differ by race and income? Findings from an enumeration study in a health disparate region. Int J Behav Nutr Phys Act, 9, 105. doi: 10.1186/1479-5868-9-105

Hosler, A. S., Rajulu, D. T., Fredrick, B. L., & Ronsani, A. E. (2008). Assessing retail fruit and vegetable availability in urban and rural underserved communities. Prev Chronic Dis, 5(4), A123.

Israel, B.A., Eng, E., Schulz, A.J., & Parker, E.A. (Eds.). (2005). Methods in Community-Based Participatory Research for Health (1 ed.). San Francisco, CA: Josey-Bass.

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments: disparities in access to healthy foods in the U.S. Am J Prev Med, 36(1), 74-81. doi: 10.1016/j.amepre.2008.09.025

Local Area Unemployment Statistics: Unemployment Rates for Metropolitan Areas. Retrieved December 26, 2012, from http://www.bls.gov/lau/

Lutfiyya, M. N., Chang, L. F., & Lipsky, M. S. (2012). A cross-sectional study of US rural adults' consumption of fruits and vegetables: do they consume at least five servings daily? BMC Public Health, 12(1), 280. doi:10.1186/1471-2458-12-280

Middaugh, A. L., Fisk, P. S., Brunt, A., & Rhee, Y. S. (2012). Few Associations between Income and Fruit and Vegetable Consumption. J Nutr Educ Behav, 44(3), 196-203. doi: 10.1016/j.jneb.2011.10.003

Motley, M., Holmes, A., Hill, J., Plumb, K. , & Zoellner, J. (2012). Evaluating Community Capacity to Reduce Obesity in the Dan River Region: A Case Study. Am J Health Behav, 37(2), 207-216.

National Cancer Institute. December 21, 2010. Usual Dietary Intakes: Food Intakes, US Population, 2001-04. Retrieved February 20, 2013, from http://riskfactor.cancer.gov/diet/usualintakes/pop/

Saelens, B. E., Glanz, K., Sallis, J. F., & Frank, L. D. (2007). Nutrition Environment Measures Study in restaurants (NEMS-R): development and evaluation. Am J Prev Med, 32(4), 273-281. doi: 10.1016/j.amepre.2006.12.022

Sampson, R.W. (1997). Neighborhoods and violent crime: A multilevel study of collective efficacy. Science, 277(5328), 918-24.

Shaikh, A. R., Yaroch, A. L., Nebeling, L., Yeh, M. C., & Resnicow, K. (2008). Psychosocial predictors of fruit and vegetable consumption in adults a review of the literature. Am J Prev Med, 34(6), 535-543. doi: 10.1016/j.amepre.2007.12.028

Sharkey, J. R. (2009). Measuring potential access to food stores and food-service places in rural areas in the U.S. Am J Prev Med, 36(4 Suppl), S151-155. doi: 10.1016/j.amepre.2009.01.004

Sharkey, J. R., Horel, S., Han, D., & Huber, J. C., Jr. (2009). Association between neighborhood need and spatial access to food stores and fast food restaurants in neighborhoods of colonias. Int J Health Geogr, 8, 9. doi: 10.1186/1476-072X-8-9

Sharkey, J. R., Johnson, C. M., & Dean, W. R. (2010). Food access and perceptions of the community and household food environment as correlates of fruit and vegetable intake among rural seniors. BMC Geriatr, 10, 32. doi: 10.1186/1471-2318-10-32

Sloane, D. C., Diamant, A. L., Lewis, L. B., Yancey, A. K., Flynn, G., Nascimento, L. M., . . . Cousineau, M. R. (2003). Improving the nutritional resource environment for healthy living through community-based participatory research. J Gen Intern Med, 18(7), 568-575.

Smith, C., & Morton, L. W. (2009). Rural food deserts: low-income perspectives on food access in Minnesota and Iowa. J Nutr Educ Behav, 41(3), 176-187. doi: 10.1016/j.jneb.2008.06.008

Smith, D. M., Cummins, S., Taylor, M., Dawson, J., Marshall, D., Sparks, L., & Anderson, A. S. (2010). Neighbourhood food environment and area deprivation: spatial accessibility to grocery stores selling fresh fruit and vegetables in urban and rural settings. Int J Epidemiol, 39(1), 277-284. doi: 10.1093/ije/dyp221

Standard Hierarchy of Census Geographic Entities. (2010, October 27, 2010). Retrieved November 21, 2012, from http://www.census.gov/geo/reference/pdfs/geodiagram.pdf

Thompson, F. E., Subar, A. F., Smith, A. F., Midthune, D., Radimer, K. L., Kahle, L. L., & Kipnis, V. (2002). Fruit and vegetable assessment: performance of 2 new short instruments and a food frequency questionnaire. J Am Diet Assoc, 102(12), 1764-1772.

Unequal Health Across the Commonwealth. (2008). from http://www.vdh.state.va.us/healthpolicy/documents/health-equity-report-summary.pdf

USDA, Economic Research Service. (2000). Guide to Measuring Household Food Security. United States Department of Agriculture Retrieved from http://www.fns.usda.gov/fsec/files/fsguide.pdf.

Woolf, S. H., Jones, R. M., Johnson, R. E., Phillips, R. L., Jr., Oliver, M. N., Bazemore, A., & Vichare, A. (2010). Avertable deaths associated with household income in Virginia. Am J Public Health, 100(4), 750-755. doi: 10.2105/AJPH.2009.165142

Zanko, A., Reese, F., MacAuley, L., Hill, J. L., & Zoellner, J. (2012). Evaluating the public health of community gardens in a health disparate region. Paper presented at the Virginia Dietetic Association, Blacksburg, Virginia.

Zoellner, J., Hill, J., Grier, K., Chau, C., Kopec, D., Pryce, B., & Dunn, C. (2012). Better Together: Healthy Caswell County- Findings from a randomized controlled trial targeting obesity-related behaviors. Paper presented at the Society of Behavioral Medicine, New Orleans, Louisiana.

Zoellner, J. M., Motley, M., Wilkinson, M., Jackman, B., Barlow, M. L., & Hill, J. L. (2012). Engaging the Dan River Region to Reduce Obesity: Application of the Comprehensive Participatory Planning and Evaluation Process. Fam Community Health, 35(1), 44-56.

Zoellner, J., Zanko, A., Price, B., Bonner, J., & Hill, J. L. (2012). Exploring community gardens in a health disparate population: Findings from a mixed methods pilot study. Prog Community Health Partnersh, 6(2), 153-165.

CHAPTER 5: MANUSCRIPT 3

Which is better at predicting physical activity behaviors – objective or subjective distances to resources?

Authors: Waters CN[1], Zoellner JM[1], Kolivras KN[2], Estabrooks PA[1], O'Connor EF[1], Hill JL[1]

Affiliations: [1]Virginia Tech, Human Nutrition, Foods, and Exercise, Blacksburg, Virginia

[2]Virginia Tech, Geography, Blacksburg, Virginia

Introduction

Physical inactivity is a contributing factor to the prevalence of obesity in America (CDC, 1996). The current physical activity (PA) recommendation for adults is 150 minutes of moderate and vigorous aerobic physical activity or at least 60 minutes of just vigorous activity each week to reduce risk of chronic disease, including obesity (CDC, 1996; DHHS, 2008). Also included in the recommendation is incorporating a muscle strengthening activity at least two times per week. Yet only 20.6% of Americans are meeting these recommendations (Control Centers for Disease & Prevention, 2013). Regular physical activity confers a variety of physical and mental health benefits beyond weight management including bone and joint health, reducing depression and anxiety, and may be useful in management of chronic conditions such as hypertension and diabetes (CDC, 1996; Flegal, 2005; Ogden, Yanovski, Carroll, & Flegal, 2007).

Given the rising trend of obesity and the current rates of inactivity, the environment becomes an important factor for its role on health behaviors and outcomes. The built environment are man-made structures in the environment (e.g., streets, trails, homes, buildings, parks) and may influence physical activity through the availability, proximity, and quality of resources (Black & Macinko, 2008; Brownson et al., 2001; Li et al., 2009, Giskes et al., 2011). The presence of an available and close PA resource (e.g., park, recreation/fitness center, gym, other open space) is positively associated with increased PA behavior (Diez Roux et al., 2007; Giles-Corti & Donovan, 2002; Kaczynski & Henderson, 2008; Kaczynski, Potwarka, & Saelens, 2008; Saelens & Handy, 2008). Yet the relationhip between distance and PA behaviors has mixed findings. Living in close proximity to parks, open recreational space, and destinations facilitate PA behavior (Ohri-Vachaspati et al., 2013; Saelens & Handy, 2008), including walking, as residents are more likely to meet recommendations for PA (Diez Roux et al., 2007; Duncan, Spence, & Mummery, 2005). However in his study of neighborhood parks, Kaczynski found that the average travel distance to the park did not significantly influence PA (Kaczynski, Potwarka, & Saelens, 2008). While the presence of an outlet is important for PA, individual perceptions of the availability and accessibility (i.e., proximity) of a physical activity outlet may be influential to the utilization of the outlet. If one perceives an outlet to be inaccessible due to the travel distance, this may be barrier for engaging in physical activity at this outlet despite the actual distance. A handful of studies have examined the correlation between perceived proximity, actual proximity, and PA behaviors. However, these findings on proximity perception and PA behaviors are equivocal. For example, physically active residents often rate their communities as pleasant for PA, with more available outlets and shorter walking distances (Desphande et al., 2005). Yet, research also finds there is an inverse relationship of perceived proximity to PA outlets and PA behaviors where residents who perceived outlets to be near within walking distance were not significantly more active (Jilcott, Evenson, Laraia, & Ammerman, 2007).

Low-income, minority and rural populations are less likely to meet recommendations for PA (Frost et al., 2010; Sandercock, Angus, & Barton, 2010; Sanderson et al., 2003). Low socioeconomic urban areas have been shown to have fewer physical activity resources, with fewer amenities and poorer quality compared to high socioeconomic neighborhoods (Estabrooks, Lee, & Gyurcsik, 2003; Warren, Cubbin, & Winkleby, 2008). In rural areas, accessibility and distance have been shown to be negatively related to physical activity (Frost et al., 2010; Moore et al., 2010). Travel time, transportation and lack of indoor recreational opportunities are all reported barriers to physical activity in rural environments (Aronson & Oman, 2004; Moore et al., 2010).

Rural, health disparate and high-risk populations are often difficult to reach due to geographic dispersion, low-population densities, and social or cultural barriers. Community- based participatory research (CBPR) may be an effective way to reach underserved populations (Israel, Eng, Schulz, & Parker, 2005). CBPR aims to create equitable partnerships with community members, key stakeholders, and academic researchers. Involvement by community partners in all aspects of the research process, including identification of problems and solutions may improve effectiveness and sustainability of programs (Greenwood & Levin, 2007; Israel et al., 2005). The Dan River Partnership for a Healthy Community (DRPHC) is a community-academic partnership formed in 2009 to address obesity in the health disparate Dan River Region (DRR) (DRPHC, 2012). The community identified six causal models for the region's obesity problem, including physical activity and geographic and environmental influences (Zoellner et al., 2012). To advance these community-developed causal models, several initiatives have been introduced in the region including a pilot physical activity trial (Zoellner et al., 2013). Additionally, systematic audits of the environment for physical activity were conducted (Hill, Chau, Luebbering, Kolivras, & Zoellner, 2012) and a region-wide surveillance survey provided current prevalence of health behaviors, including physical activity within the region (Hill, You, & Zoellner, Under Review). However, it is not clear the degree to which residents in the region perceive physical activity resources as accessible to them. Further, DRR includes areas from both ends of the rural-urban continuum. Barriers faced by residents in the more rural areas of the DRR may not be the same barriers in the urban areas. Perceptions on distance to a physical activity resource may differ in residents between rural or urban areas, but still may influence PA behaviors.

To contribute to the physical activity aim of the DRPHC, the first objective of this study is to describe the physical activity resources available to residents, including average distance to reach a physical activity outlet. The second objective is to determine if distance, either objective or subjective, influences individual PA behaviors and meeting PA recommendations. Since few studies have compared residents' perceived distance to the actual distance to each PA facility, objective and subjective distance to resources will be correlated. Therefore, this analysis is critically important as the existence of a significant difference in perceived versus actual distance to PA facilities could contribute to low usage of facilities if people perceive themselves as living farther from facilities than they actually do.

Methods

Study Design

This cross-sectional study utilized data collected under a variety of initiatives by the DRPHC. Primary data collected by the research partners of the DRPHC include individual behaviors (i.e., physical activity), perceptions of the environment and sociodemographic data through a telephone survey and systematic audits of the resources for physical activity. Secondary data used for analysis includes publically available GIS data.

Study Area

The DRR spans nearly 4660 km^2 across south-central Virginia and north-central North Carolina and includes three predominately rural counties anchored by two mid-size regional cities. The larger of the two cities, with a population of about 45,000 people, is the economic hub of services (e.g., retail, healthcare, higher education centers) to the surrounding counties. However, the region suffers from high unemployment, low educational attainment and high rates of chronic disease, including obesity ("Local Area Unemployment Statistics: Unemployment Rates for Metropolitan Areas," 2012; MDC, 2008).

Telephone survey to assess individual level data

<u>Sampling and survey development</u>

A professional survey company created proportional sampling frames based on population density for all 3 counties and the two major cities. In addition, a sub-sample of the population who live in government-sponsored housing also completed the telephone survey.

Modeled after the Centers for Disease Control's 2011 Behavioral Risk Factor Surveillance Survey, the telephone survey included ten modules each scored to provide surveillance dta on the health of the population within the Dan River Region. The survey included questions on health status, chronic health conditions, health beahviors such as physical activity and nutrition, along with sociodemographic data (CDC, 2011). Participants reported their height in inches and weight in pounds and body mass index (BMI) was computed based on these self-reported measures. The following paragraphs details the two modules used in this research.

<u>Individual PA behavior</u>

The modified Godin-Shephard Leisure Time exercise questionnaire measured individual PA within the preceding seven days (Godin & Shephard, 1985). Participants were asked to determine the duration, in minutes, for each frequency of vigorous, moderate, and mild exercise within the past seven days. Participants also reported the number of days they engaged in strength training activities. Total continuous minutes for moderate to vigorous exercise per week were calculated for the individual (Godin

& Shephard, 1985). Further, individuals were classified as meeting PA recommendations if their sum minutes of moderate to vigorous PA (MVPA) ≥150 minutes or vigorous PA (VPA) ≥60 minutes and they reported at least 2 days of strength training, and as not meeting recommendations if minutes of MVPA <150 and they did not meet at least 2 days of strength training (CDC, 1996).

Perception of Distance to PA outlets

Developed by Saelens and colleagues, the Neighborhood Environment Walkability Survey (NEWS) is designed to measure resident's perception of neighborhood characteristics and how these perceptions influence weight status and PA (Saelens et al., 2003). While the 68-item measure showed high test-retest reliability (Brownson et al., 2004; Leslie et al., 2005; Saelens et al., 2003), the length of the self-administered questionnaires negatively affected response rates, thus an abbreviated version (NEWS-A) was developed to have the same reliability and high construct validity (Cerin, Conway, Saelens, Frank, & Sallis, 2009; Cerin, Saelens, Sallis, & Frank, 2006). NEWS-A consists of eight multi-item subscales representing distinct constructs including: residential density, land-use mix-diversity, land-use mix-access, street connectivity, walking/cycling facilities, aesthetics, safety from traffic/crime and general neighborhood satisfaction (Cerin et al., 2009).

The telephone survey utilized two of the subscales, "land-use mix-diversity" for stores and facilities and "safety from traffic/crime". The "land-use mix-diversity" asked 13 questions on the perceived proximity from home to various types of destinations (e.g., PA resource, food outlet, retail stores and services). Respondents answered in the number of minutes they estimated it would take them to walk to the nearest destination on a 5-point Likert scale with a "1" as 1-5 minutes, "2" as 6-10 minutes, "3" as 11-20 minutes, "4" as 21-30 minutes, and "5" as >30 minutes. For this study only the questions on proximity to the nearest publicly available community resource for PA (e.g., elementary school, nearest any other school, nearest park or playground, and nearest recreation center) were used for analyses.

Enumeration of Physical Activity Outlets

All physical activity outlets were enumerated from the local government's department of parks and recreations, internet keyword searches, and drive by observations of the region. Only publicly available parks and other recreational facilities (e.g., community centers, school playgrounds, fitness centers, etc.) were included. Private country clubs with gold courses and other sports facilities, churches with playgrounds, and trails were excluded from the sample since these outlets did not align to the destinations of the NEWS-A. In total, 140 outlets were enumerated.

The Physical Activity Resource Assessment (PARA) tool was used to systematically audit all enumerated outlets, in which 105 have complete audit information. The PARA tool is a one-page survey that categorizes physical activity outlets and quantifies each outlet based on features, amenities, and incivilities (Lee, Booth, Reese-Smith, Regan, & Howard, 2005). The eight categories for outlets include fitness club, park, sports facility, trail, community center, church, school, or any combination (Lee et al., 2005). To align with the NEWS-A survey, PA outlets were categorized as “park”, “community center” or “school” for analyses. To match responses from the NEWS-A, “community center” was recoded to “recreation center”, “school” was categorized as “elementary school” or “any school” based on the school name, and “park” remained the same.

Measures of Proximity and Objective Distance to Physical Activity Outlets

All physical activity outlets and respondent home addresses were geocoded and mapped in ArcGIS™ 10.0. To determine the objective proximity from the respondent’s home to the nearest PA outlet, road network information was downloaded from the 2010 US Census Tiger® database. In ArcGIS™ 10.0, the distance, in kilometers (km), to the nearest any type of PA outlet, nearest elementary school, nearest any other school, nearest park, and nearest recreation center was computed for each resident. Since the participants’ responded on perceived proximity in categories of minutes walking, the objective distance in kilometers was converted to minutes walking. Congruent with published standards, the factor of 5.1 km per hour (3.2 miles per hour) was used to convert all objective distances in kilometers to minutes (Bohannon, 1997; Boyer, Andriacchi, & Beaupre, 2012). Subsequently, minutes were also categorized based on the same scale as the perceived distance responses (i.e., “1” as 1-5 minutes, “2” as 6-10 minutes, “3” as 11-20 minutes, “4” as 21-30 minutes, and “5” as >30 minutes).

Statistical Analyses

Individual telephone survey data was compiled and cleaned by the professional survey unit and imported into SPSS® 20.0 prior to analyses. The housing sampled differed from the random sample in terms of race, gender, and socioeconomic status; however, since there were no differences in the primary outcome of PA behavior, they were included in all analyses. All PARA audit data for outlets were entered and cleaned by pairs of research assistants in SPSS® 20.0. All proximity measures were computed in ArcGIS™ 10.0 and imported into SPSS® 20.0 for analyses.

Bivariate correlations measured the degree of relationship between subjective and objective distance to PA outlets. Since objective distances were categorized based on the same scale as the subjective distance, a Spearman’s ρ correlation coefficient will determine how closely the subjective distance is associated with the calculated objective distance.

A series of regression models tested the predictability of objective and subjective distance on minutes of MVPA and meeting recommendations. Univariate analyses tested all sociodemographic factors and determined that gender, age, income and BMI were significant covariates. All models presented in the results are adjusted for these covariates. First, a linear regression model tested if objective distance in kilometers to the nearest PA outlet, elementary school, any other school, park, and recreation center was indicative of individual minutes of MVPA. Next, two logistic regression models aimed to test if individuals were more likely to meet PA recommendations by their objective distance in kilometers, or their subjective distance in minutes. To acknowledge that our sample includes a spectrum of urban to rural locales, these models were first conducted on the total sample and then separately by an urban sample (e.g., residing within the two regional cities and a rural sample is all residents living outside the city limits).

Results

Individual PA Behaviors

The response rate of the telephone survey was 77%. Of 930 total residents who completed the survey, 16% were residents in government housing. From the completed surveys, 813 (87%) could be geocoded and included in this analysis. Those excluded from analyses (N=117, 13%) lived outside the geographic boundaries of the region (N=22), did not provide complete addresses (N=46), or provided a post office box for an address (N=49). From Table 5-1, respondents were mostly female (76.1%), White (61.7%), with a high school education or less (53.4%). Body mass index average 29.0±6.4 with 32.6% of the population reporting overweight, obese (30.4%), or morbidly obese (6.5%).

Of the 813 sampled residents, 287 (35.3%) meet current weekly aerobic PA recommendations of MVPA ≥150 minutes or VPA ≥60 minutes. However, only 83 (10.2%) meet both aerobic and strength training recommendations. The average weekly MVPA minutes were 126.7±181.9 across the region (Table 5-1). There is no significant mean difference in MVPA minutes between rural (125.8±174.1) and urban residents (128.1±194.0) (t=0.2, p=0.861). Although, a higher proportion of the rural sample (37.6% rural; 31.7% urban) met recommendations for PA, this was not significantly different (χ^2=3.8, p=0.052).

Description of PA Environment

Of the 105 total PA outlets, parks (42.9%) were the most prevalent type of PA resource followed by elementary schools (24.8%), any other schools (17.1%), and recreation centers (9.4%). Generally, residents live within 4.0±4.3 km to any PA outlet (Table 5-2). Schools were the closest to resident's homes with an average of 5.0±4.2 km and recreation centers were the farthest, averaging 12.4±15.0 km. In the cities, all residents lived within 3.2 km (<2 miles) of any type of physical activity outlet with a park being the nearest (1.6±1.1 km) and elementary school being the farthest (3.1±1.9 km). Clearly in the rural counties, residents must travel farther to reach all outlets, with the farthest of 18.8±15.9 km to the nearest recreation center. In the perceived proximity to PA outlets, the overwhelming majority of residents responded that all PA destinations were ">30 minutes of walking" (Table 5-2). Even within the urban sample, the majority of residents perceived the nearest elementary school (41.3%), any other school (46.3%), and recreation center (43.1%) being >30 minutes of walking. Only parks, in the urban sample, had the majority (33.7%) of responses being 1-5 minute of walking.

When comparing objective and subjective measures of distance, Spearman's ρ bivariate correlation coefficient show that the categorical responses in "minutes of walking" are significantly correlated ($p<0.00$) for all distances (elementary school: $\rho=.41$; any other school: $\rho=.50$; recreation center: $\rho=.46$; park $\rho=.52$). This indicates that residents' perception of distance to resources is directly comparable to the objectively measured distance.

Predictability of Minutes of PA and Meeting Recommendations

Linear regression models tested the predictability of proximity in kilometers to PA outlet on weekly minutes of MVPA. Table 5-3 reports on the β coefficient for each destination, in which no model significantly predicted weekly minutes of PA (any outlet F=8.9, p=0.80; elementary school F=8.9, p=0.96; any school F=8.9, p=0.91; recreation center F=8.9, p=0.90; park F=8.9, p=0.71). Additionally, while separating the residents by urban (any outlet F=3.4, p=0.63; elementary school F=3.3, p=0.93; any school F=3.4, p=0.78; recreation center F=3.7, p=0.19; park F=3.5, p=0.37) or rural (any outlet F=6.6, p=0.65; elementary school F=6.6, p=0.52; any school F=6.6, p=0.58; recreation center F=6.6, p=0.64; park F=6.5, p=0.69) geographic designations, proximity of physical activity outlets were not indicative of weekly minutes of PA.

Further, to determine the likelihood of meeting PA recommendations, logistic regressions models were built to test the predictors of objective distance in kilometers and subjective distance in minutes of walking (Table 5-4). Contrary to the hypotheses, the models indicate there is no significant relationship between proximity to PA outlets and meeting PA recommendations. When exploring the relationship of individuals' perception of the PA environment, perceived lower minutes of walking to the destination was not predictive of meeting PA recommendations.

Discussion

The high rates of physical inactivity in this region is concerning with only 10.2% of the sample meeting both aerobic and strength training PA recommendations. The average weekly minutes (126.7±181.9) of MVPA of the sample is lower than the recommended 150 minutes, with urban residents engaging in more weekly minutes than rural residents. The overall number of resources available to residents region-wide is 105 and 42.9% are parks, 24.8% are elementary schools, 17.1% are other types of schools, and 9.4% recreation centers. Residents lived about 4 km from any PA outlet with urban residents living closer to resources than rural residents. Rural residents, on average live farther from a physical activity outlet, but in our sample rural residents are more likely to meet recommendations for physical activity compared to urban counterparts.

The published literature on distance and physical activity has mixed results. Our data finds that distances to PA resources are not associated with minutes of PA or meeting recommendations for PA behaviors, congruent with previously published research (Edwards, Giles-Corti, Larson, & Beesley, 2013;

Eyler, 2003; Kaczynski & Henderson, 2008; Kaczynski et al., 2008; Sanderson et al., 2003). Kaczynski examined neighborhood parks and found that features and amenities within the park significantly influence PA, while the average distance to a park of about ½ mile did not influence PA (Kaczynski et al., 2008). In another study of adolescents, Edwards found that proximity to parks and other PA resources were not associated with meeting PA recommendations (Edwards et al., 2013). Yet some studies have found that a high density of non-residential destinations, such as parks, within ½ mile of their residence is positively associated with increased PA (Ohri-Vachaspati, Lloyd, Delia, Tulloch, & Yedidia, 2013; Strath et al., 2012). Ohri-Vachaspati report those individuals who live within ½ mile of a park have higher PA levels (Ohri-Vachaspati et al., 2013), our study shows that this is not consistent with residents of the Dan River Region. While many studies use a ½ mile to 1 mile (0.8-1.6 km) as a "walkable buffer" or "close proximity" in their studies of the PA environments (Diez Roux et al., 2007; Hoehner, Brennan Ramirez, Elliott, Handy, & Brownson, 2005; Jilcott et al., 2007), the PA resources in the DRR were on average >1.6 km from residents. Even in urban areas, the closest resources were parks which were 1.6±1.1 km away. While disparities in actual distance to close resources exist between urban and rural residents, weekly minutes of MVPA across the DRR is low all together. Despite living closer to resources, city residents do not report more weekly minutes of MVPA than rural residents.

Taking into account residents' perception, the perceived distance to resources was also not indicative of PA. In the predominantly rural DRR, the proximity of PA resources was accurately perceived by residents as "too far to walk". For the urban residents, parks were the closest resource and the majority perceived the parks as a "1-5 minutes" walk from their house. Even though residents did accurately perceive the distance to resources, those who perceived living closer to resources did not engage in more PA than residents that perceived living farther from resource. Our findings are consistent to some previously published research on subjective distances of PA outlets, in that PA was not associated with having destinations "within walking distance" (Eyler, 2003; Sanderson et al., 2003). Contrary to this, Deshpande reported more PA for residents who perceived shorter walking times to destinations (Deshpande, Baker, Lovegreen, & Brownson, 2005) and in the review by Frost, "walkable destinations" was positively associated with increased PA behaviors (Frost et al., 2010). These mixed findings in current literature suggest that further research is needed to better understand proximity and perceptions on PA behaviors.

This study is not without limitations. Physical activity was self-reported and therefore prone to responder bias. However, we did use measures that were previously validated for phone use. Additionally, the NEWS-A measures proximity to PA outlet, it does not ask which outlet residents use. Instead of exercising close to home, participants may choose locations close to work or school. Asking participants which outlet they use or visit would provide a better understanding of individual behavior, however researchers have found that close proximity of an outlets (e.g., within ½ mile of home address) is predictive to engaging in PA (Ohri-Vachaspati et al., 2013). Proximity may be just one predictor of PA, and other factors such as quality of resources, amenities offer and perceptions of safety are other variables not addressed in this study that could influence the likelihood of engaging in PA. Additionally, the features available at a particular resource may encourage greater use. It is important that accessibility is evaluated as a whole. Since the objectives of this study were to examine distance and PA behaviors other factors of accessibility could be the focus of future research.

While parks were the most prevalent type of resource, they were concentrated to the cities resulting in urban residents traveling only 1.6±1.1 kilometers to reach the nearest compared to rural residents who must travel 9.3±6.6 kilometers. The overall average distance to a park is over 6 kilometers for all residents of the DRR. Schools were more evenly distributed throughout the region; the average distance reaching any school is about 5 kilometers in the DRR. Since residents live, on average, closer to schools, it would be advantageous to implement shared-use policies with schools and community programs for adults and children in the neighborhood to encourage PA. Due to both the prevalence and proximity, it would be of value for community leaders to develop programs that encourage community members to utilize these available resources.

Conclusions

This research advances the community-created physical activity causal models for obesity under a CBPR framework in a health disparate region. The results of this study provide a baseline of the physical activity levels in the region. Further the data provide environmental context in terms of the physical activity resources generally available to residents. Regional participation in physical activity is very low, and to reduce obesity and improve health, increasing participation in physical activity will be necessary for community partners. Yet, resources may not be accessible to all residents in this health disparate population. Using a CBPR approach, these results and the environmental data is being shared with the community. The DRPHC has initiated a built environment subcommittee that is reviewing the data, these findings and considering future options for the physical activity opportunities.

Table 5-1. Characteristics of sampled residents in the Dan River Region

	All sampled residents (N=813)	Rural* residents (n=498)	Urban* residents (n=315)
Gender			
n(%) Male	194(23.9)	131(26.3)	63(20.0)
n(%) Female	619(76.1)	367(73.7)	252(80.0)
Mean(±SD) Age in years	55.9(17.2)	58.6(15.6)	51.7(18.6)
Race			
White	492(61.7)	378(75.9)	114(36.2)
Black	283(35.5)	99(19.9)	184(58.4)
Other and Multi-Racial	22(2.8)	12(2.4)	10(3.2)
Education			
<HS	141(17.4)	86(17.3)	55(17.5)
HS or GED	292(36.0)	180(36.1)	112(35.6)
1-3 years college	250(30.8)	155(31.1)	95(30.2)
≥4 years college	129(15.9)	76(15.3)	53(16.8)
Total Annual Household Income			
<$20,000	318(45.4)	135(27.1)	183(58.1)
$20,000-$50,000	236(33.7)	182(36.5)	54(17.1)
>$50,000	147(21.0)	104(20.9)	43(13.7)
Mean(SD) minutes of moderate and vigorous physical activity per week	126.7(181.9)	125.8(174.1)	128.1(194.0)
N(%) meet physical activity recommendations	287(35.3%)	187(37.6%)	100(31.7%)
N(%) meet physical activity and strength training recommendations	83(10.2%)	52(10.4%)	31(9.8%)
Mean(SD) Body Mass Index	29.0(6.4)	28.2(5.2)	30.3(7.8)
N(%) Body Mass Index			
Normal Weight	215(26.4%)	139(27.9%)	76(24.1%)
Over Weight	265(32.6%)	174(34.9%)	91(28.9%)
Obese	247(30.4%)	149(29.9%)	98(31.1%)
Morbidly Obese	53(6.5%)	15(3.0%)	38(12.1%)

*rural is defined as those living outside the city limits and urban are those residents living with the city limits

Table 5-2. Distance of residents to nearest physical activity outlets, reported as Mean (±SD) or n(%)

	All sampled residents (N=813)	Rural* residents (n=498)	Urban* residents (n=315)
Objective distance, in kilometers			
Nearest any outlet	4.0(4.3)	6.0(4.5)	1.1(0.8)
Nearest elementary school	5.6(4.3)	7.2(4.7)	3.1(1.9)
Nearest any school	5.0(4.2)	6.8(4.5)	2.4(1.8)
Nearest recreation center	12.4(15.0)	18.8(15.9)	2.3(1.1)
Nearest park	6.3(6.4)	9.3(6.6)	1.6(1.1)
Subjective distance, in minutes of walking			
Nearest elementary school			
1-5 minutes	29(3.6%)	8(1.6%)	21(6.7%)
6-10 minutes	51(6.3%)	15(3.0%)	36(11.4%)
11-20 minutes	103(12.7%)	39(7.8%)	64(20.3%)
21-30 minutes	95(11.7%)	50(10.0%)	45(14.3%)
>30 minutes	487(59.9%)	357(71.7%)	130(41.3%)
Nearest any school			
1-5 minutes	36(4.4%)	6(1.2%)	30(9.5%)
6-10 minutes	42(5.2%)	7(1.4%)	35(11.1%)
11-20 minutes	87(10.7%)	35(7.0%)	52(16.5%)
21-30 minutes	70(8.6%)	34(6.8%)	36(11.4%)
>30 minutes	534(65.7%)	388(78.0%)	146(46.3%)
Nearest recreation center			
1-5 minutes	21(2.6%)	4(0.8%)	17(5.4%)
6-10 minutes	39(4.8%)	9(1.8%)	30(9.5%)
11-20 minutes	86(10.6%)	26(5.2%)	60(19.0%)
21-30 minutes	59(7.3%)	13(2.6%)	46(14.6%)
>30 minutes	545(67.0%)	409(82.1%)	136(43.1%)
Nearest park			
1-5 minutes	127(15.6%)	21(4.2%)	106(33.7%)
6-10 minutes	70(8.6%)	21(4.2%)	49(15.6%)
11-20 minutes	86(10.6%)	32(64.4%))	54(17.1%)
21-30 minutes	50(6.2%)	36(7.2%)	14(4.4%)
>30 minutes	437(53.7%)	359(72.0%)	78(24.9%)

*rural is defined as those living outside the city limits and urban are those residents living with the city limits

Table 5-3. β-coefficient for adjusted linear regression models for predicting weekly minutes physical activity of sampled residents by objective distance, in kilometers, to nearest physical activity outlet

	All sampled residents (N=813)	Rural* residents (N=498)	Urban* residents (N=315)
Nearest any outlet	-0.673	1.433	-10.542
Nearest elementary school	0.123	1.946	-0.816
Nearest any school	-0.296	1.749	-2.962
Nearest recreation center	-0.100	0.406	-21.804
Nearest park	-0.656	0.842	-13.847

Models adjusted for gender, age, income and BMI

*rural is defined as those living outside the city limits and urban are those residents living with the city limits

Table 5-4. Odds ratio (95% confidence interval) for adjusted logistic regression models for meeting physical activity recommendations by objective and subjective distances of sampled residents to nearest physical activity outlet

	All sampled residents (N=813)	Rural* residents (n=498)	Urban* residents (n=315)
Objective distance (in kilometers)			
Nearest any outlet	1.03 (0.80, 1.33)	1.04 (0.77, 1.39)	1.61 (0.58, 4.46)
Nearest elementary school	1.00 (0.82, 1.23)	1.05 (0.85, 1.31)	0.64 (0.37, 1.09)
Nearest any school	1.02 (0.77, 1.35)	0.96 (0.70, 1.32)	1.48 (0.73, 2.98)
Nearest recreation center	1.01 (0.99, 1.03)	1.01 (0.99, 1.04)	0.70 (0.40, 1.23)
Nearest park	0.98 (0.90, 1.07)	0.98 (0.89, 1.07)	0.90 (0.49, 1.64)
Subjective distance (in minutes of walking)			
Nearest elementary school (ref: >30 minutes)			
1-5 minutes	1.05 (0.37, 2.95)	2.40 (0.35, 16.65)	0.67 (0.17, 2.63)
6-10 minutes	1.05 (0.46, 2.36)	2.32 (0.47, 11.58)	0.68 (0.24, 1.92)
11-20 minutes	0.77 (0.42, 1.42)	1.00 (0.39, 2.53)	0.51 (0.22, 1.21)
21-30 minutes	0.69 (0.39, 1.21)	0.69 (0.32, 1.51)	0.55 (0.23, 1.32)
Nearest any school (ref: >30 minutes)			
1-5 minutes	0.73 (0.30, 1.78)	3.55 (0.30, 41.77)	0.47 (0.15, 1.46)
6-10 minutes	0.56 (0.22, 1.43)	0.70 (0.07, 6.82)	0.46 (0.15, 1.44)
11-20 minutes	0.77 (0.41, 1.43)	0.54 (0.20, 1.46)	1.12 (0.47, 2.71)
21-30 minutes	1.04 (0.55, 1.95)	0.95 (0.36, 2.47)	1.14 (0.46, 2.84)
Nearest recreation center (ref: >30 minutes)			
1-5 minutes	0.83 (0.46, 1.51)	0.25 (0.07, 0.97)	1.21 (0.49, 2.99)
6-10 minutes	0.70 (0.34, 1.42)	0.75 (0.22, 2.58)	0.85 (0.30, 2.43)
11-20 minutes	1.01 (0.51, 2.00)	1.17 (0.39, 3.52)	1.05 (0.38, 2.93)
21-30 minutes	0.65 (0.30, 1.41)	0.74 (0.29, 1.91)	0.45 (0.09, 2.33)
Nearest park (ref: >30 minutes)			
1-5 minutes	1.22 (0.40, 3.65)	0 (0,)	2.06 (0.56, 7.63)
6-10 minutes	1.59 (0.65, 3.90)	0.73 (0.08, 6.82)	1.94 (0.68, 5.54)
11-20 minutes	1.11 (0.58, 2.10)	1.14 (0.36, 3.64)	0.98 (0.43, 2.23)
21-30 minutes	0.78 (0.36, 1.67)	0.44 (0.08, 2.40)	0.99 (0.40, 2.45)

Models adjusted for gender, age, income and BMI
*rural is defined as those living outside the city limits and urban are those residents living with the city limits

REFERENCES

Aronson, R. E., & Oman, R. F. (2004). Views on exercise and physical activity among rural-dwelling senior citizens. J Rural Health, 20(1), 76-79.

Bohannon, R. W. (1997). Comfortable and maximum walking speed of adults aged 20-79 years: reference values and determinants. Age Ageing, 26(1), 15-19.

Boslaugh, S. E., Luke, D. A., Brownson, R. C., Naleid, K. S., & Kreuter, M. W. (2004). Perceptions of neighborhood environment for physical activity: is it "who you are" or "where you live"? J Urban Health, 81(4), 671-681. doi: 10.1093/jurban/jth150

Boyer, K. A., Andriacchi, T. P., & Beaupre, G. S. (2012). The role of physical activity in changes in walking mechanics with age. Gait Posture, 36(1), 149-153. doi: 10.1016/j.gaitpost.2012.02.007

Brownson, R. C., Baker, E. A., Housemann, R. A., Brennan, L. K., & Bacak, S. J. (2001). Environmental and policy determinants of physical activity in the United States. Am J Public Health, 91(12), 1995-2003.

Brownson, R. C., Chang, J. J., Eyler, A. A., Ainsworth, B. E., Kirtland, K. A., Saelens, B. E., & Sallis, J. F. (2004). Measuring the environment for friendliness toward physical activity: a comparison of the reliability of 3 questionnaires. Am J Public Health, 94(3), 473-483.

Casey, A. A., Elliott, M., Glanz, K., Haire-Joshu, D., Lovegreen, S. L., Saelens, B. E., . . . Brownson, R. C. (2008). Impact of the food environment and physical activity environment on behaviors and weight status in rural U.S. communities. Prev Med, 47(6), 600-604. doi: 10.1016/j.ypmed.2008.10.001

CDC. (2011). Behavioral Risk Factor Surveillance System Survey Data. 2012, from http://www.cdc.gov/brfss/

CDC. (1996). Physical Activity and Health: A Report of the Surgeon General. Retrieved October 5, 2013, from http://www.cdc.gov/nccdphp/sgr/adults.htm

CDC. (2013). Adult participation in aerobic and muscle-strengthening physical activities--United States, 2011. MMWR Morb Mortal Wkly Rep, 62(17), 326-330.

Cerin, E., Conway, T. L., Saelens, B. E., Frank, L. D., & Sallis, J. F. (2009). Cross-validation of the factorial structure of the Neighborhood Environment Walkability Scale (NEWS) and its abbreviated form (NEWS-A). Int J Behav Nutr Phys Act, 6, 32. doi:10.1186/1479-5868-6-32

Cerin, E., Saelens, B. E., Sallis, J. F., & Frank, L. D. (2006). Neighborhood Environment Walkability Scale: validity and development of a short form. Med Sci Sports Exerc, 38(9), 1682-1691.

DHHS. (2008). 2008 Physical Activity Guidelines for Americans. Retrieved from http://www.health.gov/paguidelines/guidelines/default.aspx#toc.

Deshpande, A. D., Baker, E. A., Lovegreen, S. L., & Brownson, R. C. (2005). Environmental correlates of physical activity among individuals with diabetes in the rural midwest. Diabetes Care, 28(5), 1012-1018.

Diez Roux, A. V., Evenson, K. R., McGinn, A. P., Brown, D. G., Moore, L., Brines, S., & Jacobs, D. R., Jr. (2007). Availability of recreational resources and physical activity in adults. Am J Public Health, 97(3), 493-499. doi: 10.2105/AJPH.2006.087734

DRPHC. (2012). Dan River Partnership for a Healthy Community. Retrieved March 29, 2012

Duncan, M. J., Spence, J. C., & Mummery, W. K. (2005). Perceived environment and physical activity: a meta-analysis of selected environmental characteristics. Int J Behav Nutr Phys Act, 2, 11. doi: 10.1186/1479-5868-2-11

Edwards, N. J., Giles-Corti, B., Larson, A., & Beesley, B. (2013). The Effect of Proximity on Park and Beach Use and Physical Activity Among Rural Adolescents. J Phys Act Health. In press.

Estabrooks, P. A., Lee, R. E., & Gyurcsik, N. C. (2003). Resources for physical activity participation: does availability and accessibility differ by neighborhood socioeconomic status? Ann Behav Med, 25(2), 100-104.

Evenson, K. R., Murray, D. M., Birnbaum, A. S., & Cohen, D. A. (2010). Examination of perceived neighborhood characteristics and transportation on changes in physical activity and sedentary behavior: The Trial of Activity in Adolescent Girls. Health Place, 16(5), 977-985. doi: 10.1016/j.healthplace.2010.06.002

Eyler, A. A. (2003). Personal, social, and environmental correlates of physical activity in rural Midwestern white women. Am J Prev Med, 25(3 Suppl 1), 86-92.

Flegal, K. M. (2005). Epidemiologic aspects of overweight and obesity in the United States. Physiol Behav, 86(5), 599-602. doi: 10.1016/j.physbeh.2005.08.050

Frost, S. S., Goins, R. T., Hunter, R. H., Hooker, S. P., Bryant, L. L., Kruger, J., & Pluto, D. (2010). Effects of the built environment on physical activity of adults living in rural settings. Am J Health Promot, 24(4), 267-283. doi: 10.4278/ajhp.08040532

Giles-Corti, B., & Donovan, R. J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. Soc Sci Med, 54(12), 1793-1812.

Godin, G., & Shephard, R. J. (1985). A simple method to assess exercise behavior in the community. Can J Appl Sport Sci, 10(3), 141-146.

Greenwood, D.J., & Levin, M. (2007). Introduction to Action Research: Social Research for Social Change (2 ed.). Thousand Oaks, CA: Sage Publications.

Gustafson, A. A., Sharkey, J., Samuel-Hodge, C. D., Jones-Smith, J., Folds, M. C., Cai, J., & Ammerman, A. S. (2011). Perceived and objective measures of the food store environment and the association with weight and diet among low-income women in North Carolina. Public Health Nutr, 14(6), 1032-1038. doi: 10.1017/S1368980011000115

Hill, J. L., Chau, C., Luebbering, C. R., Kolivras, K. K., & Zoellner, J. (2012). Does availability of physical activity and food outlets differ by race and income? Findings from an enumeration study in a health disparate region. Int J Behav Nutr Phys Act, 9, 105. doi: 10.1186/1479-5868-9-105

Hill, J. L., You, W., & Zoellner, J. M. (Under Review). Disparities in obesity among rural and urban residents in a health disparate region.

Hoehner, C. M., Brennan Ramirez, L. K., Elliott, M. B., Handy, S. L., & Brownson, R. C. (2005). Perceived and objective environmental measures and physical activity among urban adults. Am J Prev Med, 28(2 Suppl 2), 105-116. doi: 10.1016/j.amepre.2004.10.023

Israel, B.A., Eng, E., Schulz, A.J., & Parker, E.A. (Eds.). (2005). Methods in Community-Based Participatory Research for Health (1 ed.). San Francisco, CA: Josey-Bass.

Jilcott, S. B., Evenson, K. R., Laraia, B. A., & Ammerman, A. S. (2007). Association between physical activity and proximity to physical activity resources among low-income, midlife women. Prev Chronic Dis, 4(1), A04.

Jilcott, S. B., Laraia, B. A., Evenson, K. R., & Ammerman, A. S. (2009). Perceptions of the community food environment and related influences on food choice among midlife women residing in rural and urban areas: a qualitative analysis. Women Health, 49(2-3), 164-180.

Kaczynski, A. T., & Henderson, K. A. (2008). Parks and recreation settings and active living: a review of associations with physical activity function and intensity. J Phys Act Health, 5(4), 619-632.

Kaczynski, A. T., Potwarka, L. R., & Saelens, B. E. (2008). Association of park size, distance, and features with physical activity in neighborhood parks. Am J Public Health, 98(8), 1451-1456. doi: 10.2105/AJPH.2007.129064

Lee, R. E., Booth, K. M., Reese-Smith, J. Y., Regan, G., & Howard, H. H. (2005). The Physical Activity Resource Assessment (PARA) instrument: evaluating features, amenities and incivilities of physical activity resources in urban neighborhoods. Int J Behav Nutr Phys Act, 2, 13. doi: 10.1186/1479-5868-2-13

Leslie, E., Saelens, B., Frank, L., Owen, N., Bauman, A., Coffee, N., & Hugo, G. (2005). Residents' perceptions of walkability attributes in objectively different neighbourhoods: a pilot study. Health Place, 11(3), 227-236. doi: 10.1016/j.healthplace.2004.05.005

Local Area Unemployment Statistics: Unemployment Rates for Metropolitan Areas. (2012, November 1, 2012). Retrieved December 26, 2012, from http://www.bls.gov/lau/

McCormack, G. R., Cerin, E., Leslie, E., du Toit, L., & Owen, N. (2008). Objective Versus Perceived Walking Distances to Destinations: Correspondance and Predictive Validity. Environ Behav, 40(3), 401-425.

MDC. (2008). Dan River Region Health Assessment Chapel Hill, NC.

Moore, J. B., Jilcott, S. B., Shores, K. A., Evenson, K. R., Brownson, R. C., & Novick, L. F. (2010). A qualitative examination of perceived barriers and facilitators of physical activity for urban and rural youth. Health Educ Res, 25(2), 355-367. doi: 10.1093/her/cyq004

Ogden, C. L., Yanovski, S. Z., Carroll, M. D., & Flegal, K. M. (2007). The epidemiology of obesity. Gastroenterology, 132(6), 2087-2102. doi: 10.1053/j.gastro.2007.03.052

Ohri-Vachaspati, P., Lloyd, K., Delia, D., Tulloch, D., & Yedidia, M. J. (2013). A closer examination of the relationship between children's weight status and the food and physical activity environment. Prev Med. doi: 10.1016/j.ypmed.2013.05.009

Parra, D. C., Gomez, L. F., Sarmiento, O. L., Buchner, D., Brownson, R., Schimd, T., . . . Lobelo, F. (2010). Perceived and objective neighborhood environment attributes and health related quality of life among the elderly in Bogota, Colombia. Soc Sci Med, 70(7), 1070-1076. doi: 10.1016/j.socscimed.2009.12.024

Poortinga, W. (2006). Perceptions of the environment, physical activity, and obesity. Soc Sci Med, 63(11), 2835-2846. doi: 10.1016/j.socscimed.2006.07.018

Saelens, B. E., & Handy, S. L. (2008). Built environment correlates of walking: a review. Med Sci Sports Exerc, 40(7 Suppl), S550-566.

Saelens, B. E., Sallis, J. F., Black, J. B., & Chen, D. (2003). Neighborhood-based differences in physical activity: an environment scale evaluation. Am J Public Health, 93(9), 1552-1558.

Saelens, B. E., Sallis, J. F., Frank, L. D., Cain, K. L., Conway, T. L., Chapman, J. E., . . . Kerr, J. (2011). Neighborhood Environment and Psychosocial Correlates of Adults' Physical Activity. Med Sci Sports Exerc. doi: 10.1249/MSS.0b013e318237fe18

Sallis, J. F., Johnson, M. F., Calfas, K. J., Caparosa, S., & Nichols, J. F. (1997). Assessing perceived physical environmental variables that may influence physical activity. Res Q Exerc Sport, 68(4), 345-351.

Sandercock, G., Angus, C., & Barton, J. (2010). Physical activity levels of children living in different built environments. Prev Med, 50(4), 193-198. doi: 10.1016/j.ypmed.2010.01.005

Sanderson, B. K., Foushee, H. R., Bittner, V., Cornell, C. E., Stalker, V., Shelton, S., & Pulley, L. (2003). Personal, social, and physical environmental correlates of physical activity in rural African-American women in Alabama. Am J Prev Med, 25(3 Suppl 1), 30-37.

Sharkey, J. R., Johnson, C. M., & Dean, W. R. (2010). Food access and perceptions of the community and household food environment as correlates of fruit and vegetable intake among rural seniors. BMC Geriatr, 10, 32. doi: 10.1186/1471-2318-10-32

Strath, S. J., Greenwald, M. J., Isaacs, R., Hart, T. L., Lenz, E. K., Dondzila, C. J., & Swartz, A. M. (2012). Measured and perceived environmental characteristics are related to accelerometer defined physical activity in older adults. Int J Behav Nutr Phys Act, 9(1), 40. doi: 10.1186/1479-5868-9-40

VDH. (2008). Virginia health equity report: Unequal health across the Commonwealth: A snapshot. Retrieved Accessed August 16, 2011, from http://www.vdh.state.va.us/healthpolicy/documents/health-equity-report-summary.pdf.

Warren, H., Cubbin, C., & Winkleby, M. (2008). Direct Measures of the Availability and Quality of Food, Tobacco, and Physical Activity Resources in Three Socioeconomically Constrasting Neighborhoods. International Journal of Critical Statistics, 2(1), 1-18.

Woolf, S. H., Jones, R. M., Johnson, R. E., Phillips, R. L., Jr., Oliver, M. N., Bazemore, A., & Vichare, A. (2010). Avertable deaths associated with household income in Virginia. Am J Public Health, 100(4), 750-755. doi: 10.2105/AJPH.2009.165142

Zoellner, J., Hill, J. L., Grier, K., Chau, C., Kopec, D., Price, B., & Dunn, C. (2013). Randomized controlled trial targeting obesity-related behaviors: Better Together Healthy Caswell County. Prev Chronic Dis, 10, E96. doi: 10.5888/pcd10.120296

Zoellner, J. M., Motley, M., Wilkinson, M., Jackman, B., Barlow, M. L., & Hill, J. L. (2012). Engaging the Dan River Region to Reduce Obesity: Application of the Comprehensive Participatory Planning and Evaluation Process. Fam Community Health, 35(1), 44-56.

CHAPTER 6: GENERAL CONCLUSIONS

Each of the three studies describes the built environment and examines its relationship on nutrition and physical activity behaviors for residents in a health disparate population. Ecological approaches that include a focus on environmental context, in addition to individual behavior change, are necessary to sustain behavior modifcations, such as increasing FV intake or engaging in PA. Depsite growth in ecological approaches, the results are varied and rural, health disparate populations tend to be less understood.

In the first study, we found that there were no significant differences in the availability of healthy options in stores and restaurants by block group race and income in the city of Danville, VA. While lacking statistical significance, there is a clear practical significance in the distribution of outlets between white and black block groups that mirror the disparity in income. Of the total 184 food outlets in Danville, 115 are found in middle- to high- income white block groups, as opposed to only 32 outlets are present in low- to middle- income black block groups. The predomindately black block groups only had one grocery store available to their residents; further, the healthy food availability score of the only one grocery store was 13 compared to the average healthy availability score of seven grocery stores in white block groups was about 24. This lack of a grocery store or larger supermarket may present a barrier to residents living in predominantly black or low income areas who want to acquire healthier food options in their grocery stores.

Expanding on the first study, the methods were replicated to systematically measure the healthy food availability in the Dan River Region (DRR) and to specifically examine how the healthy food availability may influence individual FV intake. Across the DRR, healthy food availability is low with only 9% meeting current FV recommendations. While grocery stores and large supermarkets had the highest healthy availability scores of all food outlets in this region, they only accounted for a small percentage of total outlets in the region and were concentrated to within the city limits of Danville and Martinsville, VA. Contrary to the research hypotheses, healthy food availability in the food environment of the DRR does not predict individual FV intake. Further, examining the specific health availability scores of the nearest stores and food outlets to individuals also did not predict FV intake or meeting FV recommendations. Health food availability is just one factor of the food environment; other factors of the environment may be influencing FV intake of residents in tihe DRR.

The third study focuses on the proximity of the physical activity (PA) environment related to PA behaviors of residents in the DRR. This study examined both the objective and subjective distances to various PA outlets from a resident and their self-reported weekly minutes of PA. There are a total of 105 PA outlets in which parks were the most prevalent type. However, schools were closer to residents' homes. Comparing objective distance to outlets, city residents lived within 2 miles of any type of PA outlets, compared to county residents who have to travel further to reach an outlet. When looking at individual's perception of distance to outlets, both city and county residents overwhelming responded that most PA outlets were "too far to walk". Neither objective nor subjective distances to outlets were significant indicators of individual PA behaviors or meeting PA recommendations. Recognizing that the DRR spans across two cities and three rural counties, both linear and regression models were also stratified by locality yet did not show any significant indicator of distance to individual PA behaviors.

Given that the findings from scientific literature suggest environmental influence on healthy behaviors, these studies show no statistically significant relationship of the availability of food outlets to FV intake or proximity of PA resources to weekly minutes of PA. It is known that in neighborhoods with high availability and accessibility of fresh produce there is a low prevalence of obesity with residents reporting better diet quality than those living in poorer food environments (Bodor, Rice, Farley, Swalm, & Rose, 2010; Larson et al., 2009; Laska, Borradaile, Tester, Foster, & Gittelsohn, 2010; Story, Kaphingst, Robinson-O'Brien, & Glanz, 2008). The disparity in the availability of resources by neighborhood race and income align with findings from previously published research. Low-income and predominantly minority areas have fewer supermarkets with reduced access to fresh produce (Boslaugh, Luke, Brownson, Naleid, & Kreuter, 2004; Franco et al., 2009; Franco et al., 2008). Yet the results of Study 2 show low FV intake for all residents despite the disparity in spatial distribution and access to healthy foods. This suggests that there are other factors influencing individuals' diets in this region. Living in close proximity to physical activity outlets increases the potential for physical activity by planned exercise and walking (Diez Roux et al., 2007; Evenson, Scott, Cohen, & Voorhees, 2007; Giles-Corti & Donovan, 2002; Kaczynski & Henderson, 2008). However, proximity to an outlet was not predictive of PA. Despite differences in distance to the neareast outlets, there were no associations between residents who lived closers to outlets reporting more weekly minutes of PA. Again, proximity is just one facet of the environment and there may be others associated with low PA in the region.

As part of the Dan River Partnership for a Healthy Community (DRPHC), these findings provide a foundation to inform future interventions and policies. The majority of the residents in the DRR are not meeting recommendations for FV intake and weekly minutes of moderate to vigorous PA. It is clear from the studies that there is a lack of healthy food options available to residents in the region. Despite accurately perceiving distance to physical activity resources, proximity to outlets was not associated with PA behaviors. These studies hypothesized that healthy food availabily and proximity of physical activity outlets would predict FV intake or minutes of PA, but that hypothesis was not supported. These studies help advance two of the six priority areas (i.e., environmental influence and geography) for the coalition. True to the community-based participatory research principles that guide the DRPHC, all findings have been or will be disseminated to the coalition. On-going efforts include forming a Built Environment

Subcommittee to oversee the next course of action items the DRPHC will undertake towards its vision of building and promoting a healthier environment for the Dan River Region residents.

Limitations

These studies are not without limitations and each study considers limitations. However, some general limitations should be noted. First, as demonstrated, there is very low intake of FV and low healthy food availability. These low mean values, create a left skewed distribution in our data compressing the variability in the outcome. This low variability may influence our ability to detect statiocal significance. Importantly, the environmental data is not a sample. Rather, we collected data from all outlets and resources available to residents in the region thereby providing a comprehensive picture of what is available. Secondly, there are several measures available and those chosen have some limitations. However, all measures selected were previously validated for methods similar to those presented here. In particular, of the many tools available for the food environment, NEMS was chosen given its focus on nationally available food prodcuts in grocery stores and the measures for restrauarnts. However, the NEMS is designed and tested predominately in traditional venues of grocer stores, conveience stores or restraurants. Therefore, non-traditional food outlets are not be captured in our data. In examining the proximity effect of resources to behaviors, residents were associated with the nearest food and physical activity outlets as calculated by a road network. The telephone survey of the sample residents did not ask whether outlets closest to the homes were utilized or if there were other preferred outlets for food purchase and physical activity. Given the limited time and length of the initial telephone survey, a follow up survey would need to be conducted to include more in-depth questions about specific outlets and destinations.

Future Directions

In the DRR, recent needs assessment suggest high rates of obesity and related chronic disease, including diabetes, coronary heart disease, and hypertension (MDC, 2008). Literature suggests that various aspects of the built environment may influence healthy behaviors and lifestyles (Black & Macinko, 2008; Booth, Pinkston, & Poston, 2005; Feng, Glass, Curriero, Stewart, & Schwartz, 2010). In the formative months of the DRPHC, community members identified geographic planning and environment as two of the six root causes for obesity in this health disparate region. The extent to which these two factors influence the health of DRR residents was unclear and the research presented in this dissertation sought to advance these causal models. Residents of the DRR are living in poor food environments with low availability of healthy foods throughout the region. In regards to the physical activity environment, residents live on average 2.5 miles away from an outlet, yet only 10% of the population is meeting current physical activity recommendations. These findings provide a context to how the environment may be influential in promoting healthy lifestyle and choices in the DRR and will be used as a foundation for potential interventions and other action-items by the DRR.

While we now have an overview of the food and physical activity environments, there is still a need for research on the varying roles availability and accessibility of resources. The role of price can be examined to determine if there is a significant mean difference between "healthy" and "regular" food options. If there is a price premium for healthy options, additional hypotheses could be explored to determine if price influences residents' purchasing behavior of "healthy" food items. Such that, the more expensive a "healthy" food item, consumer will purchase less frequently, resulting in lower consumption. In our entire DRR, there are few large grocery stores and supermarkets that offer a variety of fresh produce and healthy options. Rural residents often may travel farther distances to reach a supermarket and as a result, rely on smaller convenience stores and other stores for grocery items. Future research could consider the relationship between frequency of grocery shopping trips, purchased items and diet quality. To incorporate a spatial dimension, the greater the distance traveled to a preferred grocery store with an abundance of "healthy" options, the poorer the diet quality. This added level of information will give insight on how individuals interact within the environment and be used to inform any environmental interventions that would increase the availability and accessibility of healthier food items in those food outlets. If traveling distance is a barrier for rural residents, tailored interventions, such as community gardening projects close to their homes, can increase availability and accessibility of fresh produce.

Evident in Study 3 that the majority of residents are not meeting PA recommendations despite living within 3 miles of a PA resource lends the need to further research the quality of PA resources in the DRR as a possible barrier to promoting PA. Literature suggests the greater the number of features and amenities a resource has to offer, the more likely individuals will use the resource for PA (Black & Macinko, 2008; Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; Hoehner, Brennan Ramirez, Elliott, Handy, & Brownson, 2005). While living near an outlet is just one factor in promoting PA, additional analysis of their quality, features and amenities may help determine why residence are not utilizing these outlets for PA. There are several outlets in the DRR that are available to residence with a monthly or yearly fee for use. The cost associated with PA outlet use may be a barrier to some residents. Further, given the size of the region, transportation and travel time may be additional barriers that warrant further investigation. A focus group or a follow up community survey will help determine other environmental barriers to PA to better inform any future interventions. As this dissertation has been focused on the food and PA environments, other area-based deprivation indices may play a role in the overall health of DRR residents.

There is large support for the influence of environment on behaviors in current research, yet the results of this research did not find any significant associations between the environment and behaviors.

This may be in part that the DRR is a unique region that spans across 3 rural counties and a mid-size regional city. While much built environment research has been focused on larger, metropolitan areas, only a small percentage of studies focus on rural regions, with even fewer studies that include areas on both ends of the rural-urban continuum. These projects occurred as part of a larger on-going community-academic partnership operating under CBPR principles. The benefits of using a participatory model allow researchers to target the vulnerable and hard-to-reach populations by including community members and residents to have equitable partnership throughout the research process. The DRPHC, made up of residents, civic leaders, local organizations, and academic researchers, together identified the priority areas for research and guide all research conducted within the DRR.

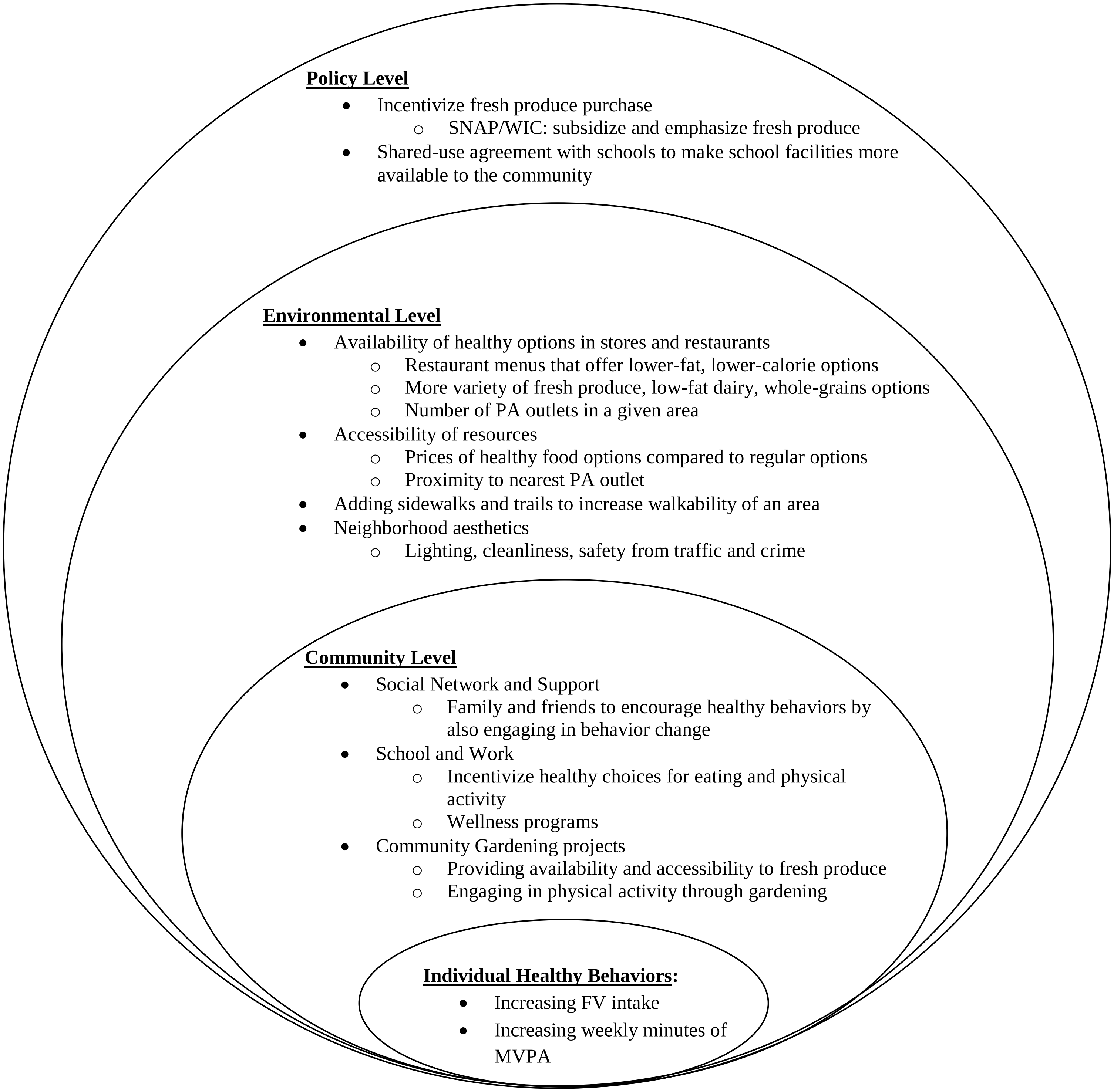
Since all results and data have been shared with the DRPHC, the next steps would be to determine action-items to address environmental approaches to increase the low fruit and vegetable intake and low weekly minutes of physical activity in the region. As previously mentioned, a Built Environment Subcommittee has been formed within the DRPHC to undertake these matters and prioritize the future direction. Figure 6-1 details some possible interventions based in the social ecological model to increased healthier behaviors.

Following an ecological model, there are multiple levels for interventions. While individual-behavioral interventions may be successful, few are sustainable at producing long-term lifestyle changes. Many interventions now focus not only the individual behaviors, but also on the environment – whether that is physical or social, or some combination of both – and policy level factors as well. The ecological framework provides a comprehensive prespective to behaviors, in which there are multiple levels of influence on an individual. It not merely individual choice and preference that guide behavior; environments and policy contribute to behaviors, as well.

Community Level Interventions

At the core of ecological models are the individual behaviors of FV intake and weekly minutes of MVPA. Proximal to the individual is the community level. Made up of family and friends and micro environments that the individual interacts with on a dailty basis (i.e., school, workplace, social organizations), interventions at this level may have the most immediate effect. While the ultimate goal is to increase the healthy behaviors, having social support throughout one's social network can help sustain individual behavior change (Figure 6-1). Behaviors among individuals in close social networks are similar and any change that is not supported is often not sustained. Therefore, the success of individually tailored interventions is due, in part, to the social support the individual receives towards the change. Families are usually the most proximal social network to the individual and when initiating healthy lifestyle change, interventions should also consider close family members. Family members can participate in some, if not all, of the intervention and the home environment can be made to support the lifestyle change. Fresh produce can be made readily available for easy snacks and dinner preparation could be made into a family affair with each member contributing to the preparation of a fresh and healthy dinner.

Figure 6-1. Potential intervention to increase FV intake and minutes of PA in context of DRR food and PA environment



Another successful way to encourage healthier eating in the community is to promote gardening and the use of community gardens. Many have found community gardening, especially with children, a mechanism to teach where their food comes from and to involve them in outdoor activities (Draper & Freedman, 2010; Ober Allen, Alaimo, Elam, & Perry, 2008). In the DRR, a tailored intervention to increase FV intake may involve weekly nutrition classes coupled with community gardening and other family-friendly events that promote healthy eating (e.g., cooking classes) (Reese & Grier, 2012; Zoellner, et al., 2012).

Environment and Policy Level Intereventions

In the DRR, the low availability and accessibility to fresh produce, low-fat dairy, whole grains, and lean meats are barriers to a healthy diet. These items are often more costly with a shorter shelf life. Many individuals and families who live below the poverty threshold rather purchase energy-dense, non-nutritious items as they are more cost- and time- efficient (pre-packaged dinners, fast food items, canned goods) (Dinour, Bergen, & Yeh, 2007; Franklin et al., 2012; Mello et al., 2010). Through this research, corner stores and neighborhood markets in the DRR rarely stock healthier food items (low-fat dairy, fresh produce) since there is little demand from the low-income residents. Yet, research has shown small, yet significant, changes in purchasing behaviors if healthier items are more available in these corner stores (Gittelsohn et al., 2008). The cost of fresh produce and healthy items may be a concern for low-income families, especially those who depend on government food assistance programs (i.e., SNAP or WIC), therefore a policy level change can incentivize the purchase of healthier food and subsidize more monthly dollars towards healthier items. In restaurants, menu labeling and notations of healthier, low-calorie entrée options may influence individuals to choose more nutritious options (Krieger et al., 2013). Restaurants in the DRR can also encourage healthy choices by offering more options to residents as well as promoting a "healthy" special.

In respect to physical activity, walking is a affordable and accessible way to meet the PA recommendations for moderate activity. The lack of destinations in the DRR may discourage individuals to walk for exercise or for leisure. The added concern of traffic and safety may deter individuals from walking. Additionally, sidewalks and trails were not measured as part of the PA environment in this research, but should be considered if promoting PA in the region. Because the DRR spans across urban-rural areas, PA resources may not be close or convenient for some residents, yet schools are located throughout the region and reasonably close for residents. A potential shared-use policy with the community can promote engagement of PA by residents when school facilities are not in use.

Seen throughout Figure 6-1, there are multiple levels for intervention. This dissertation has only focused to the environmental level of influence, in particular, to the food and physical activity environments. Other environments, such as the social environment, may play a key role in individual behaviors. Future work with the DRPHC in the region can explore the influence of social networks and social support on health behaviors. Policy changes could be implemented and enforced that encourage making healthier decisions. For any intervention to have long-term sustainability on changing behavior and lifestyle, it must consider the multiple levels of the ecological model and the different levels of influence. Since these changes occurs at all different levels of influence, examining the interaction of these levels may also give insight to health behavior choices.

REFERENCES

Black, J. L., & Macinko, J. (2008). Neighborhoods and obesity. Nutr Rev, 66(1), 2-20. doi: 10.1111/j.1753-4887.2007.00001.x

Bodor, J. N., Rice, J. C., Farley, T. A., Swalm, C. M., & Rose, D. (2010). The Association between Obesity and Urban Food Environments. J Urban Health, 87(5), 771-781. doi: 10.1007/s11524-010-9460-6

Booth, K. M., Pinkston, M. M., & Poston, W. S. (2005). Obesity and the built environment. J Am Diet Assoc, 105(5 Suppl 1), S110-117. doi:10.1016/j.jada.2005.02.045

Boslaugh, S. E., Luke, D. A., Brownson, R. C., Naleid, K. S., & Kreuter, M. W. (2004). Perceptions of neighborhood environment for physical activity: is it "who you are" or "where you live"? J Urban Health, 81(4), 671-681. doi:10.1093/jurban/jth150

Brownson, R. C., Hoehner, C. M., Day, K., Forsyth, A., & Sallis, J. F. (2009). Measuring the built environment for physical activity: state of the science. Am J Prev Med, 36(4 Suppl), S99-123 e112. doi: 10.1016/j.amepre.2009.01.005

Diez Roux, A. V., Evenson, K. R., McGinn, A. P., Brown, D. G., Moore, L., Brines, S., & Jacobs, D. R., Jr. (2007). Availability of recreational resources and physical activity in adults. Am J Public Health, 97(3), 493-499. doi:10.2105/AJPH.2006.087734

Dinour, L. M., Bergen, D., & Yeh, M. C. (2007). The food insecurity-obesity paradox: a review of the literature and the role food stamps may play. J Am Diet Assoc 107(11), 1952-1961. doi: 10.1016/j.jada.2007.08.006

Draper, C. & Freedman, D. (2010). Review and analysis of the benefits, purposes, and motivations associated with community gardening in the United States. Journal of Community Practice, 18(4) 458-492.

Evenson, K. R., Scott, M. M., Cohen, D. A., & Voorhees, C. C. (2007). Girls' perception of neighborhood factors on physical activity, sedentary behavior, and BMI. Obesity (Silver Spring), 15(2), 430-445. doi: 10.1038/oby.2007.502

Feng, J., Glass, T. A., Curriero, F. C., Stewart, W. F., & Schwartz, B. S. (2010). The built environment and obesity: a systematic review of the epidemiologic evidence. Health Place, 16(2), 175-190. doi: 10.1016/j.healthplace.2009.09.008

Franco, M., Diez-Roux, A. V., Nettleton, J. A., Lazo, M., Brancati, F., Caballero, B., . . . Moore, L. V. (2009). Availability of healthy foods and dietary patterns: the Multi-Ethnic Study of Atherosclerosis. Am J Clin Nutr, 89(3), 897-904. doi:10.3945/ajcn.2008.26434

Franco, M., Diez Roux, A. V., Glass, T. A., Caballero, B., & Brancati, F. L. (2008). Neighborhood characteristics and availability of healthy foods in Baltimore. Am J Prev Med, 35(6), 561-567. doi: 10.1016/j.amepre.2008.07.003

Franklin, B., Jones, A., Love, D., Puckett, S., Macklin, J., & Whites-Means, S. (2012). Exploring mediators of food insecurity and obesity: a review of recent literature. J Community Health 37(1), 253-264. doi: 10.1007/s10900-011-9420-4

Gittelsohn, J., Franceschini, M.C.T., Rasooly, I.R., Ries, A. V., Ho, L.S., Pavlovich, W., . . . Frick, K.D. (2008). Understanding the food environment in a low income urban setting, implications for food store interventions. J Hunger Environ Nutr, 2(2), 33-50. doi: 10.1080/19320240801891438

Hoehner, C. M., Brennan Ramirez, L. K., Elliott, M. B., Handy, S. L., & Brownson, R. C. (2005). Perceived and objective environmental measures and physical activity among urban adults. Am J Prev Med, 28(2 Suppl 2), 105-116. doi: 10.1016/j.amepre.2004.10.023

Kaczynski, A. T., & Henderson, K. A. (2008). Parks and recreation settings and active living: a review of associations with physical activity function and intensity. J Phys Act Health, 5(4), 619-632.

Krieger, J. W., Chan, N. L., Saelens, B. E., Ta, M. L, Solet, D., & Fleming, D. W. (2013). Menu labeling regulations and calories purchased at chain restaurants. Am J Prev Med 44(6), 595-604. doi: 10.1016/j.amepre.2013.01.031

Larson, N. I., Story, M. T., & Nelson, M. C. (2009). Neighborhood environments: disparities in access to healthy foods in the U.S. Am J Prev Med, 36(1), 74-81. doi: 10.1016/j.amepre.2008.09.025

Laska, M. N., Borradaile, K. E., Tester, J., Foster, G. D., & Gittelsohn, J. (2010). Healthy food availability in small urban food stores: a comparison of four US cities. Public Health Nutr, 13(7), 1031-1035. doi: 10.1017/S1368980009992771

MDC. (2008). Dan River Region Health Assessment Chapel Hill, NC.

Mello, J. A., Gans, K. M., Riscia, P. M., Kirtania, U., Strolla, L. O., & Fournier, L. (2010). How is food insecurity associated with dietary behaviors? An analysis with low-income, ethnically diverse participants in a nutrition intervention study. J Am Diet Associ 110(12), 1906-1911. doi: 10.1016/j.jada.2010.09.011

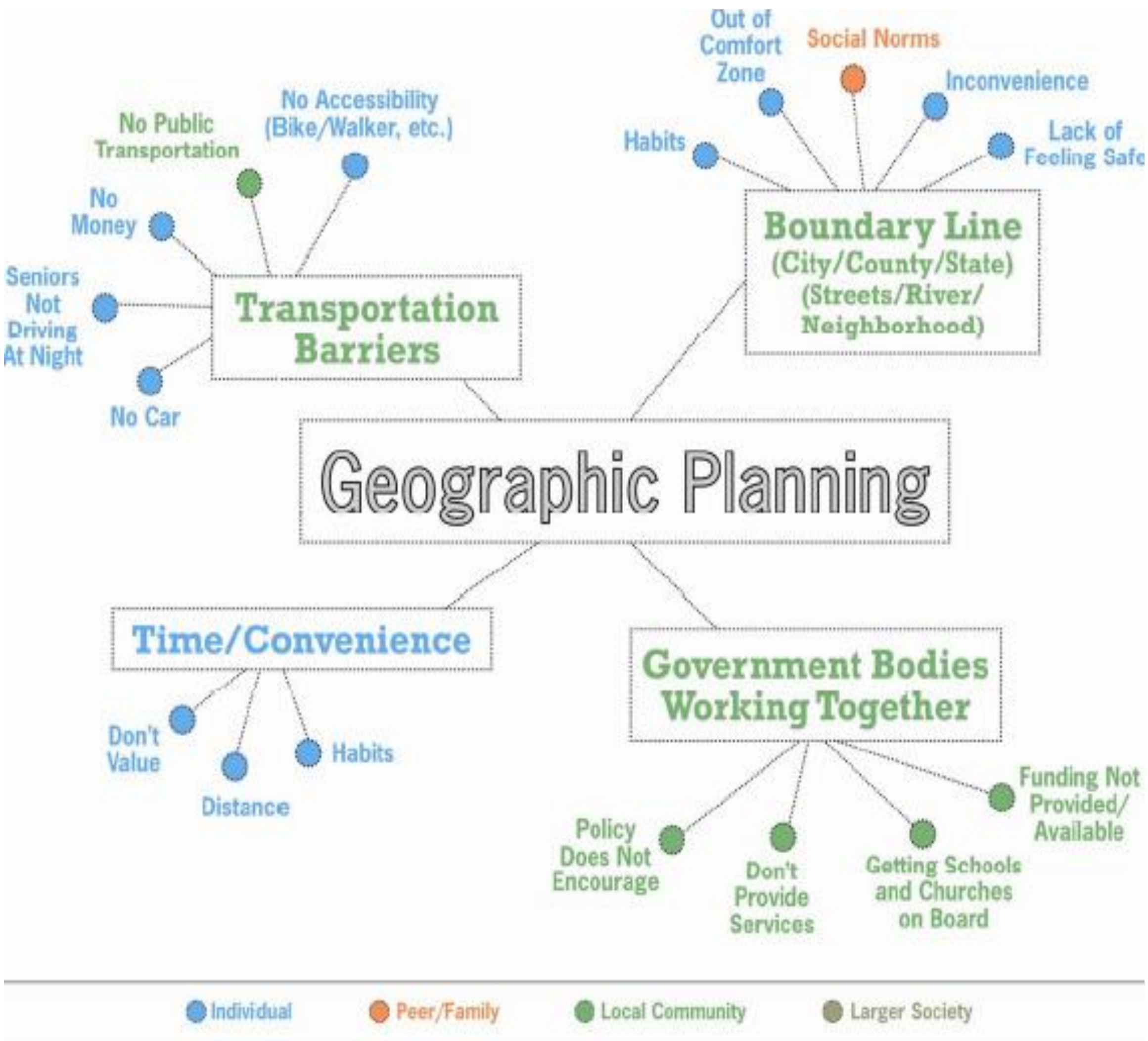
Ober Allen, J., Alaimo, K., Elam, D., & Perry, E. (2008). Growing vegetables and values: Benefits of neighborhood-based community gardens for youth development and nutrition. J Hunger Environl Nutr 3(4), 418 – 439.

Reese, F., Grier, K. (2012) How does a theory-based gardening and nutrition program impact nutritional beliefs and attitudes in youth from a health disparate area? Poster presentation at the Summit on the Science of Eliminating Health Disparities, National Harbor, Maryland.

Story, M., Kaphingst, K. M., Robinson-O'Brien, R., & Glanz, K. (2008). Creating healthy food and eating environments: policy and environmental approaches. Annu Rev Public Health, 29, 253-272. doi: 10.1146/annurev.publhealth.29.020907.090926

Zoellner, J., Zanko, A., Price, B., Bonner, J., & Hill, J. L. (2012). Exploring community gardens in a health disparate population: Findings from a mixed methods pilot study. Prog Community Health Partnersh, 6(2), 153-165.

APPENDIX A: DRPHC CAUSAL MODELS




Environment
Dysfunctional Home Environments
Lack of Education
Lack of Support
Lack of Role Models
Policy Changes
Identifying a Need to Fix Problem
Seeing the Need
Safety Issues
Lighting
Speed Control
Afraid to Walk Dogs, People
Money to Change
Priorities
Finding the Funding
Lack of Transportation to Recreational Activities
Lack of Funds
Economy Inflation
Lack of Money (Gas) and Cars
Individual
Peer/Family
Local Community
Larger Society

APPENDIX B: NUTRITION ENVIRONMENT MEASURES SURVEY – STORES (NEMS-S)

Nutrition Environment Measures Survey (NEMS)
Food Outlet Cover Page

Nutrition Environment Measures Survey
www.sph.emory.edu/NEMS

Rater ID: |__| |__|

Reviewer ID: |__| |__|

Census ID: |__| |__| |__| |__| |__|

○ GS ○ CS ○ Other:______________________________
Category: |__| - |__| |__|

Store ID: |__| |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Number of Cash Registers: |__| |__|

Census ID: |__| |__| |__| |__| |__|

○ FC ○ FF ○ SD ○ SP ○ Other: _______________
Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

Site Visit

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Menu/Internet Review

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Other Visit/Interview

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Nutrition Environment Measures Survey (NEMS)
Food Outlet Cover Page

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #1: MILK

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__| Store ID: |__| |__| |__|

A. Reference Brand

1. Store brand (preferred)   ○ yes ○ no

2. Alternate brand name: ____________________

Comments: ____________________

____

B. Availability

Comments:

1. a. Is low-fat (skim or 1%) available?   ○ yes ○ no   ____________________

   b. If not, is 2% available?   ○ yes ○ no ○ NA   ____________________

2. Shelf space: (measure only if low-fat milk is available)

Type	Pint	Quart	½ Gallon	Gallon
a. Skim	|__||__|	|__||__|	|__||__|	|__||__|
b. 1%	|__||__|	|__||__|	|__||__|	|__||__|
c. Whole	|__||__|	|__||__|	|__||__|	|__||__|

C. Pricing *All items should be the same brand*

Comments:

1. Whole milk, quart $ |__|.|__||__| ____________________

2. Whole milk, half gallon $ |__|.|__||__| ____________________

3. Skim or 1% milk, quart (lowest fat milk available) $ |__|.|__||__| ____________________

4. Skim or 1% milk, half gallon (lowest fat milk available) $ |__|.|__||__| ____________________

Alternate Items:

5. 2%, quart $ |__|.|__||__| ○ NA   ____________________

6. 2%, half gallon $ |__|.|__||__| ○ NA   ____________________

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #2: FRUIT

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__| Store ID: |__| |__| |__|

A. Availability and Price

Produce Item		**Available**		**Price**		**Unit**		**Quality**		**Comments:**
		Yes	**No**		**#**	**pc**	**lb**	**A**	**UA**	
1. Bananas		○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
2. Apples	○ Red delicious ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
3. Oranges	○ Navel ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
4. Grapes *(2. white seedless)*	○ Red seedless ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
5. Cantaloupe		○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
6. Peaches *(1. yellow, 2. white, 3. nectarine)*		○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
7. Strawberries *(1lb or 16oz carton)*		○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
8. Honeydew		○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
9. Watermelon	○ Seedless ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________
10. Pears	○ Anjou ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	______________ ______________

11. Total Types: (Count # yes responses): |__||__|

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #3: VEGETABLE

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__| Store ID: |__| |__| |__|

A. Availability and Price

Produce Item		Available Yes	Available No	Price	Unit #	Unit pc	Unit lb	Quality A	Quality UA	Comments:
1. Carrots	○ 1 lb bag ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
2. Tomatoes *(1.red ripe slicing, 2. roma)*	○ Loose ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
3. Bell Peppers	○ Green ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
4. Broccoli	○ Bunch ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
5. Lettuce	○ Green leaf ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
6. Corn		○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
7. Celery		○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
8. Cucumbers	○ Regular ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
9. Cabbage	○ Head ○ ____________	○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________
10. Cauliflower		○	○	$ |__|.|__||__|	|__|	○	○	○	○	____________ ____________

11. Total Types: (Count # yes responses): |__||__|

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #4: GROUND BEEF

Rater ID: |__| |__| Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__| Store ID: |__| |__| |__|

A. Availability and Price

Item	Availability Yes	No	NA	Price/lb	Comments
Only select organic product when non-organic is not available.					
Healthier option:					
1. Lean ground beef, 90% lean, 10% fat (Ground Sirloin)	○	○		$ |__|.|__||__|	____________________ ____________________
Alternate Items:					
Choose lean ground beef with %fat closest to 10%.					
2. Lean ground beef, (<10%) |__| |__| % fat	○	○	○	$ |__|.|__||__|	____________________ ____________________
3. Ground turkey, (<10%) |__| |__| % fat	○	○	○	$ |__|.|__||__|	____________________ ____________________

4. # of varieties of lean ground beef (≤10% fat) (including organic brands)   ○ 0   ○ 1   ○ 2   ○ 3   ○ 4   ○ 5   ○ 6+

Item	Yes	No	NA	Price/lb	Comments
Regular option:					
5. Standard ground beef, 80% lean, 20% fat	○	○		$ |__|.|__||__|	____________________ ____________________
Alternate Item:					
6. Standard alternate ground beef, if above is not available |__| |__| % fat	○	○	○	$ |__|.|__||__|	____________________ ____________________

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #5: HOT DOG

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__| Store ID: |__| |__| |__|

A. Availability and Price

Item	Availability Yes	No	NA	Price/lb	Comments
Healthier option:					
1. Oscar Mayer 98% Fat Free Wieners (turkey/beef) 0.5g fat	○	○		$ |__|.|__||__|	____________________ ____________________
Alternate Items: (≤ 9g fat)					
2. Fat-free other brand 0g fat ____________________	○	○	○	$ |__|.|__||__|	____________________ ____________________
	|__||__||__| Kcal/serving				
3. Light Wieners (turkey/pork)	○	○	○	$ |__|.|__||__|	____________________ ____________________
4. Light beef Franks (usually 1/3 less calories, 50% less fat)	○	○	○	$ |__|.|__||__|	____________________ ____________________
5. Turkey Wieners (1/3 less fat)	○	○	○	$ |__|.|__||__|	____________________ ____________________
6. Other: ____________________	○	○	○	$ |__|.|__||__|	____________________
	|__||__| oz pkg			|__||__| hot dogs/pkg	
	|__||__| g fat			|__||__||__| Kcal/serving	
Regular option:					
7. Oscar Mayer Wieners (turkey/pork/chicken) 12g fat	○	○		$ |__|.|__||__|	____________________ ____________________
Alternate Items: (≥ 10g fat)					
8. Beef Franks (regular)	○	○	○	$ |__|.|__||__|	____________________
9. Other: ____________________	○	○	○	$ |__|.|__||__|	____________________
	|__||__| oz pkg			|__||__| hot dogs/pkg	
	|__||__| g fat			|__||__||__| Kcal/serving	

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #6: FROZEN DINNERS

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Store ID: |__| |__| |__|

A. Reference Brand

1. Stouffer's brand (preferred) ○ yes ○ no
2. Alternate brand name: ______________________________

Comments: ____
____

B. Availability

1. Are reduced-fat frozen dinners available? (≤ 9g fat/8-11oz.) ○ yes ○ no ______________________ ______________________

Shelf space (measure only if reduced-fat frozen dinners are available)

2. Reduced-fat dinner/regular dinners: Proportion ○ ≤10% ○ 11-33% ○ 34-50% ○ >50%

C. Pricing *All items should be the same brand*

Reduced-Fat Dinner	Price/pkg	Regular Dinner	Price/pkg	Comments
1.Lean Cuisine Lasagna	$|__||__|.|__||__|	Stouffer's Lasagna	$|__||__|.|__||__|	______________
|__||__|oz. |__||__||__|Kcal	|__||__|g fat	|__||__|oz. |__||__||__|Kcal	|__||__|g fat	
2. Lean Cuisine Roasted Turkey Breast	$|__||__|.|__||__|	Stouffer's Roasted Turkey Breast	$|__||__|.|__||__|	______________
|__||__|oz. |__||__||__|Kcal	|__||__|g fat	|__||__|oz. |__||__||__|Kcal	|__||__|g fat	
3. Lean Cuisine Meatloaf	$|__||__|.|__||__|	Stouffer's Meatloaf	$|__||__|.|__||__|	______________
|__||__|oz. |__||__||__|Kcal	|__||__|g fat	|__||__|oz. |__||__||__|Kcal	|__||__|g fat	
Reduced-Fat Alternate	**Price/pkg**	**Regular Alternate**	**Price/pkg**	**Comments**
4. ______________	$|__||__|.|__||__|	______________	$|__||__|.|__||__|	______________
|__||__|oz. |__||__||__|Kcal	|__||__|g fat	|__||__|oz. |__||__||__|Kcal	|__||__|g fat	
5. ______________	$|__||__|.|__||__|	______________	$|__||__|.|__||__|	______________
|__||__|oz. |__||__||__|Kcal	|__||__|g fat	|__||__|oz. |__||__||__|Kcal	|__||__|g fat	
6. ______________	$|__||__|.|__||__|	______________	$|__||__|.|__||__|	______________
|__||__|oz. |__||__||__|Kcal	|__||__|g fat	|__||__|oz. |__||__||__|Kcal	|__||__|g fat	

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #7: BAKED GOODS

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Store ID: |__| |__| |__|

A. Availability and Price
Low-fat baked good ≤3g fat/serving

Item	Available Yes	No	NA	Amount per pkg	g fat/ per item	Kcal/ per item	Price	Comment
Healthier Option:								
1. Bagel Single	○	○			|__||__|	|__||__||__|	$|__|.|__||__|	______________
Package	○	○	○	|__||__|	|__||__|	|__||__||__|	$|__|.|__||__|	______________
Alternate Items:								
2. English Muffin	○	○	○	|__||__|	|__||__|	|__||__||__|	$|__|.|__||__|	______________
3. a. Low-fat muffin ________________	○	○	○	|__||__|	|__||__|	|__||__||__|	$|__|.|__||__|	______________
b. # varieties of low-fat muffins				○ 0 ○ 1 ○ 2 ○ 3+				

Regular Options (≥ 4g fat/serving or 400 Kcal/serving):

Item	Yes	No	NA	Amount per pkg	g fat/ per item	Kcal/ per item	Price	Comment
4. Regular muffin *(1. blueberry, 2.banana nut)*	○	○		|__||__|	|__||__|	|__||__||__|	$|__|.|__||__|	______________
Alternate Items:								
5. Regular Danish	○	○	○	|__||__|	|__||__|	|__||__||__|	$|__|.|__||__|	______________
6. Other ________________	○	○	○	|__||__|	|__||__|	|__||__||__|	$|__|.|__||__|	______________

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #8-CS: BEVERAGE

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Store ID: |__| |__| |__|

A. Availability and Price *(if 20oz. is not available, record prices for both 16oz. and 24oz. bottles)*

<table>
<tr><th></th><th></th><th colspan="3">Available</th><th>Price</th><th>Comments</th></tr>
<tr><th>Healthier Option:</th><th></th><th>Yes</th><th>No</th><th>NA</th><th></th><th></th></tr>
<tr><td>1. Diet Coke</td><td>12oz.</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td></td><td>20oz.</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 1</td><td>______</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 2</td><td>______</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>2. Alternate brand</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>12oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>____________________________</td><td>20oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 1</td><td>______</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 2</td><td>______</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Regular Option:</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3. Coke</td><td>12oz.</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td></td><td>20oz.</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 1</td><td>______</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 2</td><td>______</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>4. Alternate brand</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>12oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>____________________________</td><td>20oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 1</td><td>______</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>Other oz. 2</td><td>______</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
</table>

<table>
<tr><th></th><th colspan="3">Available</th><th></th><th></th></tr>
<tr><th>Healthier Option:</th><th>Yes</th><th>No</th><th>NA</th><th></th><th></th></tr>
<tr><td>5. 100% juice, 15.2oz.</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>○ Minute Maid ○ Tropicana ○ Other</td><td></td><td></td><td></td><td></td><td>______________________________</td></tr>
<tr><td>Alternate Items:</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6. 100% juice, 14oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>○ Minute Maid ○ Tropicana ○ Other</td><td></td><td></td><td></td><td></td><td>______________________________</td></tr>
<tr><td>7. 100% juice, |__||__|oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>○ Minute Maid ○ Tropicana ○ Other</td><td></td><td></td><td></td><td></td><td>______________________________</td></tr>
<tr><td>Regular Option:</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8. Juice drink, 15.2oz.</td><td>○</td><td>○</td><td></td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>○ Minute Maid ○ Tropicana ○ Other</td><td></td><td></td><td></td><td></td><td>______________________________</td></tr>
<tr><td>Alternate Items:</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>9. Juice drink, 14oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>○ Minute Maid ○ Tropicana ○ Other</td><td></td><td></td><td></td><td></td><td>______________________________</td></tr>
<tr><td>10. Juice Drink, |__||__|oz.</td><td>○</td><td>○</td><td>○</td><td>$|__|.|__||__|</td><td>______________________________</td></tr>
<tr><td>○ Minute Maid ○ Tropicana ○ Other</td><td></td><td></td><td></td><td></td><td>______________________________</td></tr>
</table>

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #8-GS: BEVERAGE

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Store ID: |__| |__| |__|

A. Availability and Price

		Available Yes	No	NA	Price	Comments
Healthier Option:						
1. Diet Coke	12pk12oz.	○	○		$|__|.|__||__|	____________
	6pk 12oz.	○	○	○	$|__|.|__||__|	____________
Other pack size	___ 12 oz.	○	○	○	$|__|.|__||__|	____________
2. Alternate brand						
	12pk12oz.	○	○	○	$|__|.|__||__|	____________
____________	6pk 12oz.	○	○	○	$|__|.|__||__|	____________
Other pack size	___ 12 oz.	○	○	○	$|__|.|__||__|	____________
Regular Option:						
3. Coke	12pk12oz.	○	○		$|__|.|__||__|	____________
	6pk 12oz.	○	○	○	$|__|.|__||__|	____________
Other pack size	___ 12 oz.	○	○	○	$|__|.|__||__|	____________
4. Alternate brand						
	12pk12oz.	○	○	○	$|__|.|__||__|	____________
____________	6pk 12oz.	○	○	○	$|__|.|__||__|	____________
Other pack size	___ 12 oz.	○	○	○	$|__|.|__||__|	____________

	Available Yes	No	NA		
Healthier Option:					
5. Minute Maid 100% orange juice, 64oz. (1/2 gal)	○	○		$|__|.|__||__|	____________
Alternate Items:					
6. Tropicana 100% orange juice, 64oz. (1/2 gal)	○	○	○	$|__|.|__||__|	____________
7. other: ____________	○	○	○	$|__|.|__||__|	____________
Regular Option:					
8. Minute Main fruit punch juice drink, 64oz. (1/2 gal)	○	○		$|__|.|__||__|	____________
Alternate Items:					
9. Tropicana fruit punch juice drink, 64oz. (1/2 gal)	○	○	○	$|__|.|__||__|	____________
10. other: ____________	○	○	○	$|__|.|__||__|	____________

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #9: BREAD

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Store ID: |__| |__| |__|

A. Availability and Price *(Use **smallest loaf size** available)*

Item	Loaf Size (oz.)	Available Yes	No	NA	Price	Comments
Healthier Option: *Whole grain bread (100% whole wheat, whole grain bread, and 100% honey whole wheat)* DO NOT include: "diet", no sugar, "natural", whole white wheat, "double fiber"						
1. Nature's Own 100% Whole Wheat Bread	|__||__|oz.	○	○		$|__|.|__||__|	____________________
Alternate Item:						
2. Sara Lee Classic 100% Whole Wheat Bread	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________
3. ___________________________	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________
Choose brand with the most shelf space. If space is equal, choose brand name closest to beginning of alphabet.						

4. # of varieties 100% whole wheat bread and whole grain (all brands) ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6+

Item	Loaf Size (oz.)	Available Yes	No	NA	Price	Comments
Regular Option: *White Bread (bread made with refine flour)*						
5. Nature's Own Butter Bread	|__||__|oz.	○	○		$|__|.|__||__|	____________________
Alternate Item:						
6. Sara Lee Classic White Bread	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________
7. ___________________________	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________
Choose brand with the most shelf space. If space is equal, choose brand name closest to beginning of alphabet.						

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #10: BAKED CHIPS

Rater ID: |__| |__| Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__| Store ID: |__| |__| |__|

A. Availability and Price *(Use smallest bag size possible, only use 1-2oz. vending machine size when other sizes are not available)*

Low fat chips ≤3g fat/1oz. serving

Item	Size (oz.)	Available Yes	No	NA	Price	Comments
Healthier Option:						
1. Baked Lays Potato Chips	|__||__|oz.	○	○		$|__|.|__||__|	____________________
Alternate Item:						
2. ____________________	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________

3. # of varieties of low fat chips (any brand)   ○ 0   ○ 1   ○ 2   ○ 3   ○ 4   ○ 5   ○ 6+
DO NOT include: tortilla chips, "organic" brands, pretzels, Pringles

---

Regular Option (select most comparable size to healthier option available):

Item	Size (oz.)	Yes	No	NA	Price	Comments
4. Lays Potato Chip Classic	|__||__|oz.	○	○		$|__|.|__||__|	____________________
Alternate Item:						
5. ____________________	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________

Nutrition Environment Measures Survey (NEMS)
STORE MEASURES – DATA COLLECTION
Measure #11: CEREAL

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__| Store ID: |__| |__| |__|

A. Availability and Price *(use smallest BOX size possible, only use individual bowl/cups when box is not available)*

Healthier cereal <7g sugar/serving

Item	Size (oz.)	Available Yes	No	NA	Price	Comments
Healthier Option:						
1. Cheerios (plain)	|__||__|oz.	○	○		$|__|.|__||__|	____________________
Alternate Item:						
2. ____________________	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________

3. # of varieties of healthier cereals ○ 0 ○ 1 ○ 2 ○ 3+

Healthy options include: Multigrain Cheerios, Special K, Total Whole Wheat, Rice Krispies, Corn Flakes

---

Regular Option: (≥7g sugar/serving)

Item	Size (oz.)	Available Yes	No	NA	Price	Comments
4. Cheerios (Flavored): ____________________	|__||__|oz.	○	○		$|__|.|__||__|	____________________
(1. Honey Nut, 2.Frosted, 3.Berry Burst, 4.Yogurt Burst)						
Alternate Item:						
5. ____________________	|__||__|oz.	○	○	○	$|__|.|__||__|	____________________

APPENDIX C: NUTRITION ENVIRONMENT MEASURES SURVEY – RESTAURANTS (NEMS-R)

Nutrition Environment Measures Survey (NEMS)
Food Outlet Cover Page

Nutrition Environment Measures Survey
www.sph.emory.edu/NEMS

Rater ID: |__| |__|

Reviewer ID: |__| |__|

Name: ______________________________________

Census ID: |__| |__| |__| |__| |__|

○ GS ○ CS ○ Other:_____ ______________________

Category: |__| - |__| |__|

Store ID: |__| |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Number of Cash Registers: |__| |__|

Name: ____

Census ID: |__| |__| |__| |__| |__|

○ FC ○ FF ○ SD ○ SP ○ Other: __________________________

Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

Site Visit

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Menu/Internet Review

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Other Visit/Interview

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Start Time: |__| |__| : |__| |__| ○ AM ○ PM

End Time: |__| |__| : |__| |__| ○ AM ○ PM

Nutrition Environment Measures Survey (NEMS)
Food Outlet Cover Page

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES – DATA COLLECTION

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

1) Type of Restaurant: Code # |__| |__|

2) Data Sources:
- **Site Visit/Observation** ○ yes ○ no
- **Take-Away Menu** ○ yes ○ no
- **Internet** ○ yes ○ no
- **Interview** ○ yes ○ no

3) Site Visit Information:

Take-away Menu ○ yes ○ no

Nutrition Information ○ yes ○ no

Other: ○ yes ○ no

Comments: ______________________

____

4) Take-Away Menu Features:

Nutrition Information ○ yes ○ no

Identification of healthier menu items ○ yes ○ no

Other: ○ yes ○ no

Comments: ______________________

____

5) Internet Site Features:

Menu ○ yes ○ no

Nutrition Information ○ yes ○ no

Identification of healthier menu items ○ yes ○ no

Other: ○ yes ○ no

Website URL: _________________

Comments: ____________________

6) Interview Information:

Menu options ○ yes ○ no

Pricing ○ yes ○ no

Other: ○ yes ○ no

Comments (describe items above):

____

____

7) Hours of operation:

Data Source(s): ○ site ○ menu ○ web

Sunday ○ open ○ closed
○ B: 6:00-11:00 am
○ L: 11:00 am-3:00 pm
○ D: 5:00 pm to close
|__| |__| **:** |__| |__| ○ AM ○ PM

Thursday ○ open ○ closed
○ B: 6:00-11:00 am
○ L: 11:00 am-3:00 pm
○ D: 5:00 pm to close
|__| |__| **:** |__| |__| ○ AM ○ PM

Friday ○ open ○ closed
○ B: 6:00-11:00 am
○ L: 11:00 am-3:00 pm
○ D: 5:00 pm to close
|__| |__| **:** |__| |__| ○ AM ○ PM

Saturday ○ open ○ closed
○ B: 6:00-11:00 am
○ L: 11:00 am-3:00 pm
○ D: 5:00 pm to close
|__| |__| **:** |__| |__| ○ AM ○ PM

○ Open 7 Days (If 7-d, only fill in *Sunday* under *Hours of Operation* section)
○ Open 24 Hours (If 24-hr, leave *Hours of Operation* section blank)

8) Access: **Drive-Thru window** ○ yes ○ no **Parking onsite** ○ yes ○ no

Comments: ____

9) Size of Restaurant:
○ Seating capacity = |__| |__| |__| **OR** ○ Number of tables = |__| |__| |__|

Comments: ____

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES – DATA COLLECTION

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

Site visit (Observation)	Select One	Comments
10) Restaurant has a salad bar	○ yes ○ no	
11) Signage/Promotions		
a. Is nutrition information posted near point-of-purchase, or available in a brochure?	○ yes ○ no	______________________
b. Do signs/table tents/displays highlight healthy menu options?	○ yes ○ no	______________________
c. Do signs/table tents/displays encourage **healthy** eating?	○ yes ○ no	______________________
d. Do signs/table tents/displays encourage unhealthy eating?	○ yes ○ no	______________________
e. Do signs/table tents/displays encourage overeating (all-you-can-eat, super-size, jumbo, grande, supreme, king size, feast description on menu or signage)?	○ yes ○ no	______________________
f. Does this restaurant have a low-carb promotion?	○ yes ○ no	______________________
g. Other? ______________________	○ yes ○ no	
Menu Review/Site visit		
12) a. Chips	○ yes ○ no	______________________
b. Baked Chips	○ yes ○ no	______________________
13) a. Bread	○ yes ○ no	______________________
b. 100% wheat or whole grain bread	○ yes ○ no	______________________
14) 100% fruit juice	○ yes ○ no	______________________
15) 1% Low-fat, skim, or non-fat milk	○ yes ○ no	______________________

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES – DATA COLLECTION

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

Menu Review/Site Visit	Select One	Choices (#)	Comments
16) Main Dishes/Entrees: a. Total # Main Dishes/ Entrees	○ yes ○ no	# |__| |__| |__|	____________ ____________
b. Healthy Options	○ yes ○ no	# |__| |__|	____________ ____________
17) Main dish salads a. Total # Main Dishes/ Entrees	○ yes ○ no	# |__| |__|	____________ ____________
b. Healthy Options	○ yes ○ no	# |__| |__|	____________ ____________
c. Low-fat or fat free salad dressings	○ yes ○ no	# |__| |__|	____________ ____________
18) Fruit (w/out added sugar)	○ yes ○ no	# |__| |__|	____________ ____________
19) Non-Fried vegetables (w/out added sauce)	○ yes ○ no	# |__| |__|	____________ ____________
20) Diet soda	○ yes ○ no		____________ ____________
21) Other healthy or low calorie beverages? ____________________	○ yes ○ no		____________ ____________

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES – DATA COLLECTION

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

Menu Review/Site Visit	**Select One**	**Comments**
22) Facilitators & Supports		
a. Nutrition information on menu (paper or posted menu) (*either **calories or fat** information for more than 1 individual entree*)	○ yes ○ no	____________
b. Healthy entrees identified on menu	○ yes ○ no	____________
c. Reduced-sized portions offered on menu	○ yes ○ no	____________
d. Menu notations that encourage healthy requests	○ yes ○ no	____________
e. Others? ______________________	○ yes ○ no	____________
23) Barriers		
a. Large portions sizes encouraged? Super-size items on menu	○ yes ○ no	____________
b. Menu notations that discourage special requests (e.g. *No substitutions* or charge for substitutions)	○ yes ○ no	____________
c. All-you-can-eat or "unlimited trips"	○ yes ○ no	____________
d. Others? ______________________	○ yes ○ no	

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES – DATA COLLECTION

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

Menu Review/Site Visit	**Select One**	**Comments**
24) Pricing		
a. Sum of individuals items compared to combo meal	○ more ○ less ○ same ○ NA	____________
b. Healthy entrees compared to regular ones (any amount difference) (*Use 16b for healthy options and choose regular entree in similar category. If 16b is 0, then use 17b; no healthy options, mark NA*)	○ more ○ less ○ same ○ NA	____________
c. Charge for shared entrees?	○ yes ○ no	____________
d. Charge for **healthy** substitution? (any amount difference) (e.g. *Substitute egg whites or cholesterol-free egg beaters for eggs Substitute grilled or baked chicken for breaded or fried chicken)*	○ yes ○ no	____________
e. Smaller portion compared to regular portion (*if 22c is No, then mark NA*)	○ more ○ less ○ same ○ NA	____________
f. Others? ______________________	○ more ○ less ○ same ○ NA	____________

Nutrition Environment Measures Survey (NEMS)
RESTAURANT MEASURES – DATA COLLECTION

Rater ID: |__| |__|

Date: |__| |__| / |__| |__| / |__| |__| |__| |__|
M M D D Y Y Y Y

Category: |__| - |__| |__|

Restaurant ID: |__| |__| |__|

Menu Review/Site Visit	**Select One**	**Comments**
25) Kids Menu?	○ yes ○ no	________________
a. Age Limit	○ 10 and Under ○ 12 and Under ○ Other ○ NA	________________
b. Any healthy entrees?	○ yes ○ no ○ NA	________________
c. 100% fruit juice?	○ yes ○ no ○ NA	________________
d. 1%, low-fat, skim or non-fat milk?	○ yes ○ no ○ NA	________________
e. Are there free refills on unhealthy drinks?	○ yes ○ no ○ NA	________________
f. Are there any healthy sides items? (either assigned or to choose)	○ yes ○ no ○ NA	________________
*(If sides from 25f are "**to choose from**", then mark 25g-i as NA)*		
g. Can you substitute a healthy side for an assigned unhealthy one?	○ yes ○ no ○ NA	________________
h. Is there a charge for substituting a healthy side for an unhealthy one?	○ yes ○ no ○ NA	________________
i. Do any entrees that have assigned sides include an assigned healthy side?	○ yes ○ no ○ NA	________________
j. Is an unhealthy dessert automatically included in a kid's meal?	○ yes ○ no ○ NA	________________
k. Are there any healthy desserts? (either free or an additional cost)	○ yes ○ no ○ NA	________________
l. Is nutrition information (e.g., calories or fat) provided on the kid's menu?	○ yes ○ no ○ NA	________________
m. Other unhealthful eating promotion?	○ yes ○ no ○ NA	________________
n. Other **healthful** eating promotion?	○ yes ○ no ○ NA	________________

Appendix D: Training Protocol of NEMS

The principle investigator (PI) trained with the NEMS survey during the Built Environment Assessment Tools (BEAT) summer institute of 2010. The project coordinator completed the online module training independently and practiced with the original NEMS survey with the PI in Blacksburg, VA. After the field practice, the PI and the project coordinator agreed to make minor adaptations to the original tool to clarify any misleading items. In previous studies that used the NEMS survey tool, the changes made were to make the instrument more relevant in the particular community setting (Gloria & Steinhardt, 2010; Gustafson et al., 2011).

Research assistants, which included graduate and undergraduate students, registered and completed the NEMS online training module for individual training before the intensive two-day didactic session including field practice with the project coordinator. The auditors were first trained on the NEMS-R protocol followed by a separate training on the NEMS-S. The training sessions included completion of the NEMS online modules, an intensive didactic in-class training followed by practice sessions in the field for each instrument. The in-class portion of the training included a project overview, a comprehensive review of the online module and practice with audit instrument in the classroom led by the project coordinator. After the in-class practice session, the project coordinator answered questions and reviewed ambiguous points and issues according to published NEMS protocols.

The trainees went out to local food establishments in pairs to completed field practice. Data collected from the field practice was entered and inter-rater reliability statistics were calculated. The second day included a review of the day 1 field practice, focused on areas that were of concern or source of low agreement between raters. The trainees, then return to the field for additional practice sessions with each type restaurant. All training data was entered and kappa coefficients computed. Trainees were certified and eligible to do study audits once they hit a threshold >0.60 on kappas. Field training for the restaurants took three days to ensure that reliability met threshold. The first two days of training focused on fast casual and fast food restaurants, while the third day was just on sit-down restaurants. The average kappa coefficient for each day of training was 0.472 for day 1, 0.635 for day 2, and 0.909 for day 3. In sum, eight graduate and undergraduate students completed the online modules for NEMS. Seven research assistants received the in class training for the restaurant measures and six completed the field training and certification for NEMS-R auditors.

The same procedures were repeated for the NEMS-S training; however, only five trainees completed the in class training and reached certification for the stores instrument. Stores field training spanned two days as the average kappa coefficient was 0.498 for day 1 and 0.793 for day 2.

REFERENCES

Gloria, C. T., & Steinhardt, M. A. (2010). Texas nutrition environment assessment of retail food stores (TxNEA-S): development and evaluation. Public Health Nutr, 1-9.

Gustafson, A. A., Sharkey, J., Samuel-Hodge, C. D., Jones-Smith, J., Folds, M. C., Cai, J., & Ammerman, A. S. (2011). Perceived and objective measures of the food store environment and the association with weight and diet among low-income women in North Carolina. Public Health Nutr, 14(6), 1032-1038. doi: 10.1017/S1368980011000115

APPENDIX E: KAPPA SUMMARY TABLES

Table E-1a. Enumeration of restaurants by census tracts.

Census Tract	Total from database	Audits from database	Extra audits	Overall total audits
1	12	7	0	7
2	31	20	1	21
3	3	2	0	2
4	2	2	0	2
5	6	4	0	4
6	3	1	0	1
7	11	8	1	9
8	64	54	1	55
9	4	4	0	4
10	2	1	2	3
11	3	1	0	1
12	3	2	0	2
13	15	12	0	12
14	1	1	0	1
Totals	160	119	5	124

Table E-1b. Enumeration of stores by census tracts.

Census Tract	Total from database	Audits from database	Extra audits	Overall total audits
1	3	3	2	5
2	4	3	5	8
3	2	1	0	1
4	5	5	2	7
5	4	3	0	3
6	3	0	0	0
7	0	0	5	5
8	8	7	4	11
9	8	5	1	6
10	2	2	0	2
11	0	0	0	0
12	0	0	1	1
13	7	7	2	9
14	3	2	0	2
Totals	49	38	22	60

Table E-2a. Kappa summary for restaurants by census tract.

Census Tract	Total Audits	Mean Kappa	Median Kappa	Kappa Range, Low	Kappa Range, High
1	7	0.816	0.822	0.560	1.000
2	21	0.878	0.909	0.739	1.000
3	2	0.824	0.824	0.647	1.000
4	2	0.915	0.915	0.913	0.917
5	4	0.895	0.876	0.830	1.000
6	1	0.565	0.565	0.565	0.565
7	9	0.876	1.000	0.628	1.000
8	55	0.802	0.829	0.510	1.000
9	4	0.915	0.915	0.913	0.917
10	3	0.955	1.000	0.864	1.000
11	1	0.882	0.882	0.882	0.882
12	2	0.912	0.912	0.824	1.000
13	12	0.908	0.913	0.628	1.000
14	1	1.000	1.000	1.000	1.000
Overall	124	0.867	0.883	0.750	0.949

Table E-2b. Kappa summary for stores by census tract.

Census Tract	Total Audits	Mean Kappa	Median Kappa	Kappa Range, Low	Kappa Range, High
1	5	0.794	0.830	0.560	1.000
2	7	0.911	0.913	0.747	1.000
3	1	0.833	0.833	0.833	0.833
4	7	0.886	0.882	0.739	1.000
5	3	0.926	0.895	0.882	1.000
6	1	0.664	0.664	0.664	0.664
7	4	0.822	0.887	0.600	0.913
8	12	0.883	0.906	0.647	1.000
9	6	0.892	0.889	0.710	1.000
10	2	0.955	0.955	0.909	1.000
11	0				
12	1	0.882	0.882	0.882	0.882
13	9	0.931	1.000	0.800	1.000
14	2	0.864	0.864	0.833	0.895
Overall	60	0.865	0.877	0.754	0.937

Table E-3a. Auditor pair t-tests for restaurants.

Pairs	Main Dish Entrée; total number available		Main Dish Salad; total number available		Facilitator; healthy entrée identified		Barrier; large portions are encouraged		Price difference; healthy vs. regular option	
	t	sig.	t	sig.	t	sig.	t	sig.	t	sig.
2 & 6	3.723	0.001*	0.288	0.774	0.279	0.781	2.433	0.018*	0.260	0.796
2 & 10	2.443	0.017*	1.121	0.266	-0.262	0.794	-0.904	0.369	0.908	0.367
3 & 4	1.386	0.171	0.866	0.892	-1.048	0.300	0.447	0.291	0.089	0.403
3 & 5	0.104	0.917	-1.105	0.272	-1.315	0.197	-4.011	0.000*	-1.093	0.281
3 & 6	-0.035	0.972	-1.577	0.199	-0.600	0.550	-0.697	0.488	-0.605	0.547
3 & 9	1.340	0.185	-1.413	0.163	-0.921	0.361	-2.128	0.039*	-0.176	0.861
4 & 5	-1.391	0.168	-1.410	0.162	-0.254	0.800	-3.277	0.002*	-2.284	0.026*
4 & 6	-1.545	0.126	-1.963	0.053	0.646	0.520	0.522	0.603	-1.706	0.093
4 & 9	-0.220	0.827	-1.723	0.089	0.193	0.847	-1.159	0.251	-1.153	0.253
4 & 10	-3.308	0.001*	-1.003	0.319	0.049	0.961	-2.925	0.005*	-0.985	0.327
5 & 6	-0.176	0.860	-0.441	0.660	1.030	0.305	4.643	0.000*	0.706	0.482
5 & 9	1.304	0.196	-0.012	0.990	0.474	0.636	2.085	0.042*	1.072	0.287
5 & 10	-1.887	0.062	0.539	0.591	0.344	0.732	0.475	0.636	1.556	0.123
6 & 9	1.629	0.107	0.443	0.659	-0.446	0.657	-1.867	0.065	0.47	0.640
6 & 10	1.831	0.070	1.049	0.297	-0.695	0.488	-4.182	0.000*	0.861	0.391

*p<0.05; t-test is significant, indicating that there is no mean difference between the pair of auditors.

Table E-3b. Auditor pair t-test for stores.

Pairs	Fruit; total number available		Vegetable; total number available		Bread; total number of healthy variety		Chips; total number of healthy variety		Cereal; total number of healthy variety	
	t	sig.	t	sig.	t	sig.	t	sig.	t	sig.
2 & 4	-0.019	0.985	0.074	0.942	-1.334	0.189	-0.971	0.336	0.191	0.850
2 & 6	0.607	0.547	0.655	0.515	-0.588	0.599	-0.360	0.720	0.110	0.913
2 & 8	0.541	0.591	0.685	0.497	0.869	0.389	0.696	0.490	0.719	0.475
2 & 10	-0.672	0.505	-0.569	0.573	-0.026	0.980	-0.232	0.818	0.299	0.762
4 & 5	-0.307	0.761	-0.252	0.803	0.854	0.399	0.662	0.513	0.060	0.952
4 & 6	0.539	0.539	0.529	0.600	0.652	0.519	0.537	0.594	-0.076	0.940
5 & 8	0.775	0.444	0.798	0.431	1.351	0.186	0.868	0.392	0.350	0.729

Table E-4a. Subtotals and composite scores for restaurants by block group race, income, and store type.

Block group race	Income	Store Type	N	Availability subtotal score Min	Max	Mean	Pricing subtotal score Min	Max	Mean	NEMS-R total score Min	Max	Mean
White	Middle	FC	7	0	21	7.9	-3	0	-1.71	0	39	11.6
		FF	19	1	16	6.4	-9	0	-3.157	-9	19	3.2
		SD	37	0	12	4.3	-1	0	-0.973	-12	14	2.7
		SP	1	3	3	3	0	0	0	3	3	3
	High	FC	3	9	18	13.3	-3	0	-2	9	39	19.3
		FF	8	3	11	4.4	-3	3	-1.125	-9	14	-0.1
		SD	8	0	9	4.1	-6	0	-1.875	-3	9	3
		SP	0									
Black	Low	FC	2	0	3	1.5	0	0	0	3	3	3
		FF	4	3	9	6.5	-3	0	-2.25	0	5	1.3
		SD	4	3	12	6.8	-3	0	-0.75	3	15	7.5
		SP	1	15	15	15	0	0	0	15	15	15
	Middle	FC	1	6	6	6	0	0	0	3	3	3
		FF	5	3	6	4.6	-3	-3	-3	-6	11	1.6
		SD	4	3	6	3.8	0	0	0	0	3	0.8
		SP	1	6	6	6	-3	-3	-3	6	6	6
Mixed	Low	FC	0									
		FF	0									
		SD	1	7	7	7	-3	-3	-3	4	4	4
		SP	1	3	3	3	-3	-3	-3	0	0	0
	Middle	FC	1	16	16	16	0	0	0	25	25	25
		FF	6	3	14	6	-3	0	-2.5	-6	20	4
		SD	5	0	6	3	-3	0	-2.4	-6	8	1
		SP	0									
	High	FC	1	17	17	17	0	0	0	32	32	32
		FF	2	3	6	4.5	-3	-3	-3	0	3	1.5
		SD	2	0	3	1.5	-3	0	-1.5	-3	0	-1.5
		SP	0									

Table E-4b. Subtotals and composite scores for stores by block group race, income, and store type.

Block Group race	Income	Store Type	N	Availability subtotal score Min	Max	Mean	Pricing subtotal score Min	Max	Mean	NEMS-S total score Min	Max	Mean
White	Middle	GS	4	17	29	23.7	-2	6	2.3	23	37	30.5
		CS	9	2	11	4.0	2	2	2.0	2	13	4.2
		other	1	3	3	3.0				3	3	3.0
	High	GS	3	20	28	25.0	2	3	2.7	29	36	33.7
		CS	9	2	23	6.9	-1	4	1.8	1	33	9.1
		other	6	4	8	6.2	-1	2	0.6	3	10	6.7
Black	Low	GS	1	13	13	13.0	1	1	1.0	20	20	20.0
		CS	7	3	5	3.4	2	2	2.0	2	7	4.9
		other	0									
	Middle	GS	0									
		CS	2	4	2	3.0				2	2	3.0
		other	0									
Mixed	Low	GS	1	17	17	17.0	-3	-3	-3.0	20	20	20.0
		CS	1	4	4	4.0				4	4	4.0
		other	1	7	7	7.0	0	0	0.0	7	7	7.0
	Middle	GS	2	18	27	22.5	0	1	0.5	24	34	29.0
		CS	4	2	4	2.5				2	4	2.5
		other	3	5	10	6.7	-1	1	0.3	4	11	6.7
	High	GS	0									
		CS	6	2	8	4.3	0	4	2.0	2	9	5.3
		other	0									

APPENDIX F: PHYSICAL ACTIVITY RESOURCE ASSESSMENT (PARA)

1) **Date** ____________ 4) **Time** **start:**_____ **stop:**_____	2) **Data col** ______ 5) **Phone Call** **departure:**_____ **arrival:**_____	3) **HD/PA Resource ID** ______________
6) **Type of Resource** **1** fitness club **2** park **3** sport facility **4** trail **5** community center **6** church **7** school **8** combination ________________		7) **Approximate Size: 1** sm **2** med **3** lg 8) **Capacity (indoor)** ______________ 9) **Cost** **1** Free **2** Pay at the door **3** Pay for only certain programs **4** Other _______________
10) **Hours** a) open _______ b) close ______		
11) **Signage –** Hours yes ☐ no ☐		12) **Signage –** Rules yes ☐ no ☐

Feature	Rating				Amenity	Rating			
13) Baseball field	0	1	2	3	26) Access Points	0	1	2	3
14) Basketball courts	0	1	2	3	27) Bathrooms	0	1	2	3
15) Soccer field	0	1	2	3	28) Benches	0	1	2	3
16) Bike Rack	0	1	2	3	29) Drinking fountain	0	1	2	3
17) Exercise Stations	0	1	2	3	30) Fountains	0	1	2	3
18) Play equipment	0	1	2	3	31) Landscaping efforts	0	1	2	3
19) Pool > 3 ft deep	0	1	2	3	32) Lighting	0	1	2	3
20) Sandbox	0	1	2	3	33) Picnic tables shaded	0	1	2	3
21) Sidewalk	0	1	2	3	34) Picnic tables no-shade	0	1	2	3
22) Tennis courts	0	1	2	3	35) Shelters	0	1	2	3
23) Trails – running/biking	0	1	2	3	36) Shower/Locker room	0	1	2	3
24) VB courts	0	1	2	3	37) Trash containers	0	1	2	3
25) Wading Pool < 3 ft.	0	1	2	3					
Incivilities	**Rating**				**Incivilities**	**Rating**			
38) Auditory annoyance	0	1	2	3	44) Graffiti/tagging	0	1	2	3
39) Broken glass	0	1	2	3	45) Litter	0	1	2	3
40) Dog refuse	0	1	2	3	46) No grass	0	1	2	3
41) Dogs Unattended	0	1	2	3	47) Overgrown grass	0	1	2	3
42) Evidence of alcohol use	0	1	2	3	48) Sex paraphernalia	0	1	2	3
43) Evidence of substance use	0	1	2	3	49) Vandalism	0	1	2	3

Comments: