Childhood Obesity in Context: Examining the Role of Ecological Factors Related to Childhood Obesity among West Virginia's Youth

Stephanie S. Frost
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Childhood Obesity in Context: Examining the Role of Ecological Factors Related to Childhood Obesity among West Virginia’s Youth

Stephanie S. Frost

Dissertation submitted to the School of Medicine at West Virginia University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Public Health Sciences

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ABSTRACT

Childhood Obesity in Context: Examining the Role of Ecological Factors Related to Childhood Obesity among West Virginia’s Youth

Stephanie S. Frost

Nearly one third of youth in the United States are overweight or obese and rates are disproportionately higher among rural youth. These rates are cause for alarm given the many short- and long-term consequences of childhood obesity. A growing body of research has begun to explore how factors outside the individual might influence obesity and obesity-related behaviors. Guided by ecological frameworks, this research has demonstrated that factors such as the socioeconomic status of the community, access to physical activity opportunities, and quality of the community food environment may contribute to this epidemic. However, much of the research to date has focused on metropolitan regions, despite the increased risk of obesity observed in rural areas. West Virginia (WV) offers an important context to examine the environmental influences of obesity in that it is a largely rural area and consistently ranks among states with the highest rates of adult and childhood obesity. The main objective of this project was to improve the current understanding of environmental influences on obesity among WV’s youth. In the first study, a secondary analysis of qualitative data was used to examine community member perceptions with regard to environmental factors associated with obesity. Data from focus groups conducted with community members (N=38) across five WV counties were transcribed and coding was guided by Social Ecology Theory. The findings indicated that factors at the individual-, interpersonal-, and environmental-level play a role in influencing obesity and related health behaviors. Participants noted that community environments in particular present barriers to physical activity and healthy eating through lack of access, suggesting that further study using quantitative methods is warranted. The themes identified in this study were then quantified in studies 2 and 3 by measuring the social and built environments within the communities surrounding WV elementary schools. Google Maps, Yellowpages.com, and local parks and recreation pages were used to establish a database of food and physical activity resources within a 1km and 5km distance from schools. Data regarding median household income, percent of residents with less than a high school education and percent of residents unemployed were extracted from Census.gov at the block group level and used to calculate the socioeconomic condition for the community environment around schools. Across studies 2 and 3, resource counts indicated greater access to unhealthy food outlets (fast food stores and conveniences stores) when compared with resources that support positive health behaviors such as grocery stores, supercenters, and physical activity resources. When data regarding school facilities made available to the public were considered in study 2, access to physical activity opportunities dramatically increased. Associations between environments and school-level obesity (N=34 schools) were also examined in study 2. Negative binomial regressions were run using IBM SPSS 19 for males only and females only; no significant relationships were found at p<.05. The third study took this work further by examining the direct and indirect effects of the
environment in relation to more proximal outcomes related to obesity (daily fruit and vegetable consumption and physical activity). Results obtained from a series of structural equation models using AMOS 18 indicated the more favorable the socioeconomic condition of the community, the greater the density of healthy and unhealthy food outlets and the greater the density of physical activity resources. No significant associations were observed between the social or built environment and either physical activity or fruit and vegetable consumption. Despite the lack of significant associations observed, quantifying the resources around WV schools demonstrated limited opportunities for engaging in positive health behaviors and the potential challenges of achieving energy balance for residents of these communities. The findings from studies 2 and 3 also support themes identified through focus groups in study 1. Major strengths of this research are that it expanded the rural focused ecological research on childhood obesity, it incorporated broader measures of the food and physical activity environment, and it applied methods used in previous research to a largely rural area. This research has implication for health policies, such as improving access to school facilities through joint use agreements and requiring healthy food options be available at non-traditional locations such as convenience stores. Future work is needed to consider where rural youth are active, the quality and condition of nutrition and physical activity resources, and to identify other variables influencing access to resources.
DEDICATION
This dissertation is dedicated to my grandmother. Her wisdom, compassion, and kindness are the greatest I have ever known.
Dzienkuje, Babcia.
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Chapter 1
Chapter 1

1.1 Background

1.1.1 Youth Overweight and Obesity

An estimated 32% of children and adolescents in the United States are currently overweight or obese.\(^1\) Children and adolescents with a body mass index (BMI) equal to or greater than the 95\(^{th}\) percentile for age and gender are considered obese, while overweight is defined as a BMI falling between the 85\(^{th}\) to 95\(^{th}\) percentiles.\(^3\) Using these definitions, data from the NHANES survey taken for the time periods 1976-1980 and 1999-2000 clearly illustrate an increasing trend in childhood obesity throughout the United States. During this time the rate of obesity among children ages 6-11 more than doubled, increasing from 6.5% to 15.8%, while the rate of obesity for adolescents (12-19) tripled (5% to 15.5%) over this time period.\(^4\),\(^5\)

These increasing rates of obesity among the Nation’s youth are cause for concern given the short- and long-term effects on health and the economic burden of obesity-related medical expenditures. Overweight and obesity in children and adolescents increases the risk of type-2 diabetes, high cholesterol, and high blood pressure among youth while also negatively impacting quality of life.\(^6\)-\(^8\) Even if chronic illness does not manifest during childhood, children who are overweight or obese are at greater risk for becoming obese adults and sustaining obesity-related comorbidities and premature death.\(^9\)-\(^{14}\) Additionally, medical expenditures for overweight and obese children and adolescents are higher than for their normal weight peers.\(^{15}\) Nationally, an estimated $14 billion in medical and pharmaceutical spending is associated with child overweight and obesity;\(^{16}\) models produced from 1998-2000 BRFSS data attributed an estimated $75 billion dollars in medical expenditures to adult obesity.\(^{17}\)
1.1.2 Geographic Populations at Risk

Childhood obesity, much like adult obesity, is disproportionately prevalent among rural youth compared to urban youth. In a study conducted with data from the National Survey of Children’s Health, Lutifyya and colleagues found that rural children between the ages of 5 and 17 were 25% more likely to be obese compared to children from metropolitan areas. Similar findings were reported by Joens-Matre and colleagues in an Iowa study where 25% more rural children in grades 4, 5, and 6 were obese compared to their urban peers; rural youth were 47% more likely to be obese compared against those from small cities. In addition to the rural-urban distinctions that have been found with regard to obesity prevalence, research evaluating the geographic characteristics of adult and childhood obesity has also indicated specific regions of the U.S. such as the Northeast and West to have lower prevalence of obesity while areas of the Midwest, South, and the Appalachians have the highest. West Virginia, a largely rural state with a population density of 75.1 persons per square mile, is entirely located within Appalachia. West Virginia’s rates of child and adult obesity have been consistently ranked among the highest in the Nation. In addition to obesity, WV also ranks among the highest in the U.S. with regard to obesity-related chronic diseases such as diabetes and cardiovascular disease. These findings demonstrate that rural populations, including those in West Virginia, are at high risk for obesity and in urgent need of research efforts that will identify factors contributing to the epidemic rates of obesity and related chronic disease. By placing specific emphasis on the factors contributing to overweight and obesity among youth, researchers will be able to inform primary and secondary prevention efforts.
1.1.3 Energy Balance

Overweight and obesity can be largely attributed to an energy imbalance -- calories consumed exceed the calories burned.\textsuperscript{29} Although individual-level characteristics related to physiology underlie this equation, an individual’s energy balance is related to potentially modifiable diet and physical activity behaviors.\textsuperscript{29, 30} Due to the limited data tracking physical activity over time, there is a lack of evidence to support a definite decline in youth physical activity or increase in sedentary behavior over the past several decades.\textsuperscript{31} However, research suggests a decrease in PE course participation between 1992 and 2001\textsuperscript{32, 33} and fewer trips made to school by walking during the period from 1977 to 2001 (21\% versus 11\%).\textsuperscript{34} Research also suggests an increase in energy consumption among children and adolescents over a similar time period\textsuperscript{35-37} and an increase in the calories consumed at locations away from home (i.e., restaurants and fast food establishments).\textsuperscript{38} In addition, cross-sectional research, though limited in its ability to determine causation, has demonstrated relationships between obesity and the following: 1) increased caloric intake,\textsuperscript{39-43} 2) greater periods of inactivity/sedentary activity,\textsuperscript{40, 43-46} and 3) lower levels of regular physical activity.\textsuperscript{41, 42, 46-49} These findings point to the need for mechanisms to increase physical activity and improve diet, thereby restoring energy balance and decreasing obesity.

Though this energy imbalance is a result of individual behavior, environmental factors associated with diet and physical activity have been shown to play a major role.\textsuperscript{26} Much of the literature exploring obesity, physical activity and nutrition behaviors has been driven by individual-level theories that, while effective in designing interventions to promote change, have been limited in their long-term effect and overall reach.\textsuperscript{50-52} However, ecological theories offer further insight towards the factors influencing childhood obesity by emphasizing macro-environments (built environment, social environment, and policy) and the constant exchange between an individual
and the environment. The Social Ecological Model of Health Promotion in particular, posits four key assumptions: 1) individuals are influenced by social and built environments, 2) environmental measures can be perceived or objective, 3) health outcomes/behaviors can be studied at multiple levels (individual, interpersonal, community, etc.), and 4) there is an interdependence between proximal and distal environments. Figure 1, adapted from Sallis et al., and Story et al., represents the levels of influence commonly recognized in Social Ecological approaches to childhood obesity research.

![Social Ecological Model of Health](image)

**Figure 1.** Social Ecological Model of Health Promotion.

Figure depicts the multiple levels potentially influencing childhood obesity. Adapted from Sallis et al., 2006 and Story et al., 2008.

The Social Determinants of Health Theory complements Social Ecological Theory by identifying factors and interrelationships across three domains: 1) Fundamental (Macro-level), 2) Intermediate (Meso/community-level), and 3) Proximate (Interpersonal) – each of which interact and contribute to health and well-being. The Fundamental Level (which consists of the natural environment, macrosocial factors, and inequalities within a community) and the Intermediate level (consisting of the built environment and social context), allow the researcher to make the
necessary distinction between factors of the social and built environments that are more fixed (natural environment and macrosocial factors at the Fundamental Level) and serve as the foundation for built environments, social capital, social networks (Intermediate and Proximate Levels), and overall health. See Figure 2.

**Figure 2.** Social determinants of health and environmental health promotion. Schulz & Northbridge, 2004.57
1.1.4 Ecological Research

1.1.4.1 Food Environment

A growing body of literature has explored the association of the food environment with dietary behaviors and obesity at a variety of geographic scales including state, county, census tract, and community. Among these studies, an increasing number have used objective measures (Geographic Information Systems and in-person audits) to examine the access and quality of food resources. The presence of fast food and convenience stores has been shown to increase the likelihood of overweight/obesity and decrease the consumption of fruits and vegetables in both children and adults, while the presence of supermarkets has been associated with lower rates of obesity in both adults and children. State-level analyses conducted by Maddock found significant correlations with state obesity rates and the number of fast food restaurants per resident. Using county-level data from the Behavioral Risk Factor Surveillance System, it was found that higher BMI was positively associated with fast food restaurants for a National sample of adults. In a study conducted by Morland et al., adults living in mostly urban areas of Mississippi, North Carolina, Maryland, and Minnesota provided health information and location of residence so that researchers could examine the association between the presence of grocery stores, convenience stores, and fast food restaurants and obesity. The food environment was measured by census tract, using residential addresses and North America Classification System codes. Findings from this study indicated that those living in census tracts with supermarkets had a lower prevalence of overweight and obesity, while those living in areas with convenience stores had a higher prevalence of overweight and obesity. Similar findings were reported by Morland and colleagues in a more recent study of urban adults in North Carolina. In addition to grocery stores and convenience stores, proximity to fast food was also measured,
finding a positive association with obesity.\textsuperscript{66} A study examining the relationship between proximity to fast food restaurants and obesity or dietary behavior of Minnesota adults did not find that fast food proximity significantly increased the likelihood of being overweight or obese. However, the study found that the presence of these restaurants increased the likelihood of eating away from home.\textsuperscript{63} For Australian parents reporting on the food environment and fruit and vegetables consumption of their 5-6 and 10-12 year old children, those with higher access to fast food and convenience stores close to the home were less likely to consume more than two servings of fruit daily, and those living further away from fast food restaurants were more likely to consume over three servings of vegetables daily.\textsuperscript{62} In a study conducted with parents of young children in the U.S., no associations between proximity to fast food restaurants and obesity were found.\textsuperscript{68} With regard to rural regions, a recent study of food deserts in rural Pennsylvania found the greater the percentage of a school districts’ population residing in a food desert, the higher the rate of obesity among students in the district (even when controlling for economic characteristics).\textsuperscript{69} Much of the other rural-focused research to date has measured food environments (food resources within the community environment) rather than evaluating relationships between food environments and dietary behavior and obesity.\textsuperscript{59, 60, 65} Therefore there is need for additional research to examine these relationships in rural areas.

Studies examining the impact of the food environment on child overweight/obesity have also begun to explore communities around schools.\textsuperscript{70-75} Evaluating the presence of fast food restaurants around Chicago schools, Austin and colleagues found that, on average, schools had 3 to 4 restaurants in walking distance with more fast food restaurants located in higher SES neighborhoods and areas outside of downtown.\textsuperscript{70} A study conducted in California (urban, suburban, and rural neighborhoods) found that children attending schools with a fast-food
restaurant within walking distance were more likely to be overweight or obese. Characterizing the food environment around schools, Zenk and colleagues, reported that nearly one third of high schools within the U.S. had at least one fast-food restaurant in walking distance, but when middle and high schools in the U.S. were stratified by urbanicity, small town and rural schools were less likely than urban schools to have food retail outlets within close proximity.

Though findings have not been consistent across all studies, the research to date emphasizes the role of the food environment in facilitating healthy dietary behaviors and healthy weight. With a limited number of studies exploring these relationships among youth, particularly those living in rural areas, additional research is needed. Given the higher rates of obesity in rural areas, it is particularly important to examine these relationships with regard to the community of the child’s school as well as the greater community.

1.1.4.2 Physical Activity Environment

Research examining the role of the built environment has assessed factors such as pleasant scenery, presence of trails, parks, recreational facilities, and light traffic, finding significant associations between these variables and higher rates of physical activity and lower rates of overweight and obesity. Few studies have examined the impact of the built environment on the physical activity of rural individuals. A study by Boehmer et al., examining both physical inactivity and a combined variable of physical inactivity and obesity in rural adults living in Missouri, Arkansas, and Tennessee reported that further distance from trails, recreational facilities, or parks was positively associated with inactivity/obesity. These associations between aspects of the built environment and physical activity of rural adults have also been reported by other researchers. Studies among youth have also largely focused on urban and suburban
youth, where associations between the built environment and physical activity have been mixed. A study conducted by Gordon-Larsen, in which the availability of recreational facilities was measured objectively from the child’s home, found a greater number of recreation facilities corresponded with lower odds of being overweight or obese and with higher odds of being physically active. Another study using GIS methods to measure the frequency of parks and recreational facilities in proximity to an adolescent’s home in San Diego County found that the number of recreational facilities was positively associated with physical activity, but parks were not. In a recent study conducted by Tucker and colleagues in London Ontario, the presence of parks and recreation facilities within the community environment around the school and the home was measured among a sample of seventh and eighth graders, finding that in both locations, a greater number of recreation facilities corresponded with higher levels of physical activity. Finally, a study conducted by Franzini et al., guided by the Social Determinants of Health model, reported that the built environment (measured as: traffic, physical disorder, low residential density, and less mixed-land use) was not significantly associated with youth physical activity.

To date, research exclusively focused on the role of the built environment on inactivity and obesity among rural youth has been conducted in two studies. In a quantitative study conducted in Alberta, Canada, Fein and colleagues examined physical activity/environment associations using a questionnaire that measured perceived physical activity resources within or around the home (15 items), and the convenience and availability of facilities within the neighborhood (17 items). The questionnaire also included information regarding the perceived importance of environmental resources for physical activity and physical activity behaviors. Results from unadjusted models indicated that the perceived availability and importance of
environmental resources accounted for 5% and 8% of the variance, respectively. The unadjusted model also showed the home, neighborhood, and school environments to significantly influence physical activity among this population. Further analyses using hierarchical regression adding individual-level variables first and environmental variables second, found that the school environment was the only environmental factor significantly associated with physical activity.  

A more recent study by Yousefian and colleagues explored barriers and enablers to physical activity among rural youth in Maine. Findings indicated that transportation presents a significant barrier to physical activity and that locations providing family friendly physical activity opportunities are needed in rural areas.

Much like research considering the food environment, physical activity research has also begun to explore the environment around schools in relation to youth. Findings from a study conducted in London Ontario suggested a greater number of recreation facilities within the community environment around the home or child’s school corresponded with higher levels of physical activity. A second study by Trilk et al., considered the influence of recreational facilities on the physical activity levels of high school girls. When objectively measured recreational facilities were modeled against minutes of moderate to vigorous activity for a sample of rural and non-rural high schools, results indicated those girls attending a high school with more than 5 recreational facilities in the community surrounding the schools were more likely to report higher levels of physical activity than girls attending schools with fewer than 5 facilities. To our knowledge, these are the only studies to date examining the availability of physical activity environments around schools.

In summary, the literature examining the role of the built environment on obesity and physical activity has identified general relationships for adults in rural and more metropolitan areas.
Research to date suggests that the presence of parks, recreational facilities, and trails, as well as safety from traffic and crime, and pleasant aesthetics are all associated with increased levels of physical activity and lower obesity. More recently, studies have also indicated the community environment around schools and availability of recreational opportunities may also play a role in influencing youth physical activity. However, due to the limited number of studies focused on these factors in rural youth, the relationships between elements of the built environment and childhood obesity and inactivity are unclear.

1.1.4.3 Social Environment

The social environment in public health research has been operationalized in a number of ways. McNeill et al., in their review of concepts related to the social environment for physical activity, outlined five key dimensions: 1) social support and social networks, 2) socioeconomic position and income inequality, 3) racial discrimination, 4) neighborhood factors, and 5) social cohesion and social capital.\(^93\) However, research to date assessing food and physical activity environments through ecological models have largely emphasized the socio-economic position of individuals and communities. Studies examining food retail stores have found that fast food outlets and convenience stores occur at higher frequency in lower socioeconomic status (i.e., higher poverty, lower educational attainment) and high minority communities.\(^67, 72, 73\) Additionally, access to supermarkets in rural areas decreased with lower aggregated SES and community deprivation.\(^60\) Studies examining physical activity resources have also reported a lack of resources within communities of lower SES.\(^67, 86, 94, 95\) It is also important to note that recent investigations assessing the role of the social environment, defined as the aggregated socioeconomic status of a community, have also used GIS techniques to obtain an aggregated socioeconomic status of the }
community, which has been found to be independently associated with health outcomes and health behaviors (physical activity and dietary behavior).\textsuperscript{96, 97}

1.1.5 Environmental Measures

1.1.5.1 Questionnaire Measure

As studies exploring the influence of social and built environments on diet, physical activity, and obesity have increased, so have the variety of mechanisms for measuring the environment. Much of the original research has involved measures of the perceived social and built environment, asking participants to report on the presence of infrastructure (sidewalks, streetlights, parks, recreational facilities, presence of trails), quality of community design (connectedness of streets, walkability of the community), perceived level of safety, or community aesthetics. Many studies capturing the perceived environment have used either the San Diego, St. Louis, or South Carolina instruments.\textsuperscript{98-102} The San Diego Instrument, also known as the Neighborhood Walkability Survey, asks participants questions that relate to nine sub-categories: 1) types of residences in your neighborhood, 2) stores, facilities, and other things in your neighborhood, 3) access to services, 4) streets in your neighborhood, 5) places for walking and cycling, 6) neighborhood surroundings, 7) safety from traffic, 8) safety from crime, and 9) neighborhood satisfaction.\textsuperscript{102, 103} The St. Louis Instrument was developed to assess relationships between the built environment and walkability among rural populations in Missouri.\textsuperscript{83, 102, 104} The measure asks questions according to categories similar to those included in the San Diego instrument, and includes questions on: overall exercise behaviors, barriers to physical activity, and presence and distance to physical activity opportunities. The South Carolina instrument measures similar dimensions of the built/physical environment as described for the St. Louis and San Diego instruments, except that questions are asked of both the neighborhood and community
environments. In the South Carolina measure, the neighborhood environment is defined as a half mile radius from the home while the community is defined as a 10 mile radius (20 minute drive) from home. It is also important to note that both the San Diego and South Carolina instruments measure the perceived social environment such as trust of neighbors, social support for physical activity, social cohesion, and community involvement. While studies incorporating these measures have been important in developing our understanding the role of the built environment with regard to individual behavior, perceived measures have been found to have little agreement between objective measures of the environment within the physical activity literature. Researchers have suggested the lack of agreement may be due to the difficulty in estimating distance (e.g., the number of recreation facilities within a 5 miles radius of the home) or source bias, meaning those who are more active will be more likely to perceive greater access to recreational opportunities. Thus, a full understanding of ecological factors influencing obesity and related health behaviors in rural areas is likely to require both perceived and objective measures.

1.1.5.2 Observation Measures

Along with these measures of the perceived environment, studies examining the influence of the built environment on physical activity have also used objective measures of the environment. The Irvine Minnesota Inventory is one example of an environmental audit tool that was developed to assess community friendliness toward physical activity and has been used to examine environments for adults and children in both urban and rural settings. This audit is designed to be conducted by trained observers who use the tool to measure neighborhood/community characteristics across four content areas: accessibility, pleasurability/aesthetics, perceived safety from traffic, and perceived safety from crime. Other
research based audit tools have also been developed to assess active friendly neighborhoods and community environments such as the Systematic Pedestrian and Cycling Environmental Scan (SPACES) and the St. Louis Audit Tool. With regard to the rural food environment, much of the observational research has involved ground-truthing (the process of documenting existing establishments and noting their location through on-the-ground audits) and direct observation of items sold at various food stores and establishments.

1.1.5.3 GIS Measures

Geographical Information Systems (GIS) have also been used to capture the built environment and have been employed in a variety of studies. GIS is a tool used to integrate spatial data by defined geographic units (counties, census tracts, census blocks, or radius from a given location). Research has used GIS to measure the presence of- or distance to- aspects of the built environment such as: parks, trails, recreation centers, school grounds, fast food restaurants, convenience stores, and grocery stores. As mentioned, although reliability studies have indicated that perceived and objective measures are not highly correlated, both types of measures of the built environment are needed for physical activity research. Whether conducted by GIS or auditing the environment, objective measures offer researchers the opportunity to examine the “actual” presence and location of resources while measuring the perceived environment may allow researchers to capture elements such as preferences, barriers, and awareness. Both are important, but first-generation research on rural youth may require emphasis on objective measures in order to assess opportunities that exist in these regions.

1.2 The Purpose of the Current Research

While it is known that rural regions of the Midwest and the South in general, and West Virginia in particular, have the highest rates of child obesity, little is known about how the social and built
environments of these regions contribute to obesity. Understanding how these environments influence childhood obesity requires an understanding of factors that act as barriers and facilitators to physical activity and healthy eating, the specific characteristics of the environments in which rural youth reside, and the potential relationships between characteristics of the social and physical environments with regard to childhood obesity. The current research seeks to address the limitations of the existing literature by focusing on rural environments in West Virginia, particularly the community environments around schools. As noted by Tucker et al., “compared to adult populations it seems logical that youth are much more captive to the opportunity structures defined by their home and school neighborhoods.”

Further, Sallis and Glanz noted, “children of all ages need and want places to play…to support the diversity of their physical activities, they need many types of recreational facilities, both public and private, near their homes and schools.” In addition, researchers have noted the need to examine environments beyond the home and have highlighted the importance of community environments around schools given that youth make regular trips through these communities on the way to and from school. The focus on elementary students (4th and 5th graders) and the environments around their schools allows for the examination of characteristics that may directly relate to health behaviors. The accessibility of fast food or convenience stores in the area around schools, for example, may encourage unhealthy snacking before or after school. Similarly, the availability of parks and other physical activity opportunities in close proximity to the school may encourage physical activity by providing places for youth to be active after the school day. Furthermore, even if youth do not access food and physical activity resources on their own, the resources around schools are likely accessible to parents and the family, and may in turn influence child dietary behaviors and physical activity. This may be particularly true for
elementary schools in West Virginia because these schools are more likely to be anchored in a neighborhood community when compared with larger middle or high schools that have undergone consolidation. Therefore, study of the environments around schools may indentify factors that influence obesity in a setting where great impact of public health intervention (policy and environmental change) is likely to be achieved. The long-term goal of this research is to increase knowledge of the contextual factors related to childhood obesity in rural areas in order to maximize prevention efforts and appropriately allocate resources.

The study described in chapter 2 uses a secondary analysis of qualitative data to examine characteristics of the social and built environments perceived to be related to obesity in rural areas. Data from focus groups conducted with community leaders and parents in five West Virginia counties was analyzed to establish a greater understanding of barriers and facilitators to physical activity and healthy eating that ultimately contribute to obesity in rural communities. The findings from this study provided the foundation for research examining the socio-economic conditions, food resources, and physical activity opportunities within a sample West Virginia communities. The studies described in chapters 3 and 4 explore the role of the social and physical environments in relation to childhood obesity by using objective measures of the community environment around West Virginia schools.

The literature reviewed in this introduction supports the need for focused childhood obesity research in rural areas and demonstrates how the current literature has primarily examined food and physical activity environments in non-rural areas. The results of the three studies described in this report will contribute to the ecological research focused on obesity among rural youth.
1.3 References


32. Li S, Treuth M, Wang Y. How active are American adolescents and have they become less active? *Obes Rev.* 2010;11:847-862.


Chapter 2
Chapter 2

Abstract: The constructs of social ecological theory provide a mechanism for understanding the multi-level factors contributing to the obesity epidemic. While this theory has been widely used to examine obesity in urban areas, more research is needed among rural areas where rates of obesity are disproportionately higher. The objective of this research was to gain greater understanding of the individual, interpersonal, and environmental factors perceived to influence obesity in five rural, Appalachian communities. Nine focus groups were conducted. Semi-structured guides were used to elicit information on topics including: community characteristics, environmental barriers, and health concerns, knowledge, and behaviors. Qualitative analysis was used to examine transcripts. Participants noted obesity to be an increasing problem among residents. Individual- and interpersonal-level factors were cited as barriers to healthy eating such as time, cost, convenience, lack of knowledge about healthy eating, and the importance of parents as role models. When asked about physical activity, participants recognized the presence of physical activity programs and facilities but cited the need for more recreational opportunities, infrastructure for safe walking, and continuity of physical activity programs offered. Through discussions about their communities, participants perceived strengths to include strong family ties, low crime and helpfulness of neighbors while weaknesses included limited resources due to high percentages of low-income families and aging adults. This study adds to a growing body of rural focused obesity research and identifies the multi-level factors contributing to obesity and the related health behaviors. These results may help inform future research and obesity prevention within rural communities.
2.1 Introduction

Rates of adult and child obesity have increased to epidemic proportions over the last thirty years.\textsuperscript{1,2} Current statistics indicate nearly 68\% of adults and 32\% of youth are overweight or obese.\textsuperscript{3,4} Research also shows these numbers to be significantly higher among minorities, low-income populations, and those living in rural areas.\textsuperscript{5,6} For example, rural youth are 25-47\% more likely to be obese than their urban peers and similar differences have been found between rural and urban adults.\textsuperscript{7,8} Considering that just over 60 million Americans live in rural areas,\textsuperscript{9} research examining the factors influencing obesity within rural communities is critical to improving our understanding of this epidemic, and thus creating effective strategies for all levels of prevention within rural communities.

Most recently, ecological approaches have been used to conceptualize multi-level influences of obesity and related behaviors. These approaches offer further insight by emphasizing macro-level environments (built, social, and policy) and the constant exchange between the individual and the environment.\textsuperscript{10,11} The Social Ecological Model of Health Promotion, for example, posits that health outcomes and health behaviors can be studied at individual, interpersonal, and community-levels with interdependence between proximal and distal domains.\textsuperscript{10,11}

This movement to evaluate obesity within an ecological framework has led to a growing body of evidence that the built and social environments are associated with physical activity, diet, and obesity. Although these studies mark significant progress in our understanding of obesity and obesity-related behaviors, the current body of literature is limited in its urban/suburban focus. In addition, little research has examined obesity within rural areas using an ecological framework. The existing research examining the rural environment cites lack of convenient and accessible facilities, lack of transportation to facilities and programs, and concern for crime or personal
safety as common barriers to physical activity.\textsuperscript{12-19} Factors such as poor community aesthetics, heavy traffic and lack of recreational opportunities are also noted as barriers to physical activity in several studies.\textsuperscript{17,20-26} Last, studies examining rural food environments indicate these geographic regions have limited access to larger grocery stores selling healthy foods such as fresh fruits and vegetables which in turn negatively impacts diet and weight.\textsuperscript{27,28} Among these rural-focused studies, however, the current body of research represents a limited geographic sample of rural communities and has not explored the rural environments within many of the regions most heavily impacted with growing rates of obesity and physical inactivity. Considering the substantial variation in rural locations due to culture and landscape\textsuperscript{29} it is particularly important to expand rural-focused obesity research by examining the epidemic in this context.

The goal of this study was to gain a greater understanding of obesity within rural communities of West Virginia, a largely rural state with rates of adult and childhood obesity among the highest in the nation.\textsuperscript{9,30} More specifically, this study aims to identify: 1) community members’ perceptions of obesity, physical activity, and diet; 2) resources for healthy eating and physical activity; and 3) factors within the social and physical environment that present barriers to healthy eating and physical activity. Because qualitative methods are well suited for, “understanding phenomena within their context (p.1759)”\textsuperscript{31} this study used data from focus groups conducted with West Virginia community members.

\textbf{2.2 Method}

The present study involved a secondary analysis of qualitative data originally collected in 2003. The data consisted of transcripts from focus groups conducted in five West Virginia counties. Counties in which focus groups took place were selected based on their obesity rates being higher than the national average.\textsuperscript{32,33} Secondary analysis was deemed appropriate for this study
because it allowed the researcher to use existing qualitative databases to consider, “new and extended inquiries” (p. 263). The type of secondary analysis conducted for this study was an analytic expansion; existing data was used to answer higher level questions and address new or expanding theories (Social Ecological). The study was approved by the Institutional Reviewed Board at West Virginia University.

2.2.1 Data Collection Procedures

The study targeted parents and community leaders. Parents were recruited through flyers sent home with pre-schoolers and community leaders were identified using the position and reputation approaches as recommended by Preston and Guseman. Parent and community leaders received a $15 incentive for participating.

Focus groups were conducted using standardized procedures and structured interview guides to ensure comparability across groups. The interview guides were developed to elicit information on a broad range of topics including: characteristics of the community, health concerns, health knowledge, health behaviors, and environmental barriers (See Table 1). Trained moderators conducted the focus groups which lasted between 50 and 70 minutes.

2.2.2 Qualitative Analysis

Each focus group was audio-taped and transcribed. NVivo 8 qualitative software was used for data storage and coding. Directed content analysis with an unconstrained matrix was used to code the transcripts. A coding scheme and dictionary were developed, guided by our specific aims and Social-Ecological Theory. Thus, definitions were established for statements representing obesity, physical activity, nutrition, community, and the physical environment. Statements within each of these 5 categories were further coded into subcategories based on
theoretical concepts and preliminary review of the transcripts (use of an unconstrained coding matrix allowed additional subcategories to emerge after preliminary review of the data). Transcripts were coded by two independent reviewers. To assess the quality of codes and the reliability between coders, a weighted kappa statistic was calculated. A threshold of .60 was set, based on the convention that .60 -.80 reflects substantial agreement and .80 -1.0 almost perfect/perfect agreement between coders. Any category with a kappa below the threshold was re-examined, the definition clarified, and the transcripts re-coded. Coding disagreements with a kappa greater than .60 were resolved by consensus. Following consensus, themes were identified within each of the secondary categories and tied to their corresponding level of influence outlined in the Social Ecological Model of Health: 1) individual, 2) interpersonal, and 3) community. (For the purposes of this study the fourth commonly cited category of Social Ecological Theory, organization, was grouped within community.)

2.3 Results
Nine focus groups were conducted across the five counties, with a total of 38 participants (9 male, 29 female). Seventeen parents and 21 community leaders took part in the focus groups. Table 2 presents demographic characteristics of participants.

A total of 11 themes were identified from the coded transcripts. Each theme is presented according to its level of influence in Social Ecological Theory (individual, interpersonal, or community) when applicable. It is important to note that many quotes were tied to multiple themes and levels of influence. See Table 3 for a complete list of coding categories, themes, and their corresponding level of Socio-Ecological Influence.
2.3.1 Obesity
When asked about major health concerns in the community, participants fully recognized obesity as a problem. One mother who had recently moved to West Virginia noted, “Obesity seems to be a big problem that I have noticed. I’ve seen more heavy people and myself, since I moved here I’ve gained 30 pounds”. Another community member said, “(obesity) That’s everywhere. All over the county. Anywhere you want to look”. A third remarked, “I see people getting larger and bigger and bigger”. This concern for the increasing obesity among community members was also identified as a problem for youth. “Some kids – it just seems they’re getting more obese and getting younger and younger and it’s an issue.”

2.3.2 Nutrition
2.3.2.1 Individual-level
The majority of participants recognized overeating and eating junk foods to be a problem related to obesity and discussed several individual-level barriers to healthy eating such as convenience, cost, and knowledge. One community leader said, “I think it’s a lot of convenience. I mean some of it is just overeating of good food but I think the bulk of it is a lot of snack and junk food between meals.” Focus group participants also recognized the difficulty of finding time to prepare healthy meals, particularly for working parents trying to prepare meals for their children. One parent stated, “You know a lot of people work, especially single mothers that work, they just don’t have time at all (to cook).” Another mother added, “Time like you said, time is one of the big priorities, you know. I have to go home at 5:00 and make dinner, and be at a meeting at 6:00. Well, how do you
make something within that half hour, make dinner that is healthy and quick and something that a 5 and 3-year old will eat?

In addition to convenience, participants unanimously commented on how cost was a major barrier to eating healthy. With the high poverty rate in many of these communities, the low cost of junk foods lead to increased consumption of such foods while the high cost of fruits and vegetables was a significant barrier. Cost was also mentioned as a barrier to nutrition programs such as Weight Watchers ®. One community member commented on the cost of fresh fruits and vegetables:

Okay, you go to the store, right? Look at vegetables and fruit. Look how expensive they are. It’s easier to get these Little Debbie snack cakes that have 50 grams of fat for a quarter. You can’t get vegetables for a quarter, you know. It’s so much cheaper to buy junk.

Another parent added:

Fruits and veggies are not cheap.... I read the Surgeon General says that you are supposed to eat from 8-10 serving of vegetables a day. Well, do you know how expensive that would actually get?

Furthermore, participants discussed how they or others they knew lacked knowledge related to healthy eating. Whether it was a matter of what to buy, how to read nutrition labels, or how to prepare healthy foods, focus group members cited lack of information as a barrier to a healthy diet. One participant stated, “I know it has to start at home and you have to regulate your eating, but where am I going to go? I don’t have access to the Internet”. A mother spoke of the need for more information in order to change her diet:
I wouldn’t know right off the top of my head how to go and change that (how to cook) and I don’t see any information or anybody leading to that information, to show someone, well this is how you change your diet.

2.3.2.2 Interpersonal-level

Focus group data related to nutrition and interpersonal relationships emphasized the role parents and families play in supporting healthy dietary behaviors. Participants recognized the need to set healthy examples for children but at the same time commented how often they or others they know give in to what the child wants. One community leader recognized the importance of serving as a role model for her children in terms of her diet saying, “I’m looking at what my kids are eating and you know, unless I can change my habits, then that’s the way they are going to keep on eating. If I get the right information it might have an impact on me and I could have an impact on my kids.

Participants also recognized that their own dietary habits and those of their children were shaped by culture and tradition. Discussing her own upbringing and how she learned to cook, one mother said, “Everything was fried in butter when we grew up and you know you have to learn how to break that. But how do you do it”. Another mother said, “I can’t just off the top of my head make something healthy, you know because of the way I was brought up, the way I was fed. I just want to cook like that.”

2.3.2.3 Community-level

Several community leaders reported the presence of nutrition education programs for specific populations such as senior citizens or those with diabetes. Several participants also noted the
work being done through Head-Start programs to try to teach parents and children about healthy eating as noted by a Head Start Teacher:

\[
\text{We cook with the kids. They have cooking experiences. (When) they have parent meetings we might cook something. There’s also a newsletter that we try to send out to the community. We’ve sent out newsletters with recipes.}
\]

Despite the existence of several nutrition education programs, parents indicated a frustration with not knowing where to turn for education or cost-effective recipes for healthy eating. One parent stated, “With a lot of people, they know they need to lose weight or they know they need to get healthy but then again they don’t have the knowledge to know how to do it.” Another parent suggested, “I think what needs to be done at a clinic (is to have) someone like a volunteer come in once a week and say, ‘Look, this is how we can cut fat in this. This is how we’re going to substitute healthy for that,’ and show you how to do it.”

Several parents were concerned about their children’s access to unhealthy foods in school or through school programs such as school lunches, vending machines, or reward programs offering food coupons to fast food outlet. One parent commented, “(Children are eating) pepperoni rolls and pizza. Some kids eat pizza every day. Mine do. There are also soda machines in the schools that they have access to.” With regard to fast food coupons sent out as a reward for a good report card one community leader commented, “I hate that. My kids love it. They get a coupon for French fries. They get rewards from anywhere.” Another community leader voiced a similar frustration agreeing that healthy foods or book store certificates would be better rewards. “My daughter loves to read and I get that (fast food) coupon and that just burns me up and I

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1 In 2008, the West Virginia Board of Education passed the New Standards for School Nutrition, Policy 4321.1, mirroring recommendations outlined by in the Institute of Medicine’s 2007 report, Nutrition Standards for Foods in Schools: Leading the Way toward Healthier Youth.
throw it in the trash.” In addition to the school setting, participants also voiced frustrations with easy access to unhealthy foods and limited access to healthy foods at food pantries, in convenience stores, and other food outlets within the community. Several participants did note small efforts to bring fresh produce to their communities by starting up farmers’ markets or community gardens.

2.3.3 Physical Activity

2.3.3.1 Individual-level
A number of participants shared information about what community residents do to be physically active, which mostly consisted of walking for adults and sports for youth. However participants mentioned that only a small percentage of individuals were regularly active, and indicated that many people in their communities were inactive or sedentary, particularly children. One community leader noted the transition to more sedentary activities among both youth and adults:

When I was growing up we would go out and run around in woods or play until it was time for supper. I just think there’s a lot less (physical activity) now and children are not seeing it from their parents. They’re not seeing activities done by their parents.

Another community leader said: “the impression I get is the total population doesn’t exercise.”

2.3.3.2 Community-level
Participants in each focus group recognized the presence of programs in their community which support physical activity either through church-based exercise classes, youth sports, or walking clubs. Participants also discussed the need for more physical activity programs for youth and adults as well as support groups for walking or exercising. One community member recognized
that a continuity of programming was needed so that children had consistent opportunities to be active. One community leader said:

\[
I \text{ would welcome more structured programs because the only exercise kids are getting outside of school hours – if they get it anymore – schools had to cut music and PE in order to pay the bills - but the organized activities are about all that the kids are doing.}
\]

A member of a parent focus group spoke to the need for organized activities and social support when asked how one could get the community involved in becoming healthy. “(We need) some kind of support groups that met on a regular basis even if it was just to walk the streets.”

Within the physical environment, community members recognized a number of resources for engaging in physical activity such as hiking trails, paths, school facilities, and recreation centers, but there were several barriers to accessing these opportunities such as child care, cost, distance, or adequate lighting. One mother commented, “You know there is nowhere around here like gym where they (the community) can go and exercise.” Another parent stated:

\[
\text{It just doesn’t feel like there are enough outlets around here. Like, the gym, Curves, none of them offer day care on site. YMCA does but that to me is a waste of travel and it’s a little more expensive than I want to pay for a membership fee.}
\]

While discussing barriers to physical activity, the need for more physical infrastructure for walking emerged. Many participants commented that roads in their community were unsafe for walking, lacking sidewalks and protection from traffic. One parent noted, “The size of your roads here are not conducive to walking, they’re not”. Other participants agreed stating, “Absolutely not, you’ll get killed.”
2.3.4 General Community Environment

When participants described their communities they identified a number of strengths and challenges present in each. With regard to challenges, several participants reported their communities had a large aging population and a high percentage of low income families. When exploring why obesity and poor diets were so common in these communities, several community leaders discussed how many families have to be concerned with more fundamental elements of living such as finding a job and an affordable place to live. One community leader stated, “I think it stems from our kids being low-income and that we’re talking about survival, about shelter, we’re talking about keeping warm.” In addition to the high rates of poverty, many of the participants noted that each is an aging community creating additional programmatic and infrastructure needs. One community leader commented:

The problem is that the community has grown a lot older and there is very high senior population. These are people who are retiring back to their hometown after they went away to work and now they’re coming back as retirees.

In addition to the challenges that communities face, participant’s also recognized a number of strengths within their communities such as the ability to trust one’s neighbors, low crime, strong family ties, and an overall sense of willingness to help one another. One mother described her neighborhood as a place where, “You can leave your front door unlocked...It's not a high crime place.” Another parent explained that neighbors are trustworthy and commonly look out for one another.

Where you live you know your neighbors and they kind of watch out for each other. I know if my daughter is outside playing and I have to run in and get the phone for a
minute, and neighbor is the yard next door, I know they are going to watch her for just a minute while I run in to get the phone. That’s trustworthy.

Similarly, one community member noted, “This is a safe and caring community. I mean there is vandalism to an extent but we don’t have the big crime issue at this point. People are pretty good about watching out for everything.”

2.4 Discussion

With regard to overall perceptions and level of concern, parents and community members alike noted that obesity, physical activity, and poor dietary behaviors were prevalent within their communities. Multiple participants indicated children and adults were becoming more overweight and that a small percentage of community members were regularly active. The high level of awareness of public health related problems in these communities is encouraging and suggests residents may be receptive to future efforts to address healthy eating, physical activity, and obesity.

At the individual-level, characteristics such as cost, time, and knowledge were viewed as contributors to poor diet and obesity. These findings are comparable to those assessing barriers to healthy eating among urban and rural populations.\textsuperscript{15,16,39,40,41} Unlike findings from two rural focused studies which suggested nutrition knowledge was not a key issue,\textsuperscript{15,39} focus group participants in this study identified lack of knowledge regarding healthy eating practices as a barrier and discussed a need for nutrition education and programs. Participant responses also suggested that individual-level barriers to healthy eating were further complicated by limited access to healthy foods. Though these themes were presented within the individual-level of influence, the comments illustrate the interconnectedness between the individual-level and
interpersonal and community levels; thus highlighting the fact that in order to bring about change in dietary behavior, attention must also be given to addressing access and the food environment and providing educational opportunities for residents. It is important to note that although some community members reported easy access to unhealthy foods, several participants identified projects such as community gardens and farmer’s markets being developed in their communities making fresh produce readily available.

Within the social environment, multiple factors were reported to either be a barrier to- or facilitator for- physical activity and healthy eating. The regional history, landscape, and economic development of many of these regions produced specific relationships with food and cooking styles. Discussions revealed that residents often learned to cook from their mothers or grandmothers, frying foods in butter and preparing meals that were low cost and could last several days. Future work should consider how nutrition education or nutrition programs could address healthy eating and cooking techniques that are consistent with regional culture and tradition.

The desire for support groups and networks for physical activity also highlights the importance of the social environment for physical activity within these communities. The majority of participants noted that they would like to be physically active, but did not want to go to the gym alone or walk by themselves. These findings are important to note because providing community members with opportunities within the physical environment may not be enough to promote increased activity among residents and may require organized programming such as walking clubs or exercise classes.
At the interpersonal-level, the importance of parents as role models for positive health behaviors was discussed. Comments addressed the need for parents to set a positive example and not give into children’s desire for junk foods. With regard to physical activity, the importance of parents modeling physical activity was also mentioned, but did not rise to the level of a theme. These findings suggest that further research and interventions can not only focus on the physical activity and nutrition of the individual, but must incorporate techniques that can be used to encourage healthy eating and regular physical activity for families.

Although the number of comments did not qualify as a theme, the fact that parents voiced concern over schools supporting unhealthy eating should be noted. These comments are consistent with recent trends emphasizing the role of the role of the school in addressing childhood obesity.\(^{42}\)

As mentioned earlier, lack of knowledge was cited as a barrier to healthy eating, particularly among parents. The fact that community leaders reported the presence of nutrition education programs, but only for certain populations (seniors or those with diabetes), supports the need to expand the reach of these programs. The rural schools in particular may be an important outlet for nutrition education.

Finally, when considering potential next steps for obesity prevention programs in rural areas, it is important to keep in mind the fundamental characteristics of the communities themselves. From the focus groups, participants identified their communities as being composed of a large aging population, having limited resources, and high poverty. This indicates that projects/programs addressing health behaviors need to address multiple generations in order to be time and cost effective. In addition, the resources within the community may need to serve multiple purposes.
O’Hara Tompkins and others have highlighted the importance of school facilities for providing physical activity opportunities to rural residents. Any improvements to physical activity infrastructure or nutrition programs should also consider low-cost alternatives (e.g., trails versus sidewalks, programs to get people active in parks) and how these opportunities can be accessed by everyone from youth to seniors.

The participants mentioned that the strengths of their rural communities were safety, trust and helpfulness of neighbors. These strengths serve as a starting point which future research and interventions can be built upon and may point to the need for future research to capture more detailed measures of the social environment in rural areas (e.g., social capital, social cohesion).

2.4.1 Strengths & Limitations

This qualitative study adds to a limited body of research using an ecological approach to understanding obesity in rural areas. More specifically, we highlight findings from rural communities noted to have obesity rates higher than the national average. Additionally, the qualitative approach allowed for greater appreciation of the characteristics of the social and physical environment specific to this region of Appalachia. Finally, the findings from the focus groups confirmed that obesity, physical activity, and diet are influenced by individual, interpersonal, and community-level factors.

Several limitations to this study should be noted. First, our study populations were sampled from community leaders and parents in five West Virginia counties, therefore findings reported here may not be generalizable to other rural areas. Second, although the focus of our study was rural communities, there was variety with regard to the population density of the five counties and participants reported living in remote locations and populated areas of town. Thus, although we
sought to capture a detailed view of rural communities in Appalachia, there is more than one type of rural community. Third, data used for this study were collected in 2003 as part of a larger project. However, Census data from 2000 to the present indicate that socio-economic conditions have remained relatively constant during this period, and Behavioral Risk Factor Surveillance Survey data demonstrate small increases in obesity from 2003 to 2007. Finally, the methodology of using a priori coding is a limitation in that data can be forced into categories. However, the use of multiple coders, assessing reliability and identifying themes by consensus increases the integrity of the coding process and helps ensure that themes accurately represent the data present in the transcripts.

2.4.2 Conclusion
The results from focus groups conducted with parents and community members across 5 rural communities in West Virginia confirmed factors at the individual-, interpersonal-, and environmental-level play a role in influencing obesity and the related health behaviors. Although many barriers to physical activity and healthy eating were cited, the strengths of the community such as trust of neighbors close family networks, and an overall willingness to help maybe the foundation upon which to build efforts that can improve infrastructure, enact policy, establish programs, and ultimately bring about behavior change in these rural communities. Important considerations for future rural focused research should emphasize objective measurements of community resources (food and physical activity) and the social environment. The results from this study combined with quantitative measures of the rural social and physical environment can help inform strategies for all levels of obesity prevention.
Table 1. Focus Group Questions

<table>
<thead>
<tr>
<th>Focus Group Interview Guide: Sample Questions</th>
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</thead>
<tbody>
<tr>
<td>1. Is weight much of a concern for people here?</td>
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<tr>
<td>2. What can you tell us about the health of people in your community?</td>
</tr>
<tr>
<td>3. Are people in your community knowledgeable about risk factors for heart disease? For diabetes?</td>
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<tr>
<td>4. Do people in your community think having good health is something people can control, or do they think that it is due to fate or luck? Do people think that maintaining good health is their responsibility?</td>
</tr>
<tr>
<td>5. How would you describe the eating habits of people in this community?</td>
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<tr>
<td>6. Would you consider people in this community to be physically active or generally sedentary?</td>
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<tr>
<td>7. Are children more or less active than the adults?</td>
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<tr>
<td>8. What might be some local barriers to healthy eating?</td>
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<tr>
<td>9. What are some of the local barriers to exercise (for adults and children)?</td>
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<tr>
<td>Characteristic</td>
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<td>--------------------------------</td>
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<tr>
<td><strong>Gender, n (%)</strong></td>
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<tr>
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<tr>
<td>Male</td>
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<tr>
<td><strong>Average age in years</strong></td>
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<td><strong>Range</strong></td>
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<td><strong>Education n (%)</strong></td>
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<td>Graduated from high school</td>
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<td>Some college</td>
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Table 3. Themes and Associated Social-Ecological Theory Level

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<th>Level 1 Coding</th>
<th>Level 2 Coding</th>
<th>Theme</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Obesity/Overweight</td>
<td>General</td>
<td>1. Community concern for obesity: Participants acknowledge obesity increasing.</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>Individual</td>
<td>No themes emerge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of information</td>
<td>No themes emerge</td>
<td></td>
</tr>
<tr>
<td>2) Physical Activity/Sedentary Behavior</td>
<td>Physical Activity Behavior</td>
<td>2. Physical activity in the community: Active community members walk or participate in sports leagues. However, a large portion of the community is inactive.</td>
<td>2. Individual</td>
</tr>
<tr>
<td></td>
<td>Social Environment PA</td>
<td>3. Physical activity programs: Programs for physical activity exist but more programs for youth and support groups for PA are needed.</td>
<td>3. Community</td>
</tr>
<tr>
<td></td>
<td>Physical Environment PA</td>
<td>4. Barriers to physical activity and physical activity opportunities: Communities have outlets for PA but there are barriers to access. Also there is need for improved infrastructure for walking.</td>
<td>4. Community</td>
</tr>
<tr>
<td>3) Nutrition</td>
<td>Nutrition Behavior</td>
<td>5. Poor diets are related to obesity: Overeating and eating junk foods is a primary reason for obesity.</td>
<td>5 &amp; 6. Individual</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Factors facilitating poor diets: Poor dietary habits are related to cost, convenience, knowledge, and tradition.</td>
<td></td>
</tr>
<tr>
<td>Physical Environment Nutrition</td>
<td>7. <strong>Limited access to health foods</strong>: Participants voiced frustrations with access to unhealthy food at various venues such as grocery stores, schools, and other food outlets.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Social Environment Nutrition  | 8. **Role of family and diet**: Parents and families play a role in healthy eating which is further shaped by culture.  
9. **Need for nutrition education**: Although community leaders reported the presence of nutrition education programs, many parents identified need for nutrition education. |
| Social Environment Challenges  | 10. **Community challenges**: Participants indicate their community has a number of challenges to face such high poverty, high unemployment and an aging population. |
| Social Environment Strengths   | 11. **Community strengths**: Participants indicate their community has a number of strengths and strong qualities such as close family ties and community, low crime, and an overall willingness to help. |
| 5) Environment                 | **Dropped – redundant**                                                                                                          |
| Environment Physical Activity  |                                                                                                                                 |
| Environment Nutrition          | **Dropped – redundant**                                                                                                          |
| General Environment            | **No themes emerged**                                                                                                            |
2.5 References


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Chapter 3
Chapter 3

Abstract: Ecological frameworks have been used increasingly to help researchers understand community characteristics contributing to the childhood obesity epidemic. Despite the increased obesity risk observed in rural areas, few ecological studies have focused on rural youth and only a limited number have considered the community environment around schools. Thus, the current study characterized the social and physical environments of communities surrounding 34 West Virginia elementary schools and examined associations between environments and school-level obesity by gender. The number of food and physical activity (PA) resources within a 1km- and 5km radius of a school was determined and resource availability per 1,000 residents (density) was calculated using population data for the 5km area. Descriptive statistics, t-tests, chi-square tests, and logistic regressions were conducted using PASW-18. Results demonstrated fast food establishments and convenience stores to be readily accessible to elementary schools, as the majority of schools had at least one within a 1km distance. At 5km, all schools had at least one convenience store and fast food establishment, while 25% of schools lacked the presence of a grocery store. School communities had the greatest access to recreation facilities with 50% of schools having at least one recreation facility within 1km of the school and 94% of schools having one within 5km. The majority of schools lacked access to parks (N=2) or trails (N=1) at a 1km distance and nearly a third of schools lacked access to such facilities at a 5km distance. When publically available school facilities were included in the parks and trail categories, the percentage of schools with these facilities at 1 and 5km dramatically increased. The results of our negative binomial regression found no significant association between food and PA resources and student obesity rates. This study marks an important contribution to obesity research in rural settings by demonstrating the ease of access to unhealthy food outlets and limited support for healthy eating and physical activity in these 34 elementary school communities. Our findings also highlight the role schools can play to increase access to PA resources and the potential importance of pursuing joint use agreements.
3.1 Introduction

Recent research indicates that nearly one third of children in the United States are overweight or obese.\textsuperscript{1,2} While the rates of childhood obesity have held fairly constant over the last 10 years, the fact that 1 in 3 children in the U.S. are affected remains a major public health concern.\textsuperscript{1} This concern is warranted given the numerous short- and long-term consequences of obesity, such as diabetes, high cholesterol, heart disease, and high blood pressure.\textsuperscript{3-7} The long-term consequences of childhood obesity have been projected to result in decreased life expectancy for the current generation of youth.\textsuperscript{8,9} Thus, an urgency has been attached to childhood obesity prevention efforts.

Within the United States, childhood obesity has been shown to disproportionately impact certain communities. The higher prevalence of childhood obesity among high minority and low income communities has been well documented.\textsuperscript{10-13} Along with these factors, increased likelihood for childhood obesity has also been demonstrated in certain geographic areas, including regions of the Midwest, South, and Appalachia. In addition, rural youth have been shown to be 25-47\% more likely to be obese compared to peers living in urban areas and small cities.\textsuperscript{14,15} These statistics emphasize the need for further study examining contextual factors influencing obesity and related health behaviors in rural regions.

The community characteristics believed to contribute to the increased risk of obesity have been tied to environmental supports for physical activity and nutrition. From a theoretical framework, this is consistent with Social Determinants of Health and ecological theory, which emphasize the multi-level influences on health behaviors and health outcomes.\textsuperscript{16-18} With regard to nutrition, an individual’s access to quality foods has been associated with a decreased risk for obesity and an increased likelihood of meeting the recommended guidelines for fruit and vegetable consumption.
among both adults and youth.\textsuperscript{19,20} One recent study in East Harlem found the presence of one or more convenience stores in close proximity to a child’s home was associated with a higher BMI percentile.\textsuperscript{21} In addition, state and county-level analyses have demonstrated significant positive correlations between the number of fast food restaurants per capita and obesity rates.\textsuperscript{22,23}

A growing body of research has documented the food environment in rural areas, with methods mainly focused on characterizing access.\textsuperscript{24-27} As expected, median food store densities per 10,000 residents for convenience and fast food establishments far out numbered densities for grocery stores, and the healthiest food options are found in the latter store type.\textsuperscript{24,28} It has also been noted that associations between the food environment and obesity in rural areas have been mixed, indicating a need for further research, particularly among rural youth.\textsuperscript{25,28,29}

Opportunities for physical activity within the community have also emerged as important considerations in childhood obesity prevention. Environmental factors such as pleasant scenery, presence of trails, parks, recreational facilities, and light traffic, have been shown to have significant positive associations with higher rates of physical activity and lower rates of overweight and obesity.\textsuperscript{30-32} Although limited, research specific to rural areas has also found significant associations between characteristics of the physical environment, physical activity and obesity.\textsuperscript{33} Studies suggest that rural residents living in close proximity to trails, recreational facilities or parks are less likely to be inactive or obese.\textsuperscript{34} Even among children, a greater number of recreation opportunities has corresponded with greater levels of physical activity,\textsuperscript{35-42} and studies indicate environmental resources may impact the physical activity levels of boys and girls differently.\textsuperscript{13,38,41,43,44} Although the body of literature is growing, there remains much to be learned about how physical environments in rural areas impact obesity.
As noted, research has established higher rates of obesity in low income areas.\textsuperscript{12, 13, 45, 46} Social environment factors considered when defining low income have included: median income, percent of residents living in poverty, percent of residents unemployed, and/or percent of residents with less than a high school education. Whether examined at state, county, census tract, or census block group levels, areas with poor socio-economic conditions are less likely to have access to physical activity facilities and quality food environments.\textsuperscript{13, 47-49} Among children and adolescents, area-level poverty, unemployment, and low education have been commonly used to measure socio-economic condition and demonstrated significant positive associations with obesity and physical inactivity.\textsuperscript{12, 50, 51} Further, these associations have been shown to differ by gender, as females living in economically disadvantaged neighborhoods appear to be at greater risk of obesity and inactivity than males living in similar communities.\textsuperscript{48, 51}

Beyond the environment around the home, research has also begun to assess environments around the school, and has indicated many schools have convenience stores or fast food establishments within walking distance but limited availability of fresh fruits and vegetables.\textsuperscript{52-56} In addition, greater densities of fast food restaurants around the school have been shown to occur in low income communities.\textsuperscript{55, 57} Three studies to date have considered the association between food environment around schools and obesity; one in Canada (percent obese =5.7\%) and two in California (percent obese=10.4-12\%).\textsuperscript{58, 59} Small but significant positive associations were found between child overweight or obesity and the presence of fast food or convenience stores in close proximity of the school in the two California studies.\textsuperscript{59, 60} However, no significant relationships were found between the food environment around schools and child obesity in the Canadian study.\textsuperscript{58}
The physical activity environment around schools has been studied to a lesser extent than the food environment. In a recent study conducted by Tucker et al., in London Ontario, the presence of parks and recreation facilities within the community environment around the school and the home was measured among a sample of seventh and eighth graders. In both locations, a greater number of recreation facilities corresponded with higher levels of physical activity.\(^{40}\) A second study by Trilk et al., considered the influence of recreational facilities on the physical activity levels of high school girls. Objective measures of recreational facilities were modeled against minutes of moderate to vigorous activity among a sample of students attending rural and non-rural high schools. The results of the study found girls attending a high school with more than 5 recreational facilities in the surrounding community were more likely to report higher levels of physical activity than girls attending schools with fewer than 5 facilities.\(^{39}\) To our knowledge, these are the only studies to date examining the availability of physical activity environments around schools. As noted by Tucker et al., “compared to adult populations it seems logical that youth are much more captive to the opportunity structures defined by their home and school neighborhoods.”\(^ {40}\) By determining access to food and physical activity opportunities around schools, there is the potential to determine factors within the rural environments that may be modified to increase physical activity, improve diet, and decrease childhood obesity. Further, this information could be used to develop focused interventions likely to have great impact for youth. This research is urgently needed to expand the existing knowledge base and help guide obesity prevention efforts.

West Virginia provides a particularly relevant setting to study childhood obesity as it is consistently ranked among the states with the highest rates of adult and childhood obesity, and nearly 65% of the population lives in rural areas.\(^{61-63}\) In addition to obesity, the state is also
burdened with high rates of chronic disease,\textsuperscript{64} which are likely to increase given the early onset of conditions such as diabetes and high cholesterol among today’s overweight and obese youth.\textsuperscript{64}

The primary goal of this study was to determine the characteristics of the social and built environments (food and physical activity) surrounding elementary schools in West Virginia. Secondary goals were to examine potential differences between schools with high and low obesity prevalence, and to assess the relationships between characteristics of the social and physical environments and school-level obesity by gender.

### 3.2 Methods

#### 3.2.1 Sample

**3.2.1.1 Schools**

A convenience sample of 34 schools was used in the present study. Selection was based on Physical Education (PE) teacher participation in the West Virginia Health and Physical Education Academy training during the 2007-08 school year. PE teachers from 34 schools throughout the state were trained in standardized methods for height and weight measurement and provided these data to the West Virginia University Health Research Center.

**3.2.2 Measures**

**3.2.2.1 Body Mass Index**

Body mass index (BMI) assessments of fifth grade students conducted as part of the Year One Evaluation of the West Virginia Healthy Lifestyles Act were used to provide estimates of school-level obesity prevalence.\textsuperscript{65} Trained physical education (PE) teachers at 34 schools throughout West Virginia measured the heights and weights of fifth grade students in their schools and recorded age, date of birth, and gender. Measurements were obtained from 94\% of all fifth
graders across the 34 schools (N=1640). A reliability analysis, conducted with a randomly chosen sub-sample of fifth grader students (n = 114) yielded a high correlation between two separate BMI measurements ($r = .98$, $p < .001$). BMI percentiles were calculated using Epi Info version 3.5, and weight categories (underweight, healthy weight, overweight, and obese) were determined using standard cutoffs.

3.2.2.2 School Location

The physical locations of the 34 schools were determined using data from the West Virginia GIS Technical Center. Coordinates of 885 West Virginia schools grades PK-12 were captured in 2004 by the WV Army National Guard as part of the state’s Drug Task Force Efforts. One of the 34 schools was built after 2004, and coordinates for this school were recorded on site. All locations were verified using Google™ satellite images.

3.2.2.3 Defining Community

Consistent with previous research examining the food environment around schools, the community was defined as the area within a 1 km radius (walkable destinations) or a 5km radius (larger community) of an elementary school. When the buffer exceeded West Virginia state boundaries, only the area within the state was included in our analysis and the number of resources were weighted to reflect the number of establishments given a 5km area.

3.2.2.4 Physical Activity & Food Environment

The number of physical activity resources (parks, recreation centers, and trails) and food resources (fast food restaurants, grocery stores, and convenience stores) within each community was determined using Google Maps™ and yellowpages.com. In the case of physical activity

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2 See Appendix A for representation of 1km and 5km buffers
resources, county parks and recreation websites were also used to supplement the Google Maps and yellowpages databases. To establish an anchor, the school coordinates were used along with a series of search terms. Searches were saved and coordinates were obtained for each of the resources. Food and PA resource databases were then cleaned, eliminating duplicate locations and those that did not qualify as a food or physical activity outlet. Categories were evaluated and re-assigned as needed based on established definitions of food and physical activity outlet types. The main food resource categories were fast food restaurants (major chain fast food outlets, local fast food chains, pizza shops/restaurants, and sub/sandwich shops) convenience stores, and grocery stores. Although both healthy and unhealthy items can be found in grocery stores and certain fast food retailers, particularly sandwich shops, grocery stores were considered a healthy food resource given the large variety of foods sold having high nutritional value (fruits, vegetables, dairy products, meats) when compared with foods sold at fast food establishments (CDC Guide to strategies for reducing the consumption of energy dense foods 2010). The main physical activity resource categories were parks, trails, and recreational facilities. After calculating as the crow flies distances, a count for each food and physical activity resource category was determined within the 1km and 5km buffers. Last, school physical activity resources within the 1km and 5km buffer were added to the PA list if a school made facilities available for public use. Principal and physical education teacher responses from surveys conducted during the year 2 evaluation of the Healthy Lifestyles Act were used to determine the types of outdoor facilities on the school campus and whether facilities were available to the public. The availability of school yards with courts, fields, or playground equipment was then

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3 See Appendix B for a list of food and physical activity resources search terms
4 See Appendix C for step by step methodology
5 See Appendix D for physical activity outlet definitions
6 See Appendix E for food resource definitions
considered a park following the definitions used in a recent study. A small validation study of 3 school communities was conducted after resource databases were compiled to determine accuracy. The results of the validation are presented in Appendix f.

3.2.2.5 Rurality

The degree of rurality in communities surrounding WV elementary schools was determined using data from the National Center for Educational Statistics (NCES). The NCES provides a classification code based on distance from urban center and the population density of the communities surrounding schools. Locale coding information is based on a listing of West Virginia schools for the 2007-08 school year. The 12 identified classifications of rural-urban were collapsed into four major categories: city, suburb, town, and rural.

3.2.2.6 Social Environment

The social environment was defined as the aggregated socio-economic condition of the community. Unemployment rate, median household income, percent than with less than a high school education, and total population were extracted at the census block group level from census.gov. The extracted census block group data files were merged with a West Virginia block group shapefile using QGIS 1.5.0. School locations were then intersected with the new shapefile and 5km buffers were created. Using QGIS geometry tools, the area of each census block group within the buffer was calculated and recorded. The area contributed by an intersecting block group was used to create a weighting factor for census variables (unemployment, income, education, and population), allowing statistics specific to the 5km area

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7 See Appendix F for description of resource validation
8 See Appendix F for the NCES locale code definitions
to be calculated. 9 Similar methods have been used in previous research for calculating population density of the buffer.79

Using methods from previous research,55 an SES index for each buffer was calculated based on unemployment rate, median household income, and percent of the population with less than a high school diploma. All variables were coded so that higher values reflected a more favorable socio-economic environment.

To capture racial and ethnic diversity, the percent minority reported for each school during the 2007-08 school year was obtained from the WV Department of Education website.80 A full description of all variables can be found in Table 1.

3.2.2.7 Standardized Food/Physical Activity Resource Availability

A standard measure of resource availability per 1,000 residents was calculated for each of the main food and physical activity categories. Previous work has used this or comparable approaches to arrive at a population adjusted measure of food environment density.29, 55, 58, 81 The number of each food and physical activity resources and the population for the buffer was used to arrive at availability of establishments per 1,000 residents.

3.2.3 Data Analysis

All analyses were conducted using IBM SPSS 19. Descriptive statistics were assessed for demographic and primary study variables (obesity, food environment resources, physical activity environment resources, and socio-economic index). Differences in socio-economic conditions, PA resources, and food resources by high and low obesity prevalence schools were examined with chi-square or t-tests for the 1km and 5km buffers. Because few food and PA resources were

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9 See Appendix G for further description of calculating census statistics for the 5km buffer
present within the 1km radius, counts were dichotomized into present or absent and chi square tests were conducted. At the 5km radius, the number of resources per 1,000 residents was used. Differences in the SES index were only assessed at the 5km radius. Significance was set at p < .05.

The final analysis for the study involved a negative binomial regression testing the relationship between high and low obesity schools and variables representing the social and physical environment of the community. Regression models were evaluated for outliers, multicollinearity, adequate cell sizes, and overdispersion. The hypotheses tested included the following: 1) schools with a greater number of parks, recreation centers and grocery stores are less likely to have high obesity, 2) schools with a greater number of convenience stores and fast food restaurants will be more likely to have high obesity, and 3) schools with more favorable social environments will be less likely to have high obesity.

3.3 Results

3.3.1 Descriptive Statistics

3.3.1.1 Schools

The 34 schools were distributed across 16 counties, and approximately half of the schools (53%) fell within the NCES rural classification. Of the remaining 16 schools, 2 locations were classified as small city, 2 as suburb, and 12 were considered small town. Average school enrollment was 352 students (SD = 181.1) with a range of 133 to 950. The majority of schools had a student body that was primarily white (mean percent white = 91%, SD = 18%). A geographic distribution of the schools is provided in Figure 1.

Of the 1640 5th grade students measured, 3% were underweight (N=53), 49% healthy weight (N=808), 18% overweight (N=296), and 30% obese (N=483). These proportions followed the
same general distributions when examining weight categories for male (N=845) and female (N=795) students separately. At the school-level, obesity prevalence ranged from 5.9% to 50% with similar ranges observed for girls (10-64%) and boys (0-55%).

### 3.3.1.2 Food Resources

Approximately half of the schools (N=18) had at least one fast food establishment within walking distance (1km) and the number of establishments per school ranged from 1 to 14. Nearly 25% (N= 9) of schools had at least one grocery store located within a 1km radius. Convenience stores were the most prevalent food resource, with over two-thirds (N =23) of schools having at least one store within a 1km radius. At the 5km distance, all schools had at least one convenience store and 76% had at least one grocery store. The median number of food resources per 1,000 residents was highest for fast food (4.9) and convenience stores (3.3) and lowest for grocery stores (1.3). Table 2 provides details regarding the number and percent of schools with each establishment type at the 1km and 5km distance and the median number by area and per 1,000 residents.

### 3.3.1.3 Physical Activity Resources

The number and density of physical activity resources is also provided in Table 2. At the 1km distance, the most prevalent PA resource was recreation facilities with 50% of schools having at least one such establishment. When publicly available school facilities were included in the parks and trail categories at the 1km distance, the proportion of schools with access to parks and trails/tracks increased to 100% and 47%, respectively; similar increases were seen at the 5 km distance. Including school yards in the parks category indicated that 100% of schools had at least one park type location within 5 kilometers, with a median of 3 for the 5km area. As shown in Table 2, this was also true for trails as 68% of schools had at least one trail/track at the 5km...
radius, but nearly all schools (94%) had at least one in the 5km area when including trails or tracks available on schools grounds. The median number of PA resource by area and per 1,000 residents is also provided in Table 2.

**3.3.1.4 Community Socio-Economic Conditions**

Variability was observed for the three indicators of socioeconomic condition: percent unemployed ranged from 2.7% to 9.7% (M =7%, SD = 1.5%), percent of population with less than a high school education ranged from 16.5 to 42.85 (M = 25.9, SD = 5.4), and median household income ranged from $21,409 to $41,084 (M =$29,701, SD = $4,631). Rankings for each of these three variables were added to obtain the SES index of the 5km area (item-index correlations ranged from $r$.77-.86, $p$.001, alpha=.84) with higher SES index scores reflecting more favorable socio-economic conditions of the community (higher median income, low percentage of the population with less than a high school education, and low unemployment). The SES index across the 34 communities ranged from 5 to 96 (M=52.5, SD=26).

**3.3.2 Chi Square and T-tests**

**3.3.2.1 Resources Differences among High & Low Obesity Schools**

The two groups were divided into schools above (n=14) and below the median percent obese (n=14), with values centered around the median excluded (n=6). Obesity prevalence ranged from 5.9% to 27.5% among the below median schools and from 31.3% to 50% among the above median schools. At the 1km distance, food and physical activity categories were collapsed into “present” or “not present”. Chi-square tests to examine differences in the 1 km presence of food and PA resources between high and low obesity schools revealed no significant differences (all $ps > .05$). Resource and community SES differences between high and low obesity schools at the 5km distance were examined using Independent sample T-tests. Because the distribution of food
and physical activity density variables were highly skewed and the variances were unequal, a square root transformation was applied. No significant differences between high and low obesity schools were found for food resources \([t \ (1.2-1.3), \ p=.21-.25]\), physical activity resources \([t \ (.3-1.2, \ p=.24-.79)\] ), or SES \([t \ (1.1), \ p=.26] as shown in Table 3.

3.3.3 Negative Binomial Regression
A negative binomial regression was conducted to examine the relationship between high and low obesity prevalence schools and eight predictor variables: 5km density of fast food, convenience stores, grocery stores, trails, parks, and recreation facilities; SES index; locale code (rural, non-rural) ; and percent of non-minority students per school. The negative binomial regression was deemed the most appropriate method of analysis due to the nature of the dependent variable (count data) and the presence of overdispersion. The dependent variable (number of obese 5th grade youth per school) was weighted by the total number of 5th graders screened and the model was run with the robust estimator function to account for possible clustering of the independent variables. Based on previous research suggesting females and males are likely to interact with social and physical activity environments differently,\(^{41, 44, 48}\) separate models were run by gender. Examination of linearity statistics revealed the fast food density variable contributed multicollinearity to the full model with a tolerance statistic of .06 and a variance inflation factor (VIF) greater than 10 (approximately 17 for both female and male regression models). Further, Pearson’s correlation revealed multicollinearity due to the high correlation between fast food and grocery stores \((r=.91, \ p<.001)\).\(^{82}\) For this reason, fast food was taken out of the full model and the regression was run with the remaining 7 variables. The negative binomial regression models predicting proportion of obese 5th graders per school as a function of the social and physical environment were statistically significant for females (likelihood ratio chi-square= 83.96, \(df=8, \ p<.001\)) and males (likelihood ratio chi-square=66.69, \(df=8, \ p<.001\)). Although the model was
significant, the deviance statistic of 8.27 for females and 7.49 for males suggest poor model fit. In addition, none of the predictor variables were found to be significant at p<.05 as shown in Table 4.

3.4 Discussion
The primary goal of this study was to characterize the food and physical activity resources in communities surrounding West Virginia’s elementary schools. Although childhood obesity is a major public health concern across populations, understanding the community environments within West Virginia is particularly important as rates of child and adult obesity, and adult chronic disease, are significantly above the National average. From examination of descriptive statistics, it was found that there were limited supports for engaging in physical activity or healthy eating at the 1km and 5km distance from schools. Within the food environment, nearly one half of schools had a fast food restaurant within 1km and two-thirds of schools had at least one convenience store; all schools had at least one convenience store present at the 5km distance. Few schools had physical activity opportunities within close proximity to schools and approximately one third lacked any physical activity resources at the 5km distance. However, when publically-available school facilities were included in our physical activity resource categories, the percent of schools with access dramatically increased; demonstrating the potential importance of making school facilities available to the public.

Our finding that nearly 50% of schools in our sample had one or more fast food establishments within 1km was fairly consistent with other studies measuring the food environment within a walkable distance of the school (1km or less). Studies of the food environments surrounding public schools in Los Angeles County California and Chicago, Illinois, found that 65% and 75% of schools, respectively, had one or more fast food establishments within an 800m
Researchers in Canada, using methodology similar to that of the current study, reported a slightly lower percentage of schools with fast food within 1km (31%), and suggested that the slightly lower occurrence of fast food might be related to greater income disparities in the U.S. and a higher number of fast food chains. When considering access to convenience stores, a greater percentage of schools in our sample had a convenience store within 1km or 5km compared to previous research, which may be a feature of the rural environment. This study also found that the median density of food resources, (measured as the median number of establishments per 5km buffer) was higher for convenience stores and fast food establishments and lower for grocery stores in the West Virginia sample when compared with the Canadian study conducted by Seliske and colleagues. In addition, a much higher percentage of the overall sample in this WV study (29%) were found to be obese when compared with the previous research examining similar associations (e.g., 5.7% classified as obese in the Canadian study). Despite the lack of association between the food environment and percent obese, the current study documents the severity of the childhood obesity epidemic in West Virginia and the limited access to quality food resources in the communities surrounding schools. Thus, this study marks an important contribution to the research examining food environments in rural areas, particularly in the communities surrounding schools, and our findings point to the need for further research.

This study was among the first to examine physical activity resources within the community environment surrounding schools. Because these environments provide opportunities for physical activity outside of the school day, they are a critical aspect of obesity prevention for youth as well as the greater community. Although two prior studies examined the availability of physical activity resources surrounding schools, the data were presented as dichotomized...
categories, thus limiting the ability to fully characterize access to physical activity opportunities or directly compare results across studies. A strength of the current study lies in the fact that the physical activity environment around school was characterized using continuous data, allowing for a variety of indices to be calculated (i.e., the percent of schools with facilities present, the range, and median density across community). A major contribution of the current research was the inclusion of publicly available school facilities, as it provides a more accurate estimate of the physical activity resources available to the community. In capturing this level of information we were able to quantify how school facilities increase the physical activity opportunities for communities. As described, including publicly available school resources increased access to parks from 6% to 100% at the 1km distance and from 65% to 100% at the 5km distance. Access to trails also increased at 1km (2.9% to 47.1%) and 5km (67.6% to 94.1%). This highlights the importance of schools working with communities and making facilities available beyond the school day, particularly in rural communities. These data also provide support for policies requiring joint use agreements between schools and communities, which have been successful in reducing disparities in PA access in urban areas. Although no significant associations were observed in our small sample between high and low obesity prevalence schools and characteristics of the food, physical activity, and social environments, the means were as expected, suggesting that schools with obesity prevalence below the median had greater food and physical activity resources and more favorable socio-economic conditions. Similarly, the results of the negative binomial regression models did not find significant associations between predictor variables and school-level obesity, but several of the coefficients demonstrated values in the expected direction. The fact that outcomes of our statistical tests varied in the expected direction (though not significant) suggests the potential
influence of social and physical environments in relation to childhood obesity and the need for further research.

3.4.1 Limitations

Several limitations of the current study should be noted. First, *as the crow flies* distances were used to evaluate the number of food and PA resources with 1- and 5km buffers of the 34 schools. Due to the mountainous terrain found throughout the state, particularly in the most rural areas, the straight-line distance may substantially underestimate the actual distance between two points. Future research should seek a mechanism to account for elevation change and limited road access, such as with an index of road density, or use a methodology that more accurately captures walkable destinations and easily reached community locations. Second, though measures of food, physical activity, and social environment were standardized to the same 5km area, the area defined as the community around the school may not correspond with actual school catchment areas. However, the use of catchment areas would have created large variation in the spatial area for social and physical environments, and these areas are subject to change over time. Third, we only accounted for permanent food stores and PA resources within a physical location. Thus, our food environment did include farmer’s markets or food pantries and our PA listings did not include programming such as sports leagues or community exercise programs, which have been identified as an important element for physical activity among rural youth.86 Finally, as noted, the small sample size (34 schools) did not provide us with sufficient power to detect environmental influence of obesity. However, this work yielded findings that raise further questions about the physical environment in rural areas and supports the need for future research.
3.4.2 Implications and Future Research

Findings from this study provide implications for public health policy and practice as well as guidance for future research. First, the ease of elementary school student access to fast food establishments and convenience stores is concerning given that these establishments primarily offer calorically dense items with minimal nutritional value. Because there was limited availability of establishments offering healthy options (grocery stores) in the 34 communities, policies could be established to encourage or require convenience stores and fast food establishments to offer healthy snacks. Initiatives such as the Food Trust’s Healthy Corner Stores might be applicable to this rural environment, given the volume of convenience stores observed in this study. Additionally, the ease of access to unhealthy food resources may work against school-based obesity prevention initiatives, as noted by Sturm and co-authors. School wellness committees and groups working toward school-based obesity prevention would be well advised to form partnerships with food retailers in the community and local policy makers. Through these partnerships, school committees might work toward the goal of increasing access to healthy foods in the community surrounding schools. Similar work could also be done to improve access to physical activity resources in these communities. As our descriptive work demonstrated, few school communities had access to facilities but when school facilities made available outside the school day were included, the percent of schools communities with resources available increased to nearly 100%. Thus demonstrating that in many rural areas, school facilities may present the only location for the community to engage in physical activity outside the home. Again, the partnership of policymakers, school committees, and the greater community is essential to improving access to physical activity resources. At the
state-level, work needs to be done to help schools overcome barriers to making facilities available, such as the high cost of liability insurance.

It should be noted that the lack of significant associations observed in the current study may be related to the use of obesity as the outcome of interest. Using the social-determinants of health framework, obesity is a more distal outcome, and health behaviors such as diet and physical activity levels are more proximal.\textsuperscript{16} Thus, examining food environments in relation to dietary behaviors and physical activity environments in relation to amounts of moderate to vigorous physical activity may shed greater light on the influence of the physical environment in rural areas. Future work should seek to examine these relationships in rural settings. In addition, the fact that the current study did not account for mode of transportation to school should be noted. This may be an important factor in determining how a child interacts with the environment around their school. When children are bused to school or driven by their parents, particularly if they live at some distance from the school, the children may have limited opportunities to interact with this community environment. However, when youth walk or bike to school they may be more likely to frequent convenience stores and fast food restaurants or to use parks and trails in the community environment surrounding schools. The inability to include a mode of transport measure in the current study may provide a partial explanation for the lack of significant associations between the community environment and BMI.

3.4.3 Conclusion

This study adds to a growing body of research exploring physical environments as they relate to childhood obesity in rural areas. Although the importance of individual- and family-level factors cannot be understated, this work contributes needed information about environmental factors potentially influencing the higher obesity rates observed in rural areas. In addition, the community surrounding schools is likely to reflect the general community of rural areas. Thus,
the food and physical activity environments not only impact youth, but all members of the community. Characterizing the food and physical activity environments around schools in rural areas contributes to our knowledge base and offers implications for policy and environmental change interventions at the school- and community-levels. To help guide these efforts, future research should consider more proximal outcomes in relation to the environment around schools (i.e., physical activity and dietary behavior).
<table>
<thead>
<tr>
<th>Table 1. Study Variables and Descriptions</th>
</tr>
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<tr>
<td><strong>Reference Variable</strong></td>
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<tr>
<td>School Location</td>
</tr>
<tr>
<td><strong>Dependent Variable</strong></td>
</tr>
<tr>
<td>School BMI</td>
</tr>
<tr>
<td><strong>Demographic Variables</strong></td>
</tr>
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<td>Minority Status</td>
</tr>
<tr>
<td><strong>Built Environment: Nutrition</strong></td>
</tr>
<tr>
<td>1. Fast Food</td>
</tr>
<tr>
<td>2. Convenience</td>
</tr>
<tr>
<td>3. Grocery Stores</td>
</tr>
<tr>
<td><strong>Built Environment: Physical Activity</strong></td>
</tr>
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<td>1. Parks</td>
</tr>
<tr>
<td>2. Recreation Centers</td>
</tr>
<tr>
<td>3. Trails</td>
</tr>
<tr>
<td>4. School Parks</td>
</tr>
<tr>
<td>5. School Trails</td>
</tr>
<tr>
<td><strong>Social Environment</strong></td>
</tr>
<tr>
<td>1. Unemployment</td>
</tr>
<tr>
<td>2. Education</td>
</tr>
<tr>
<td>3. Median Household Income</td>
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Figure 1. Geographic Distribution of Schools
Table 2. Food and Physical Activity Resources surrounding 34 West Virginia Elementary Schools

<table>
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<th>Food Store Category</th>
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<th>5km</th>
<th></th>
<th></th>
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<tr>
<td></td>
<td>Number of</td>
<td>range</td>
<td>Number of</td>
<td>range</td>
<td>Median</td>
<td>Median</td>
<td></td>
</tr>
<tr>
<td></td>
<td>schools (%)</td>
<td></td>
<td>schools (%)</td>
<td></td>
<td>number of</td>
<td>stores per</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>locations</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>within 5km</td>
<td>residents</td>
<td></td>
</tr>
<tr>
<td></td>
<td>buffer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast Food</td>
<td>16(47)</td>
<td>1-14</td>
<td>29(85.3)</td>
<td>1-54</td>
<td>6.5</td>
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<td></td>
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<tr>
<td>Grocery stores</td>
<td>9(26.5)</td>
<td>1-3</td>
<td>26(76.5)</td>
<td>1-15</td>
<td>1.3</td>
<td>1.5</td>
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</tr>
<tr>
<td>Convenience Stores</td>
<td>23(67.6)</td>
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<td>34(100)</td>
<td>1-26</td>
<td>4.6</td>
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<tr>
<td>Parks</td>
<td>2(5.9)</td>
<td>1</td>
<td>22(64.7)</td>
<td>1-6</td>
<td>1</td>
<td>.8</td>
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</tr>
<tr>
<td>Parks (including school facilities)</td>
<td>34(100)</td>
<td>1-5</td>
<td>34(100)</td>
<td>1-17</td>
<td>3</td>
<td>2.6</td>
<td></td>
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<tr>
<td>Trails</td>
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<td>23(67.6)</td>
<td>1-5</td>
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<tr>
<td>Trails (including school facilities)</td>
<td>16(47.1)</td>
<td>1-3</td>
<td>32(94.1)</td>
<td>1-7</td>
<td>1.2</td>
<td>1.8</td>
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<tr>
<td>Recreation Facilities</td>
<td>17(50)</td>
<td>1-3</td>
<td>24(70.5)</td>
<td>1-20</td>
<td>2.1</td>
<td>1.8</td>
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Table 3. Differences in 5km Food Resource Density by High-Low Obesity in Schools

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<thead>
<tr>
<th></th>
<th>Mean* of Low Obesity Schools</th>
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<th>df</th>
<th>p-value</th>
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<td>8.8(11.8)</td>
<td>6.3(7.8)</td>
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<td>0.25</td>
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<td>Grocery per 1,000</td>
<td>4.6(3.2)</td>
<td>3.1(1.9)</td>
<td>1.3</td>
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<td>Convenience per 1,000</td>
<td>7.1(6.2)</td>
<td>5.5(5.1)</td>
<td>1.2</td>
<td>26</td>
<td>0.21</td>
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<tr>
<td><strong>Physical Activity Resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parks per 1,000</td>
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<td>.6(1.3)</td>
<td>0.5</td>
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<td>Parks (including school) per 1,000</td>
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<td>1.5(3.2)</td>
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<td>0.45</td>
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<tr>
<td>Trails per 1,000</td>
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<td>.6(6)</td>
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<td>.6(1.4)</td>
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<td>Recreation Facilities per 1,000</td>
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<td>SES Index</td>
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<td>46.1</td>
<td>1.1</td>
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<td>0.26</td>
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<td>Percent of students White</td>
<td>91.3</td>
<td>93.7</td>
<td>-.41</td>
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*Food and Physical Activity Resource variables presented are based on the square root transformations. The untransformed mean is presented in parentheses.
Table 4. Negative Binomial Regression of School-level Obesity Schools as a Function of Community Environment Variables

<table>
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<tr>
<th></th>
<th>β (SE)</th>
<th>Wald</th>
<th>Sig.</th>
<th>Exp(β)</th>
<th>95% Confidence Interval</th>
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<td><strong>School-Level Obesity: Males only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Constant</td>
<td>.15(1.02)</td>
<td></td>
<td></td>
<td>1.00</td>
<td>(.75, 1.54)</td>
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<td>SES</td>
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<td>.07</td>
<td>.79</td>
<td>1.00</td>
<td>(.65, 1.33)</td>
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<tr>
<td>Locale (rural)</td>
<td>-.07(.18)</td>
<td>.16</td>
<td>.69</td>
<td>.93</td>
<td>(.65, 1.33)</td>
</tr>
<tr>
<td>Parks density per 1,000</td>
<td>.08(.08)</td>
<td>.85</td>
<td>.36</td>
<td>1.08</td>
<td>(.91, 1.29)</td>
</tr>
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<td>Recreation facilities per 1,000</td>
<td>-.06(.05)</td>
<td>1.87</td>
<td>.17</td>
<td>.94</td>
<td>(.86, 1.03)</td>
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<tr>
<td>Trails density per 1,000</td>
<td>.02(.11)</td>
<td>.04</td>
<td>.85</td>
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<td>(.82, 1.28)</td>
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<tr>
<td>Grocery density per 1,000</td>
<td>.04(.06)</td>
<td>.38</td>
<td>.54</td>
<td>1.04</td>
<td>(.92, 1.18)</td>
</tr>
<tr>
<td>Convenience density per 1,000</td>
<td>.04(.03)</td>
<td>2.21</td>
<td>.14</td>
<td>1.04</td>
<td>(.99, 1.10)</td>
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<tr>
<td>Percent white</td>
<td>.02(.01)</td>
<td>2.41</td>
<td>.12</td>
<td>1.02</td>
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<tr>
<td><strong>School-Level Obesity: Females only</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Constant</td>
<td>1.14</td>
<td>1.08</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>-.01(.00)</td>
<td>3.55</td>
<td>.06</td>
<td>.99</td>
<td>(.98, 1.00)</td>
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<tr>
<td>Locale (rural versus non-rural)</td>
<td>.36(.24)</td>
<td>2.18</td>
<td>.14</td>
<td>1.43</td>
<td>(.89, 2.30)</td>
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<td>Parks density per 1,000</td>
<td>.04(.11)</td>
<td>.15</td>
<td>.70</td>
<td>1.04</td>
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<tr>
<td>Recreation facilities per 1,000</td>
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<td>.56</td>
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<td>Trails density per 1,000</td>
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<td>.24</td>
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<td>Grocery density per 1,000</td>
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<td>.42</td>
<td>1.06</td>
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<td>Convenience density per 1,000</td>
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<td>1.47</td>
<td>.22</td>
<td>1.06</td>
<td>(.97, 1.21)</td>
</tr>
<tr>
<td>Percent White</td>
<td>.01(.01)</td>
<td>1.03</td>
<td>.31</td>
<td>1.01</td>
<td>(.99, 1.03)</td>
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</table>
3.5 References


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Chapter 4
Abstract: The epidemic of childhood obesity has been largely attributed to energy imbalance (calories consumed exceed calories burned). Both current research and conceptual models offer insight into how the environment plays a role in this equation. Despite the fact that rates of obesity are disproportionately higher among rural youth when compared with urban and suburban peers, research examining ecological correlates among this population remains limited. The purpose of the current study was to examine direct and indirect relationships between the social and physical environments (food and physical activity) in relation to child fruit and vegetable (FV) intake, physical activity and BMI percentile. Survey data were used to obtain information regarding child behavior and family demographics. GIS technology was employed to objectively measure the environments within a 1km and 5km radius of a child’s school. Analyses included descriptive statistics (IBM SPSS 19.0) and structural equation modeling (SEM) using AMOS 18.0. Results indicated the majority of schools had greater access to unhealthy food resources when compared with healthy food or physical activity resources; highlighting the challenges of achieving energy balance in these environments. SEM analyses revealed the social environment of the community was a significant predictor of the density of community resources. No associations were observed between environmental characteristics and physical activity, FV intake, or child BMI percentile. This study marks an important contribution to the literature regarding obesity in rural areas and is among the first to consider the relationship between resources in the community environment around schools and physical activity behavior. Further study to determine where rural youth are active and factors that may influence access to food and physical activity resources is warranted.
4.1 Introduction
Childhood obesity is one of the leading public health issues in the U.S. today. Current research indicates nearly 35% of youth ages 6-19 are overweight and 19% are obese.¹ These rates have been shown to be even higher in rural areas where youth are more likely to be obese when compared with peers living in non-rural areas.²,³ Most recently, a study using objectively measured height and weight from the National Health Assessment Examination Survey (NHANES) found a significantly greater percentage of rural youth were obese (21.8%) than urban youth (16.9%).⁴ Given the many health consequences of childhood obesity that may present in childhood and persist into adulthood,⁵-⁷ research to uncover the factors influencing childhood obesity in rural areas is critical.

Obesity has been attributed to energy imbalance; meaning energy intake exceeds energy expenditure.⁸,⁹ Although individual-level factors related to human genetics and physiology play a role in this equation, the imbalance is largely attributable to behavioral mechanisms.⁹,¹⁰ The significance of this concept to public health prevention lies in the fact that behaviors related to energy intake (dietary) and energy expenditure (physical activity) may be modifiable. Further, the potential to impact behavior is apparent when considering changes in weight status and weight-related behaviors track with changes in the environment and lifestyle over time.¹¹-¹⁶ For example, a study by Nielsen et al., found that between 1977 and 1996, youth consumed a decreasing percentage of their calories at home (74.1% to 60.5%) while the percentage of calories consumed at restaurants and fast food establishments increased (6.5% to 19.3%).¹² Commenting on the changes to the environment in the modern western world in relation to energy balance, Peters et al. noted, “the problem is that food is nearly always available and
physical activity is seldom required.” Thus, factors outside the individual are likely to influence health behaviors and energy balance.

From a theoretical perspective, models such as the social determinants of health\textsuperscript{17} and the Social Ecological Model of Health Promotion\textsuperscript{18, 19} provide a framework for understanding how the environment may influence energy balance. As discussed by Stokols, an individual, their health and their behavior have the potential to be influenced by factors working at multiple levels. \textsuperscript{18, 19} Under this conceptualization, health behavior may be influenced by factors related to: 1) the individual, 2) interpersonal relationships, 3) the social environment, 4) the physical environment, and 5) the policy environment.\textsuperscript{20} Studies have demonstrated the influence of these multi-level factors with regard to child physical activity and dietary behavior, with the most extensive research occurring at the individual- and interpersonal-levels. Characteristics such as child gender as well as parent health behavior, income, education level, and marital status have been associated with child dietary behavior and physical activity.\textsuperscript{21-26} A growing body of research has also begun to explore the relationships between physical activity and dietary behaviors with the community environment. For example, the presence of convenience stores and fast food establishments in close proximity to the home has been associated with a decreased consumption of fruits and vegetables among both adults and children.\textsuperscript{27-29} As expected, the availability of fruits and vegetables at retail outlets such as grocery stores and supermarkets has been associated with increased consumption of these foods.\textsuperscript{30-32} Similarly, physical activity opportunities such as parks, trails, and recreational facilities in close proximity to the home have demonstrated positive relationships with rates of physical activity.\textsuperscript{33-42} It is also important to note that research has shown the more economically deprived communities typically have limited access to both physical activity resources\textsuperscript{36, 43-45} and quality food environments.\textsuperscript{46-52} However,
associations between the environment and behavior have not been consistent across studies and few studies have examined environments in rural areas.

Most recently, research focused on youth has begun to examine the community environments surrounding schools. Studies examining the food environments around schools have shown a large percentage of schools to have fast food restaurants within walking distance.\textsuperscript{53-57} Studies, such as those by Seliske and colleagues in Canada, have also assessed access to convenience stores and supermarkets in school communities. They found that at a 1km distance, none of the schools had a grocery store, 58\% of schools had at least one convenience store, and a third of schools had at least one fast food restaurant. Measuring access for the larger community, defined as a 5km radius from the school, the authors found more than 75\% of schools had access to at least one grocery store, fast food establishment, and convenience store.\textsuperscript{58} Some research has reported positive associations between convenience stores and fast food establishments and youth overweight and obesity, although findings have been inconsistent.\textsuperscript{53, 59} No study to date has considered the association between the community food environment surroundings schools and more proximal outcomes, such as child dietary intake.

In contrast to the number of studies examining the food environment, few studies have characterized the physical activity environments surrounding schools. Among the studies that have been conducted, a positive association has been observed between access to physical activity opportunities in the communities and youth physical activity levels. A study conducted in London Ontario with 7\textsuperscript{th} and 8\textsuperscript{th} graders, for example, found that a greater number of recreation facilities within the community environment around the child’s home or school corresponded to higher levels of physical activity.\textsuperscript{37} In a study examining the association between the built environment and physical activity levels among high school girls in South
Carolina, girls attending a high school with more than five recreational facilities in the surrounding community were more likely to report higher levels of physical activity than girls attending schools with fewer than 5 facilities. To our knowledge, only one study to date has examined the association of publically available school facilities and physical activity. Among schools in this study, the authors found that school facilities represented 44% of the potential locations for physical activity; however, they did not find a significant relationship between weekend schoolyard accessibility and weekend moderate to vigorous physical activity among adolescent girls.

Although the research exploring environmental resources around the home and school has expanded the ecological research related to health behaviors, a limited number of investigations have explored these associations in rural environments, particularly those demonstrating high risk for childhood obesity. Because West Virginia is a largely rural state with rates of youth and adult obesity among the highest in the nation, it provides an important setting to examine social and physical environments and the associations between environment and behavior. Further, study of the environments around West Virginia’s schools may help to identify factors that can be modified to support healthful behaviors and inform obesity prevention interventions for rural youth.

The purpose of the current study was to characterize the community environments among a large sample of West Virginia schools and determine the relative influence of the social and physical environments on the diet and physical activity behaviors of 4th and 5th graders. Although a growing body of literature has examined the associations between ecological factors and obesity related behaviors, few studies have considered rural environments with regard to childhood obesity. The current study contributes further by examining both physical activity and food
environments. Our objective was to determine the direct and indirect relationships between characteristics of the social and physical environments and physical activity, diet, and BMI among fourth and fifth graders in West Virginia using a series of structural equation models that combine the conceptual framework of the Social Ecological Model and the Social Determinants of Health Theory. We hypothesized that individual behaviors and obesity will be influenced by factors related to the social and physical environments of the community either directly or indirectly while controlling for individual and family characteristics.

4.2 Method
4.2.1 Individual-level Data

Individual-level data for this study came from phone interviews of parents of 4th and 5th grade students conducted as part of the evaluation of West Virginia’s Healthy Lifestyles Act. The interviews, conducted with a random, stratified sample of families throughout the state, followed an 82-item structured protocol on the following topic areas: 1) demographics, 2) parent and child health behavior, 3) parent perceptions of school-level obesity prevention, 4) obesity knowledge and 5) interactions with health care providers. A stratified proportional sample of parents with children attending West Virginia schools was obtained during two years of the statewide evaluation. Year One targeted parents of children in grades K, 2, 4, 5, 7, and 9 (250 interviews per grade), and Year Two targeted parents of children in grades K, 2, 5, 7, and 9 (300 interviews per grade). A subset of parents of students in grades 5, 7, and 9 (N = 140/grade) were asked to allow their child to be interviewed; when this occurred, students provided self-reports of their nutrition and physical activity and parent reports of these variables were not obtained. To maintain consistency of methods, only parent-reported data were used (110 interviews each with 4th and 5th grade parents in Year One, and 160 interviews with 5th grade parents in Year Two).
Stratified sampling ensured schools and parents from all WV counties were represented and that the number of parents interviewed was proportional to the numbers of students attending small, medium, and large schools in the state. A full description of the methods used to conduct the evaluation has been published previously. Interviews with 4th and 5th grade students were used in this investigation in order to ensure sufficient years of experience interacting with the community environment and to follow-up on previous research focusing the environmental influences of school-level childhood obesity among 5th graders.

The following individual-level variables were included in the present study: 1) parent report of child weight, 2) parent report of child height, 3) child date of birth, 4) child gender, 5) child’s school, 6) number of days child was active for at least sixty minutes in past week, 7) number of servings of 100% fruit juice consumed yesterday, 8) number of servings of fruit consumed yesterday, and 9) number of servings of vegetables consumed yesterday. Child height, weight, gender and date of birth were used to calculate body mass index (BMI) percentiles. Servings of fruit, fruit juice, and vegetables were summed to form an index of fruit and vegetable intake. To capture the socioeconomic status of the family the following parent variables were also included: 1) marital status (dichotomized into married and separated/divorced/widowed), 2) educational attainment, and 3) occupation. Parent SES was determined by calculating the Hollingshead Index, a measure combining parent education level and occupation.

4.2.2 Community-level data

4.2.2.1 School Locations

Parent report of the school attended by their child was noted and GIS coordinates were obtained to form an anchor for each community (i.e., the school coordinates were used as the point from which the 1km and 5km buffers were assigned). Exact locations of the schools associated with
all 4th and 5th grade students were determined using a database from the West Virginia GIS Technical Center and locations were verified using Google™ satellite images.

4.2.2.2 Defining Community

The community environment around the school was measured at 1 km and 5km distances based on previous research examining the food environment around schools.59, 65 In the case of a buffer that exceeded West Virginia state boundaries, only the area within the state was included in our analysis, and area-based counts were weighted to reflect the number of establishments given a 5km area.

4.2.2.3 Food and Physical Activity Environment Databases

A database of food and physical activity resources was established via web searches using Google Maps™ and yellowpages.com. County parks and recreation websites were also used to gather information regarding physical activity resources. Searches were conducted using an established list of terms and saved to a category-specific database. Categories were evaluated and re-assigned as needed based on established definitions of food and physical activity outlet types.10,11 After cleaning the resource data bases, the files were merged with West Virginia block group shapefiles and our school location database. Queries were run with the merged files in QGIS to determine the number of establishments per category within a 1km and 5km distance of a school. Parks, recreation facilities, and trails were the components measured and conceptualized to make up the physical activity environments surrounding schools. In addition, school facilities were included in the lists of physical activity resources if facilities were made available to the public. This applied to all schools in our sample (N=200), as well as any schools

10 See Appendix D for physical activity outlet definitions
11 See Appendix E for food resource definitions
located within a 5km radius. Data regarding school facilities and their availability were obtained from principal surveys conducted in conjunction with evaluation of the West Virginia Health Lifestyles Act. Finally, food

resources were split into “healthy” and “unhealthy” environments. The unhealthy food environment, categorized as such due to the preponderance of high fat/high calorie processed foods, included retail outlets such as fast food establishments, sandwich shops, pizza places, and convenience stores; grocery stores and supercenters were included within the healthy food environment due to the presence of fresh fruits and vegetables in these stores, as well as the availability of other foods of high nutritional value (dairy products, frozen fruits and vegetables, meats and proteins, and grain products) (CDC guide to strategies for reducing the consumption of energy dense foods). These categories are consistent with those used in previous research.

4.2.2.4 Social Environment

For the purposes of this study, the social environment was defined as the aggregated socio-economic condition of the community. Unemployment, median household income, education, and population were extracted at the census block group level from census.gov. An intersect was created between census block group data files and a West Virginia block group shapefile using QGIS 1.5.0. School locations were then intersected with the new shapefile and 5km buffers were created. Using the QGIS geometry tools, the area of each census block group within the buffer was calculated and recorded. The area being contributed by an intersecting block group was used to create a weighting factor for census variables (unemployment, income,
education, and population), allowing statistics specific to the 5km area to be calculated. For a full description of variables and their data sources see Table 1.

4.2.2.5 Standardized Food/Physical Activity Availability

A standard measure of availability per 1,000 residents was calculated for each of the main food and physical activity categories. Previous work has used this or similar definitions to arrive at a weight-adjusted measure of food environment density.\textsuperscript{58, 59, 74, 75} The number of each food or physical activity resource and the population for the buffer was used to arrive at the availability of establishments per 1,000 residents.

4.2.3 Data Analysis

Descriptive statistics and frequencies were run using IBM SPSS-19 to assess individual and community characteristics. The main analyses sought to assess direct and indirect relationships between the environment, behavior, and obesity. Six models were examined via structural equation modeling (SEM) using AMOS 18. In the first two models, we assessed the direct and indirect relationships between the unhealthy food environment and the social environment with: 1) dietary behavior and 2) child BMI percentile. In the second set we examined associations with these variables and unhealthy food outlets. Finally, the last two models considered associations between the physical activity environment and the social environment with: 1) physical activity, and 2) child BMI percentile. Child gender, parent marital status, and parent SES were control variables in each of the models. We hypothesized that factors related to the social and physical environments of the community would be related to individual behaviors (physical activity and fruit and vegetable intake) and obesity either directly or indirectly. We also hypothesized the physical activity environment and healthy food environment would demonstrate positive

\textsuperscript{k} See Appendix G for further description of calculating census statistics for the 5km buffer
relationships with their associated behaviors. Finally, we expected to find a negative relationship between the following: 1) the unhealthy food environment and fruit and vegetable intake, 2) the physical activity environment and BMI percentile, and 3) the healthy food environment and BMI percentile.

The assumptions of SEM were examined and maximum likelihood estimation was used to estimate all models. Overall fit was assessed by examining model chi square statistics and other commonly used fit indices.\(^7^6\)

4.3 Results
A total of 520 parent interviews including reports of student physical activity and nutrition were available for 4\(^{th}\) and 5\(^{th}\) grade students from the Year One and Two surveys. One or more data elements needed to calculate child BMI (height, weight, and date of birth) was missing from 171 parent interviews. An additional 41 interviews were missing data related to fruit and vegetable intake, physical activity, or demographics. After excluding cases with missing data related to the key variables in this study (N=212), 308 cases remained for analysis.

4.3.1 Individual-level
Among the 308 4\(^{th}\) and 5\(^{th}\) graders in the final sample, 53% were male and the vast majority were white (96%). Nearly all the parents completing the survey were married (94%) and 46% had a college degree or higher. The Hollingshead Index, calculated from parent education level and occupation, ranged from 11 to 69. The proportion of families that fell into the five classification categories of the Index were as follows: 4% Class 1 (e.g., principal, physician, engineer), 25% Class 2 (e.g., registered nurse, teacher), 22% Class 3 (e.g., real estate agent, sales representative, computer technician), 29% Class 4 (e.g., coal miner, cashier, cook), and 20% Class 5 (e.g.,
laborer, construction worker, unemployed). Thus, higher index values reflect less favorable
dependent socio-economic position.\textsuperscript{64}

When asked about fruits and vegetables consumed the previous day, parent reports revealed
children, on average, consumed 0.95 glasses of 100% fruit juice (SD=1.18), 1.86 servings of
vegetables (SD=1.23), and 1.75 servings of fruit (SD=1.34). Combined, the average daily fruit
and vegetable intake for children was 4.6 servings (SD=2.5). With regard to physical activity, the
average number of days spent in physical activity for at least 60 minutes over the previous week
was 4.7 (SD=2.2). Last, parent reports of child weight, height, age, and gender were used to
calculate BMI percentiles. The average BMI percentile among the 4th and 5th graders in the
study was 62.52 (SD=31.36), with 18% of youth characterized as obese, 6% as underweight,
60% as healthy weight, and 16% as overweight.

4.3.2 Community-level Data

4.3.2.1 School Locations

The 308 students in the current study attended 200 elementary schools throughout the state,
representing 49 of West Virginia’s 55 counties. See Figure 1 for the distribution of schools
throughout the state.

4.3.2.2 Food and Physical Activity Environments

Over 50% of schools (N = 117) had a convenience store within 1km and roughly one quarter of
schools (N=49) had a fast food establishment within that distance. Among those schools that
had fast food present, the number of establishments within 1 km ranged from 1 to 7. When
compared with these less healthy food outlets, fewer schools had access to healthy food outlets
such as grocery stores (N=53) or supercenters (N=5) at the 1km distance. When measuring
access for the greater community environment (5km radius from the school), almost all school communities had a convenience store (N=184), and nearly two thirds (N=118) had a fast food or sandwich establishment. However, the number of establishments for each category varied widely as noted in Table 2. Finally, density calculations for the food environment indicated the median number of outlets per 1,000 residents was highest for convenience stores (8.5) and lowest for grocery stores and supercenters (1.8 and .3, respectively).

The number and density of physical activity resources is also provided in Table 2. When determining school based facilities for the 5km area, it was determined that 71% of the 200 targeted elementary schools had one or more additional schools in the area. Unfortunately, data regarding the public availability of school facilities was missing from a large number of schools (N=80), so these data were not included in the analyses for physical activity environments. Therefore, the physical activity resources discussed here-in reflect community based opportunities only.

At the 1km distance, the most prevalent physical activity resource was recreation facilities (including gyms, dance studios and martial arts studios), as 22% of schools had access to these resources; only 16% of schools had a park and 5% had a trail at the 1km distance from the school. A similar distribution was observed at the 5km distance with the largest percentage of schools (68%) having at least one recreation facility in the greater community and fewer schools having access to parks (51%) or trails (21%).

4.3.2.3 Social Environment

The socio-economic condition of the community was calculated for the 5km buffer. Three census variables (median income, percent of residents with less than a high school education, and
unemployment rate) were used to represent the socio-economic condition of the community based on previous research. The average median income across the 200 communities was $33,313 (SD= $6,876). Considerable variability was observed with regard to the percent of residents with less than a high school education, with values ranging from 12% to 60% across communities (mean= 23.3%, SD=7.2); unemployment rates ranged from 2 to 17.7% (mean=6.7%, SD=2.5).

4.3.2.4 Food Environment versus Fruit & Vegetable Intake & BMI

Structural equation modeling was used to determine the direct and indirect relationships between fruit and vegetable intake, the social environment of the community, and food resources within the greater community (5km buffer). To assess the effects of healthy versus less healthy food establishments, separate models were run for each. In the first model, the relationships between the unhealthy food environment, the social environment, and fruit and vegetable intake were examined. The healthy food environment model (grocery stores and supercenters) produced a chi square that was significant $\chi^2$ (34)=85.80, $p<.001$; adjusted $\chi^2$ (CMIN/DF) = 2.52, and demonstrated fair fit indices; comparative fit index (CFI)= .90 and root mean square error of approximation (RMSEA) = .07 (See figure 3). Chi square values for the unhealthy food environment model (fast food, pizza, sandwich, and convenience stores) were again significant $\chi^2$ (53)= 153.39, $p<.001$ ; adjusted $\chi^2$ (CMIN/DF) = 2.89; and the model demonstrated similar (fair) values fit indices; CFI=.95 and RMSEA=.08.(See figure 4 for full model). The results of the two models indicated the social environment was positively associated with both healthy and unhealthy food environments, but no significant associations were observed between fruit and vegetable intake and community SES or the food environment. As shown in Figures 2 and 3,
being female, having married parents, and parents of higher socio-economic status were all found to be positively associated with child fruit and vegetable intake.

Models were also run to examine relationships between the social environment, food environment, and child BMI percentile. The models demonstrated good model fit, but again the only significant relationships observed at the community-level were between community SES and the unhealthy food environment ($\beta=.32, \ p<.001$) or the healthy food environment ($\beta=.37, \ p<.001$); significant associations were also observed between BMI percentile and child gender, parent marital status, and parent socio-economic position.

4.3.2.5 Physical Activity Environment versus Days Active & BMI

A structural equation model was also used to examine the relationship between the social environment, physical activity environment, and the number of days a child was active for 60 minutes or more. The chi square statistics for the model were significant $\chi^2 (43) =148.376, \ p<.001$; adjusted $\chi^2 (43) = 3.45, \ p<.001$. Model fit indices were again fair with a CFI of .89 and a RMSEA of .09, indicating reasonable model fit. Community-level variables did not demonstrate a significant association with days active, but community SES was positively associated with physical activity environment, as shown in Figure 5. The model produced similar results when BMI percentile was modeled as the outcome of interest.

Across all SEM models, the variables used to represent the latent variables (community SES, healthy food environment, unhealthy food environment, and physical activity environment) performed well as shown by the high factor loadings.
4.4 Discussion

The primary goal of this study was to assess the direct and indirect relationships between community variables and child physical activity and fruit and vegetable consumption. Using a series of structural equation models combining concepts from Social Ecological Theory and the social determinants of health, we established valid methods for assessing the SES of the community, as well as the food and physical activity environments as demonstrated by the high factor loadings for these variables. The overall outcomes of the models indicated community SES to be a significant predictor of food and physical activity environments, with a greater density of food (both healthy and unhealthy) and physical activity resources associated with more favorable community SES. However, community SES was not found to be directly associated with dietary or physical activity behaviors or BMI percentile. Additionally, no significant associations were observed between food and physical activity environments and the related health behaviors among youth in this sample. Finally, despite the lack of association between the environment and BMI, physical activity, and fruit and vegetable intake, descriptions of the environments around these 200 WV schools highlight the challenges of achieving energy balance -- a higher percentage of schools had access to unhealthy food resources than healthy food or physical activity resources.

Our finding that community SES was positively associated with the density of healthy food outlets is consistent with much of the previous research documenting the food environment.46, 47 A contrary finding was reported in a rural-focused study conducted in Texas, but it is possible that method variance, based on the more extensive definition of socio-economic condition (a 7 item deprivation scale including unemployment, poverty, education, crowding, public assistance, vehicle ownership, and telephone access) partially explains the negative association that was
observed. To our knowledge only one Canadian study has examined the relationship between the density of supermarkets surrounding schools and neighborhood SES. The fact that our finding was consistent with this Canadian study is particularly encouraging, given the similar methodologies used to measure community SES. In addition, the high factor loadings observed in the current study indicate percent unemployed, percent with less than a high school education, and median household income were valid measures of community SES.

Much of the current research has found a negative relationship between community SES and the density of fast food restaurants, indicating that lower SES communities have greater access to unhealthy food environments. In contrast, findings from the present study are consistent with those of Seliske and colleagues and Austin and colleagues, as both observed a positive association between community SES and density of unhealthy food outlets (fast food, pizza, subs, or convenience stores). Again, the consistency of our findings with those of Seliske is reassuring given similar methodologies to measure food and community socio-economic environments. The fact that our findings and those of Seliske et al., differ from the other studies is likely explained by the differences in geographic focus. All of the studies to date reporting low neighborhood SES or high deprivation to be associated with increased access to fast food outlets have studied large urban areas either in the U.S. or abroad (e.g., New Orleans, LA; Los Angeles County, California; Montreal, Canada; Melbourne, Australia); nearly 40% of the school environments in the study conducted by Seliske and colleagues were considered rural. One strength of the current research is that a greater variety of unhealthy food outlets were captured such as sandwich shops and local fast food chains. This marks an important contribution for rural research in particular given a recent study that noted non-traditional fast
food outlets (outlets other than large chain stores) significantly contribute to the unhealthy food environment in rural areas.79

Similar to our findings regarding the food environment and neighborhood SES, we found the density of physical activity resources significantly increased with community SES. This relationship also has been demonstrated in previous national and regional studies.43-45 The current study expands this research by establishing the relationship between PA resources and community SES in a primarily rural region.

Though significant associations were observed between community SES and food and physical activity environments, our research found no significant associations between these environments and health-related behaviors and outcomes (child fruit and vegetable intake, physical activity, or BMI percentile), indicating the food and physical activity environment did not impact these variables in a detectable way among this sample of youth. The findings of the present study differ from previous research in that several studies to date have found a positive association between supermarket access and fruit and vegetable consumption.30, 32, 80, 81 In addition, the lack of association between the physical activity environment and child physical activity differs from previous work as most studies have demonstrated a significant positive relationship.36-39, 41, 42, 82 It is important to note that much of the research that has established an association between physical environments and physical activity has been conducted among youth in grades 7 through 12 and physical activity has been commonly measured via child self-report. The use of parent report of child physical activity and a younger age group (4th and 5th graders) may explain the lack of association found as well as the fact that the current study differed from previous research in its rural focus.
In addition to differences in methodology, it should be noted that the lack of association between the environment and behavior could be due to the sample used in this study. Although the sample was representative of the state geographically, nearly half the parents reported having a college degree or higher and 94% reported being married. Statewide statistics from 2008 indicate only 19% of West Virginia residents have a college degree or higher, and 2000 census statistics report married couples made up 54% of all households in the state. Thus, our youth had parents who were more highly educated and are less likely to be single than the majority of youth in the state. Therefore, the lack of association observed between the environment and behavior may be due to higher individual SES, which provides the ability to overcome access issues in the immediate environment. Moreover, dual parent households may also have a greater ability to travel in order to access physical activity or food resources. The association observed between the Hollingshead Index and health behavior becomes difficult to explain using this rationale, given that less favorable parent SES (high Hollingshead values) was associated with greater physical activity and fruit and vegetable intake. However, the observed association was slight ($\beta=.17$) and the unexpected direction of the relationship could be a function of the Hollingshead Index itself (i.e., misclassification). Because the process of creating the index requires one to assign categories to parent education level and occupation, and the occupation codes were developed several decades ago, the coding dictionary may be limited in its ability to categorize professionals that have emerged over the last 20-30 years. Thus, either under- or overestimating parent SES. Given the unexpected findings that parent SES was associated with greater fruit and vegetable consumption and greater physical activity, these individual-level relationships warrant further investigation.
The nature of the individual-level data used in this study may also provide some explanation for the lack of significant relationships between environmental characteristics and child behavior. Data related to child height, weight, days active, and fruit and vegetable consumption were all obtained through parent report. It is likely that child weight may have been underreported and both physical activity and fruit and vegetable consumption over reported. Previous research has indicated that parents tend to underreport child weight when compared to objective measures, particularly among youth in the highest weight categories. In addition, studies have noted inconsistencies when self-reported physical activity is compared with objectively measured physical activity, as self-report typically overestimates “true” activity. Furthermore, the average reported daily servings of fruits and vegetables in the study sample was higher than the national average of 3.6 for similar age groups suggesting parents may have over reported child fruit and vegetable consumption. If accurate reports of BMI and obesity-related health behaviors were not provided by parents, the predictive ability of the models would be compromised. The demographic characteristics of the sample (46% of parents with a college degree or more) may offer some insight into the high consumption of fruit and vegetable intake and days of physical activity reported among youth in this sample. Parents with higher education levels may have greater access to resources supporting positive health behaviors and this level of access may mitigate the role of the community environment, thus offering another explanation for the lack of significant associations observed between environmental characteristics and child behavior.

In addition to the use of parent-reported data, the fact that the current study did not capture mode of transportation to school may have limited the ability to examine environmental influences. Whether a child takes a bus to school, walks, or is driven by family members may mediate the role of the environment on child weight, fruit and vegetable intake, and physical activity
behaviors. Because children who walk or are driven by parents may have greater opportunities to interact with the community environment when compared to those who are bused to school, this may provide further explanation for the lack of significant findings reported here.

Despite the lack of association observed between the environment and health outcomes, the environmental characteristics of these communities are noteworthy. The results of this study indicate that the food environment around schools provides limited resources to support healthy eating and physical activity. For example, just over half of the schools had at least one convenience store yet fewer than 25% had any physical activity resources. At the 5k distance nearly all schools had at least one convenience store, but over 30% of schools lacked access to a grocery stores or any type of physical activity resource. These findings are of concern because the environments around these 200 schools may hinder the obesity prevention initiatives taking place in schools. Efforts to improve physical activity and diet during the school day and educating students to make healthy choices will have limited impact if the community environment does not provide adequate resources to support these behaviors. Given these findings, the current study contributes to the rural-focused research by highlighting areas where access could be improved.

4.4.1 Limitations
This study has several limitations. First, the Euclidian or as the crow flies distances used in the present study may overestimate access to food and physical activity resources. The mountainous terrain throughout West Virginia is such that many roads follow rivers or creeks, particularly in the most remote areas. Thus, the travel distance may be far greater than the straight line distance. Future research should consider incorporating driving distances or develop an index of road networks within each buffer. Second, although this study marks an important contribution to
rural obesity research, our findings may not be generalizable to other rural areas given factors specific to West Virginia, such as mountainous terrain and limited zoning requirements and may not be generalizable to other populations within the state, due to the higher SES characteristics of our sample. Third, the current study only captured permanent physical activity and food resources tied to a specific location. Because neither physical activity opportunities offered through community or church programs nor farmers markets and food pantries were recorded, the density of resources in this study may underestimate what actually exists in the community. Fourth, the parent-reported nature of the dependent variables may be a limitation in that parents could have underreported child weight and over reported child fruit and vegetable consumption. The fact that days active and fruit and vegetable consumption were higher than national and state statistics 90, 96, 97 suggests parents may have misrepresented child behavior, or the sample was not representative of the state. Finally, this study was cross-sectional and does not allow for the identification of causal relationships.

4.4.2 Implications and Future Research
The results of this study point to several areas for future research. First, due to the lack of rural research examining environments and youth health behaviors, future work should examine these relationships among a diverse age group. Second, ecological research concerning rural youth may need to consider where youth are active. Recent developments in technology are allowing researchers to combine GPS and GIS technology with accelerometers to examine where youth engage in physical activity. Future research should consider applying these methods to rural areas in order to determine the environments that are most important for engaging youth of all ages in physical activity. Similar methods could also be applied to study what Sharkey discusses
as potential access and realized access\textsuperscript{48} within the food environment. Ecological research as a whole would also benefit from more standardized measures of physical activity and diet. As this body of research progresses, more work will be needed to develop consistent, accurate, and accessible methods for documenting physical activity and food environment.

As noted, one of the limitations of the current study is that we only examined geographic access to food and physical activity outlets. Given that a significant association was observed between density of food and PA resources and community SES, further research should consider the accessibility of these resources to the most low income families.

Finally, the descriptive information from this study regarding the density of food and physical activity resources has relevance to policy and policy makers. The lack of access to healthy opportunities documented in these communities provides a method for prioritizing environmental improvements. For example, opportunities for physical activity, or the lack there of, can help inform policy makers where funds for recreation should be directed.

4.4.3 Conclusion
The present study documents the environmental equivalent of energy imbalance. Although we did not see a direct significant relationship between food or physical activity resources and their related behaviors, we observed an unbalanced ratio with regarded to unhealthy (fast food and convenience stores) versus healthy (food and physical activity) resources in these communities, underscoring the challenges of achieving energy balance in these environments. These data also highlight important information to be used by policy makers to direct efforts for improving environments and access to healthy opportunities. Because rural obesity research has been limited, and our sample did not appear to be representative of the state, future work in needed
with a more diverse sample of youth. In addition, it may be important to examine use or patterns of access among different demographic groups in rural environments.
<table>
<thead>
<tr>
<th>Reference Variable</th>
<th>Description</th>
<th>Data Source</th>
<th>Year</th>
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<tbody>
<tr>
<td>School Location</td>
<td>Latitude and longitude for all WV schools based on the 2005 school directory. Used as a reference point to calculate community-level resources.</td>
<td>WV GIS Technical Center</td>
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<td>Dependent Variable</td>
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<td>Individual Child BMI</td>
<td>Parent report data regarding child’s height and weight used to calculate BMI (accounting for age and gender).</td>
<td>WV HLA Year One &amp; Year Two child proxy interviews of parents with children in grades 4 or 5</td>
<td>2007-2008</td>
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<td>Individual-level Factors</td>
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<td>1. Child age</td>
<td>Parent report of child age.</td>
<td>WV HLA Year One &amp; Year Two child proxy interviews of parents with children in grades 4 or 5</td>
<td>2008-2009</td>
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<td>3. Parent Marital Status</td>
<td>Question asks whether parent is: married, divorced, widowed, separated, never married, or a member of an unmarried couple.</td>
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<td>4. Parent Social Position</td>
<td>Variable is a combination of education and current occupation using the Hollingshead Index</td>
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<td>5. Minority Status</td>
<td>Child race as reported by parent.</td>
<td>WV HLA Year One &amp; Year Two child proxy interviews.</td>
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<td>Child Physical Activity</td>
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<td>Child Nutrition</td>
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<td>1. Servings of fruit</td>
<td>How many servings of fruit yesterday?</td>
<td>WV HLA Year One &amp; Year Two child proxy interviews of parents with children in grades 4 and 5</td>
<td>2008-2009</td>
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<td>2. Serving of vegetables</td>
<td>How many servings of vegetables yesterday?</td>
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<td>3. Fruit juice</td>
<td>How many glasses of 100% fruit juice</td>
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<td>Community Variables</td>
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<td>Parks</td>
<td>Measured as the number of each of the given resources within a 5km radius from a child’s school.</td>
<td>Data obtained by using the latitude and longitude of schools.</td>
<td>2008-2009</td>
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<td>Recreation Centers</td>
<td>The locations of parks and recreation centers will be established by Google Maps; the locations of trails will be identified from a WV GIS technical center database.</td>
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<td>Trails</td>
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<td>Fast Food</td>
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<td>Data obtained by using the latitude and longitude of schools.</td>
<td>2008-2009</td>
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<td>Restaurants</td>
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<td>latitude and longitude of schools.</td>
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<td>Convenience Stores</td>
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<td>Social Environment</td>
<td>Aggregated measure of the community SES, measured as an index of percent: below poverty, unemployed, and high school education.</td>
<td>Measured by census blocks contained within a 5km radius of schools.</td>
<td>2008-2009</td>
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</tbody>
</table>
Figure 1. Distribution of Schools (N=200)

*Counties not represented include: Pleasants, Ritchie, Gilmer, Webster, Tucker, Summers, Clay*
Table 2. Food and Physical Activity Resources surrounding 34 West Virginia Elementary Schools

<table>
<thead>
<tr>
<th>Food Store Category</th>
<th>1km</th>
<th></th>
<th>5km</th>
<th></th>
<th>Median number of locations within 5km buffer</th>
<th>Median stores per 1,000 residents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of schools (%)</td>
<td>range</td>
<td>Number of schools (%)</td>
<td>range</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Unhealthy Food Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast Food</td>
<td>49(24)</td>
<td>1-7</td>
<td>118(59)</td>
<td>1-31</td>
<td>2.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Pizza</td>
<td>84(42)</td>
<td>1-6</td>
<td>155(77)</td>
<td>1-37</td>
<td>3.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Subs/Sandwiches</td>
<td>38(19)</td>
<td>1-4</td>
<td>118(59)</td>
<td>1-26</td>
<td>1.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Convenience Stores</td>
<td>117(58)</td>
<td>1-8</td>
<td>184(92)</td>
<td>1-38</td>
<td>5.11</td>
<td>8.5</td>
</tr>
<tr>
<td><strong>Healthy Food Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grocery Stores</td>
<td>30(15)</td>
<td>1-2</td>
<td>126(63)</td>
<td>1-11</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Walmart/Supercenters</td>
<td>3(2)</td>
<td>1</td>
<td>58(29)</td>
<td>1-3</td>
<td>0</td>
<td>.34</td>
</tr>
<tr>
<td><strong>Physical Activity Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parks</td>
<td>32(16)</td>
<td>1-3</td>
<td>112(51)</td>
<td>1-9</td>
<td>1.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Trails</td>
<td>10(5)</td>
<td>1</td>
<td>42(21)</td>
<td>1-3</td>
<td>0</td>
<td>.30</td>
</tr>
<tr>
<td>Recreation Facilities</td>
<td>44(22)</td>
<td>1-7</td>
<td>136(68)</td>
<td>1-38</td>
<td>2.0</td>
<td>6.3</td>
</tr>
</tbody>
</table>
Figure 3. Unhealthy Food Environment

* Values in bold indicate significance at $p<.05$
**Figure 4.** Healthy Food Environment

* Values in bold indicate significance at $p<.05$
Figure 5. Physical Activity Environment

* Values in bold indicate significance at $p<.05$
4.5 References


65. Seliske L. *The Food Retail Environment Surrounding Canadian Schools and its Impact on Overweight and Obesity.* Kingston, Ontario: Department of Community Health and Epidemiology, Queen's University; 2007.


73. *Quantum GIS Geographic Information System* [computer program]. Version 1.6.0; 2009.


Chapter 5
5.1 Summary

The main objective of the overall study was to improve the current understanding of environmental influences on obesity among West Virginia’s youth in order to maximize prevention efforts and provide information that can be used to guide interventions and resource allocation. Although childhood obesity has been shown to impact rural youth at a higher rate than urban and suburban youth, few studies have examined the role of social and physical environments in relation to obesity among this population. The research that has been conducted in rural areas has primarily focused on adults and has identified the absence of accessible facilities, lack of transportation to facilities and programs, and concern for safety as barriers to physical activity. Much of the research that has been conducted regarding rural youth has employed qualitative methods focused on the community environment. Quantitative studies have largely examined childhood obesity in the context of non-rural environments, finding that characteristics such as access to fast food, supermarkets, physical activity opportunities, and community SES may influence obesity and related health behaviors. Though much of this research has examined the community in reference to the child’s home residence, an increasing number of studies have also begun to examine other contexts such as the community environment around a child’s school. However, research around the school has little to no rural focus, is limited in the geographic regions studied, and has largely involved samples of older adolescents.

West Virginia provides an important environment for the examination of factors influencing childhood obesity based on its rurality and consistent ranking among states with the highest adult and childhood obesity rates. The urgent need for this research is also highlighted by West
Virginia’s high rates of chronic disease, which can only be expected to increase given the many short- and long-term consequences of childhood obesity.

The qualitative study described in Chapter 2 used data from focus groups conducted with community leaders and parents from six West Virginia counties in order to gain a better understanding of the barriers and facilitators to physical activity and healthy eating encountered by individuals living in those communities. The findings from that study confirmed that factors at the individual-, interpersonal-, and environmental-level influence obesity and related health behaviors. At the individual-level, cost, time and knowledge were perceived to contribute to poor diet and obesity. Participants also spoke to the importance of a strong social environment as they expressed a need for physical activity support groups and networks. Aspects of the social environment related to culture were also noted, in that many participants developed unhealthy cooking practices because they had cultural significance (passed down from mothers) and economic efficiency (e.g., food that were fried would be low cost and typically last several days).

Although many barriers to physical activity and healthy diet were cited, the strengths of the community such as trust of neighbors, close family networks, and an overall willingness to help, may be the foundation upon which communities can improve infrastructure, enact policy, establish programs, and ultimately bring about behavior change. The results of the qualitative study also emphasized that lack of access to physical activity opportunities and quality foods as well as low-socioeconomic conditions were all barriers to healthy living. For example, participants mentioned that the communities face challenges with regard to the high percentage of low-income and unemployed residents as well as the high proportion of older adults. The community socio-economic condition of the community discussed in the focus groups has the potential to be a barrier to improving recreational opportunities in that these communities are
likely to have limited funds generated through tax revenue to create or maintain fields, parks or walking trails. These findings provided the foundation for examination objective measures of socio-economic conditions, food resources, and physical activity opportunities within a sample of West Virginia communities.

Objective measures of the community social and physical environments were described in studies 2 and 3. The knowledge gained from the qualitative study helped shape measures of the environment that were used in the later studies. Unemployment rate and low income residents were factors identified through focus groups as key characteristics of the greater community. This information combined with methods from previous research, were used to establish a measure of community SES (unemployment, percent with less than a high school education). As noted in study 3, these variables were shown to be a valid representation of community SES by the high factor loadings observed (percent unemployed= -.68 to -.69, median household incomes =.80 to .83, and percent less than a high school education= -.90 to -.93).

In the second study, examining the community environment around 34 elementary schools, one of the main goals was to assess the relationship between school-level obesity and environmental resources. The first set of analyses involved a series of t-tests to consider possible differences between high (above median) and low (below median) obesity schools (N=34). Although no significant differences were observed in this small sample (p’s=.21-.79), the means of the two groups were in the expected direction with low obesity schools having a greater density of food and physical activity resources and a more favorable community SES index. To examine potential relationships between school-level obesity and environmental factors by gender, two negative binomial regression models were run. These results again found no significant associations as the p-value of all beta weights ranged from .06 – .85, but several of the regression
weights did present in the expected direction (SES and female obesity $\beta = -.01, p = .06$; convenience stores and female obesity $\beta = .05, p = .22$; trails and female obesity $\beta = -.18, p = .24$; conveniences stores and male obesity $\beta = .04, p = .14$; recreation facilities $\beta = .04, p = .17$). In addition, the models produced different results for males and females, suggesting that future work should consider whether the rural environment impacts male youth differently from female youth.

Despite the small sample size and lack of significant findings in study 2, it was a key preliminary study for two reasons. First, study 2 allowed for methods documenting the environment around schools to be developed and refined (i.e., refining the list of search terms used to capture resources of interest, developing methodology to save and convert Google Map searches, refining the coding of resource databases to assure locations were assigned to the most appropriate category, and refining the methodology for capturing the SES index specific to the 5km buffer around schools). Second, the descriptive statistics alone produced detailed information about the social and physical environments around schools. For example, the limited number of schools with community physical activity resources or grocery stores at a 5km distance from the school highlighted the lack of access to community supports for healthy living. Examining these findings and the lack of association observed between the environment and school-level obesity was important because it pointed to the need to examine the influence of the environment with more proximal outcomes such as physical activity and dietary behavior; thus setting the stage for study 3.

The main objective of the 3rd study was to examine direct and indirect associations of the social and physical environments with child fruit and vegetable intake, physical activity and BMI percentile using structural equation modeling (SEM). The final sample consisted of 308 4th and
5th graders who represented 200 schools throughout the state. Both food and physical activity environments were measured for the community environment around the school (1km and 5km buffers). Across all three SEM models, community SES demonstrated a significant association with food and physical activity resources ($\beta = .32-.37, p<.05$), revealing that the more favorable the community SES (lower percent unemployment, lower percent with less than a high school education, and higher median income), the greater the density of resources (unhealthy foods, healthy foods, and physical activity). This significant association observed between community SES and food and physical activity resources is notable because it quantifies the theme that emerged in study 1 where residents identified the high percentage of low-income families to be a challenge facing their communities.

Associations between food and physical activity environments and the related behaviors did not produce significant results as discussed in study 3. The use of parent report of child physical activity, a younger age group (4th and 5th graders), and the rural focus in study 3 may all provide explanations as to why the expected associations between environment and behavior were not observed. In addition, the fact the sample in study 3 was highly educated may contribute to the findings observed. If parents were more highly educated they may have a greater ability to access resources to engage in healthy lifestyles and be less influenced by their immediate environment. It is also important to consider these findings in the context of study 1. The majority of participants indicated that knowledge, cost, time, and lack of access were barriers to healthy eating and physical activity. With regard to educational level, the majority of parents (82%) lacked a college education. This is an important comparison because it suggests the sample in study 3 may not represent the same population identifying barriers and facilitators to healthy
living in study 1 focus groups. Thus, future research with a more representative sample is warranted.

It should be noted that although the data collection methods for documenting the food and physical activity environments progressed nicely in study 2, the time demands became intensified when applying the methodology to a larger sample (N=200 schools). For this reason, the amount of time required to develop the food and physical activity database was considerably longer than expected. Acquiring data from search engines, determining the latitude and longitude of each location and cleaning data to ensure locations were correctly classified based on established definitions took on average 4 hours per school. The primary variable that required additional time was physical activity resources. Overall, food environments are documented in a much more retrievable and reliable way than physical activity resources. Being able to identify the presence of trails and community parks did present a challenge but multiple methods were used obtain and verify these physical activity resources to the greatest extent possible. None the less, the challenges faced with regard to documenting the physical activity environment speaks to the need for more complete data sources as research in this field moves forward.

The descriptive characteristics of the food and physical activity environments were captured in both studies 2 and 3. Across the two studies, convenience stores were the most prevalent food resource with over half of schools having one in close proximity (1km) of the school. At the 5km distance, nearly all communities had at least 1 convenience store with some schools having as many as 38 stores. Opportunities to access healthy foods at grocery stores or supercenters were limited as indicated by the lower proportion of schools with these establishments at a 1km (less than 30%) and 5km (less than 80%) radius from a school. A high proportion of schools were also shown to lack access to physical activity facilities. At the 5km distance there were a fair number
of schools that lacked access to a park (study 2, 35%; study 3, 49%), a trail (study 2, 32% : study 3, 79%), or recreational facilities (study 2, 30% ; study 3, 32%). Interestingly in study 2, data were available to also capture the PA resources available to the public on school grounds. When these facilities were included in the physical activity resource counts, the access to physical activity opportunities dramatically increased highlighting the potential importance of school based facilities as a recreational opportunity for youth and the greater community. It is also important to note that the observed characteristics of the food and physical activity environment substantiate the lack of access to quality foods and physical activity opportunities that emerged as barriers to healthy lifestyles from the qualitative data presented in study 1.

5.2 Significance
The long-term goal of this project was to increase knowledge about the characteristics of social and built environments related to childhood obesity among West Virginia youth in order to maximize prevention efforts and provide information that can be used to guide resource allocation. This study is significant for several reasons. First, ecological research at the community-level has not been conducted within this high risk population. Therefore the current research answers the urgent need of examining multi-level factors contributing to obesity among WV’s youth. Further, by focusing on the environment around the school, there is the potential to determine factors within the rural environment that may be modified to increase physical activity, improve diet, and decrease childhood obesity. Second, this study examined both food and physical activity environments in the context of community socio-economic condition. In doing this, the findings illustrated the external imbalance that exists with regard to unhealthy (fast food, pizza, convenience stores) and healthy resources (supermarkets, supercenters, physical activity resources); demonstrating that with even the most progressive school-level
obesity prevention efforts children may not be able to sustain healthy behaviors learned or modeled in school because the environmental supports are lacking within the community. A third significant contribution lies in the fact that this study considered the availability of school facilities to the public. This marks a major contribution to the field because few studies have quantified school based resources along with community-based physical activity resources.\textsuperscript{16, 21} The findings from this study highlight how making school facilities available can improve access to physical activity opportunities in even the most deprived communities. Fourth, the current research established the high density of convenience stores at both the 1km and 5km radius of a school. Given that most convenience stores carry a preponderance of energy dense snacks and beverages,\textsuperscript{35} the ease of proximity and density of these establishments is alarming. As noted by Morland et al., 2006:

\textit{Since the food choices that people make are limited to what is available to them, and convenience is an important predictor of food habits...individuals living in areas with few food choices other than convenience stores may be more likely to adopt an energy dense diet.}\textsuperscript{36}

With this in mind, the data related to food environments and physical activity environments may be particularly significant for policy makers who can explore policy interventions to improve access to FV’s in nontraditional settings (e.g., convenience stores, fast food restaurants) and policies to increase access to school facilities for the entire community. Fourth, by considering the environment around the school, the study has assessed an environment that youth interact with on a regular basis, thus offering the potential to create environmental change interventions that will have reach and impact. Finally, both the qualitative and quantitative results highlight the fact that the resources a community can provide may be limited given its demographic composition. Thus, efforts to improve access must be targeted and economically efficient.
Objective measures of the social and physical environment such as those used here can serve as an important jumping-off point for targeting communities in greatest need and assessing changes (intervention, policy, or environmental change) that would best support obesity prevention.

5.3 Strengths and Limitations

The findings from this project should be viewed in the context of its strengths and limitations. With regard to strengths of the current research, it should be noted that this study is among the first to examine environmental influences on obesity and health behavior among rural youth. Additionally, much of the previous research has pointed to the need to examine multiple contexts where youth may interact with the environment. By examining the environments around the school, the current study speaks to that need. Quantifying the environments around West Virginia schools also builds upon research that has been conducted at the county-level as we examine the food, physical activity and social environments on a smaller scale (1km and 5km buffers). A second strength is that this research was able to use a mixed methods approach to examine both the food and physical activity environments. Although several qualitative studies have considered these environments and the related health behaviors among adults, few quantitative studies have examined both food and physical environments simultaneously. To our knowledge this is the only study to date which has examined objective measures of both the food and physical activity community environments in a largely rural area. Third, we were able to consider the relationships between social and physical environments and child obesity as well as more proximal outcomes such as fruit and vegetable intake and physical activity. This again marks a contribution to the literature as few studies have examined these associations among rural youth. Fourth, we were able to profile the community environments around nearly 230 WV schools study 2 and 3 and the sample represented nearly every county in the state (N=49). Given
this distribution, the findings are likely to reflect an accurate picture of food and physical activity density throughout the state. Finally, the research examining physical activity opportunities in study 2 was able to consider not only community based facilities, but also school facilities made available outside the school day. Only a limited number of studies to date have considered community access to school facilities or have documented the contribution made to the physical activity environment.

There are also several limitations of the current study that should be noted. First, while the three studies provide an important contribution to rural obesity research, the findings may not be generalizable to all rural areas due to factors such as regional culture, landscape,\(^{40}\) and even zoning laws. Second, the current study may have been limited in that secondary data were used for both qualitative and quantitative analysis; the only means of primary data collection involved measures of the social and physical environments. Because the qualitative data were collected previously, the current study could not seek clarification on perceptions related to the environment or alter the interview guide with the emergence of new themes as typically done through primary qualitative data collection.\(^{41}\) In addition, it may have been beneficial to have additional demographic variables at the school-level for the data described in study 2 (to allow for multi-level modeling) or additional measures of diet and physical activity behavior in study 3. Being able to document the percent of children walking, being bused, or driven to school by a parent may have been an important variable to measure as it may reflect the degree to which youth interact with the community environment around schools. Also, measures of physical activity and diet in study 3 may have contributed limitations due to the fact that data were reported by parents and only reflected a narrow snapshot of diet and physical activity behavior. Future work should consider objective measures of physical activity and expand dietary
behaviors to include consumption of fast foods, sugar sweetened beverages, and other foods of minimal nutritional value. A third limitation is that the current study only measured spatial access to food and physical activity resources using a predefined buffer. As noted previously, focus group participants mentioned factors such as cost and affordability being barriers to healthy eating and accessing physical activity opportunities as well as distance to recreational facilities. Future work should consider factors influencing access, particularly among low SES communities and low SES families. Because geographic access was measured by Euclidian or as the crow flies distances, driving distances were not captured. The mountainous terrain throughout the state and limited road networks in rural areas make it likely that Euclidian distances overestimate access. Finally the current study was not able to obtain catchment areas for each of the schools in the study. Therefore, the 5km buffer may over or underestimate the area serviced by the school.

5.4 Future Research
The current study highlights the need for additional research to expand understanding of how the social ecological model of health and social determinants of health relate to obesity in a rural context. As noted previously, the qualitative findings indicate that factors influencing physical activity and dietary behavior are related to access. Participants in focus groups discussed cost of foods and physical activity programs/facilities and geographic distance to food and physical activity outlets as barriers to healthy eating and physical activity. Although our examinations of the school communities measured spatial access to food and physical activity resources, future work should consider the variety, cost, and quality/condition of these resources. Sharkey and colleagues argue that including objective measures of these factors will allow researchers to distinguish potential access (availability) from realized access (actual use). Thus, future
research should include more detailed objective measures of the food and physical environment (i.e., conduction in person audits/observations of quality, condition or price) as well as measures for examining participant perception (i.e., perceived access) of food and physical activity environments in their community.

5.5 Conclusion
Findings from this research project have expanded the current understanding of social and physical environments in rural areas by characterizing community socio-economic status as well as food and physical activity environments. In addition, we explored associations between these environments and school-level obesity and individual-level child BMI, FV intake, and physical activity. Despite the fact that only community SES was shown to have a significant relationship with food and physical activity environments, quantifying the resources within these WV communities alone marks a significant contribution. The descriptive statistics indicated that at both the 1km and 5km distances, the communities around schools had limited resources for engaging in positive health behaviors. Thus, indicating the challenges of achieving energy balance given the environment in these communities. Our study was also able to show the potential importance of school based physical activity facilities as the number of PA resources dramatically increased when including this resource type in our density measure. Given the potential limitations of the current sample (sample size and representativeness) the current research may be limited in its policy implications, but it does make an important first step in considering ecological factors and childhood obesity. Future work is needed to examine where rural youth are active, whether the environment may impact males versus females differently, and the role of the social environment (social support, culture, safety, and social cohesion of the community) with regard to obesity, physical activity, and dietary behavior. In addition, future
work should consider other measures of access such as travel distance to the closest food/physical activity resource, the quality or condition of food and physical activity resource, and the variety of resources available.
5.6 References


29. CDC. West Virginia: Burden of Chronic Diseases.  


Appendices
Appendix A. 1km and 5mk Buffers for Kingwood Elementary School
### Appendix B. Google Maps Search Terms

<table>
<thead>
<tr>
<th>Physical Activity Resources</th>
<th>Food Resources</th>
</tr>
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<tbody>
<tr>
<td>State Parks</td>
<td>Fast Food</td>
</tr>
<tr>
<td>State Forest</td>
<td>Pizza</td>
</tr>
<tr>
<td>Parks</td>
<td>Bakery</td>
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<tr>
<td>Recreation</td>
<td>Donut Shop</td>
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<td>Coffee Shop</td>
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<td>Athletic Fields</td>
<td>Ice Cream</td>
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<tr>
<td>Dance Studio</td>
<td>Sandwich Shop</td>
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<tr>
<td>Martial Arts</td>
<td>Grocery Store</td>
</tr>
<tr>
<td>Swimming Pool</td>
<td>Walmart</td>
</tr>
<tr>
<td>Skating Rink</td>
<td>Convenience Store</td>
</tr>
<tr>
<td>YMCA</td>
<td></td>
</tr>
<tr>
<td>Gym</td>
<td></td>
</tr>
<tr>
<td>Walking Trails</td>
<td></td>
</tr>
<tr>
<td>Hiking Trails</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C. Search and Database Development Methodology

METHODS FOR SEARCHING AND CONVERTING

Set Up: PART A

1) Google Search: GMAPtoGPX – should bring you to the link below.
   http://www.elsewhere.org/journal/gmaptogpx/

2) Scroll down to yellow box under instructions:
   
   Instructions:
   
   Firefox: Drag the following link to your browser’s bookmark toolbar.
   Internet Explorer: right-click on the following link and “Add to Favorites…”
   This is the link: GMapToGPX

3) Right click on the yellow box and go to “Add to Favorites”

PART B

4) Go to Google Maps and type in the latitude and longitude (or address) of a school. Within the
   search term box type the food/physical activity category title and “near”
   Ex: Fast Food near 39.031806, -79.925583

5) Once search is completed, a list of terms will appear on the left column of the webpage, by
   going back up to the “Favorites” menu, scroll down to the GMAPtoGPX application that was
   added and click. This will pop open a new window in an XML format. These results will
   correspond to search page 1 from Google Maps.

6) Select all (CNTRL A) for the text in the XML window.

7) Then copy all (CNTRL C)

8) Open notepad (Start – Run – notepad)

9) Paste the results into notepad, name (Ex, Belington Elementary Fast Food).

10) To record additional locations, click the “BACK” arrow from the window that popped up with the
    XML text.

11) Click page “2” to reveal the next page of search results and repeat steps 5-8.

12) Once the desired number/amount of locations have been converted to XML, copied, and copy
    and pasted to notepad, they text can be converted to table format.

13) Once the all the needed search data has been added into notepad save.

   → Save including the school name and search category
   (e.g. BELINGTON Fast Food)
Special things to pay attention to when doing Google Searches:
- Because you can no longer search within a certain radius (ex., 1 mile or 5 miles) scan through the 20 pages of search results provided
- When clicking on the GPX link, scan the transformed data to make sure it corresponds with the information provided on the regular Google page. This is important because one of two things can occasionally occur:

  1) The information provided in the GPX window is for a completely different area like Illinois or Chicago! In this case close the tab, open a new tab and try starting the search again.
  2) The information provided in the GPX window corresponds with information from other Google search pages. In some cases there are too many lines of text on the Google search page and the information in the gpx window does not match. Often times the information will be included in the next search page (if you gpx-it).
  3) Sometimes the establishment will be closed. If this happens, just make note of the establishment and location.
  4) Converting Google search info for 5 or more pages will often lock up the system – that is after this many pages, it will no longer convert Google to gpx. When that occurs, just open a new tab and begin again. This may be where a situation like that listed in #1 happens, so pay attention and make sure the gpx locations match the Google page.

PART C
14) Once the Notepad file is saved – convert to xml. This will require the file to be cleaned in order to export xml to excel.

15) XML does not like the “&” symbol. Search the notepad document before saving as xml (see example on page 3).

   To do this select control “H” – this will change ALL &’s to and

16) Delete extra code at the beginning and end of the document (see text highlighted in yellow on page 3)

17) Once steps 15 and 16 are complete, save the file as an XML file (e.g., BELINGTON Fast Food.xml)

PART D
18) With the XML and Notepad files closed, open a new Xcel file.

19) If windows 2007, click on the “data” tab/ 2003 click “data”

   → 2007: next click “From Other Sources” (fourth icon from the left)
   2003: “Import External Data”
→ Select the third option down “From XML Data import”
   2003: “Import Data”

→ 2003 & 2007: Select file (e.g. BELINGTON Fast Food.xml) – double click to open

→ Next a window will pop up “The specified XML source does not refer to a schema... click “OK”

→ A new window will pop up – Import Data. Click “OK”

→ Insert a row on top with the School’s Name and the Coordinates

→ Save file as xls: BELINGTON Fast Food.xls

PART E
20) Code Excel sheets based on the coding definitions and descriptions previously developed.

21) Count the number of establishments in the 1km and 5km radius.

EXAMPLE of XML TEXT
(Delete highlighted text)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<gpx version="1.1"
    creator="GMapToGPX 6.4b - http://www.elsewhere.org/GMapToGPX/"
    xmlns="http://www.topografix.com/GPX/1/1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.topografix.com/GPX/1/1 http://www.topografix.com/GPX/1/1/gpx.xsd">
  <wpt lat="39.01664" lon="-79.93076">
    <name>Price Pizza (101 East Crim Avenue, Belington, WV 26250)</name>
    <cmt>101 East Crim Avenue, Belington, WV 26250 (Price Pizza)</cmt>
    <desc>101 East Crim Avenue, Belington, WV 26250 (Price Pizza)</desc>
  </wpt>
  <wpt lat="39.01664" lon="-79.93076">
    <name>Hometown Pizzeria (101 East Crim Avenue, Belington, WV 26250-9460)</name>
    <cmt>101 East Crim Avenue, Belington, WV 26250-9460 (Hometown Pizzeria)</cmt>
    <desc>101 East Crim Avenue, Belington, WV 26250-9460 (Hometown Pizzeria)</desc>
  </wpt>
  <wpt lat="38.93131" lon="-79.86404">
    <name>Main Street Bakery & Pizza Co (1313 Harrison Avenue, Elkins, WV 26241-3322)</name>
    <cmt>1313 Harrison Avenue, Elkins, WV 26241-3322 (Main Street Bakery & Pizza Co)</cmt>
    <desc>1313 Harrison Avenue, Elkins, WV 26241-3322 (Main Street Bakery & Pizza Co)</desc>
  </wpt>
  <wpt lat="38.9266" lon="-79.84949">
    <name>Papa John's (425 Davis Avenue, Elkins, WV 26241)</name>
    <cmt>425 Davis Avenue, Elkins, WV 26241 (Papa John's)</cmt>
    <desc>425 Davis Avenue, Elkins, WV 26241 (Papa John's)</desc>
  </wpt>
  <wpt lat="38.94065" lon="-79.85359">
    <name>Domino's Pizza (653 Pike Street, Elkins, WV 26241)</name>
    <cmt>653 Pike Street, Elkins, WV 26241 (Domino's Pizza)</cmt>
    <desc>653 Pike Street, Elkins, WV 26241 (Domino's Pizza)</desc>
  </wpt>
</gpx>
```
## Appendix D. Physical Activity Resource Definitions and Decision Rules

<table>
<thead>
<tr>
<th>Proposed Physical Activity Composite Category</th>
<th>Physical Activity Resource Type</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks</td>
<td>State parks</td>
<td>State owned and operated area with an availability of green space for unstructured physical activity.</td>
<td>Blackwater Falls, Bluestone, Tygart Lake</td>
</tr>
<tr>
<td>Town or community parks</td>
<td>Town or community owned and operated parks with an availability of green space for unstructured physical activity.</td>
<td>Krepps Park, White Park, Marilla Park, Whitemoore Park, King Street Park, Jack Roberts Park, Suncrest Mini Park</td>
<td></td>
</tr>
<tr>
<td>Skate parks</td>
<td>Outdoor facility for skate boarding and/or BMX bike riding which may include a half-pipe and ramps. Skate parks may or may not be part of a larger state, town, or community park.</td>
<td>Marilla Skate Park</td>
<td></td>
</tr>
<tr>
<td>Town/community athletic fields and courts</td>
<td>Town/community owned and operated athletic fields for soccer, baseball, and softball or courts that may or may not be part of a larger state, town, or community park.</td>
<td>Krepps Park Athletic Fields &amp; Courts, White Park, Athletic Fields, Marilla Park, Athletic Fields &amp; Courts, Jack Roberts Park Athletic Fields &amp; Courts</td>
<td></td>
</tr>
<tr>
<td>School facilities (indoor/outdoor courts, etc)</td>
<td>Publically accessible indoor and outdoor facilities located on the school campus.</td>
<td>Indoor gym, pool, basketball court, volleyball court, or indoor track. Baseball,</td>
<td></td>
</tr>
<tr>
<td>Recreation Facilities</td>
<td>Sports clubs/gyms</td>
<td>Free or privately owned gyms or sports clubs.</td>
<td>YMCA, Healthworks, or Curves</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------------</td>
<td>---------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Sports clubs/gyms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerobics, martial arts, or dance studios</td>
<td>Facilities offering structured physical activity through dance, martial arts, aerobics, or other types of instruction.</td>
<td>Casey’s ATA, Morgantown Dance Studio, WV Gymnastics Training Center</td>
<td></td>
</tr>
<tr>
<td>Pools</td>
<td>Public or private pools that may be indoor or outdoor. These may or may not include pools that part of a park, but does not include pools located on a school campus.</td>
<td>Krepps Park Pool, Marilla Park Pool</td>
<td></td>
</tr>
<tr>
<td>Skating/roller skating rink</td>
<td>Public or private skate rink that may or may not part of a state, town, or community park.</td>
<td>White Park Skating Rink</td>
<td></td>
</tr>
<tr>
<td>Trails</td>
<td>School/community trails and tracks</td>
<td>Publically available tracks or walking trials located on the school campus.</td>
<td></td>
</tr>
<tr>
<td>Trails</td>
<td>Community Trails</td>
<td>State, community, or town trials that may or may be located in a town or community.</td>
<td>White park trails, Decker’s Creek trail, Morgantown rails to trails.</td>
</tr>
<tr>
<td>Trails</td>
<td>Park hiking trails</td>
<td>Trials that are located in State Parks that are used for hiking or mountain biking.</td>
<td>Blackwater Falls hiking trails, Tygart Lake hiking trails</td>
</tr>
</tbody>
</table>

football, or soccer field. Tennis or basketball courts, playground, or outdoor pool.
Decisions Rules:

1) Overarching categories were determined based on classification/category on Google Maps™

2) If the physical activity resource category could not determined by Google Maps™, a call was placed to the establishment or a web search was conducted to gain more information to appropriately categorize the establishment. For parks, the local parks and recreation website was visited to determine resources available. If a park had multiple facility types available (skating rinks, skate parks, or trails), the location was coded under park, recreation facility, and trail. For example, White Park would be counted as a park and because it also has a skating rink and trails, the skating rink would be counted as a recreation center and trails would also be counted in the second category.
<table>
<thead>
<tr>
<th>Proposed Composite Category</th>
<th>Food Outlet Type</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Food</td>
<td>Franchised Fast Food</td>
<td>Restaurants meeting the following criteria: 1) has franchise Nationwide or in multiple states, 2) has multiple locations in state, 3) serves meals without the assistance of a waiter or waitress. ¹</td>
<td>Mc Donald’s, Burger King, Taco Bell, Wendy’s, Arby’s, Chik-fil-A, KFC, Long John Silver, Qdoba, Sheetz, * Dairy Queen/Brazier**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Domino’s, Pizza Hut, Little Ceasar’s, Fox’s Pizza, Cantoni’s pizza, Casa D’ Amici, Papa John’s, Cici’s Pizza, Gino’s</td>
</tr>
<tr>
<td></td>
<td>Pizza</td>
<td>Establishment is 1) a recognized National pizza establishment or 2) is a local pizza establishment with pizza in the name.</td>
<td>Dairy Queen**, TCBY, Carvel, Coldstone Creamery</td>
</tr>
<tr>
<td></td>
<td>Ice Cream Shop</td>
<td>Local or National chain ice cream shop. Establishment type determined by the name of the establishment when possible. Primarily serves ice cream or other frozen treat and desserts.</td>
<td>Subway, D’Angelo’s, Blimpie, Quizno’s, Jimmy John’s</td>
</tr>
<tr>
<td></td>
<td>Sandwich Shop</td>
<td>Local or National chain establishment primarily serving subs or sandwiches.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full Service Restaurant</td>
<td>National chains that are not recognized as fast food outlets because provide waiters/waitresses (including buffets).</td>
<td>Red Lobster, Olive Garden, Cheddar’s, Cracker Barrel, Bob Evan’s, Shoney’s, Eat-n-Park, Ruby Tuesday’s, Chili’s, Texas Long Horn, Texas Roadhouse, Friendly’s, I-HOP, Outback, Perkins, Golden Corral</td>
</tr>
<tr>
<td></td>
<td>Local Full Service Restaurant</td>
<td>Local establishment that offers full service dining (including buffets.) including ethnic restaurants, including local chain restaurants.</td>
<td>Oliverio’s, Boston Beanery, Rio Grande, Voyagers’, Blue Moose, Black Bear, Archie’s</td>
</tr>
<tr>
<td>Convenience Store</td>
<td>Convenience Store</td>
<td>Stores that carry a limited selection of foods, mostly snack foods, whether or not attached to a gas station² also included here will stores that have “variety” or “mart” in the name.</td>
<td>Sheetz, 7-11, BP Station, Convenience Plus, Go-Mart, Kwik Mart, Dairy Mart, Quick Stop</td>
</tr>
<tr>
<td>Supermarket</td>
<td>Large corporate owned “chain” food stores.(^2)</td>
<td>Food Lion, Kroger, Wal-mart Super Center, Giant Eagle, Aldi, Shop’N Save, Save-A-Lot</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>Those establishments unable to be classified through NAICS codes, yellow pages, or Google Maps™.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Decision Rules:**

1) If food outlet type could not be determined given the descriptions provided above, the National American Industry Classification System (NAICS) codes were used. These codes are used by federal agencies to classify business establishments which allow them to collect and analyze statistical data about the US economy. [http://www.census.gov/eos/www/naics/](http://www.census.gov/eos/www/naics/)

2) If the food outlet type could not be determined based on the description given above or NAICS codes, a call was placed to the establishment to inquire about the types of foods/services provided.

3) Any establishment indicating that the primary classification relates to the sale of alcohol was not included in the database for our study. This was determined by 1) reviewing the names of local establishments (i.e. establishments with pub or bar in the title, and 2) looking up NAICS codes.

4) An establishment was double coded if it fell into more than one food outlet type. For example, Sheetz was will be listed as both a convenience store and a fast food outlet given that the establishment serves made to order foods. The Sheetz Corporation states, “Sheetz is about providing kicked-up convenience while being more than just a convenience store. Sheetz is a mecca for people on the go.” [http://www.sheetz.com/main/about/definition.cfm](http://www.sheetz.com/main/about/definition.cfm). Another example for double coding would be Dairy Queen. Since Dairy Queen may also serve a variety of fast foods (Brazier) it was coded as both an ice cream shop and a fast food establishment. This was readily determined using Google/Google Maps usually provides a brief description of menu options. For example, the Dairy Queen on High Street is listed as only serving ice cream whereas the Dairy Queen in Westover is listed as serving ice cream, soft serve, burgers, fries, etc.

5) If a classification for an establishment cannot be determined, it will be coded in the unknown category.

6) It should be noted that although bakeries, donut shops, and coffee shops were part of the data collection, these locations were not included in the fast food category presented due to the large number of keno locations that list as coffee shops and cafes in West Virginia (e.g., City Perk). Because of this, it was difficult to reliably distinguish those that were not Keno locations.

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1 Definition used by Burdette et al., 2004.
2 Definition used by Morland et al., 2006
Appendix F. Description of Validation Study

A small validation study was conducted using a convenience sample of three school communities. Schools were selected based on the criteria that each was in a different county and located in an area considered to be rural. This was done in order to examine the accuracy of the resource database in more remote settings. The validation took place in two phases. First a representative of each community was identified and asked to review the physical activity and food resource lists for the school community. Community members were asked to verify whether establishments were open or closed and comment on the accuracy of the physical address. For each food and physical activity category, community members were also asked to write-in any resources they knew to exist but were not included. The second phase of the validation involved trips made to each community in an effort to ground truth the resource lists. Using methods similar to those of Sharkey & Sorel, 2008, each establishment was identified and the latitude and longitude of each location recorded. The level of agreement between ground truthing observations and resource lists was examined using calculations from previous research (establishments located and open/establishments located and open + found and not listed). In addition, we considered the level of agreement between the verification information received from community members and from on the ground observations.

Results from our study revealed the vast majority of food stores obtained from Google were verified through ground truthing. Out of the 38 food outlets identified in the resource list, all but one was verified. It is interesting to note that the location of this establishment was correct, but the store had recently closed. Only one food store was ground truth identified (i.e., not in the food resource list but observed during the community audit). Overall percent agreement was found to be 95%.

In contrast to the food resource database, more discrepancies were found when verifying physical activity resources. Resources identified from Google, yellowpages.com, or county/city parks and recreation pages estimated a total of 6 physical activity resources across the 3 communities. Recreation facilities were most consistent but in several instances the presence of trails or parks was only recorded through on the ground observations. In total, the ground truthed observations yielded a sensitivity of 60%. Though not ideal, this is consistent with recent research reporting a 42% agreement between a commercial database of recreational facilities and the total number of facilities observed through ground truthing. Boone et al., propose that while commercial databases of recreational facilities may contain error, the error is likely to bias associations downward. Finally, it should be noted that comparisons between ground truthing and community member verification yielded the same results. Meaning the same discrepancies observed between resource lists and the observed environment were the same discrepancies identified by community members. This may be an important finding for future work as community member verification may offer an efficient and cost effective way to verify lists.


### Appendix G. NCES Classification for School Communities

<table>
<thead>
<tr>
<th>Urban-Centric Locale Code Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>City: Large</td>
<td>Territory inside an urbanized area and inside a principal city with population of 250,000 or more.</td>
</tr>
<tr>
<td>City: Midsize</td>
<td>Territory inside an urbanized area and inside a principal city with population less than 250,000 and greater than or equal to 100,000.</td>
</tr>
<tr>
<td>City: Small</td>
<td>Territory inside an urbanized area and inside a principal city with population less than 100,000.</td>
</tr>
<tr>
<td>Suburb: Large</td>
<td>Territory outside a principal city and inside an urbanized area with population of 250,000 or more.</td>
</tr>
<tr>
<td>Suburb: Midsize</td>
<td>Territory outside a principal city and inside an urbanized area with population less than 250,000 and greater than or equal to 100,000.</td>
</tr>
<tr>
<td>Suburb: Small</td>
<td>Territory outside a principal city and inside an urbanized area with population less than 100,000.</td>
</tr>
<tr>
<td>Town: Fringe</td>
<td>Territory inside an urban cluster that is less than or equal to 10 miles from an urbanized area.</td>
</tr>
<tr>
<td>Town: Distant</td>
<td>Territory inside an urban cluster that is more than 10 miles and less than or equal to 35 miles from an urbanized area.</td>
</tr>
<tr>
<td>Town: Remote</td>
<td>Territory inside an urban cluster that is more than 35 miles of an urbanized area.</td>
</tr>
<tr>
<td>Rural: Fringe</td>
<td>Census-defined rural territory that is less than or equal to 5 miles from an urbanized area, as well as rural territory that is less than or equal to 2.5 miles from an urban cluster.</td>
</tr>
<tr>
<td>Rural: Distant</td>
<td>Census-defined rural territory that is more than 5 miles but less than or equal to 25 miles from an urbanized area, as well as rural territory that is more than 2.5 miles but less than or equal to 10 miles from an urban cluster.</td>
</tr>
<tr>
<td>Rural: Remote</td>
<td>Census-defined rural territory that is more than 25 miles from an urbanized area and is also more than 10 miles from an urban cluster.</td>
</tr>
</tbody>
</table>

*NCES: National Center for Education Statistics*
Appendix H. Calculating Census Statistics for the 5km Buffer

The figure to the left illustrates how multiple block groups intersect the 5km buffer. In this case, 9 block groups are represented in the buffered region.

In the Table below is an example of calculating the population for the buffer area, given the area contributed by each BG and the population for each BG.

<table>
<thead>
<tr>
<th>Block Number (from above)</th>
<th>Area Block Group Contributes in meters</th>
<th>Percent of Area Contributed by Block Group</th>
<th>Total Population of Entire Block Group</th>
<th>Weighted Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>207165.7952</td>
<td>0.00268161</td>
<td>716</td>
<td>2.0</td>
</tr>
<tr>
<td>8</td>
<td>12515187.02</td>
<td>0.161999984</td>
<td>1318</td>
<td>213</td>
</tr>
<tr>
<td>7</td>
<td>12302300.16</td>
<td>0.159244318</td>
<td>948</td>
<td>150</td>
</tr>
<tr>
<td>6</td>
<td>10844799.79</td>
<td>0.140378037</td>
<td>1062</td>
<td>149</td>
</tr>
<tr>
<td>5</td>
<td>6121156.524</td>
<td>0.079233914</td>
<td>1155</td>
<td>91</td>
</tr>
<tr>
<td>4</td>
<td>3895618.388</td>
<td>0.050425944</td>
<td>979</td>
<td>49</td>
</tr>
<tr>
<td>3</td>
<td>9813443.675</td>
<td>0.127027883</td>
<td>934</td>
<td>118</td>
</tr>
<tr>
<td>1</td>
<td>21554577.24</td>
<td>0.279008309</td>
<td>1438</td>
<td>401</td>
</tr>
<tr>
<td>Total Area:</td>
<td>77254248.59</td>
<td>0.279008309</td>
<td>1176</td>
<td></td>
</tr>
</tbody>
</table>