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To the Graduate Council:

I am submitting herewith a dissertation written by Kristin Ashley Riggsbee entitled "A Multi-Method Measurement of Adolescent Food Environments and Related Health Behaviors and Food Choices: School, Community, and Home Environments." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Nutritional Sciences.

Sarah Colby, Major Professor

We have read this dissertation and recommend its acceptance:

Marsha Spence, Elizabeth Anderson Steeves, Elizabeth Johnson, Wenjun Zhou

Accepted for the Council:

Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

A Multi-Method Measurement of Adolescent Food Environments and Related Health Behaviors and Food Choices: School, Community, and Home Environments

A Dissertation Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Kristin Ashley Riggsbee
May 2019

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DEDICATION

This dissertation is dedicated to my husband and two sons, the loves of my life.

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"We don't have to do all of it alone. We were never meant to."
— Brené Brown, Rising Strong

This effort was not done in isolation, and I absolutely would not be here without my family, friends, mentors, and colleagues. First, I am deeply indebted to my mentors, colleagues, and committee members for their time and feedback during this entire process. Dr. Colby, I'm not sure how I lucked out when I ended up in your lab, but it was meant to be. I knew from the first interview that you were a great advisor, and you have never let me down. I know there have been both tears and laughter through this, but I think of you as family. Thank you for always reminding me what is really important. Dr. Spence, you are the person who made me fall in love with community work, and I always looked up to you and your approach in the classroom. Dr. Anderson Steeves, I had no idea that I would gain such a fantastic mentor when you came to join our faculty. From day one, you have always been incredibly thoughtful with your advice, and having someone with your immense knowledge and expertise on food environments has been invaluable. Dr. Johnson, your insight into my project allowed me to view it with other lenses, and I always appreciated you making time for me to discuss my research. Dr. Zhou, you also have spent a great amount of generous time with me (and my data), and you have a gift of making challenging analyses seem much more straightforward. I am also grateful to the entire nutrition faculty and staff. Additional thanks to the REACH lab for their time, brain power, and extra set of willing hands to help with this project when

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ABSTRACT

Background: Many researchers have investigated the role of environments in food behavior. Methods used to assess these environments often involve community members' participation. Adolescents engaging in food environment assessments may impact health behavior change and food choices. **Methods:** Development of the Food Environment Curriculum (FEC) included a cyclic action research approach with inclusion of students engaging in food environment data collection as a component of a nutrition high school wellness class. Adolescents (n=17; 13-15 years of age) at one high school, in one wellness class, participated in testing of the FEC. Quantitative testing included pre-and post-surveys assessing fruit and vegetable (F/V) intake and meal pattern. After the FEC, five focus groups were completed (n=30) and a subsample (n=6) from the intervention group participated in a Photovoice project of their food environment. Focus group (exploring relationships between food environments, behaviors, and choices) data were analyzed using multiple coding mechanisms for emergent themes. Data integration of all qualitative and quantitative data (surveys, focus groups, and Photovoice) was re-analyzed using grounded visualization and coded for themes. Themes were used to create a story map using ArcGIS online. **Results:** No significant changes were found for dietary behaviors from pre-FEC to post-FEC. Focus group findings emphasized the need for convenient, healthier food items that adolescents could control the selection of within their food environments. Themes emerged from the integration of data, including transportation, family support, cooking skills, and the use of technology in meal planning and preparation. **Conclusions:** Further testing needs to be conducted with a larger group and over a longer time-period

to implement the FEC. Additional research is needed to better understand how story maps could be used by and influence adolescents in a larger intervention process. The use of grounded visualization and story map development was a novel way to gain an understanding of adolescent food environments. Results indicated that future food interventions with adolescents may need to consider transportation independence, adolescent control over food choice, and use of technology in meal planning and preparation.

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CHAPTER 1 : INTRODUCTION

Obesity is a serious public health crisis, particularly in the adolescent population.[1-5] The development of obesity is in part due to less than optimal eating behavior.[6, 7] Adolescents are particularly prone to problematic eating behaviors and consistently fail to meet national recommendations for nutrition guidelines.[8-11] If population-wide diet patterns included more fruit, vegetables, fiber, water, lean protein, and less saturated fat, added sugar, and salt then fewer individuals would suffer from obesity and associated co-morbidities. Interventions, that effectively improve dietary behavior, are needed to address the current obesity crisis, particularly in the adolescent population.[12, 13] One factor associated with both dietary behavior and the risk of developing obesity is the food environment.[14-19] Researchers have conducted food environment interventions to promote improved dietary behavior of community members and ultimately affect obesity prevalence.[14, 17, 20-23] As a part of these food environment interventions, researchers often assess food environments; sometimes members of the community work with researchers to conduct these food environment assessments. Previous work by the lead researcher with adolescents has provided antidotal evidence that assessing food environments may change perceptions and knowledge, ultimately leading to behavior change. The impact of conducting food environment assessments on the population's dietary behaviors is currently unknown.[24-26] Adolescents conducting food environment assessments may function as an intervention that promotes healthful dietary behavior in the short term that may be associated with long-term obesity prevention.[27, 28] Further, use of story mapping and geographical information system mapping techniques in combination with qualitative insight from the population of

interest may provide rich, thick descriptions of adolescent food environments that help shape future interventions and nutrition education.

Adolescence

Development of the Adolescent

Adolescence is a transition period in an individual's life that bridges childhood to adulthood, with physiological, psychological, and social changes occurring.[29-31] This life stage ranges from 10 to 29 years of age.[29, 32, 33] Historically it was proposed that adolescence was synonymous with the teenage years, ranging from approximately 13 to 18 years.[29] Considering the age when puberty begins has caused researchers to lengthen the time span. Some researchers have additionally proposed expanding the time span to include the early 20's as individuals wait until later in life to move away from family.[32-34] It is important to note that emerging adulthood is a newer categorization, proposed by Arnett.[34] Further, emerging adulthood has the increased likelihood of being even more individualized than previous categories as adolescents make decisions to attend college, work jobs, and establish economic independence.[34] However, criticism of emerging adulthood is that it may only be reflective of a more traditional college experience for the late adolescent. Traditional views of adolescence have expanded, dividing the puberty span into four interrelated categories: early adolescence, middle adolescence, late adolescence, and emerging adulthood.[29, 34, 35] Table 1.1 indicates the differences and overlapping characteristics of these categories. It may be more appropriate to gauge the beginning and end of adolescence by judging whether an individual has met certain development criteria.[35] For these reasons, the period of adolescence can vary from individual to individual.

Table 1.1. Categories of Adolescence.

Categories of Adolescence	Age (in years)	Characteristics
Early adolescence	10 – 13 years	Junior high or middle school
Middle adolescence	14 – 17 years	High school
Late adolescence	18 – 21 years	College
Emerging adulthood	18 – 29 years	Final transition from adolescence to adulthood

John Hill, a prominent psychologist, and pioneer in adolescent research, proposed a framework to understand the changes and development of adolescents in 1983.[35] The Hill framework describes adolescent development in three stages: physiological, cognitive, and social changes. He terms these three transitions as the fundamental changes of adolescence.[35] As described previously, the experience of an adolescent can vary widely; however, Hill suggested that all adolescents must broadly go through all three of the fundamental changes to transition to adulthood.[35, 36] However, it is important to note that these fundamental changes are not happening individually or in isolation; they are all happening at the same time and are often interrelated.

Physiological Changes of the Adolescent

Puberty

The most prominent physiological change that occurs in adolescence is puberty, which can encompass all the physical changes that take place in males and females as they move towards adulthood and capability of sexual reproduction.[37-40] Many of the physiological changes of puberty are subclinical for years before the official start of puberty.[38] Puberty can be divided into three clinical manifestations of the transition: rapid growth, development of primary sex characteristics, and development of secondary sex characteristics.[38] Puberty involves the endocrine system and is regulated by a hormone feedback loop, which allows the body to gauge how much of a hormone needs to be produced to reach a set point.[38] Although changes in the behavior of the adolescent are typically attributed to puberty, the biological theory behind hormones indicates that some tendency towards behaviors is arranged before birth.[40-43] The

presence or absence of masculinizing hormones in the brain at eight weeks' post-conception program the brain to develop in certain ways and may predict following behaviors. Thus, hormones related to puberty simply "activate" the behaviors.[40-43]

Rapid Growth

A period of rapid growth occurs in adolescence, often referred to as the adolescent growth spurt.[38] This increase in stature and weight is the result of a rapid increase in thyroid hormones, androgens, and growth hormones. Often, this growth spurt can occur rather quickly, particularly for males. The term peak height velocity is often used by health practitioners to describe this process; it is a time in which an adolescent is growing most rapidly.[38] Another biological indicator of the conclusion of puberty is epiphysis.[38] This term is used to describe the closing of the ends of the bones, indicating the end of the adolescent growth spurt.[38] In addition to height, weight changes occur for males and females, including an increase in fat deposits and muscular development. Males typically see a slight reduction in body fat percentage before puberty.[38] These physiological changes are imperative considerations when assessing the nutritional needs of an adolescent.

Cognitive Changes of the Adolescent

Brain maturation and advanced thinking and reasoning processes during adolescence is another critical component of adolescent development.[44, 45] First, the addition of deductive and inductive reasoning and hypothetical thinking enable the adolescent to consider possibilities and draw logical conclusions.[46-49] Secondly, adolescents are able to think abstractly far greater than their young counterparts.[44] This is often why adolescents began evaluate moral or ethical dilemmas that arise in their

life.[50] An increase in abstract thinking also makes adolescents able to contemplate social cognition and societal norms.[44] Adolescents are also able to think about thinking. The term for this thinking process is metacognition.[44, 45] Metacognition allows an individual to be introspective about strategies or methods to learn or study, as well becoming self-aware of emotions.[44, 45] However, the use of introspection may also lead the adolescent to heightened self-consciousness and egocentrism.[51] Another way in which adolescence cognition develops is being able to think in multiple dimensions, such as critical thinking skills and statistical reasoning.[44] A final cognitive concept is that adolescents are able to see things as relative as compared to absolute. For this reason, an increase in skepticism and not accepting everything presented as fact is a common trait of the adolescent.[52, 53] Brain maturation and recent research related to the physiological development during this time support these cognitive changes. Both the prefrontal cortex and continued myelination both support increased information processing.[54-56]

Social Changes of the Adolescent

Through adolescence, society and culture redefines the roles or status of an individual, often increasing responsibilities as he or she moves closer to adulthood.[29, 57] Social transition also often changes relationships with peers and family. While adolescents may be given adult freedoms, these new found freedoms also come with self-management and personal responsibility.[57] Social transitions during adolescence often progress in stages. Many societies consider extrusion, or the removal of children from a parent's household, a crucial step in social redefinition.[29, 34, 54, 58] The amount of time and quality of time spent in peer relationships shifts dramatically in adolescence.

Adolescents typically rely on peer influence for attitudes and beliefs, even on a daily basis.[29, 59] Further, peer relationships are critical to the developing adolescent as sexual identities, views on intimacy, and romantic relationships form.[59] This does not suggest that parental relationships are absent or unimportant to the adolescent. However, it is important to note that family closeness and parental monitoring are crucial components to maintaining trust and influence from caregivers.[29]

The social development of adolescents is not just limited to changing relationships and further independence from caregivers. Emotional and social competence are necessary skills for the adolescent to acquire.[29, 54, 59] Further, these two skills are interrelated. As adolescents learn more about relationships with others, they are able to understand more about their own emotions and become more self-aware.[54, 58, 59] Self-awareness is necessary for adolescents to be able to identify and label their emotions, assisting with management and regulation of the emotions. Self-management of emotions also interact with other cognitive development processes as the growing adolescent learns to reason and use abstract thinking to examine emotions and reactions.[59]

Obesity

The Rising Rates of Obesity

U.S. obesity rates are most often evaluated using the National Health and Nutrition Examination Survey (NHANES). A mobile data collection unit allows researchers to collect anthropometric measurements on participants, and the data is then used to calculate BMI.[4, 60, 61] BMI is used to estimate body fat by accounting for height and weight; it is typically calculated by dividing weight (in kilograms) by the

squared height (in meters).[62] Adults' BMI is categorized into established parameters as indicated in Table 1.2.[62] Children and adolescents aged 2 to 19 years are evaluated based on sex-specific BMI for age growth charts set by the CDC.[1, 3, 62] The two principal diagnoses from the BMI growth charts are overweight and obesity. The definition of "obesity" is a BMI percentile above or at the 95th percentile specific for sex and age, and the definition of "overweight" is being above or at the 85th percentile on the BMI growth for age charts.[3, 5, 61]

Obesity is a continuing public health concern, spanning across all segments of the population.[1, 61, 63, 64] The Centers for Disease Control (CDC) estimates that one in three adults in the United States is considered to be overweight or obese.[64] Obesity rates among children and adolescents aged 6 to 19 years tripled between 1980 and 2002.[1-3, 61] The prevalence of obesity extends beyond the North American continent, affecting many developed countries globally, such as Great Britain, Australia, Brazil, and China.[65] Since 1960, extensive epidemiological studies established the rising prevalence across the world.[66-68] From 1980 to 1991 in Great Britain, the number of adults with a Body Mass Index (BMI) of 30 or greater doubled.[69] One current concern is the increase in class II and class III obesity; with some of the largest percentage changes in obesity rates occurring in those who are considered to be severely obese.[3, 4, 64]

Recent research related to the obesity prevalence in the United States indicates minimal progress in prevention efforts. In 2018, Hale et al. published an analysis of NHANES data, comparing 2007-2008 to 2015-2016 rates of youth and adult obesity.[70] Significant differences in the prevalence of adult obesity and severe obesity were noted

at 33.7% to 39.6% and 5.7 % to 7.7%, respectively. Notable differences within the adult group were also significant, with rates increasing in women and adults over the age of 40 years.[70]

Disparities in obesity exist related to poverty.[3, 5, 71] Data from NHANES 2008 revealed that there were no significant differences in adult male obesity rates by income level.[5, 72] However, women with higher income levels were less likely to be obese when compared to women from lower income levels. Further, women with college degrees and higher levels of education were less likely to be obese when compared to those with no college degree.[50] For children, the statistics of obesity and poverty are more alarming. For both male and female children, obesity rates increase as the household income decreases.[3, 4, 72] In 2018, Lundeen and colleagues analyzed obesity rates compared to geographical regions of the country and whether surveyed participants lived in a metropolitan versus non-metropolitan area. Overwhelmingly, obesity rates were higher in non-metropolitan areas, no matter the region. However, the highest rates of obesity were noted in the non-metropolitan areas in the South region (including South Atlantic, East South Central, and West South Central divisions), which the authors suggested related to increasing rates of poverty.[73]

Obesity Prevalence in Adolescence

The epidemic of obesity is just as prevalent in the adolescent population. However, the main public health concern for this particular population is the enormous increase in overweight and obese children in the US between 1963 and 1994.[1,2,49,52] In 2004, Ogden and colleagues reported that 17.1% of U.S. children and adolescents were overweight.[52] Further, the prevalence of overweight female children and adolescents

Table 1.2. CDC Guidelines for Categorizing Adult BMI.

Classifications of BMI	BMI Measurements
Underweight	Less than 18.5 kg/m^2
Normal weight	18.5 – 24.9 kg/m^2
Overweight	25 – 29.9 kg/m^2
Obesity (Class I)	30 – 34.9 kg/m^2
Obesity (Class II)	35 – 39.9 kg/m^2
Severe obesity (Class III)	40 kg/m^2 or greater

increased from 13.8% to 16% in four years. Prevalence in male children and adolescents also increased from 14% to 18.2%.[52] Most recent research from Hale and team indicate that these rates for obesity in youth remain steady at 18.5% in 2015-2016, with no significant changes in this population over the last decade.[70] Research has cited the changing food environment affecting youth as the primary factor in these changing statistics.[1,2,49,52]

Similar to obesity in adulthood, health inequities are evident.[1-3, 5, 61] When comparing NHANES data in 1994 and 2000, Ogden and colleagues found that Mexican-American and non-Hispanic black adolescents' obesity rates increased over 10%.[1] Logistic regression analysis in the same study allowed comparison of odds ratio between gender, age, and race. Male children and adolescents who were also Mexican-American were more likely to be obese when compared to their non-Hispanic white counterparts (OR = 1.73).[1, 2] Higher rates of obesity have been noted in adolescent population of lower socioeconomic status.[5] Specifically, non-Hispanic white boys and girls are less likely to be obese compared to those children living in households with an adult with less than a high school degree.[5] Skinner and team also noted some significant differences in youth obesity rates in 2018, with African American and Hispanic children among all age groups with higher rates of overweight and obesity.[61]Prevalence of overweight and obesity in youth (ages 2 to 19 years) of higher income groups were lower based on NHANES from 2011 to 2014 (10.9% compared to 18.9% in the lowest income and 19.9% in the middle income group).[74]

Recent research from Ogden and colleagues have reported there have been some success in the child and adolescent populations, but other reports have not been

as promising.[1] Trends from the NHANES data indicated that obesity decreased in children ages 2-5 from 13.9% to 9.4% in one decade.[1] Rates of obesity for children ages 6 to 11 have remained the same. However, obesity in adolescents (ages 12-19) significantly increased from 10.5% to 20.6% in the last twenty years. In addition, adolescents have also seen a significant spike in severe obesity from 2.6% to 9.1%.[1] In 2018, Skinner and team noted no significant decreases in overweight and obesity rates in all age categories of children and adolescents. In fact, some evidence from this publication indicated that rates of severe obesity in young children (ages 2 to 5 years) and adolescents was increasing.[61] These reports provide an indication that there is still a need for intervention and focus on the obesity epidemic, particularly in an adolescent population.

Health Outcomes Related to Obesity

Obesity has been linked to a multitude of chronic diseases, such as cardiovascular disease, metabolic syndrome, hyperlipidemia, hypertension, type 2 diabetes, sleep apnea, and osteoarthritis.[13, 75-77] The presence of these secondary disease processes may put a client at greater risk for morbidity and/or mortality related to obesity. [13, 75-77] Other medical disorders associated with obesity include gallstones, amenorrhea, osteoarthritis, and incontinence. These are typically not life-threatening but can disrupt activities of daily living. Obesity being a leading cause of mortality is one of the reasons that obesity is a serious public health concern. [13, 75-77]

Because obesity is related to secondary chronic disease processes, such as type two diabetes, hypertension, and stroke, the direct medical costs related to the comorbidities are expected to rise as the obesity rates increase.[78] There are

significantly higher accumulated medical costs for overweight and obese patients compared to people of a healthy weight, including pharmaceuticals and hospitalizations.[78] Obesity can increase lifetime health care expenses by 50% for hypertension, hypercholesteremia, type two diabetes, stroke, and congestive heart disease. Severe obesity could double accumulated medical costs.[78]

Health Outcomes Related to Obesity in Adolescence

What is most concerning about the rising adolescent obesity rates is the risk associated with adult obesity.[79-83] Dietz and team identified the adolescent life stage as the highest risk for long-term health outcomes related to obesity due to adiposity rebound.[79] Adiposity rebound is the period of time in which BMI begins to increase, which has been found to correlate with a risk of obesity later in life. Early adiposity rebound is also found to be associated with parental obesity, putting these youths at even higher risk for adulthood overweight and obesity.[79]

It has been well established in the literature that obesity in late childhood and adolescence is a predictor of adult obesity.[80, 81, 83] Whitaker and colleagues found that the probability of maintaining obesity as an adult increased for each year a child was obese.[80] The risk was statistically significant if either parent was obese. However, after removing the parental obesity variable, the increased risk for adulthood obesity remained, especially as the age of the child increased.[80] An epidemiological meta-analysis revealed that not only did the adult obesity risk increase, but there was an even greater risk for adolescents who were obese when compared to younger youth.[81, 82]

An adolescent with obesity can suffer from both short-term and long-term effects of the disease.[84-86] Short-term effects of obesity in adolescence include gastrointestinal

disturbances, cardiopulmonary issues, orthopedic pains, and endocrine system dysfunctions. However, most of these problems are only seen in the patients with severe obesity.[84] Intermediate effects of adolescence obesity is an increased risk of adult obesity and cardiovascular risk factors, such as atherosclerosis, dyslipidemia, and hypertension. Long-term effects of adolescence obesity can include altered eating patterns, distorted body image, poor self-esteem, and further increased risk of cardiovascular disease. [84-86] Research has shown that the long-term effects of negative self-esteem related to obesity persist into adulthood.[87, 88] There is less scientific evidence that an adolescent with obesity is at a greater risk for adult chronic disease processes and premature mortality, but this may be due to a lack of appropriate longitudinal studies to test the long-term effects of obesity during this time period. [84-86, 89]

The Causes of Obesity

The definitive causes of obesity remain unclear, but there are many possibly contributing factors that have been identified.[66, 84, 90-92] Some of the major contributors to obesity are biological, psychological, behavioral, and social in nature. Although there has been some genetic basis to obesity established, no single gene can be found to result in obesity. [66, 84, 90-93] Although biological components to obesity are crucial components, it is unlikely that biology alone can be the cause of the increased prevalence of obesity in the last fifty years. To address the prevalence of obesity, researchers have started to focus on behavioral and environmental aspects to target obesity prevention.[16, 18, 26, 93-96]

The most basic cause of obesity is an imbalance in caloric intake resulting in weight gain.[90-92] However, this simple explanation does not address external factors that

influence an individual's food choices and eating behaviors.[10, 97] Research indicates that dietary intake plays a vital role in the prevention of chronic diseases and obesity, and nutrition is considered to be a modifiable risk factor for the development of obesity and secondary co-morbidities.[66, 67, 76, 98] Changes in population dietary habits would have immense benefit to American population health. These changes include increasing consumption of fresh fruits and vegetables, reducing saturated fats, decreasing caloric intake, increasing consumption of whole grains, reducing sodium and added sugar consumption, would lead to overall better health and well-being.[98-101]

The Link Between Diet and Obesity

Epidemiological studies have determined that dietary behaviors are related to the obesity prevalence in developed countries through population monitoring strategies, such as NHANES.[90] A World Health Organization (WHO) expert committee reviewed the population data for the U.S. and graded evidence of factors that increased and decreased the risk of obesity.[102] Some of the most convincing evidence for a decreased risk of obesity is related consumption of adequate fiber and non-starchy carbohydrate foods with an increased risk due to high intake of energy-dense foods.[102]

Obesity Prevention through Dietary Interventions

The gold standard for weight management and treatment of obesity is lifestyle modification.[99] This approach includes nutritional interventions, an increase in physical activity, and behavioral therapy. Research has established that behavior modification may be the most important factor for long-term weight loss and maintenance. Further, weight management strategies require a multi-disciplinary approach that may include assessment of community resources. In 2016, the Academy of Nutrition and Dietetics

recommended approaching weight management through use of community resources, environmental changes, and addressing multiple layers of the SEM to better support lifestyle interventions.[99]

In a 2012 review of current dietary strategies for short and long term weight maintenance, Makris and Foster identified several dietary strategies that have been historically prescribed for weight loss and maintenance.[103] Overall, many of the diets were found to reduce weight, but the authors noted that long-term results and efficacy were only seen in studies that included a behavioral therapy with ongoing support component. Low carbohydrate diets have been effective in reducing the risk for cardiovascular disease and dyslipidemia related to obesity.[103] However, Makris and Foster also noted that long-term diet adherence was rare, and related weight re-gain was common. Future research with obesity prevention and treatment may be well-suited to determine how to focus on behavioral factors that may decrease long term dietary adherence, such as problematic eating behaviors and foods available in the environment.[99, 103]

Treatment and Prevention of Obesity in Adolescents Using Diet

The National Institutes of Health (NIH) recommends that adolescents with obesity should maintain current weight while focusing on making long-term lifestyle changes unless secondary disease processes or medical complications exist. Lifestyle changes are similar to adult strategies, including increasing physical activity and monitoring caloric intake.[93, 104, 105] Additionally, identifying and monitoring problematic eating behaviors and the inclusion of behavioral therapy provides the most benefit for long term health changes.[93] General nutrition recommendations related to weight

management for children and adolescents should include limiting sugar-sweetened beverages, consuming an adequate amount of fruits and vegetables, appropriate portion sizes, limiting fast food and excessive snacking, and eating meals together as a family.[104, 105]

Some recent research has shown that appropriate portions and a well-balanced diet that meets national nutrition recommendations along with family behavior therapy can limit weight gain in children and adolescents.[103] Further, reducing saturated fat intake will likely help adolescents because snacking and convenience foods are such a significant portion of the average diet. Reviews of adult diet therapy research have revealed an association between total and saturated fat intake and weight gain.[104] One caution is of the use of highly restricted diets, particularly in calories for adolescents and children. Long-term effects of highly restricted diets on adolescents remains unsure.[104]

Fruit and Vegetable Intake as Overall Dietary Quality Indicator

One method of measuring overall dietary quality, particularly in the adolescent population is the use of daily fruit and vegetable consumption as an indicator. A June 2016 study published in the Journal of the Academy and Nutrition and Dietetics found that higher intake of canned fruits and vegetables among children and adolescents overall yielded better macronutrient distribution and increased vital nutrients and minerals.[106] Specifically, children who were high consumers of fruits and vegetables were also found to also take in 7.6% more in fiber, 3.7% more total energy, 5% calcium, and 11.3% Vitamin A. Also, it was noted that high fruit and vegetable consumers took in less total and saturated fat.[106] Although fruits and vegetables are only one component of a healthy diet, these objective measures may provide a way to track a change in an

adolescent's diet. Similar results were found in a national longitudinal study of adults, with the most significant associations between better dietary quality (i.e. fruit and vegetable intake in this case) and lower body weights in younger adults and older adolescents.[107]

Nutritional Needs of the Adolescent

The developmental changes of the adolescent demand an increase in nutritional needs.[89] Rapid growth during adolescence often increases the body's need for calories and energy as well as total nutrients.[108-110] However, based on psychosocial changes for an increased need for autonomy and immature cognitive abilities, adolescents are at a great risk for poor nutritional status.[110] Appropriate macronutrient distribution is similar to that of adult nutrition recommendations, with fat limited to 20-30% of daily diet and less than 10% of that being saturated fat. Dietary calcium is critical to bone development and to prevent osteoporosis later in life. [108-110] These nutritional needs are crucial for appropriate growth and development and adoption of long-term health behaviors. [108-110]

Despite the need for appropriate nutrition, research has consistently shown that the American adolescent's diet fails to meet nutrition recommendations.[111] Adolescents tend to consume too few fruits, vegetables, whole grains, and low-fat dairy products while taking in too many calories with nutrient poor foods that are frequently high in fat.[8, 111] Story et al. reported that only 2% of males ages 9-13 and 5% of males ages 14-19 met national nutrition recommendations. Further, no females in the sample in either age group met all the recommendations of mean servings for the food groups.[8, 110] In 2010, research showed that the top sources of energy of consumed for ages 2-18 were made

up by grain desserts, pizza, and soda with 40% of energy consumed being those of empty calories.[112] Additionally, sugar sweetened beverages are a staple of the adolescent diet, with males ages 14-18 consuming 3 or more servings per day.[112]

Adolescents also exhibit various problematic eating behaviors that may affect nutritional intake.[10, 113-115] One of these behaviors is skipping meals, particularly in adolescent females. The most frequently skipped meal is breakfast, with an increase in skipping noted in mid to late adolescence.[116-118] Several barriers were identified with consuming breakfast, including lack of time in the morning, increased desire to sleep compared to eating in the morning, decreased appetite in the morning, and desire to lose weight.[118] Another problematic behavior is poor snacking habits, as snacks have been found to account for nearly one-third of an adolescent's caloric intake.[114, 119] Snack foods typically chosen by adolescents are high calorically with low nutrient density and high fat and/or high sugar.[114] Convenience and taste have been found to be priorities when choosing snack items as adolescents typically snack on what is available to them.[118] In addition, eating out, particularly at fast food outlets, has been established as a frequent behavior for this age group.[118] The likelihood of food acquisition outside of home and school increases as the middle to late adolescent gains autonomy and independence.

Theoretical Framework Related to Obesity Prevention Strategies

Although obesity can be intervened at the individual level with a focus on behavior change, a population-based approach could be more cost efficient and address the causes of obesity in an upstream approach.[12, 18] Further, individual treatments for obesity may not be available to all populations, particularly to those of

lower socioeconomic status, which perpetuates the existing health disparity.[120, 121] Geoffrey Rose, an epidemiologist credited with the population-based approach to public health approaches and preventative medicine. Rose proposed that preventative care should target those at the highest risk and most vulnerable.[122] The population-based approach affects the lowest risk population, while providing the most potential to affect society by removing an exposure that creates an increased prevalence of disease.[122] This approach targets to the most vulnerable by addressing fundamental causes, such as knowledge, finances, or social status, that help a group of people avoid risk and gain protective properties against a disease. Rose proposed that the population-based approach was most effective because it would decrease prevalence and may reduce social, cultural, or economic barriers for those most vulnerable. Ultimately, Rose's theory would decrease risk for the entire population.[122]

The Socioecological Model

When considering public health programs or interventions that may reduce obesity rates, it is critical to understand theoretical frameworks related to health behavior and preventative care. The socio-ecological model (SEM) is recommended by the Centers for Disease and Control (CDC) to better understand the causes of public health issues, such as obesity, and the effect of potential interventions.[120, 123-125] The SEM also provides insight as to how complex and interrelated the relationships are between an individual's knowledge, attitude, and beliefs (micro-level) to how governmental influence may affect eating patterns (macro-level).[120, 123-125] Further, the SEM also allows for interaction between the levels and indicates that it may be necessary to act at all levels of influence to change health behaviors. The SEM also

provides some explanation of how an individual's weight status can be affected by his or her environment.[120, 123-125] Figure 1.1 indicates the levels of the SEM.

Social Cognitive Theory

Bandura's Social Cognitive Theory (SCT) is another framework that provides reasoning as for how multiple layers of external influence can directly affect an individual's eating patterns.[126-129] Bandura proposed that the relationship between a person, their behavior, and their environment is a dynamic, fluid relationship, as displayed in Figure 1.2.[126] Past experiences are another component to SCT, taking into account a person's experience for creating a present behavior pattern. SCT also takes behavior maintenance, not just initiation, into account, by explaining how people control behavior over time.[126] The theory is made up of six constructs: reciprocal determinism, behavioral capacity, observational learning, reinforcements, expectations, and self-efficacy.[103] Self-efficacy is an especially important construct when considering health behaviors, as it takes environmental facilitators and barriers into account, when a person feels his/her confidence in the ability to change a behavior. [126-129] Theory of Planned Behavior is an extension of the SCT and self-efficacy that further explains how a person perceives their surroundings, to establish intention for a behavior.[129]

Theoretical Framework to Describe Adolescents

Changes in the adolescent often alter eating behaviors, with increased choices and availability of foods compared to childhood. Analyzing the eating behaviors and food choices of adolescents can be explained through previously described theoretical frameworks.[118, 130, 131] The SCT and SEM both support reciprocal determinism, which indicates that behavior and environment are bidirectional relationships.[126, 128, 129, 132]

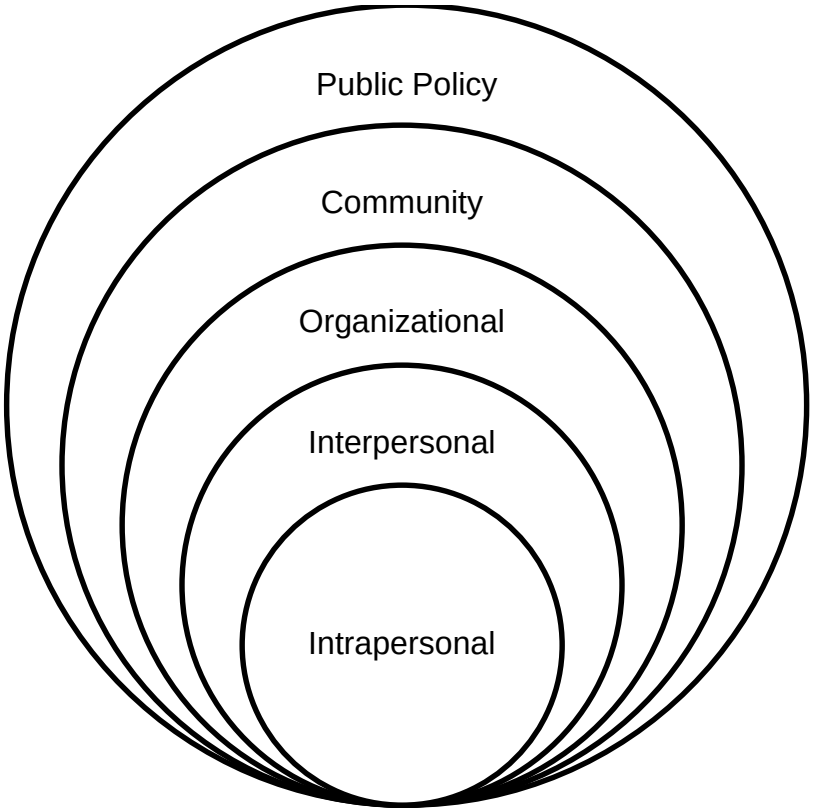

Figure 1.1. The Five Levels of the Socioecological Model (SEM).

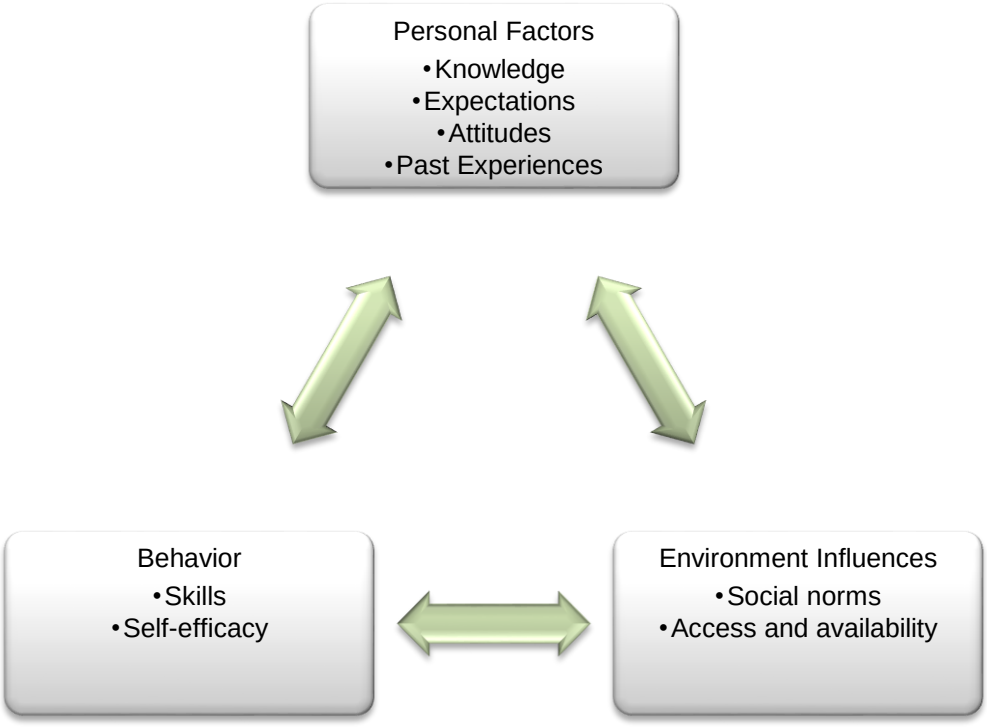

Figure 1.2. Bandura's Social Cognitive Theory (SCT).

Thus, environment can dictate a person's behavior, but a person can also change his or her environment in order to better meet their needs.[129]

Using these concepts, Story and colleagues from the landmark, longitudinal study, Project EAT, proposed a framework specific to adolescent eating behaviors, displayed in Figure 1.3.[10] This particular model is a synthesis of the Socioecological Model and the Social Cognitive Theory to display adolescents eating behaviors and the influences on them. The middle of the model is similar to the Socioecological Model with layers of influence. Particularly, important to note is the text from each layer of influence set aside by the bracket. This is how the Social Cognitive Theory affects these levels of influence on adolescent eating behaviors. The theory is meant to help guide intervention development targeted at changing an adolescent's eating patterns. Within this framework, there are four levels of influence: intrapersonal, interpersonal, physical environment, and macro system.[10]

The Food Environment

Lack of access to healthy foods and food equity, which primarily occurs in lower socioeconomic neighborhoods, contributes to differences in dietary patterns observed between differing income levels and thus may affect obesity rates.[133, 134] Food acquisition for an individual can rely on a multitude of factors including store accessibility, food availability, cost, and food choice priorities, among many others. The built environment can either facilitate or create a barrier for individuals to eat healthfully.[95, 96, 133] The term "built environment" defines the physical aspects of where communities live, such as schools, homes, food stores, streets, and parks. It is typically thought of as, made by humans for humans.[96]

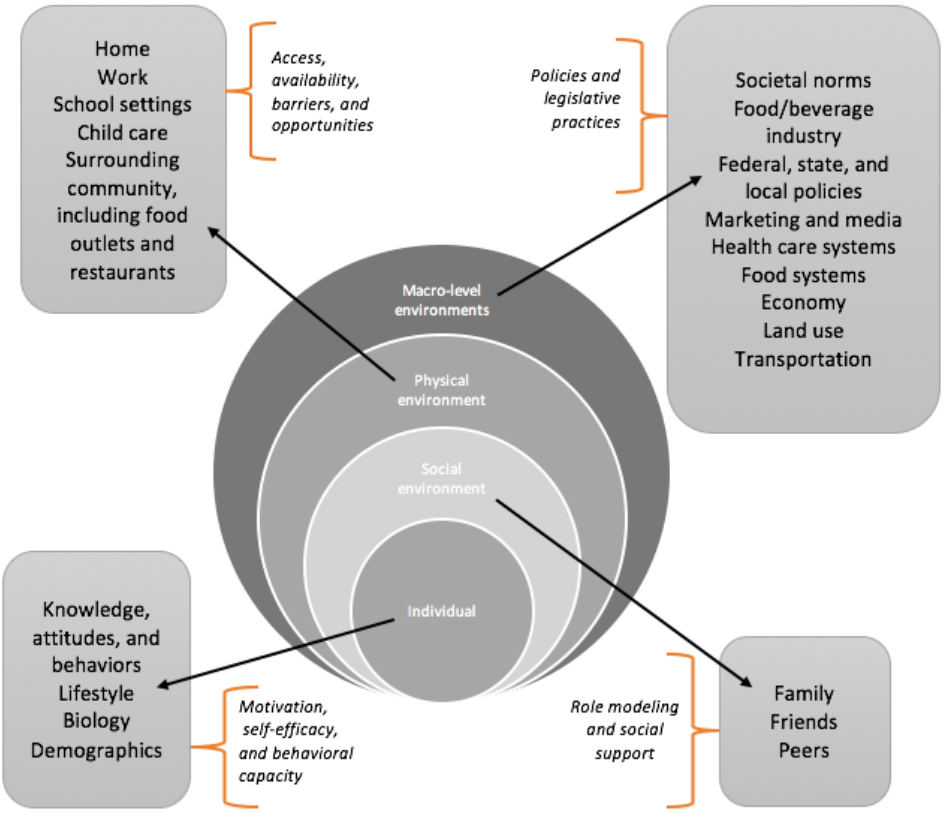

Figure 1.3. Story et al. Proposed Model for Adolescent Eating Behaviors.

Defining the Food Environment

The food environment of a neighborhood is thought to play a significant role in the risk for obesity and secondary chronic diseases.[94, 135-137] Food environment is the presence or absence of types of food sources. It includes any setting in which an individual can acquire food and can include a variety of settings, including residential spaces, schools, worksites, food stores, public facilities, and restaurants.[22, 23, 137, 138] Due to the broad and complex nature of an individual's food environment, it has been difficult to capture all the factors that might be involved when connecting environment to dietary behaviors.[137]

Significant changes in the American food environment have taken place over the last century, driven by food and agricultural policies, technological advances, and lifestyle changes. Food is now often readily accessible in many types of settings, with

the amount and availability of convenience foods growing exponentially.[135] Glanz recommended that the term food environment is separated into two different concepts for research: community food environment and consumer food environment.[137] The community food environment is measured by looking at food sources within a specific neighborhood to assess the distribution of food stores, restaurants, and other environmental components. The consumer food environment is more individualized when compared to the community food environment. It includes the type of food products available to the consumer within the environment.[137]

When describing food environments, Charriere and colleagues suggested that use of the Penchansky and Thomas health care access model created in 1981.[139, 140] This model outlines five constructs within health settings: availability, accessibility, affordability, acceptability, and accommodation. The terms availability and accessibility

are most often used to describe food environments.[139, 140] Availability is the adequacy of the food supply; this can include the distribution of supermarkets in the neighborhood and if healthy food is available. Accessibility is often thought of in geographic terms. It is the location of the food supply and whether consumers can get there. Affordability is difficult to measure because it includes a consumer's perceptions of the food products' price.[139, 140] Acceptability includes the consumer's attitude and perceptions of the food supply. Accommodation is much harder to define, as it refers to the ability of the food environment to change to meet the consumers' needs.[139, 140] This could include factors such as store hours. Accommodation is rarely captured in food environment research.[139, 140]

Larger grocery stores are the primary source of food for most Americans and play an influential role in the types of foods consumed.[141] However in more rural areas, small food stores, convenience stores, and fast food outlets tend to be the primary option for obtaining food resources.[22, 141-143] Larger stores also tend to supply healthy food at a lower cost to the consumer due to wholesale buying capacity than small food stores or convenience stores. Smaller markets are unable to compete with larger ones for the distribution prices.[135] The presence of supermarkets in a neighborhood has been associated with a lower prevalence of overweight and obese residents.[22, 133] On the other hand, the increased presence of convenience stores is related to a higher prevalence of obesity in a community.[94, 144] Morland and team found that African-American residents in one community increased their fruit and vegetable intake by 32%, for each supermarket in their neighborhood.[22] Further, a study in the United Kingdom noted that individuals with a low fruit and vegetable consumption pattern (less than two

servings daily), increased their consumption by 0.23 cups after a supermarket was added to the community.[145]

Restaurants have also seen an exponential growth primarily in fast food outlets and drive-thrus in the last fifty years.[137] Fast food outlets often provide calorically dense and low nutrient value foods at a low cost.[146, 147] The success of fast food outlets indicates the consumer's need or preference for convenience and low prices when choosing food products.[84] Caspi and research team found only 38 studies to establish some link between individual dietary patterns and food environments.[15] Another study found that urban residents living in downtown Philadelphia with greater access to fast food outlets, consumed more of the restaurant foods that were offered, when compared to residents in other areas of the city with less access to fast food.

Research over the last several decades has shown that there is a significant difference in healthy food availability and relative price in low-income neighborhoods and/or racially diverse communities.[133, 134, 142, 148-150] Larson and team conducted a national study that assessed the availability of grocery stores across the country and found that low-income, minority, or rural areas were more likely to be affected by poor access and availability issues.[133] Another geographical analysis of neighborhoods and food store locations found that white, non-Hispanic communities typically had four times as many supermarkets as non-Hispanic/ African American areas.[22]

With the shift to many upper income consumers primarily using large grocery stores and living in suburban areas in last fifty years and an influx of fast food outlets and convenience stores in lower income neighborhoods, inequities in food access started to occur.[133, 134] It is estimated that approximately 30 million people live in areas

in which food access is limited.[151] Furthermore, the neighborhoods with limited access often have a higher percentage of individuals with low income with racial and/or ethnic diversity.[151] Consumers in these neighborhoods must either make a choice to shop at the local corner stores or spend 20 minutes or more traveling to larger supermarkets. Traveling may not be an option in some cases considering that nearly 2.1 million households in the United States do not possess a vehicle, with a greater likelihood for those with lower incomes not to own a vehicle.[151] Access to better food choices for these consumers is a much bigger problem when living in rural areas, due to lack of public transportation. Distance to food stores and the availability of healthful foods within those markets are shown to be directly correlated with the eating patterns of the residents.[141]

The cost of food is another important economic factor to consider. Cost and taste preference tend to be the top two reasons that a consumer chooses food items.[141, 152] Agricultural regulations on fresh foods, including meats, fruits, and vegetables are significant influences on the purchases of these foods. It is this factor that makes food policies different from other public health initiatives, such as physical activity since food is a commodity. Food products are a multi-million-dollar business in the U.S., and it is often difficult for federal policies to intervene with the commercial sector when interventions may affect profits.[151] When one considers the current structure of the American food system, the calorically dense, high-fat, and high sugar items, tend to be a lower cost. These foods may be selected for economic reasons despite possible negative associated health consequences.[141, 152] Further compounding diet quality disparities associated with food price, consumers in low-income neighborhoods often

described the price of produce as a significant barrier to purchase of these food items.[141, 152]

Communities often default to addressing local food access and hunger issues to emergency food supply systems, such as pantries and food banks.[153] However, this approach is downstream, and it would be more conducive to address food access in an upstream approach.[16, 154] Common city policies, such as zoning laws, economic development strategies, land use, parking, and traffic management, all may have a direct association with the local food system.[155] Recently, increased attention has been placed on the use of local planning commissions to assess local food environments and help guide policy related to zoning and regulation. Another local approach to food access has been establishing farmers' markets and allowing these markets on city-owned property.[155]

Food Environments of Adolescents

An adolescent's physical environment dictates eating behaviors through accessibility, availability, and affordability of food items in the adolescent's food environment. Story and colleagues also identified physical environment as a main component that is related to adolescent eating behaviors.[10] One-third of adolescent food acquisition occurs outside of the home, and one-half of that occurs in schools.[112, 119] There are three main components that have been studied previously as components of the adolescent food environment: community, home, and school food environments.[10, 26, 156, 157] Recent research from Gustafson et al. indicated the need to study all three together to better understand how diet quality, food choices, and food behaviors are related to each environment.[158] Shopping at convenience and discount stores was

found to be associated with unhealthy eating patterns, whereas increased fruit and vegetable availability at home was associated with an increased consumption of fruits and vegetables.[158] Similar findings were seen in school environments, where an increase in healthier food items predicted an increase in fruit and vegetable consumption.[158]

Community Environment

Community food environments incorporate restaurants, grocery stores, convenience and small food stores, and vending machines. Community food environments are typically evaluated observationally from the consumer perspective or through government data source related to store and/or restaurant availability.[137] Research focused on community nutrition environments began in the late 1980s. Sallis and colleagues conducted a study in San Francisco and assessed the availability of heart healthy food items in grocery stores.[159] In another study, Cheadle and his team evaluated the availability of low fat and high fiber foods and how promotion of these items impacted consumer purchasing.[160]

Fast food restaurants are a major contributor to the community adolescent food environment. As stated previously, fast food and snacks contribute significantly to the overall adolescent diet, and with the increase in the fast food restaurants in the last fifty years, it is not surprising that 33% of adolescents food acquisition away from home is from fast food outlets.[156, 161] Another necessary site to evaluate for the adolescent food environment is food stores, particularly convenience stores.[22] Both of these frequented environments may relate to previous research that states cost and convenience are major determinants in adolescent food choice.[10, 118, 130, 162-164] However, the concern is

that these two food choice priorities may not always provide the most healthful options, particularly in low income neighborhoods.[22, 164]

Home Environment

The home food environment is much more complex and difficult to capture than the community food environment. Availability and accessibility are typically the focus in home food environment assessments.[156, 158, 165, 166] However, it is imperative to note that internal validity of home studies is often limited as it is difficult to closely control a home environment. Home food environment research started in the 1990s with two major studies. Hearn and team studied the food choices of young children based upon parental modeling of healthy behaviors and availability of food items in the house, with an association established between the children's healthful eating and both healthy modeling and availability of healthy foods.[167] Recent research from Loth et al. indicated similar findings as Hearn's original findings. Loth found that increased healthier food items in the home food environment was associated with an increased intake of fruits and vegetables in adolescents while also decreased sugar-sweetened beverage intake.[168] Additionally, Patterson and colleagues studied children and their patterns of dietary intakes to see if a relationship existed between modeling and availability and healthfulness of diet, and the research team noted that no association was found between adolescents and their parents' diet.[169] The finding may be related to the increased autonomy of food acquisition for adolescents.[130]

What may of utmost importance when considering the effects of the adolescent home food environment is the lifelong effects that may exist in relation to healthier food availability and engagement in food practices. Previous longitudinal research from

Project EAT indicated that assistance with meal preparation and participation in regular family meals in adolescence often projected later in life, with young adults (ages 20-30 years) exhibiting similar behaviors.[116, 117]In 2017, a different cohort from Project EAT that was followed for 15 years indicated similar findings. Female parents in the follow-up group were predictive from their reported mealtime practices during adolescence, including healthier food items available, eating in front of the television, and parental modeling.[170]Additionally, parents of both sexes who reported frequent family meals also reported similar behaviors in adolescence.[170]

School Environment

School food environments have been relatively well studied. However, the main limitation is that the research has been rarely generalizable to other schools or other regions.[119, 158, 161, 171-174] School food environments are typically evaluated as part of an intervention, and the tools used to measure the environment have not frequently been tested for psychometric properties.[172] Food acquisition in the school can come from school-provided breakfast or lunch, a la carte food items, and vending machines. Previous research has indicated that nearly 40% of an adolescent's daily caloric intake may come from school foods.[109, 110, 119] Although most schools participate in the National School Lunch Program (NSLP), it is important to note that participation in this program that provides nutritious foods declines drastically as students enter middle and high schools.[115, 119] Although school nutrition standards have been extended to other food sources in the school, there is still a plethora of food items that may be of low nutrient value available, and high school students may often skip lunch or consume snack foods in place of a well-balanced meal.[114, 115, 118, 119]

Measuring the Food Environment

Geographical Information Systems

Geographical Information Systems (GIS) is one way in which food environment data can be analyzed. GIS is typically utilized when assessing community nutrition environments to see the accessibility of food outlets in neighborhoods and communities.[22, 23, 140, 175, 176] Researchers can easily obtain government data, specifically census-tract data, needed for GIS mapping. GIS maps are built to allow researchers to evaluate various community demographics and properties in comparison to food access. This includes both spatial or thematic analysis of neighborhoods.[140, 176] This type of methodology can be helpful in determining where health disparities exist within a community or associations between community health outcomes and the built environment.[22, 23, 140] Caspi found that 26 out of 38 studies reviewed that assessed local food environment and dietary outcomes used GIS methods. However, mixed results were found between communities with better food access and positive dietary outcomes.[15]

Although GIS methods have been heavily utilized in food environment research in the last two decades, one potential limitation of this methodology is the inability to establish causality between aggregate data and community disease prevalence; this type of data cannot reflect individual health behaviors and other factors that may contribute to disease prevalence.[15, 22, 23, 140, 155] Another limitation of using GIS methods to analyze food environments is the use of government data sources without “ground truthing”.[177-180] Ground truthing is the practice of ensuring that stores and food outlets do indeed exist where census-level data indicates.[177, 181]

"Gold standard" measurement approaches to evaluate food environment have not been established in the literature. In a systematic review conducted in 2010, Charreire and team noted that two constructs of density and proximity are both used to assess the food environment. However, density can be measured through buffer zones (both circular and network), kernel density, and spatial clustering.[140] The most common of these measurements is buffer zones.[140] However, no "gold standard" for what is an appropriate buffer zone distance has been set. Caspi, in a different review, found that buffer zones ranged from 500 meters to ten miles in 20 studies included.[15] Distance is used to measure proximity, but there are also several different methods to measuring distance, such as Euclidean (straight line), Manhattan (city blocks), and network distance.[140] These measures don't capture what also may be important in both urban and rural studies, which is travel time.[15]

Critical GIS and Story Mapping

Critical GIS emerged in the last thirty years but has been gaining traction in the last decade as a way to provide social transformation and justice to underserved communities.[182] Critical GIS is the approach of adding qualitative insight and narrative to typically quantitative spatial analysis, often utilizing new visualization technologies and/or incorporating communities in map creation.[183] One methodology proposed by GIS researchers to analyze quantitative and qualitative data together is grounded visualization, which allows for an incorporation of qualitative and quantitative analysis to provide better understanding of a community's environment.[183, 184] Grounded visualization is a combination of two methodologies--spatial analysis (i.e. objective assessments) and grounded theory. Similar to concepts of grounded theory, the

process of grounded visualization is recursive and iterative in nature, exploring possibilities without a specific hypothesis a priori. Knigge and Cope are the first to tout this methodology and propose that grounded visualization provides rich context and incorporates the knowledge and power of the community into the scientific process. Additionally, they make the case that doing so often reduces barriers of marginalized representation of underrepresented communities' perspectives.[183, 184] The authors make this connection between data visualization using spatial analysis as well as grounded theory by comparing the two methods as "exploratory, iterative, recursive, simultaneous consideration of general patterns and particular instances, encourages multiple views and perspectives."[184]

When considering optimal ways to depict critical GIS approaches, story mapping is one tool that is offered through the Environmental Systems Research Institute (ESRI).[185] Many GIS scientists utilize ESRI's ArcGIS platform for data visualization and geospatial analysis. However, ArcGIS has limited capability to include embedded photos or narratives and is quite cumbersome to utilize, particularly for someone not trained. Story maps, on the other hand, are mean to be user-friendly for the average person to tell a narrative with both maps and embedded photos, videos, and written passages.[185] Users can choose many types of storytelling formats as well as colors, designs, and fonts. ESRI has suggested five principles that are best practices when developing a story map through their cloud-based system: audience suitability, appeal, user experience, easy-to-read maps, and simplicity of the story. They also recommended using these principles as a possible way to evaluate the effectiveness of story maps for the user.[185]

One major disadvantage to story mapping is that there is a lack of recommendations from peer-reviewed publications about the best practices for development and evaluation of story maps, particularly from an education or action research standpoint. However, some recent research has indicated use of story maps as an education tool in community research and/or formal education settings.[186, 187] Cope et al. concluded that use of student-generated story maps as a function of learning about course topics in an undergraduate course may be a novel way to address course objectives.[186] Students provided feedback that use of story maps as a visual and hands-on learning tool was helpful when compared to traditional learning methods.[186] Berendsen and team also found similar results when transitioning an existing paper student atlas to a story map and evaluating student responses. Overwhelmingly, students enjoyed being able to zoom and scroll to view features closer.[188]

Walker and Hanchette used grounded visualization to establish framework for their study regarding neighborhood perspectives of a low-income population, which ultimately resulted in story map.[189] The authors' three-prong approach included geospatial analysis of the studied neighborhood, participant interviews, and a Photovoice project to depict the neighborhood.[189] The purpose of the study was to gain insight from the neighborhood community concerning a larger revitalization effort in Louisville, Kentucky. The authors compare their work to being based in similar approaches as community-based participatory and action research, with incorporating participants' views and considering them to shape the research as the project progressed.[189] Although the authors did not use ESRI story maps, they created a

presentation with mapping of the neighborhood before and after revitalization, embedding participants' words, voices, and photos to describe the process. One important thing to note is that the authors do not describe how this critical GIS map was used and/or evaluated by the community members.[189]

Store Audits

Store audits are commonly conducted to assess the consumer nutrition environment. Store audits are typically conducted by researchers to assess prices, food items available, quality of food items, healthfulness of food offered, or shelf space in the store.[137, 176] These objective measures often provide composite scores for store types to allow researchers to compare stores within a community and often to compare different store types, such as supermarkets and corner stores.[156,157] In the review conducted by Caspi and colleagues in 2012, a null association between store audit findings and positive dietary indicators was found.[15] Often, the method was combined with GIS technology.[15, 176, 180]

Glanz and colleagues developed one of the most widely used and validated audit system, the Nutrition Environment Measures Survey (NEMS).[190-192] The two main NEMS audits developed were to analyze retail food outlets (NEMS-S) and restaurants (NEMS-R).[191, 192] For food stores, the NEMS-S audit generates scores for food outlets based upon indicator food availability, price, and quality. Thus, store types in a community can be evaluated while each store's offerings can also be analyzed.[191] The NEMS-R audit allows objective measures to be obtained concerning availability of food choices in both sit-down and fast food restaurants. One addition to NEMS-R is the analysis of signage and promotion of healthy food items.[192] Both NEMS-R and NEMS-S

audits were tested for validity and reliability with multiple methods. Further, both NEMS-S and NEMS-R are able to assess consumer and community nutrition environments with each audit.[191, 192]

Healthy Campus Environmental Audits

The Healthy Campus Environmental Audit (HCEA) is a set of assessments to establish the environmental supports and/or barriers for health promotion and obesity prevention.[193-199] The HCEA is able to be used to evaluate restaurants, convenience stores, vending machines, recreation programs and facilities, walkability and bike-ability, and health policies. [193-199] The HCEA can be used to document, monitor, and advocate for environmental and policy change. Each audit is made up of approximately 15-25 items, with criterion scored using a five-point scale for each item. Each audit has been reviewed by experts and pilot-tested at multiple college campuses. Audits are administered via Qualtrics and can be collected on a mobile device or iPad. [193-199]

There are some inherent strengths and weaknesses to using the HCEA to assess environments. One benefit to using the HCEA is that it is applicable for a variety of campus types: worksites, schools, college/university, hospitals, and communities. Further, it was originally created to assess campus environments and to be used by an older adolescent population. [193-199] Thus, much of the materials and evaluation techniques are applicable to the high school population. Another benefit is that the extensiveness of the implementation of the audit is decided by the team of evaluators. [193-199] Thus, the assessment team is often part of the community using the resources within an environment and may be the best to choose what the environment entails. One weakness to the HCEA is that validation is not fully complete. [193-199] Validation

studies for the HCEA tools were completed at colleges in 2016-2017, with peer-reviewed publications for these currently in review. However, they have yet to be validated for the high school population. Although training for conducting HCEA can be done online, another weakness is the length of time that training to complete an audit takes. There are online presentations, quizzes, practice evaluations, and IRR to complete prior to data collection. Despite participant burden and current validation, the HCEA may be an appropriate tool to utilize when collecting environmental data in a high school population. [193-199]

Consumer Surveys

One methodology less utilized in the literature is consumer perception surveys. These surveys often attempt to measure customer perceptions of the food environment, particularly on perceived affordability, accessibility, and availability of food in the neighborhood.[15, 137, 176] One major limitation in this particular methodology is the lack of psychometrics reported for previous studies and the applicability of these tools to other studies.[15, 176] Often, these types of customer surveys are developed in response to an intervention.[176] In her systematic review of food environment studies and dietary outcomes, Caspi and team found that the studies used consumer surveys infrequently (*n* = 12). Yet, the surveys showed the strongest indicator of perceived healthfulness associated with a healthful diet when compared to store audits and GIS measures.[15]

Green and research team started developing the Perceived Nutrition Environment Measures Survey (NEMS-P) to capture some of this objective data.[200] The core constructs included in NEMS-P include consumer nutrition environment, community nutrition environment, and the home food environment. The survey was

found to be reliable and valid through multiple methods, including face and content validity, cognitive interviewing, and statistical methods.[200] Test-retest reliability for the NEMS-P was moderate to good (r = 0.52 – 0.83). NEMS-P was also developed and tested to assess differences between high and low SES communities. The perceived measures, including NEMS-P, allow for full testing of food environment constructs, such as consumer acceptability and store accommodation.[200]

Community Involvement with Food Environment Interventions

Environmental audits have most frequently been done by research team, typically those outside of a given community. This can create a juxtaposition that a research team may not fully understand the food environment compared to the community it serves. One area of food environment research that has been least formally studied is how community involvement in changing the local food environment affects the environment, community disease prevalence, and individual health outcomes. Unfortunately, many of these community-driven initiatives have not been formally studied or evaluated, and information may be limited in peer-reviewed journals.[15, 201, 202]

It is imperative to note that despite decreased evidence available that community approaches are quite important when considering food environment changes. In 1998, Hill noted that individual health outcomes related to food environment interventions with fixed food environments (indicating decreased external validity) were overall ineffective in obesity treatment and prevention.[16] Story and colleagues touted the critical nature of including community and policy approaches in food environment research, noting that including a socioecological framework for developing future research was necessary.[131]

Glanz remarked in her 2009 review of food environment literature that true, sustainable change that would affect health outcomes could not occur in a bubble and must include a multi-level, food systems approach.[137]

For these reasons, it is necessary to consider how a community can be active in future food environment research and interventions. When applying the SEM, civil society could be considered a component of organizations.[7, 18] Morland describes this use of civil society in shifting environmental change as a "push-pull model".[203] The community can "pull" on local business and the economy through purchasing more produce or frequenting businesses that provide more food resources. The community can also "push" on local government by voting for policies that increase access to healthy food items and advocate for change.[203] It is often the grassroots change and civil society demanding change that prompts changes in local ordinances and government.[18, 203]

However, it is important to note that simple awareness of how good or poor a community member's food environment is not enough to create behavior change. Previous research in health promotion and obesity prevention has indicated that use of experiential learning techniques as part of a treatment may lead to behavior change.[28, 204-208] Thus, use of active involvement in environmental assessments, including data collection and environment determination, may act as a catalyst for behavior change. Yeager et al. propose that it is necessary to engage adolescents as active, equal partners in research to successfully initiate behavior change.[209] This area of research is often called Youth-Led Participatory Action Research (YPAR).[210] YPAR often trains and

empowers adolescents to evaluate their own communities, determine the problems, and advocate for solutions.[210, 211]

Adolescents Engaging in Action Research for Health

One such use for YPAR is health promotion and health behavior change in adolescents. For example, many leading obesity prevention researchers recommend use of YPAR as the next step, and YPAR has been used with success in other health behaviors, such as smoking cessation, HIV/AIDS prevention, and sexual education. [12, 212-217] Other health studies using YPAR that include active involvement during data collection , particularly those involving experiential learning techniques, can support health behavior change.[218, 219] Thus, involvement in data collection of food environments, driven by youth, could potentially change behavior. However, little information is known on how youth involvement in data collection regarding food environments impacts individual health behaviors, perceptions of food environments, and food choices.

Conclusion

Adolescence is seen as a time of psychosocial, cognitive, and physiological changes, and, as a result, the nutritional needs of this population are increased.[109, 110] Despite the need for appropriate nutrition, research has consistently shown that the American adolescent's diet fails to meet nutrition recommendations.[111] Adolescents tend to consume too few fruits, vegetables, whole grains, and low-fat dairy products while taking in too many calories with nutrient poor foods that are frequently high in fat.[8, 111] Adolescents also exhibit various problematic eating behaviors that may affect nutritional intake, such as meal skipping and increased snacking.[114] Previous research

has indicated that some of these problematic eating behaviors may place adolescents at a much greater risk for overweight and obesity, with long-term health consequences.[1, 12, 98, 220] Interventions, that effectively improve dietary behavior, are needed to address the current obesity crisis.[98, 221]

One factor associated with both dietary behavior and the risk of developing obesity is the food environment. Food environment is the presence or absence of types of food sources, and it includes any setting in which an individual can acquire food, showing how cost and availability can influence eating behaviors.[14, 26, 137] Story and colleagues also identified the environment as a main component that is related to adolescent eating behaviors.[10] There are three main components that have been studied previously as components of the adolescent food environment: community, home, and school food environments.[10, 158, 171, 222, 223] Although some research has noted community involvement in food environment evaluation, the impact of conducting food environment assessments on those community members' diet behavior is currently unknown. Using experiential learning techniques, adolescents can be engaged in conducting environmental assessments. Adolescents conducting food environment assessments may function as an intervention that promotes healthful dietary behavior in the short term that may be associated with long-term obesity prevention.[28, 208] For adolescents, the concept of youth advocacy and action research have shown to be important catalysts in health promotion and behavior change.[27, 28, 224] Thus, the use of story mapping as a method for grounded visualization methodology may be an appropriate way to engage adolescents in action research related to food environments since the method is founded on participants having a voice and valued role in the

process as experts of their own situations.[27, 28, 224] A story mapping methodology used with an adolescent population may be especially important to use in a project that has a long-term goal of promoting healthier adolescent food choices.

Overview of Dissertation Research

The primary aim of this dissertation was to develop and test a Food Environment Curriculum (FEC) to engage adolescents in research with their food environments (school, community, and home). The FEC was tested both quantitatively and qualitatively to determine acceptability and feasibility. The FEC was further assessed via informal feedback from an expert committee and students in the high school course. Additional questions regarding the food behaviors and food choices of adolescents and how to better measure and represent the food environments were also explored through additional qualitative methods. Lastly, all data from the testing of the FEC were integrated into a story map to contextualize the adolescent food environment experience.

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CHAPTER 2 : DEVELOPMENT AND TESTING OF THE FOOD ENVIRONMENT CURRICULUM

This article hasn't been published anywhere, nor will it be before I turn in the final version of my ETD, so I didn't include a publication statement.

Abstract

Background: Food environments are implicated as factors in adolescent food behaviors and choices. **Objective:** To describe the development of the Food Environment Curriculum (FEC), an educational approach to improve dietary behaviors and adolescent knowledge of food environments by increasing awareness of the food environments they encounter daily. **Methods:** The FEC was developed using a cyclical action research approach with an expert committee (n=10) reviewing all steps of the process and making modifications as needed. The FEC was delivered as part of a required high school wellness course, with participants receiving the nutrition and food environment lectures (twice weekly; total of 10 classes); the participants also conducted hands-on assessments of their own food environments over the five weeks outside of class using the Healthy Campus Environmental Audit (HCEA) tool. Fidelity testing was conducted in both classes to ensure lesson consistency in both arms. The FEC was tested using pre-and post-health behaviors surveys [fruit and vegetable intake (F/V) and meal patterns]. Analysis of variance and chi-square tests were conducted to evaluate differences between the two arms. The FEC was evaluated qualitatively through informal feedback from the expert committee, course participants, and formal focus groups. **Results:** There were no significant changes in F/V or meal patterns after the implementation of the FEC. However, participants reported that the FEC was an acceptable form of nutrition education in the high school wellness classroom setting.

There were some changes made to the length, duration, and content of the FEC after testing as well as the addition of mapping activities as a component for the FEC.

Conclusions and Implications: This curriculum designed to increase awareness of food environment issues and impact adolescent food choices were found to feasible and acceptable for further testing in the high school setting. Future research is needed to confirm or challenge the role of an individual's awareness of food environments as a non-factor in food behavior.

Background

Obesity continues to be an epidemic, with nearly one in three American adults considered obese.[1] Obesity is a concern not only among adults but also children and adolescents. Hales and colleagues noted that the prevalence of obesity in children and adolescents was 18.5% nationally in 2015-2016. Obese children and adolescents may be a greater risk of developing secondary chronic diseases earlier in life. [2, 3] Although some successes have been made in reducing early childhood obesity, obesity prevalence in adolescents (ages 12-19 years) is higher than younger children (ages 2-5 years) (20.6% and 13.9%, respectively), with most recent reports indicating that these rates are not decreasing for adolescent populations.[1, 4]

Because of the continuing obesity epidemic, researchers have studied many possible etiological factors, including built environments[5-8]. The food environment, which encompasses both the community and consumer environments, is one component of an individual's built environment.[9] Community food environments are defined as food establishments accessible to an individual in a given geographical area. The consumer food environment is comprised of the food items available for acquisition at a food establishment.[9]

Adolescent food environments include three key components: school, community, and home.[10-12] Research from a landmark, longitudinal study on adolescent eating behaviors, Project EAT, indicated that these three environments play a critical role in determining an adolescents' individual dietary behaviors.[11-14] The school food environment comprises the foods offered through the National School Lunch Program (NSLP) as well as a la carte items, vending machines available, and food options in areas surrounding and accessible from the school campus.[15-17] The adolescent

community food environment includes fast food and sit-down restaurants, grocery stores, convenience stores, and any other places for food acquisition surrounding the adolescent's home but can also include a much larger area due to independent travel-activity patterns that start to occur with the attainment of drivers' licenses.[18, 19] Lastly, the home food environment is evaluated through food availability, family meals, assistance with food work (i.e. grocery shopping and meal preparation), and familial influence on food choices.[20, 21]

Recent research indicates that participant advocacy may be a useful strategy in obesity prevention research. Advocacy efforts can be combined with health education to bolster not only individual but community health outcomes. [22-25] One way to include health advocacy efforts in adolescent programs is by experiential learning and community based participatory research. Providing adolescents a way to express themselves as well as be engaged in data collection and reporting of results may increase changes at all levels of the socioecological model for both nutrition and physical activity.[26-28]

Youth health advocacy has been shown to be a powerful factor in health promotion and nutrition education efforts.[29-31]. Facilitation of those advocacy efforts can include the collection of community information, such as food availability and accessibility, and previous research has indicated that active involvement in research, particularly those involving experiential learning techniques, can support behavior change.[32, 33] The use of experiential learning can be further expanded in other theoretical models, such as Brofenbrenner's Socioecological Model (SEM) and Bandura's Social Cognitive Theory (SCT). These theories include the hypothesis that

relationships exist between environments and behaviors.[34, 35] Further, the transtheoretical model may explain how increased consciousness may shift health behavior change.[36]

The purpose of this report is to describe the development of the Food Environment Curriculum (FEC), a nutrition education curriculum. The FEC exposes high school students to food environment concepts as a component of required wellness classes. The curriculum was designed to improve dietary behaviors and adolescent knowledge of food environments by increasing awareness of the food environments they encounter daily.

Development Process

Curriculum design of the FEC was based on action research concepts. Action research is typically a cyclical approach in which the curriculum is constantly reviewed and revised in each phase of the process. Phases of action research curriculum development include: (1) creation of learning objectives; (2) lesson planning and materials to support each lesson; (3) test the model with the population of interest; (4) evaluate feedback from the learners. This report provides information on all key four points of the action research curriculum for the FEC, including key modifications made based on evaluation of the lesson plans from learners (students) and an expert committee. Experiential learning was a key component to the FEC with the inclusion of (1) in-class food environment training using environmental data collection tools, (2) opportunities for practicing food environment data collection in small groups, (3) environmental audits in the school and community done individually by students, and (4) modified electronic Photovoice of the home and community food environments

conducted by the students. The development and testing of the FEC is outlined in Figure 2.1.

The curriculum was designed for the high school setting to meet state wellness competencies for nutrition as well as to include food environment education and advocacy to ultimately change student dietary behaviors. Based on these learning objectives, the lead researcher used both quantitative and qualitative methods to analyze acceptability and feasibility of the FEC. An expert committee composed of undergraduate and graduate college students (n=7), obesity prevention and food environment researchers (n=2), and a high school wellness teacher (n=1) reviewed the FEC during the 8-week development phase to ensure that the lesson plans retained fidelity to theoretical frameworks and youth advocacy efforts. The undergraduate and graduate college students also worked to create lesson plan materials and implemented modifications to the curriculum throughout the development process based upon committee feedback, meeting at least three times weekly.

The FEC curriculum was based on trainings developed for the Healthy Campus Environmental Audit (HCEA) tool. The HCEA is a validated environmental audit, composed of six audit tools, that was developed and utilized to evaluate the healthfulness of college campus environments. The six audit tools were designed to create an overview of a campus environment included: (1) on and off campus dining (restaurants and dining halls); (2) convenience and corner stores; (3) on and off campus recreation centers; (4) walkability and bikability on campus; (5) vending machines; and (6) health policies.[37-41] The use of HCEA as a tool to change individual behavior was based on the Social Cognitive Theory (SCT) in which posits that increased learner

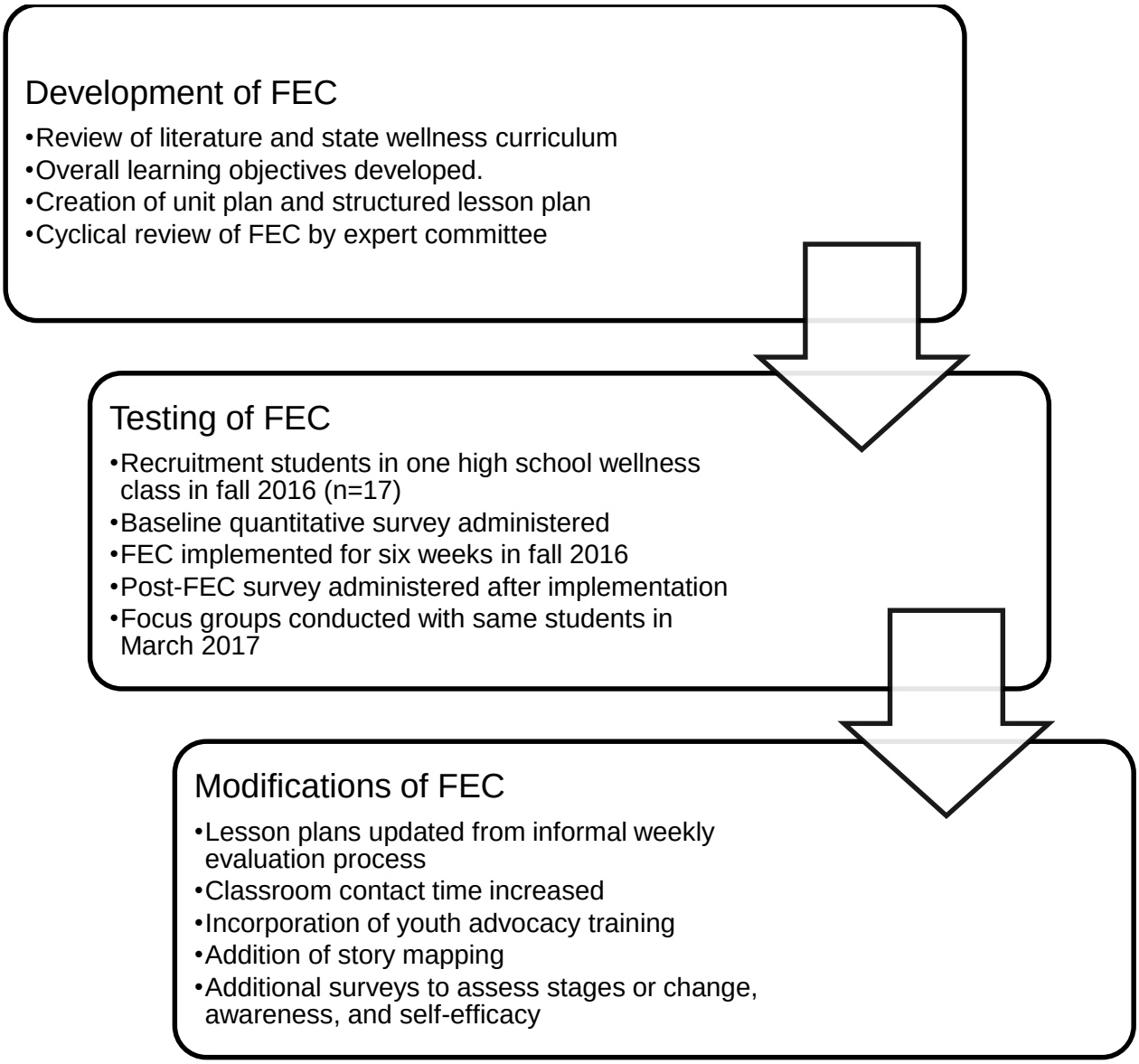

Figure 2.1. Outline of Development and Testing of Food Environment Curriculum.

awareness of the environment would impact individual behavior. Although this theory is the basis of the HCEA tool, the use of food environment awareness impacting behavior change is grounded in the Transtheoretical Model of Health Behavior Change. Prochaska et al. note that an increase in consciousness raising and environmental re-evaluation for an individual can initiate changes in behavior.[36]

The FEC focused on the education of the three adolescent environments (school, community, and home) with the incorporation of independently evaluating food environments using select HCEA tools (dining, vending, and stores) in the course. The school environmental audit included use of the dining and vending audits, including off-campus dining available within a three-mile radius. The community audit incorporated in the dining and store audit with the addition of a community food environment Photovoice project.[42] The home food environment was assessed using a Photovoice project. In addition, nutrition education, such as label reading, food groups, MyPlate, and calorie calculations, was included in the FEC because some of the HCEA tools require this level of knowledge. Additionally, these objectives met state guidelines for health and wellness education.

The expert committee developed an overall FEC unit plan to reflect overall learning objectives as well as developed each lesson plan with the following elements: objectives, an introduction (3 to 4 minutes), a review of previous content (3 to 4 minutes), presentation of primary lesson content via PowerPoint slides (5 to10 minutes), experiential learning component to lesson (15 to 20 minutes), closing and/or assignment of homework assignments (5 to 7 minutes), and materials. The FEC lasted for five

weeks, with classes meeting twice weekly and lasting 45 minutes for each lesson. There was a total of ten lessons delivered (Table 2.1).

Monitoring and Evaluation

The acceptability and feasibility of the curriculum were evaluated via process evaluations. Because the FEC was intended to be delivered with an evaluation component that would assess changes in knowledge and dietary behavior, and the acceptability and feasibility of the assessment process was also considered as a part of the overall FEC acceptability and feasibility evaluation, the assessments were administered via online surveys in the classroom setting pre- and post-FEC. Baseline data was collected in October 2016, and post-FEC period data was collected six weeks later. Qualitative evaluation was conducted via participant focus groups, which were held in a private classroom at the high school in March 2017. The sessions were audio-recorded, transcribed and analyzed using multiple coding mechanisms.[43] There were 17 students in the class that had parental consent and student assent forms completed (out of a class of 32 students) that were included in both quantitative and qualitative evaluation of the FEC.

Quantitative testing of the FEC occurred as part of the nutrition curriculum in one high school wellness course in fall 2016. The National Cancer Institute Fruit and Vegetable Screener (NCI F/V) was used to evaluated daily intake of fruits and vegetables in cups as well as test the effectiveness of the intervention as a proxy for overall dietary quality. The validated, twenty-question questionnaire assesses the average intake of various products that include F/V items over the last 30 days.[44] A validated screener assessing the frequency of adolescents consuming all three meals

Table 2.1. Components of Tested Food Environment Curriculum.

Topic (Lesson number)	Lesson Components (per class period)
Introduction to Nutrition (1)	Nutrition defined, six classes of nutrients, relationship between diet and disease
Calories and Energy (2)	Calorie and energy defined, Calories in versus calories out, evaluating personal energy needs
Healthy Living (3)	Dietary guidelines, MyPlate, food label reading activity
Food Choices (4)	Factors that influence food choices (social, psychological, physical), assessing personal food choices to national standards
Built Environment (5)	Built and food environment defined, aspects of the built environment, what is a healthy community activity
School Food Environment (6 and 7)	Defining the school food environment Overview of HCEA dining and vending audit (lecture) HCEA virtual training for dining and vending audits* Data collection of vending machine and cafeteria*
Home Food Environment (8)	Defining the home food environment Data collection of photos related to home food environment*
Community Food Environment (9 and 10)	Defining the community food environment Overview of HCEA store audit (lecture) HCEA virtual training for Store audits* Data collection of one corner store audit and one restaurant audit* Data collection of photos of community food environment*

as well as fast food intake from Project EAT was included to assess the changes in meal patterns from pre-to post intervention.[14, 45] Each of the four questions was a 5-point Likert scale for participants to report frequency of breakfast, lunch, dinner, or fast food in the last seven days prior to the survey. Demographic information including age, race, free/reduced lunch status, gender, food security status, and year in school. Food security status was assessed using a validated two-question screener.[46]

Additionally, learners and the expert committee provided informal feedback about the FEC lessons, to the lead researcher, allowing her to make key modifications to future iterations of the curriculum. This feedback process included comments from student participants in the high school courses during and following the lesson testing, meetings with the expert committee, and a meeting with the high school wellness teacher prior to each class period and once weekly during a planning period. Following quantitative (dietary survey outcomes) and qualitative analysis (focus groups) of the FEC, the lead researcher made key modifications to the FEC to reflect lessons learned from the development and testing phase. With the iterative nature of the cyclical action research process, the lead researcher tracked feedback and modifications made during all stages of the model via an online document that was updated after each lesson. Undergraduate students who assisted in the classroom also had access to the feedback document and were required to revise and add additional comments based on their observations. Further, notes from all weekly meetings were kept on the online document to track all feedback for the modification phase. A final review of the curriculum was conducted following testing by the FEC expert committee, and comments regarding proposed changes were also tracked.

To ensure consistency in the course the lead researcher was also present for all class sessions and completed a fidelity testing instrument at each session. This fidelity tool was previously developed for another curriculum-based childhood obesity prevention program and adapted for use in this study.[47] The fidelity testing included student attendance in the course, timing of lesson components, comparison of for instructors for approach and perceived effectiveness, and whether lesson objectives were met.

Quantitative Outcomes for the FEC

All of the participants were high school freshmen. Most of the participants were male (n=10, or 58.8%), and white, non-Hispanic (n=12, or 70.6%). The mean consumption of F/V was 2.05 cups (SD=1.35). None of these participants reported perceived food insecurity. Table 2.2 provides an overview of baseline characteristics. The primary outcome of interest designed to be used in future application of the FEC was change in F/V intake pre- to post- FEC. After logarithm transformations for the F/V score, the change in such log values, i.e., [log (post) – log (pre)], was -0.24 on average (SE = 0.28, 95% CI = [-0.38, -0.09]), indicating a negative change from pre- to post-FEC. However, this change was not noted as significant. Figure 2.2 notes the distribution of value change in logarithmic F/V intake. The secondary outcome of interest, change in meal patterns, was found not significant from pre- to post-FEC with the data noted in Table 2.3. Although the research team were not able to detect statistical significance, this may be attributable to the small sample size.

Table 2.2. Baseline Demographic Characteristics (n=17).

Characteristic	Count (%) or Mean (SD)
Age (years)	
13	1 (5.8)
14	13 (76.5)
15	3 (17.7)
Year in school	
Freshman	17 (100)
Gender	
Male	10 (58.8)
Female	7 (41.2)
Race/Ethnicity	
White only (non-Hispanic)	12 (70.6)
Black only (non-Hispanic)	0 (0)
Other (including biracial and Latino)	5 (29.4)
F/V intake (cups)	2.05 (1.38)
Weight (pounds)	137.3 (25.1)
BMI (%)	21.8 (4.16)
Food security (n=16)	0 (0)
Vegetarian	3 (18.8)

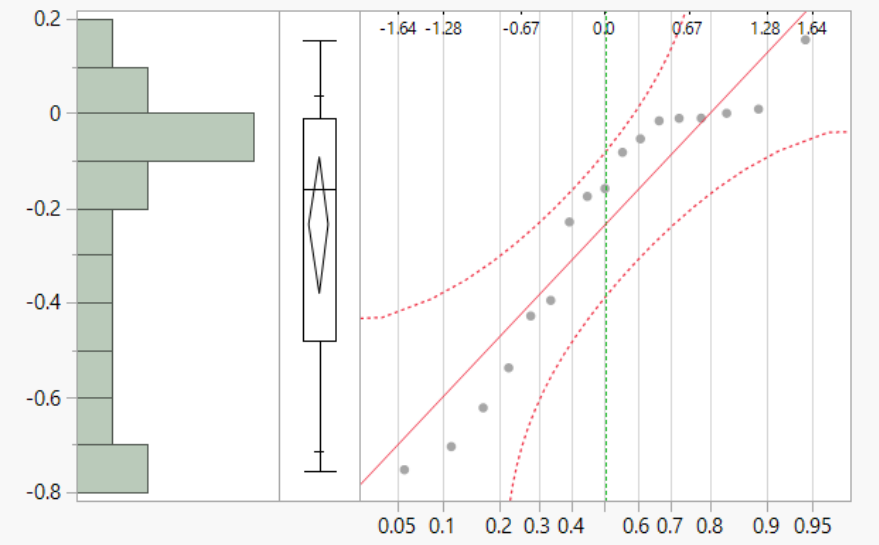

Figure 2.2. Distribution of Data Based on Log Change in F/V Intake (n= 17).

Table 2.3. Distribution of Meal Patterns and Fast Food Intake at Baseline (n=17).

Question	Responses	Count (%)
During the past week, how many days did you eat breakfast?	Never	1 (5.9)
	1-2 days	3 (17.6)
	3-4 days	2 (11.8)
	5-6 days	2 (11.8)
	Every day	9 (52.9)
During the past week, how many days did you eat lunch?	Never	0 (0)
	1-2 days	0 (0)
	3-4 days	2 (11.8)
	5-6 days	3 (17.6)
	Every day	12 (70.6)
During the past week, how many days did you eat dinner?	Never	0 (0)
	1-2 days	0 (0)
	3-4 days	0 (0)
	5-6 days	2 (11.8)
	Every day	15 (88.2)
During the past week, how many days did you eat something from a fast food restaurant (like McDonald's, Burger King, or Hardee's)?	Never	7 (41.2)
	1-2 days	5(29.4)
	3-4 days	5 (29.4)
	5-6 days	0 (0)
	Every day	0 (0)

Qualitative Outcomes for the FEC

Overall, participants reported that the FEC was an acceptable form of nutrition education in the high school wellness classroom setting. Several students noted that food environments were a new concept to them, and one student said, “It’s something different to learn about food and nutrition than MyPlate. We all know about that.” Participants reported that they perceived their food choices at home to be healthier in comparison to food behaviors at school and in the community. Thus, a few students recommended more of a focus on home food environment (as compared to one lesson). The activity identified by students as a favorite was mapping their home and community environment via Google Maps, which was conducted as a part of the in-class assignment for community food environments. Students were asked to use Google Maps to locate their home with a three-mile radius around it; students then identified food sources within their environment.

Key Modifications to FEC

Following the testing of the FEC, the expert committee made small changes to lesson timing, classroom activities, and the review of previous class material as needed. The overall key modifications are outlined in Table 2.4 as the final curriculum unit plan. This was based primarily on the learner feedback as well as needs of the classroom as communicated by the high school wellness instructor. Another important modification was the addition of potential ways to modify the FEC as needed based on environmental factors. One significant thing that happened during testing was the re-ordering of later lessons to allow for participants to conduct community environmental audits on a day with better weather. Because the reality of changing external factors, the steering committee have provided optional ways to modify the unit plan to still meet

Table 2.4. Components of Modified Food Environment Curriculum.

Topic	Class Number	Lesson Components (per class period)	Class activities
Introduction to Nutrition	1	Nutrition defined, six classes of nutrients	Matching game of nutrients
	2	Relationship between diet and disease	Mini research projects about a disease process – presented back to classmates
Calories and Energy	3	Calorie and energy defined, Calories in versus calories out	Scales and bean
	4	Assessing personal energy needs	Case studies to determine energy balance
Healthy Living	5	Dietary guidelines and MyPlate	N/A
	6	Navigating a food label	Food label activity
Food Choices	7	Factors that influence food choices (social, psychological, physical)	N/A
	8	Assessing personal food choices to national standards	Food log and calculate food group servings with electronic tool
Healthy Advocacy	9	Healthy Advocacy Training	N/A
Built Environment	10	Built and food environment defined, Aspects of the built environment	N/A
	11	Introduction to HCEA	Navigating the HCEA website
School Food Environment	12	Defining the school food environment	
	13	Overview and Training of HCEA dining and vending audit	Data collection of vending machine and cafeteria
Home Food Environment	14	Defining the home food environment	Making a meal plan and grocery list
	15	What is Photovoice?	Data collection of photos related to home food environment
Community Food Environment	16	Defining the community food environment	Google map of each student's community
	17	Overview and Training of HCEA store audit	Data collection of one corner store audit and one restaurant audit, Data collection of photos of community food environment
Story Mapping	18	Introduction to ArcGIS and story mapping	Navigation of ArcGIS
	19	Building your story map	Work on ArcGIS in class, Continue to build outside of class
	20	Story map presentations to peers (may be multiple classes to allow all students to present)	

learning objectives to account for these factors. Additionally, a list of optional class activities that still meet learning objectives is necessary to allow for adaption of the FEC to classrooms with access to less technology and/or resources.

There were some changes made to the length, duration, and content of the FEC after testing. Previous studies have indicated that including multiple factors is critical in nutrition education in the classroom to creating behavior change, including amount of time spent on curriculum (minimum 40 to 50 hours), intensity of lessons, and involvement of the school, community, and parents.[48, 49] Thus, the FEC was expanded to allow for more time in the classroom, at minimum doubling the total classroom engagement time to 20 hours, with the additional 20 hours needed for behavior change gained in the HCEA data collection outside of the classroom. Another key component added to the lessons was the incorporation of youth advocacy training that similar studies have included as part of the curriculum. Trude et al. found that training to act as a mentor to advocate for nutrition issues was integral to long-term sustainability of an obesity prevention program aimed at adolescents. [29-31, 50]

Because the SEM, SCT, and experiential learning theories were well-supported by previous literature, there are evaluative tools that were added to the FEC to ensure better measurement of objectives of interest.[25, 34, 35] A hypothesis for future FEC testing would be that awareness and active learning through environmental data collection would support health behavior change, i.e. increased dietary intake of F/V and improved meal patterns.[51] However, there are additional stages of change (as represented in the Transtheoretical Model) that exist between dietary behavior change and engaging in food environment data collection.[36]. Additional surveys have been added to data

collection to assess stages or change, awareness and/or knowledge of food environments, and self-efficacy. Informal qualitative feedback was elicited from experts, the expert committee, and the learners during the testing phase as well. Also, formal qualitative measures, done through focus groups, are key components to understanding the changes in perception and awareness of adolescent food environments after engaging in the FEC.

The last significant change that was made to the FEC was the addition of technology to further engage in experiential learning with adolescent food environments. One such way of doing this was the addition of story mapping as a key component to teaching about food environments. Story mapping is a web-based application available through ArcGIS that provides quantitative information (i.e. mapping) about environments while also allowing for users to upload stories, photos, and videos, creating a multi-modal representation of an individual or community's environment[52]. Story mapping has been minimally researched formally in the nutrition area, but it has been used as an activity in the classroom to enhance learning[53-57]. Early research by Riggsbee et al. suggests that story mapping may be a useful tool to support experiential learning and youth health advocacy in adolescents.[58] Thus, two lessons were added to the FEC (Table 2.4) to incorporate this novel technology to better meet the learning objectives of the FEC.

Implications for Research and Practice

The FEC was created to utilize experiential learning techniques with high school students evaluating their food environments with participation in food environment assessments. The approach of using environmental audits with high school students as

a component of the wellness curriculum was novel. Students were engaged with nutrition and wellness topics in different ways than previously studied in the classroom. Additionally, conducting environmental audits using experiential learning techniques allowed students to observe environments outside the classroom and practice learned concepts and skills in real world settings. The FEC was developed and tested based on a cyclical, action research-based approach, allowing for modifications and feedback from key stakeholders at all four phases of the project, potentially lending to better acceptability and sustainability for the population of interest.

Considering the challenges presented in testing acceptability and feasibility of the FEC, the modified unit plan includes the following components: suggested ways to modify activities and lessons as needed, increased education duration, additional surveys of stages of change and perceptions of food environments, the addition of focus groups, youth advocacy training, and the incorporation of story mapping. Addition of these concepts central to public health and nutrition education allowed for a more evidence-based approach to introducing a novel concept in the high school setting. Further, allowing those who use the FEC the flexibility of changing activities and ordering of certain lessons increases usability in an ever-changing environment as well as addressing potential limitations in classroom resources.

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CHAPTER 3 : “I EAT WHATEVER I SEE BEFORE I RUN OUT THE DOOR”: A QUALITATIVE STUDY TO UNDERSTAND ADOLESCENT FOOD ENVIRONMENTS AND FOOD CHOICES

A version of this chapter is currently under review by the Journal of School Health by Kristin Riggsbee, Lauren Moret, Melissa Vilaro, Marsha Spence, Elizabeth Anderson Steeves, Melissa Olfert, Sa'Nealdra Wiggins, and Sarah Colby.

My contributions to the paper were i) study design, ii) preparation and submission of the study protocol to the University of Tennessee at Knoxville Institutional Review Board (IRB), ii) participant management, iii) focus group moderation, iv) focus group transcription and verification (n=5), v) data analysis, vi) manuscript preparation, editing based on co-author feedback, and submission for publication; S. Colby, M. Spence, and E. Anderson Steeves contributed to i) study design and ii) preparation for focus group administration. L. Moret contributed to i) study design and ii) design concerning data analysis, storage and organization All co-authors read and approved the final manuscript.

Abstract

Background: The objective of this study was to explore adolescents' perceptions of their food environment (school, community, and home). **Methods:** Adolescents participated in focus groups to describe perceptions associated with food environments and how they influenced food choice. Five focus groups, with 5-8 participants per group (n=30), were conducted with students enrolled in a high school wellness course in the southeastern US. Students were selected from a group of students who had participated in a larger health-related school research project. Focus group questions were designed to elucidate perceptions regarding the three distinct adolescent food environments: school, community, and home with specific probes for each area. Data analyses included multiple rounds of coding to determine overall themes. **Results:** Overarching themes emerged, which related to all three food environments: convenience, control of food choice, and meal irregularity. School food environments were focused on lunch meals offered, with concerns about special diet options and adequate variety of food items. In addition, students who reported not having drivers' licenses or who used technology for meal planning perceived differences related to increased healthier food availability in their respective food environments. **Conclusions:** Autonomy to select healthier, convenient, and acceptable food options in multiple adolescent food environments appears to be an important focus for inclusion in interventions promoting adolescent healthy eating patterns.

Background

Obesity among Americans remains a prominent and complex issue, despite continuing public health efforts.[1] Although there are likely many causes to the obesity epidemic, including biological, social, and psychological factors; access to and choice of adequate and nutritious foods may be one of the factors that play an important role. The relationship between food access and obesity rates has yet to be causally linked, and food environment studies have produced mixed results on how the two relate.[2-10] Additionally, it is necessary to evaluate how food access and availability relates to food choices and how healthier food choices can be supported through environmental changes. It is hypothesized that increasing healthy food availability and accessibility would encourage a better built environment, making healthier choices easier.[11] This is particularly true with the adolescent population, who have continued to see increases in overweight and obesity across all segments of the population, regardless of gender or race.[1, 12] Additionally, adolescents are in a unique time of development, where a combination of environmental and psychosocial variables are at play in relation to food access and food choice.[11, 13]

Food environment is defined as the presence or absence of types of food sources, and it includes anywhere that an individual can acquire food items.[14, 15] Specifically, for adolescents, three main types of food environments are: school, community, and home.[11] Community food environments incorporate restaurants, grocery stores, convenience and small food stores, and vending machines.[16] Of those environments, fast food outlets and convenience stores act as the major contributors to the adolescent food environment.[16] The school food environment is a critical source of food acquisition for an adolescent as at least one-third of daily intake occurs at school

from school-provided breakfast or lunch, a la carte food items, food brought from outside sources and/or vending machines.[11, 17, 18] For the home food environment, the importance of family meals and availability of healthier food items in the home is immense.[19-21] To gain a holistic look into an adolescent's food environment, the school, community, and home spaces must all be studied together to better understand adolescent food choice and food acquisition.

Previous qualitative studies regarding adolescent food choices and environments have established varying themes.[22-27] Focus group work from Neumark-Sztainer, Story, and colleagues suggested that environmental changes were necessary to modify adolescent food choices.[11, 28] Croll et al. found that adolescents were able to correctly identify critical components of healthy eating (moderation, variety, and balance), yet they were unable to relate this to specific recommendations for eating healthier food items, such as fruits and vegetables.[23] These focus groups also identified limited healthy food availability as a barrier to making healthier food choices.[23] Bassett et al. identified choosing preferred food items as a prominent reported factor in adolescent food choice.[24] However, there is evidence that food choices shift for the population based on environment and psychosocial factors, including presence of peers, geographical location, socioeconomic status, variance in school food environment availability, access to food items, and food security.[2, 4, 29, 30] The food environments of adolescents can also differ significantly.[11]

Because of the potential influence of food environments on food behavior and the variability that has been found between adolescents' food environments, qualitative projects can assist with identifying individual experiences and nuances in this population

and finding some key concepts that may exist among this age group in their environments.[28, 31] The objective of this study was to explore adolescents' perceptions of their food environment (school, community, and home) to further understand the perceptions, facilitators, and barriers that may exist within adolescent food environments and how those factors influence food choice. The specific research questions that guided the inquiry were:

1. What were adolescents' attitudes and beliefs about their food environments?
2. What facilitators and barriers to healthier eating existed in adolescents' food environments (in school, community, and home environments)?
3. How did the adolescent food environment influence food choices?

Methods

Participants

Middle adolescents, ages 14-17 years, from one high school in the Southeast were recruited through two physical education and wellness classes to participate in a larger wellness research project. The high school is a public, magnet high school in a county school system, with a focus on Science, Technology, Engineering, and Mathematics (STEM) that is open to all students in the county through an annual application process. All students enrolled in the school were required to take these courses during their first or second year of enrollment at the school. The students were provided with a consent form for caregivers to sign and asked to return the forms to the teacher within one month. Additionally, the lead researcher visited the classes to explain the larger study and this subproject, answer questions, and discuss the consent forms.

Any student who returned a parental consent form, provided participant assent, and was enrolled in one of the two classes was classified eligible. Of 58 students in both classes, 51.7% were eligible and participated in the focus groups (*n* = 30). No incentives were offered for participation in the study. Descriptive data for participants (gender, age, year in school, class, free/reduced lunch status) was obtained from baseline quantitative online surveys obtained previously from the larger study during October 2016.

Description of Focus Groups

Students were assigned to focus groups first based upon which class they attended, then within the class, they were assigned into a focus group with teacher input. Three focus groups were conducted with students from one of the wellness classes, and two focus groups from the other course. The range of participants in each focus group was five to seven students.[32] The five focus groups, each lasting approximately thirty to forty minutes in length, were held over a two-week period in March 2017.

Focus groups sessions were held in a private classroom at the high school and facilitated by two members of the research team, both of whom were trained in focus group facilitation; the lead researcher was the moderator and the other researcher served as the assistant moderator. The moderator facilitated the interview protocol while the assistant moderator took notes of seating, room arrangement, and non-verbal cues during the focus group session. The sessions were audio-recorded and transcribed verbatim to preserve emic terminology.

Focus Group Questions

Focus group questions were developed based on previous literature and behavioral theory, including the Socioecological Model (SEM), Social Cognitive Theory (SCT) and a framework of adolescent food environments described by Story and Neumark-Sztainer.[28, 33-36] The moderation guide was designed to elucidate perceptions regarding the three distinct adolescent food environments: school, community, and home. Specific probes recommended for use during the focus groups were included in the moderator's guide.[23, 32, 37] Questions were asked in a semi-structured manner, allowing for additional probing and questions based on participants' responses during the focus group session.[38-40] Questions were then reviewed by a group of nutrition (*n*=6) and adolescent experts (*n*=2) as well as graduate (*n*=3) and undergraduate college students (*n*=4) for clarity and content as a form of internal validity.[41]

Data Analysis

Verbatim transcripts were uploaded in the NVivo 11.4.3 software for storage and organization to conduct analysis.[42, 43] Descriptive information from assistant moderator notes was uploaded into NVivo to create contextual case information of each study participant. The analysis occurred through two cycles of coding, with multiple types of coding used in each cycle. The specific coding mechanisms were chosen based on current qualitative research methods proposed by Saldaña, specific techniques that were used in methodology and methods, previous literature of adolescent food environments, and the research questions being asked for this inquiry.[23, 28, 32, 33, 44] Figure 3.1 outlines the coding mechanisms in each cycle of coding conducted by the lead researcher.

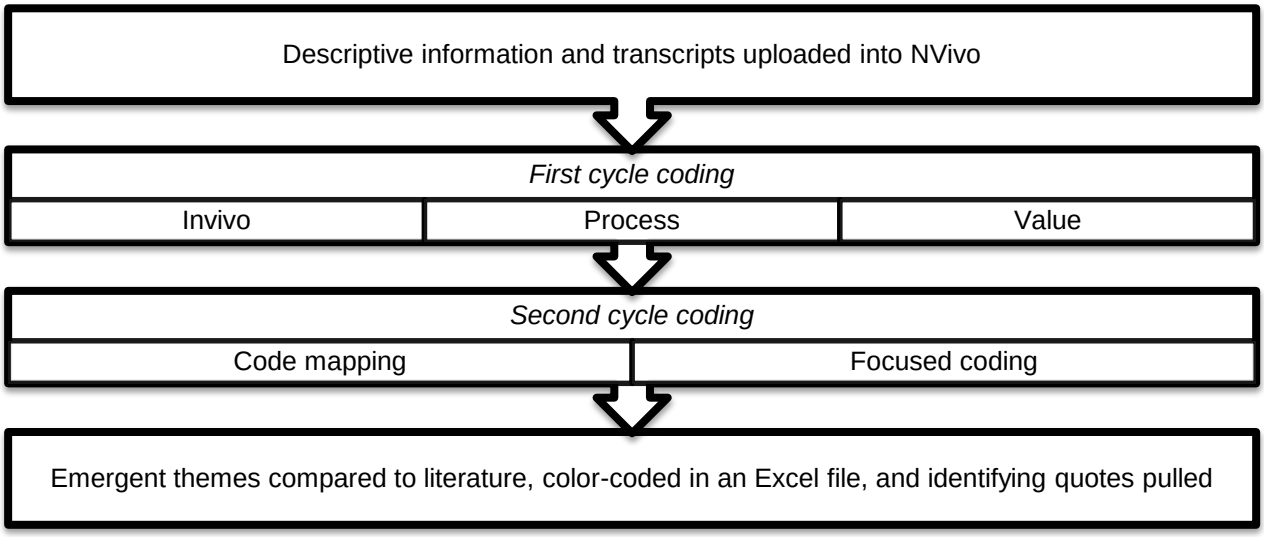

Figure 3.1. Overview of Data Analysis and Coding Processes.

As iterative rounds of coding supported similar emergent themes across focus groups and no new concepts were discovered, the lead researcher determined saturation and the completion of analysis. Emergent themes were compared to existing literature and discussed with research assistants and other members of the research team.[44, 45]

Results

The participants from the focus groups were primarily white, non-Hispanic (80%), female (58.6%), Freshman (86.7%), and 14 years old (73.3%). 10% of participants reported free or reduced lunch status. Additional demographic information is outlined in Table 3.1 to further describe this sample.

The perceptions of food environments and food choices of middle adolescent participants yielded distinct results about school, community, and home environments. However, there were three themes that emerged from all three environments considered to be overarching: convenience, control, and irregularity. These overarching themes are discussed below first, followed with a description of each of the themes present separated by the three different environments. Figure 3.2 indicates the themes in their respective categories as presented below.

Table 3.1. Demographic Characteristics of Focus Group Sample (n=30).

Characteristic	Count (%)
Age (years)	
13	1 (3.3)
14	22 (73.3)
15	7 (23.3)
Year in School	
Freshmen	26 (86.7)
Sophomore	4 (13.3)
Gender (n=29)	
Male	12 (41.4)
Female	17 (58.6)
Race	
White only (non-Hispanic)	24 (80)
Black only (non-Hispanic)	1 (3.3)
Other (including biracial and Hispanic/Latino)	5 (16.7)
Free/Reduced Lunch Status	3 (10)
Characteristic	**Mean (SD)**
F/V Intake (cups)	2.76 (2.63)
BMI (kg/m^2)	20.85 (3.34)

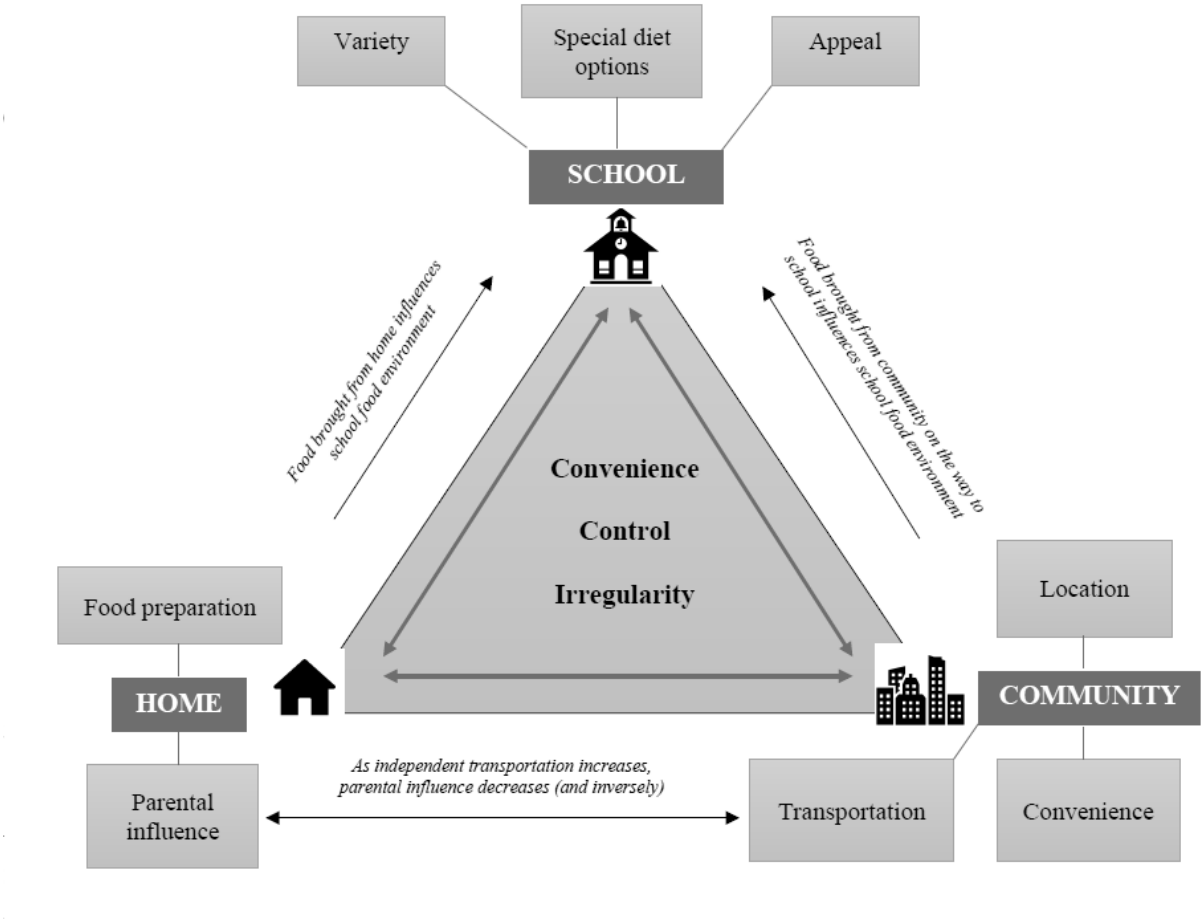

Figure 3.2. Overarching and Individual Themes of Adolescent Food Environments.

Overarching Themes

Convenience

"[I eat] whatever I see before I run out the door to go to the next place I have to be…"

--Female, 15 years old, Freshman student

One of the most prominent themes apparent in all food environments was the importance of convenience for the middle adolescent. This concept of convenience was most frequently discussed in the context of the school food environment. Despite concerns about the variety, quality, and healthfulness of school food offerings, participants reported that their peers continued to buy lunch due to convenience. Similar concepts were reported in community and home food environments, with participants discussing how critical it was to have options just to grab when they were on the go. Convenience was cited as a primary reason for choosing fast food options as well.

Control

"I like to bring one [lunch] because like I can control what I'm eating." – Female, 14 years old, Freshman student

Another prominent reason for adolescent food choice was autonomy and independence of choosing food items. Participants who reported packing their lunch for school noted that it was important to them to be able to have the food items that they liked for lunch, and this was an easy and convenient way to ensure that. Additionally,

participants reported assisting with meal preparation and grocery shopping at home simply to make sure there were foods available that they liked.

Irregularity

"Sometimes over the weekend I'll just be too lazy to get up and find something to eat so I'll just sit there hungry and like eh whatever." – Male, 14 years old, Freshman student

The last overarching theme that emerged among all environments was the irregularity of eating patterns. There was a discrepancy noted in how students reported their meals during the week versus the weekend. Many participants noted that weekends were time for rest and relaxation, and meals might be limited to once or twice a day or intake completely reliant upon snacking and grazing. During the week, meals were structured around school and extracurricular activities, with frequent snacking reported compared to three structured meals. During the week, participants also noted that meal times would vary in the evening based on evening activities and homework.

School Food Environment

Three primary themes specifically related to the school food environment were identified: Variety of healthier options, appeal, and special diet options. Much of the participant food comments revolved around the lunch meal offered at school, but the use of vending machines where no acceptable food items were available was also discussed.

Variety of Healthier Options

"Yeah it's redundant and there's not much variety and I know the chicken sandwiches aren't healthy at all." – Female, 15 years old, Freshman student

Despite frequent jokes about variety and quality of school food items, many students still report buying lunch or a la carte items from the cafeteria. The term "healthy" was frequently discussed when expressing concerns about school food items, but foods that were reported as "good [tasting]" or "better than others" were noted by adolescents as typically being "unhealthy" foods, such as breaded chicken sandwiches and pizzas. Participants who expressed personal concern over lack of variety and quality frequently reported bringing their lunch to ensure that they had enough acceptable food items to eat.

"Practically a meme, like a known concept around at least the U.S. that school lunches are just terrible." – Male, 14 years old, Freshman student

The foods that students felt were most unappealing or "looked fake" were fruits and vegetables. Participants stated that these items were not local, rarely prepared in an acceptable way, or were not fresh. Repeated agreement among peers concerning this topic was evident across the data set.

Special Diet Options

"And like she said, maybe make it more variety because like for vegans and vegetarians, people who can't eat gluten and stuff, there's only like cheese pizza as an option. They don't really have much choices for what they can eat." – Female, 14 years old, Freshman student

Another point of concern about the school food environment was the lack of special diet options. Participants, who did not have special diet needs, reported concerns about limited food items for their peers. The specific special dietary needs that were discussed in the focus groups included vegan, vegetarian, nut-free, nut-sensitive, gluten-free, gluten-sensitive, dairy-free, and options for those with braces, with the most frequently discussed being vegetarianism.

Community Food Environment

The location of this high school was unique as it consisted of students from all over a county with areas considered to be urban, suburban, or rural. The participants expressed a diversity of opinions about their community food options. Three themes specific to community food environments emerged: location, convenience, and transportation.

Location

"Well I live near like a whole bunch of places. We're closer to the grocery store so that's kind of why we don't go out often but the restaurants are nearby." – Female, 14 years old, Freshman student

There was a discrepancy reported in food availability within the community environment evidenced by one participant noting that the nearest grocery store was approximately 30 minutes away, and other participants noted that stores were as close as 1 to 2 minutes away from their homes. Despite reporting a lack of options for grocery stores for those in rural areas, all participants reported that grocery stores were the primary source of food acquisition and associated these purchases as "healthy." Families buying in bulk and at a discount were also frequently discussed.

Convenience

"I mean, our main reason is like going to fast food places is convenience" – Female, 14 years old, Freshman student

One commonality that was seen in the community food environments between adolescents was the prevalence of fast food restaurants, even at times when participants noted no grocery stores around. Further, the groups stated that fast food restaurants were preferred over sit-down restaurants due to ease and convenience during meal times. Most participants reported occasional use of fast food restaurants as a primary source of food acquisition, but, when probed about what occasional meant, it was found that this could range from one to four times per week.

Transportation

In the study, most participants (97.7%) reported that they had not yet obtained a driver's license.

"I can't really drive to go anywhere, so I just have whatever is at my house." – Male, 14 years old, Freshman student

Thus, participants reported to still be reliant upon where their parents or caregivers were willing to take them because most had not yet obtained drivers' licenses. Additionally, participants reported that older friends with drivers' licenses were a source of food acquisition after school and anticipated changing their own places to purchase food items, such as fast food restaurants, when acquiring a driver's license.

"Um well when I drive, I'll probably be going a lot of places, so I'll probably be picking something up instead of going all the way back home, or like go to a friend's house or something." – Male, 14 years old, Freshman student

Home Food Environment

Two primary themes emerged specific to home food environments: food preparation and parental influence. Overall, participants reported that the perceived home food environment had healthier food items available compared to the other environments.

Food Preparation

"Yeah, my mom, she usually like if she's going to the grocery without us, she usually just texts us and asks us to give her life a grocery list sort of what we want..." – Female, 14 years old, Freshman student

Participants assisting with family food preparation was a prominent theme in the data set. Students reported helping with grocery shopping and making lists was often due to food acquisition of preferred food items. One emerging concept was the use of technology to include adolescents in meal planning and grocery lists. Participants discussed use of group texting and web-based applications, such as Our Groceries or Out of Milk, to assist indirectly with grocery list and family menu planning.

"We try to make a menu at the beginning of the week and everybody has ideas and we decide on what we want and add throughout the week and then we go grocery shopping. A lot of times that doesn't work but we try." – Female, 14 years old, Freshman student

Participants also reported helping with meal preparation and grocery shopping when they did not have homework and extracurricular activities. Many stated that the entire family had to assist with food-related chores to make family meals happen, such as describing starting meals for parents working late or prepping food items for siblings.

Parental Influence

Overall, participants reported that they perceived their food choices at home to be healthier (compared to community and school) and that parents were a source of positive reinforcement for eating healthfully. Caregivers were frequently reported as ensuring that vegetables and fruits were available in the home as well as providing healthier snack items compared to non-healthy food items.

"Both of my parents actually cook a lot and we have mostly vegetarian meals and we're actually pretty healthy." – Male, 15 years old, Freshman student

Perception of parental influence on food choices was overwhelmingly positive, but participants also valued the ability to make choices for their preferred food items, citing this again as a significant reason for assisting with home food work.

"I enjoy it [grocery shopping] because I just know what like there's going to be food in the house" – Female, 14 years old, Freshman student

Discussion

The overarching themes of convenience, autonomy, and irregular meal patterns are well-established concepts in the field of adolescent food environments.[23, 24, 28] The importance of convenience when choosing food items was one of the most prominent themes in all three food environments (school, community, and home). Multiple studies concerning adolescent food choice support these findings.[22-24, 28, 29, 31] As adolescents'

lives become more complex, it is imperative that convenient healthier food choices are available in their environments. Although availability does not necessarily equate to consumption, participants in this study indicated a need for availability of healthier options, particularly in the school and community environments. A recent meta-analysis by Micha et al. indicated that providing healthier options, including fruits and vegetables via lunch programs and healthier snack options, revealed that changes in the school food environment and policies may lend to healthier dietary patterns.[46]

The adolescent stage of development during the life cycle makes it a particularly transitional and dynamic time.[47] Some of the most salient themes that emerged were independence and autonomy, particularly in food choice.[24] However, the food choices adolescents may be making during this time of burgeoning independence may be of concern for this population, as they are most often not meeting dietary recommendations and tend to have lower dietary quality than younger children.[30, 48] Further, evidence suggests that lifestyle behaviors developed during this point have importance on risk of future chronic diseases and obesity.[49] Neumark-Sztainer et al. suggested that adoption of healthy lifestyle behaviors as an adolescent was an integral reason for larger societal and environmental changes that impact adolescent food choice.[11, 28, 46]

One unique theme that emerged from this study was the incorporation of technology by adolescents in food preparation. Frequently, participants reported use of web-based applications or simply group texting with family members to convey grocery lists. The use of technology to connect adolescents to food preparation in the home food environment needs to be studied further. There is a potential that technology could

be related to other areas of assisting in food-related chores at home that results in positive health outcomes.[20, 50] Previous research has suggested that adolescents who engaged in food preparation practices and cooking skills exhibited similar behaviors later in life with a significant increased difference in consumption of fruits, vegetables, and whole grains when compared to adolescents who did not engage in food preparation and cooking.[20, 50]

The potential difference of the food environment between those who were not yet driving compared to those who were driving was another emergent theme for this study. The middle adolescent time period, although the typical range is only four years difference, may experience a significant amount of variance in availability of food items due to whether or not they are able to drive independently. Recent research on adolescent females indicated a strong relationship between driving licensure on independence and travel-activity patterns.[51] Future work in this area may allow comparison of groups that can and cannot drive to evaluate differences in types of food environments as well as resulting food choices. Additionally, it would be important to identify how these travel-activity patterns may vary widely between adolescents living in more metropolitan areas (where public transportation is more available) and pre-driving adolescents living in rural areas.

There are some strengths and limitations in this study. One strength of this study was the ability to gain information on all three food environments that are strong influencers of adolescent food choice, particularly in a sample of middle adolescents that are not yet driving independently. Another strength was the use of focus group methods in this population to generate emic data that is reflective of the experiences

and perceptions of the sample. However, some of the most important questions and/or information collected from this study may have been sensitive in nature, and the adolescent participants may have been reluctant to share information about foods in their home or potential food security issues.[29]

One limitation of the study was the method of one researcher completing the analysis. To mitigate and decrease biases that may be present from this method, multiple coding mechanisms that were consistent with qualitative methodology and previous literature were chosen. Coding in multiple ways allows the data to be processed differently and analyzed for consistent themes, no matter the analysis. Data and findings were also discussed and reviewed by the research team during and immediately following analysis. Further, this study included aspects to increase credibility (prolonged engagement and persistent observation of sample), transferability (thick description of setting and context), dependability (external audits by members of the research team during analysis and writing), and confirmability (audit trail and the practice of lead researcher reflexivity) as outlined by Lincoln and Guba.[52-55] Another limitation is the generalizability of this particular sample when compared to other adolescent populations. In this area, driving played a prominent role in autonomy of travel activity patterns. However, in larger, metropolitan areas, other forms of transportation may allow more independence in travel activity, thus influencing available food environments. Therefore, future research should include transportation questions to better understand how travel activity can affect adolescent food environments.

Implications for School Health

Further research is needed to better understand how adolescents incorporate technology to assist with meal preparation and grocery shopping. This information may be useful in developing dietary interventions for this population. Additionally, there needs to be further exploration of how travel-activity patterns change as adolescents use different forms of transportation independently. Because convenience and control were cited as primary factors in adolescent food choice, as well as variety and appeal in school lunches, better availability of a variety of appealing fruits and vegetables that adolescents can quickly select from in school lunches may help encourage healthier food choice and increased consumption in this population.[46]

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CHAPTER 4 : MORE THAN FAST FOOD: DEVELOPMENT OF A STORY MAP TO COMPARE ADOLESCENT PERCEPTIONS AND OBSERVATIONS OF THEIR FOOD ENVIRONMENTS AND RELATED FOOD BEHAVIORS

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My contributions to the paper were i) study design, ii) preparation and submission of the study protocol to the University of Tennessee at Knoxville Institutional Review Board (IRB), ii) participant management, iii) participant recruitment, iv) development of the story map, v) data analysis, vi) manuscript preparation, editing. based on co-author feedback, and submission for publication. J. Riggsbee contributed to i) study design, ii) development of the story map, and iii) data analysis. S. Colby, L. Moret, M. Spence, and E. Anderson Steeves contributed to i) study design, ii) provided feedback on study protocol, and iii) provided extensive feedback during story map development. All co-authors read and approved the final manuscript.

Abstract

The purpose of this convergent, multiphase, mixed methods study was to better understand the perceptions of adolescents' food environments and related food behaviors using grounded visualization and story mapping. Adolescents from one high school (13–16 years) in the southeastern U.S. were evaluated via data from health behavior surveys (*n* = 75), school environment maps, focus groups (*n* = 5 groups), and Photovoice (*n* = 6) from October 2016 to April 2017. Data from each phase were integrated using grounded visualization and new themes were identified (*n* = 7). A story map using ArcGIS online was developed from data integration, depicting the newly identified themes. Participants failed to meet national recommendations for fruit and vegetable intake (2.71 cups). Focus group and Photovoice findings indicated the need for convenience food items in all environments. The story map is an online, interactive dissemination of information, with five maps, embedded quotes from focus groups, narrative passages with data interpretation, pictures to highlight themes, and a comparison of the participants' food environments. Story mapping and qualitative GIS approaches may be useful when depicting adolescent food environments and related food behaviors. Further research is needed when evaluating story maps and how individuals can be trained to create their own maps.

Introduction

The built environment has been studied as a contributing factor to the increased exponential changes in the prevalence of obesity over the last fifty years [1-4]. The built environment encompasses all human-made aspects of our environments, and the food environment is one subset of the built environment. Specifically, the food environment is defined as places where individuals can acquire food items, such as restaurants, grocery stores, farmers' markets, convenience stores, workplaces, schools, and home [5, 6].

In the adolescent population, three primary food environments have been identified that influence food choice and consumption: School, the community, and home [7, 8]. With rates of adolescent obesity steadily increasing in the last decade, researchers continue to investigate environmental and policy approaches to address the epidemic [9]. Evidence of the relationship between obesity and food environments, particularly for adolescents, is mixed, and methods used to analyze these environments typically focus on either neighborhood level data or perceptions of the environment [10-13].

Geographic information systems (GIS) have long been used to quantitatively assess food environments in terms of density or proximity to certain types of food outlets [5, 14-19]. However, GIS professionals and social science researchers are now considering qualitative activity data, including interview quotes and pictures of a

neighborhood taken from the perspective of community members, as helpful in explaining behaviors and experiences beyond what quantitative objective measurements are able to capture [20, 21]. Another way that GIS data have been used with qualitative research is story mapping [21, 22]. Typically used in community settings to allow stakeholders and community members to better understand their shared experiences, story maps embed photos, videos, comments, and other information in an online, interactive map. Story maps provide context and socially constructed information beyond objective assessments [23, 24].

Research from Knigge and Cope has established grounded visualization as a methodology that can be used to incorporate qualitative data with GIS [25-27]. Based on grounded theory approaches, the process of grounded visualization is iterative in nature, exploring possibilities without a specific hypothesis a priori [22, 28]. Use of this methodology can incorporate the knowledge and power of the community into the scientific process, often reducing the barriers of marginalized representations of underrepresented communities' perspectives [22]. Walker and Hanchette used grounded visualization to establish a framework regarding neighborhood perspectives of a low-income population, displaced by local revitalization. They outlined this methodology in a three-pronged approach, which included mapping the studied neighborhood, conducting community member interviews, and using modified Photovoice methods termed "drive-by photography" [29].

Story mapping (with grounded visualization as a guiding methodology) may be an appropriate way to engage adolescents in action research and support them in working towards health promotion and behavior change outcomes [25-27]. The objective of this exploratory study was to better understand the perceptions of adolescents' food environments, food behaviors, and choices using grounded visualization and story mapping. Similar to Walker and Hanchette's three-pronged approach to grounded visualization, this paper used a four-pronged approach to advance scientific knowledge on how story mapping and use of qualitative GIS can be utilized to better understand the links between adolescent food environments and food choices [29].

Materials and Methods

In this convergent, multiphase, mixed methods study, data were collected from one high school in the southeastern U.S. from October 2016 to April 2017. The research team explored adolescent food environments, health behaviors, and demographic characteristics for a larger health-related study and then engaged a sub-population in focus groups and action research to provide further context. The methods are outlined based on a modified grounded-visualization, four-pronged approach resulting in a story map of information integrated from all stages of data collection and analyses [22, 29]. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the

protocol was approved by the Ethics Committee of the University of Tennessee (UTK IRB-14-09366 B-XP) as well as the high school administration board.

Prong 1: Dietary Behaviors Data Collection

Students from one high school were recruited via wellness class announcements, general school announcements, flyers, and face-to-face contact for six weeks (September and October 2016). T-shirts, pens, stadium cups, and other merchandise were provided to students to increase awareness of the larger research study, which encompassed this project. Students currently enrolled at the high school were eligible to participate if they had documented parental consent and provided assent. The survey was administered via an online platform and offered during class times and lunch periods. Of 565 students attending the school, 13.3% (*n* = 75) completed the online survey and were considered eligible. This aim of this prong was to understand the dietary behaviors and food environments of the school overall. Online survey components included dietary behaviors (fruit and vegetable (FV) intake, perception of support, and meal patterns), self-reported height and weight, and demographics [30, 31]. Self-reported height and weight were used to calculate body mass index (BMI) [32, 33]. ArcGIS online was used to develop multiple maps of the school, surrounding food environment, and census tracts of the county that students reside in based on data provided by the American Community Survey and census tracts [34]. Additionally, listings of potential food stores, convenience stores, grocery stores,

and restaurants were identified surrounding the school environment with a three-mile buffer from Google maps with additional comparison maps and ground-truthing to verify [6, 19, 35].

Prong 2: Focus Groups

Individuals were recruited through high school wellness classes (*n* = 2 classes) to participate in focus groups using in-class announcements and flyers. Participants were deemed eligible to participate in Prong 2 if they met the previous eligibility criteria. Demographic data from the online surveys were linked to participants in the focus groups. The aim of Prong 2 was to glean information about how perceptions of adolescents' food environments (from the adolescent viewpoint) related to food behaviors and the perceived factors that impact on those behaviors. Five focus groups were conducted, with approximately five to seven students in each group (*n* = 30 total participants). Participants were asked to elaborate on three food environments (school, community, and home), including facilitators and barriers to making desired food choices. A semi-structured interview guide was developed based on the socioecological model, social cognitive theory, and proposed adolescent food choice framework proposed by Story et al. [8, 36-41]. Focus groups were audio recorded and transcribed verbatim.

Prong 3: Photovoice of Community and Home Environments

The research team invited all participants from the focus groups to participate in a modified, electronic Photovoice project to gain a more in-depth analysis of the community and home food environments [42]. Students were eligible to participate in Prong 3 if they met all previously stated criteria. Of 30 students who were asked to participate, 6 (20%) participated and submitted pictures online. Demographic data, including home addresses, were linked with the sub-sample. Participants were asked to take pictures of their community and home food environments during two different weeks using their cell phones; they were instructed to take pictures of anywhere they acquired food items, any foods they commonly eat, any meals, and depictions of the different types of food environments they encounter [43, 44]. Instructions, a guide for ethical photography, and a written prompt were provided in the classroom [42, 45-47]. The pictures were then uploaded by the participants to the online survey platform with an open space for the participant to comment on each picture [43, 44].

In addition to the identification of major themes in pictures, travel activity patterns (identified in Prong 1 with mapping) were re-analyzed and associated with Photovoice pictures. Home food environments were mapped, and census data were used to assess the proximity and amount of food outlets near home. Additionally, the research team coded for the access and availability of food items around the home food environments

and, looking along the travel activity patterns, estimated that of the school food environment.

Prong 4: Development of Story Map

The development of the story map began with data merging and integration based on a convergent, multiphase approach, outlined by Onwuegbuzie and Teddlie [48]. Baseline descriptive statistics were used to describe dietary behaviors and meal patterns and were performed using JMP version 14.0 to assist in quantitative data reduction [49]. Developed maps from food environments were also reviewed by a GIS analyst for common themes. Two researchers separately reviewed findings, noted common themes, and then discussed any discrepancies in themes. A modified Prong 1 data set was created based on these qualitative themes from the quantitative strand in Excel. Focus group analysis was conducted by the lead researcher, first with multiple rounds of first cycle coding (in vivo, process, and value), second cycle coding (focused), and code mapping to determine overall themes, and data organization was done on NVivo version 11.0 [50, 51]. Photovoice and related comments were then coded separately, utilizing open coding (first cycle) and axial coding (second cycle) to develop separate themes. Major findings from all Prongs were merged to an Excel spreadsheet. A Prong 4 data set was created with themes from all comparisons (n = 11).

The Prong 4 themes were then used to develop a story map using ArcGIS Online [34]. As outlined in grounded visualization, researchers iteratively went back to previous

maps and Prong data sets to ensure representation of themes and visualization was an accurate representation of participants' experience in the story map [22]. No photographs taken during the modified Photovoice project were utilized in the story mapping application due to low resolution; to represent themes derived from coding Photovoice, stock photos were used. As a member check for validity, the story map was presented via email to the students who participated in Prongs 1–3 to ensure the map was reflective of their experiences [42, 45-47]. Participants recommended changes in visual appeal, and these changes (*n* = 6) were made.

Results

Prong 1: Quantitative Dietary Behavior and Mapping

Participants in Prong 1 were white non-Hispanic (81.3%), Freshmen (74.7%), 14–15 years old (86.7%), and 54.1% were male. Twelve percent of the sample reported free or reduced lunch status; 29.3% chose not to answer or reported not knowing. The mean reported daily FV consumption was 2.71 (SD = 2.29) cups. Overall dietary patterns indicated that 48% consumed breakfast daily, and 54.7% consumed fast food at least once per week. Baseline demographics and dietary behaviors are further outlined in Table 4.1.

Figure 4.1 depicts the school food environment with the sub-sample of participants' (*n* = 6) community food environments highlighted in blue with potential travel activity patterns (based on population density and major roadways) outlined in

red. Of 262 food sources (grocery stores, convenience stores, drug stores, discount stores, and restaurants) identified in the school's 3-mile buffer zone, 154 (58.8%) were restaurants, primarily fast food or quick service. One important thing of interest concerning the sub-sample was that the participants resided in all areas of the county, including one who lived outside of the county, commuting over one hour each way per day.

Prong 2: Focus Groups

The Prong 2 sample was similar demographically to Prong 1; 80% reported being white non-Hispanic, Freshmen (86.7%), and 14 years old (73.3%). Three overarching themes emerged and were apparent in all three food environments: Convenience (use of grab-and-go meal and snack items), irregularity (irregular meal patterns, particularly with differences on week and weekends), and control (independence of food choices and meals). Overall, youth reported issues related to convenience, lack of time due to extracurricular activities, and busy schedules that limit family meals as factors that increase fast food consumption and promote an unhealthy community and home food environment. Similar to current literature, convenience was of utmost importance to participants in this sample, citing it as a common reason for consuming fast food and snack items.

Table 4.1. Baseline Characteristics from Prong 1 Sample (n = 75). FV = Fruit and Vegetable, BMI = Body Mass Index.

Characteristic	Count (%) or Mean ± SD
Age (years)	
13	1 (1.3)
14	42 (56)
15	23 (30.7)
16	7 (9.3)
17	2 (2.7)
Year in School	
Freshmen	56 (74.7)
Sophomore	13 (17.3)
Junior	5 (6.7)
Senior	1 (1.3)
Gender (*n* = 74)	
Male	40 (54.1)
Female	34 (45.9)
Race	
White only (non-Hispanic)	61 (81.3)
Black only (non-Hispanic)	4 (5.3)
Other (including biracial and Hispanic/Latino)	10 (13.4)
Free/Reduced Lunch	9 (12)
FV Intake (cups)	2.71 ± 2.29
BMI (%)	21.71 ± 4.08
Vegetarian	7 ± 8.1

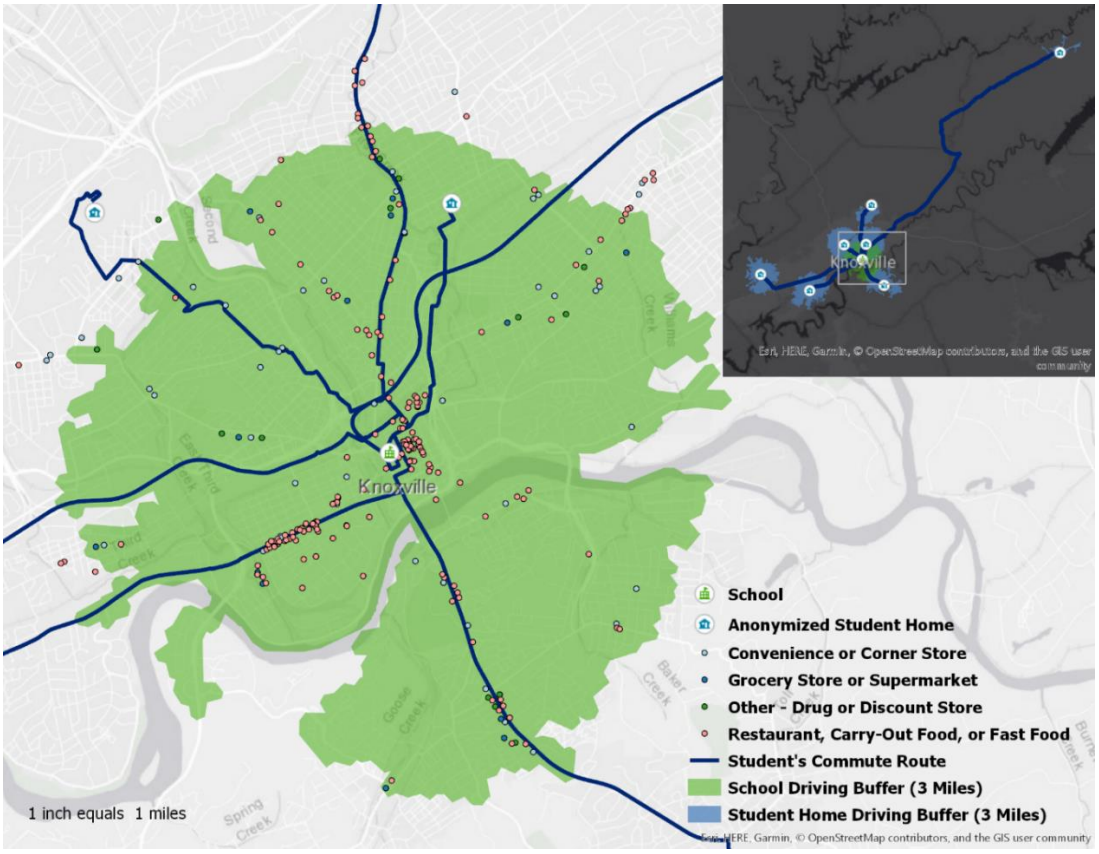

Figure 4.1. In-depth Analysis of School Food Environment with Buffer Zone Surrounding School.

Two novel findings in this prong were related to use of technology for meal planning and influence of independent travel activity via personal vehicle on food behaviors. Youth also identified use of technology (including phone applications) in meal preparation and meal planning, particularly when used in conjunction with other family members, as ways to be more involved in the home food environment. Specifically, the youth identified that using group texting and applications were a way for them to contribute to the family shopping list. Online grocery ordering done by youth and their families as well as participation in meal subscription boxes were also notable characteristics of engagement in technology to participate in meal planning and preparation activities. Participants in this sample did not have driver's licenses and reported having a driver's license was a critical component for increased independent food acquisition for high school students. Thus, participants without driver's licenses reported that food acquisition was limited to times when they were traveling with parents or friends and acknowledged that independent travel activity may alter community food environment exposure.

Prong 3: Modified Photovoice Sub-Sample

The Prong 3 sample reported being white non-Hispanic (57.1%), with the remaining participants reporting being biracial and/or Hispanic, all Freshmen students (100%), and 14 years old (71.4%). 57.1% of the sample reported being male. Similar to Prong 2 findings, convenience was an overarching theme of Photovoice analysis. Snack

food items were prominent in the home food environment, with 26.2% of photographs including snack items (as identified by participants in the comments). Pictures of snack cabinets, fruit bowls, and stocked refrigerators were common for the home food environment with the sub-sample. Family meals were also frequently depicted, with some participants noting special holiday meals and theme nights as reasons for eating together.

In the community food environment photographs, a divergence of snack food options was depicted at home versus non-home settings. Gas stations and convenience stores were reported as sources of high-fat, high-sugar foods and beverages when not at home, but fresh fruits, vegetables, and whole grain options were offered at home more frequently. Convenience was also depicted in both community and home food environments through photographs of fast food outlets and bringing quick meals home. Participants frequently took photographs of food outlets from a vehicle while riding with another person.

Prong 4: Development of Story Map to Describe Adolescent Food Environments

The new data set derived from analysis included seven overall themes (indicated in Table 2) with 1 to 2 sub-themes fitting under most categories. Based on integration of Prongs 1–3, some new themes that were generated in Prong 4 included cooking skills, FV intake, family support of healthy food behaviors, and limited food access for some. Figure 4.2 is a pictorial description of the map. A detailed description of the new themes

and how they relate to the story map follow below (in Table 4.2). A link to the story map is included in the Supplementary Materials of this article.

Detailed Description of Story Map

The story map exists on ArcGIS Online, a cloud-based system that allows anyone with the hyperlink to visit. Interaction with the story map is often done with scrolling and zooming capabilities. It is important to note that the maps are the central theme in a story map and should be considered prior to adding photos or words. On these first slides, the location and description of the sample are shown to assist in providing context to the adolescents' perspectives from this sample. This section includes demographics of the overall sample from Prong 1, the purpose of the study, a map describing the geographical location, and specifically noted the driving status of this sample. A regional map of the sample's location is also included. In the next block of slides, the focus is placed on convenience, as this was a prominent theme in all prongs, and quotes from the focus groups are used to illustrate this concept. For example, a picture of the family meal with fast food options is depicted with a focus group quote stating, "We're just super busy, and like my dad gets home late, like around 6:30 or sometimes 7, so it just depends, and we usually sit down as a family but not everyone is always there because that's just how it goes." In this section, two students from the Photovoice sub-sample were chosen to illustrate differences in rural and non-rural individuals from this area. The home environment in the rural area depicts limited

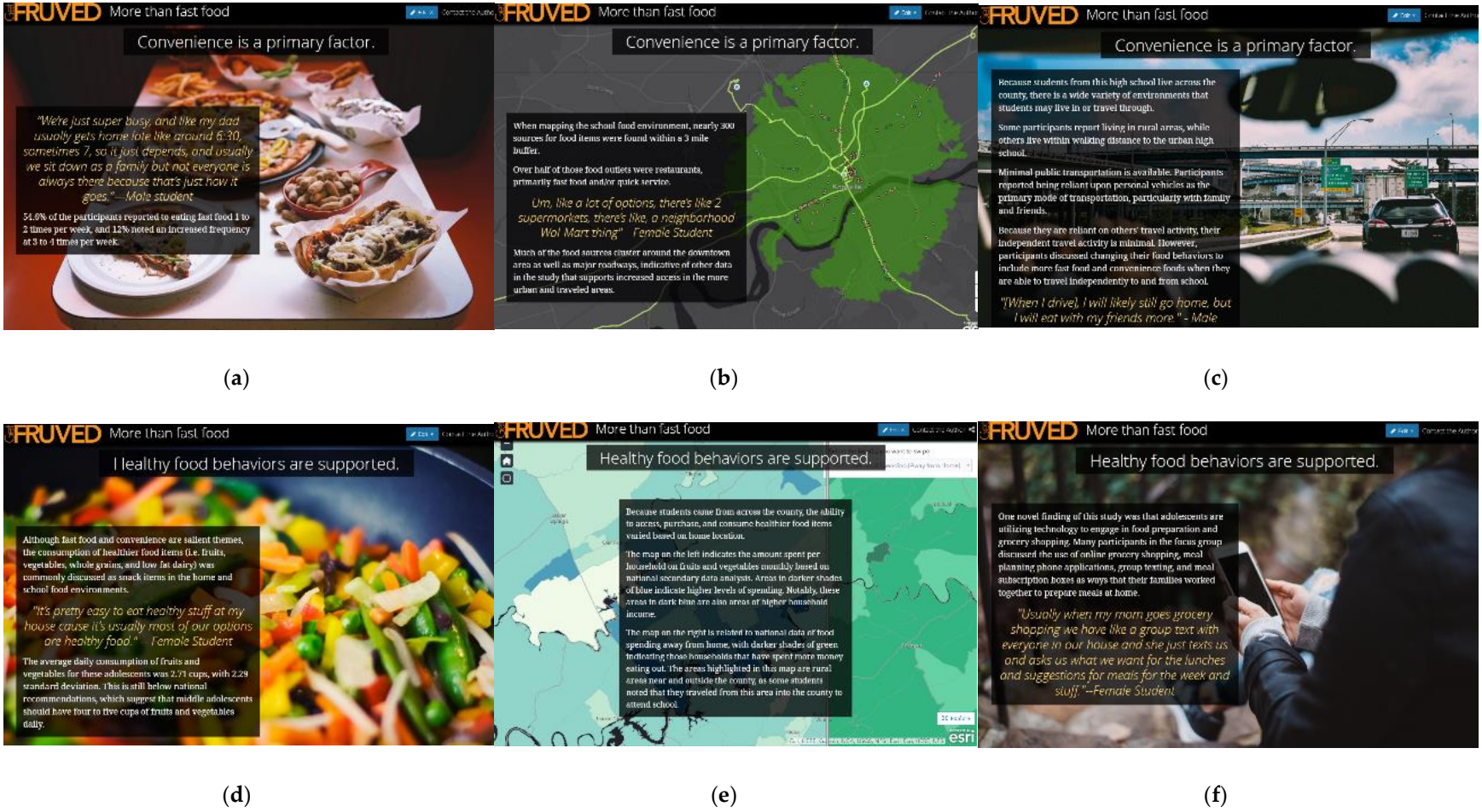

Figure 4.2. Pictorial Depiction of Online, Interactive Story Map as Follows: (a) Start of convenience section where fast food is depicted for family meals and embedded quote from focus groups; (b) next convenience section where school food environment with buffer and identified food outlets are shown; (c) transportation shown with narrative regarding dependent travel activity and embedded quotes from focus groups; (d) the next section depicting support of healthy behaviors starts with cooking skills; (e) mapping of county region from Prong 1; (f) use of technology with meal planning and preparation shown.

Table 4.2. Data Integration from All Four Prongs to Display Development of Story Map Themes.

Comparison of Information from Prongs 1–3 to Develop New Prong 4 Themes			
Prong 4	**Prong 1**	**Prong 2**	**Prong 3**
Convenience	• Places of food acquisition centrally located in more urban areas and near major roadways • Limited food access for some in more rural areas	• Busy schedule for both adolescents and parents as a reason for convenience foods • Decreased price compared to healthier options	• Grab-and-go snacks • Quick service meals for family meals • Meals on go while heading to next place
Fruit and vegetable (FV) intake	• 1.87 cups daily (Range: 0.25 to 13 cups)	• Increased availability of FV at home	• Fresh fruit and vegetables depicted in home and taking in school lunch
Fast food	• 32% reported never consuming in last week • 54.6% reported 1–2 times per week consumption • Mainly fast food and quick service restaurants in three-mile radius	• Increased availability of fast food	• Fast food outlets and quick service meals at home
Support of healthy behaviors	• 66.6% reported friends think it is "somewhat" or "very much" important to be healthy	• Parents provide positive role modeling for healthy eating • Parents provide access to healthy foods • Parents sometimes are negative role models for healthy eating	• Access to FV in home provided by parents • Snacks provided by parents are healthier items • Family meals at dinner table
Travel activity	• Limited public transportation options across county • Must use personal vehicle to access	• No drivers' license • Relied on family and friends	• Community pictures while riding in car with family member
Cooking skills	N/A	• Parents cook frequently with adolescents' help • Starts preparing dinner for family at times • Satisfaction in being able to assist family with cooking • Prepares meals for self frequently	• Meal preparation
Technology	N/A	• Use of phone applications, group texting, food subscription boxes, online food shopping to acquire food items • Family uses online recipes frequently	• Pictures of meals and food from social media outlets and internet influenced food choices

access to gas stations and/or food outlets with none noted. Compared to the rural area, the other participant lives in a suburban environment, with access to multiple grocery stores, restaurants, and outlets for food acquisition. This section also presents the importance of transportation and displays the school food environment that all participants share. The green zone is a 3-mile radius surrounding the school, with 300 food sources identified in this area (depicted in Figure 4.1 as well). Major roadways are highlighted in light green, leading to the sub-samples' home addresses. Wide variance exists between the sub-sample and their home food environments and travel activity patterns, despite having a common school environment. The last section focuses on support of healthy behaviors, addressing the perceived differences in healthier food items being available in the home as well as assistance with meal preparation, both directly and indirectly with technology. Based on the Prong 4 data, support for healthy behaviors from family and peers was a critical component in the youth's behaviors. Thus, the discussion surrounding family meals and assistance with cooking was also dependent upon if parents or caregivers expected participation from the youth and if busy schedules limited them. The technology component was highlighted by one focus group quote from a female participant, stating, "Usually when my mom goes grocery shopping we have like a group text with everyone in our house and she just texts us and asks us what we want for the lunches and suggestions for meals for the week…"

Discussion

Much of the data derived from both qualitative and quantitative strands of data were reflective of current literature regarding adolescent food environments, including issues related to convenience, use of fast food restaurants as a food source, and busy

schedules that limit family meals [7, 8, 52, 53]. However, novel findings for nutrition literature related to the use of technology and travel activity were also common themes from all prongs. New themes based on the analysis of the integrated data set that were not specifically identified with either qualitative or quantitative analysis included the importance of cooking skills as well as familial and peer support for healthy behaviors. Some of these differences may exist due to the unique nature of the middle adolescent period in which independence is emerging, while also peer and family support are still prominent.

Data integration from the quantitative and qualitative strands was mostly convergent, but there were some notable divergences as well. Support of healthy behaviors, particularly from parental influence in the home food environment, was another prominent theme in Prong 4 with divergent data. Although participants reported increased availability of healthier food items due to parental food acquisition and positive role modeling making it easier to eat healthier food items at home, some participants in Prong 2 noted that parents often provide negative role modeling by providing high-fat, high-sugar items in the home that are tempting, particularly when parents are consuming them frequently. These findings support previous research conducted by Anderson Steeves et al. [54].

Story mapping has been commonly used in community settings to spark conversation surrounding pertinent issues. However, the development and use of story mapping for health promotion and related behavior change is an underdeveloped area in peer-reviewed publications [55, 56]. Thus, a better understanding of ways to develop the map in the web-based application as well as effective, evidence-based methods for

presenting back to the community with evaluation is the necessary next steps in the literature. Some literature indicates appropriate teaching methods of story map development to adult learners and ways for community members to create their own story maps [23, 57, 58]. Further engagement in the research with participants directly developing the story map from training provided by researchers may also be a mechanism for community action and behavior change.

Many aspects of the study are unique. First, the use of grounded visualization and critical GIS methodology to incorporate both perceptions and observations of food environments is a new, developing approach, but one that addresses previous gaps in the literature. Based on grounded visualization with an embedded, mixed methods framework, data analysis and interpretation were an iterative process that provided rich context beyond quantitative data alone. Additionally, because all food consumption is important when conveying the participant experience, the research team refrained from coding Photovoice food items and meals as “healthy” or “unhealthy”. These categorical terms are subjective in nature, and the objective of the project was to accurately reflect adolescent food environments from this sample’s perspective through the use of story mapping and qualitative GIS approaches. The research team simply considered what environments and context related to acquisition or consumption of healthier food items when doing qualitative data analysis to decrease this known bias.

Although grounded theory is well developed and understood, the use of qualitative theory in GIS and spatial analysis is fairly new, particularly in nutrition and health promotion research [22, 23, 28, 29, 59]. However, many of the gaps previously identified in nutrition and food environment research have been focused on combining

individual behavior and perceptions with environmental aspects, consistent with social cognitive and socioecological model theories [37, 38, 60]. The use of critical GIS and grounded visualization helps to bridge that gap, despite its novelty [22]. However, sample size has been difficult to determine with this methodology [22]. Typical geospatial analyses rely on large amounts of data at a population level. However, the focus groups and other qualitative data are often done with smaller samples, allowing for decreased spatial analysis in mapping software when incorporating the two types of data [22, 59]. Appropriate data collection methods and ways to evaluate the use of story maps have limited evidence in peer-reviewed publications.

One limitation of this study is the use of convenience sampling. This sampling framework used across all methods of data collection created a sample that may not be representative of all adolescents, nor the school overall. Additionally, participants who continued as part of the sub-sample in Prong 3 may not be the most representative of the entire sample because those who continued participation may have an increased interest in discussing health-related issues or engaging in health promotion efforts. Thus, the story map that we developed may be unique to those youth who are more interested in health and nutrition, and later community engagement with the maps may be altered based on this perspective. Also notable is the low sample size as the prongs in the study progress, and the sub-sample engaged in the modified Photovoice procedures was six. Wang et al. recommended an optimal Photovoice sample size of 7 to 10 participants, and Walker and Hanchette used five participants for their interview and drive-by photography approach to develop a narrative story map [29, 42]. Another limitation was the absence of an interview with the sub-sample who completed the

modified Photovoice. Conducting an interview with the adolescents and allowing the sub-sample to choose photographs to be included in the story map aligns more closely with typical Photovoice methods and it was not possible for it to be conducted in this study. To mitigate this slightly, the research team allowed participants to provide comments when submitting pictures and following the creation of the story map.

Conclusions

Use of grounded visualization and story mapping may be useful tools when evaluating adolescent food environments and related food behaviors. Future research should evaluate the effects of developed story maps when presenting back to the population of interest, particularly for behavior change. Additional research needs to be conducted on the use of grounded visualization with other populations and their food environments, as well as effective ways to develop and evaluate this data visualization tool.

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CHAPTER 5 : CONCLUSION

The original hypothesis for the FEC was that awareness and active learning through environmental data collection would support health behavior change, in this case, increased dietary intake of F/V and improved meal patterns. The FEC was found to be feasible and acceptable with key modifications. However, no change in dietary behaviors from the FEC was detected, and there were potential missing mediating factors that may have impacted behavior change and should be included in future testing. Key modifications to the FEC include an increase in lecture and out-of-class activities and the incorporation of mapping technologies.

For the qualitative portion of this dissertation, the overarching themes of convenience, autonomy, and irregular meal patterns are well-established concepts in the field of adolescent food environments. The importance of convenience when choosing food items was one of the most prominent themes in all three food environments (school, community, and home). Multiple studies concerning adolescent food choice support these findings. So, based on these findings and other literature, as adolescents' lives become more complex, it is imperative that convenient healthier food choices are available in their environments. Although availability does not necessarily equate to consumption, participants in this study indicated a need for the availability of healthier options, particularly in the school and community environments.

Related to the story map, there are many gaps that exist. Although grounded theory is well developed and understood, the use of qualitative theory in GIS and spatial analysis is new, particularly in nutrition and health promotion research. However, many of the gaps previously identified in nutrition and food environment research have been focused on combining individual behavior and perceptions with environmental aspects,

consistent with Social Cognitive and Socioecological Model theories. The use of critical GIS and grounded visualization helps bridge that gap, despite its novelty. However, sample size has been difficult to determine with this methodology. Typical geospatial analyses rely on large amounts of data at a population level. However, the focus groups and other qualitative data are often done with smaller samples, allowing for decreased spatial analysis in mapping software when incorporating the two types of data. Story mapping has been commonly used in community settings to spark conversation surrounding pertinent issues. However, the development and use of story mapping for health promotion and related behavior change is an underdeveloped area in peer-reviewed publications. Thus, a better understanding of ways to develop the map in the web-based application as well as effective, evidence-based methods for presenting back to the community with evaluation are necessary next steps in the literature.

Some literature indicates appropriate teaching methods of story map development to adult learners and ways for community members to create their own story maps. Further engagement in the research with participants directly developing the story map from training provided by researchers may also be a mechanism for community action and behavior change. For example, having youth create their own story maps to present back to their peers should be further studied, and this was another reason that it was included as a component in the FEC. Use of grounded visualization and story mapping may be useful tools when evaluating adolescent food environments and food behaviors. Future research should evaluate the effects of developed story maps when presenting back to the population of interest, particularly for behavior change. Additional research needs to be conducted on the use of grounded

visualization, development of story mapping, techniques for teaching adolescents how to utilize story maps, and, most importantly, how to evaluate the effects of story maps.

CHAPTER 6 : LESSONS LEARNED

During my dissertation and time as a doctoral student at the University of Tennessee, I have learned many lessons that have shaped my view as a scholar and future academic professional. One of the most critical lessons I have learned is to respect the journey that I have been on and trust in those who are mentoring and advising me. I often found myself worrying unnecessarily about the next moves or choices to make when this was often alleviated simply by having discussions with those on my committee. The advice of my committee has been invaluable and has helped me push through some of the toughest times. However, I think it was also important for me to learn how to advocate for myself and speak up when necessary. Being able to feel secure enough to ask for help and say when I didn't know something was a skill I had to learn, and my committee was supportive in these processes.

Probably the most important thing I have learned through this process is flexibility, in multiple contexts. I have learned to be flexible when my academic advisor asked something new of me, especially when it required a new skill or something I wasn't comfortable with doing. I have learned to be flexible when plans in our lab change and the communities we work with have other needs. I have learned to be flexible at home, finding ways to accomplish my school tasks while also being a mother. Most importantly, my mentor has instilled a flexibility in me when collaborating with other researchers. This last skill has been especially important as I have thought about ways to work with others in a new professional setting.

Through my time spent in the high schools, at the University of Tennessee, and while teaching adjunct at Maryville College, I have learned how much I thoroughly enjoy being in a creative environment that allows me the privilege of being able to work with

so many remarkable, brilliant young people. I am amazed daily by the students that I have encountered, and this joy for my students has allowed me to continue through my research and studies when things are difficult. I often think of my research in terms of impact, but I think a much greater representation of me professionally is looking at the students I have taught and trained in my doctoral work. I am far prouder of their accomplishments and work than what I have done.

I was fortunate enough to take many classes at the University of Tennessee that impacted me. However, one class left a lasting impact on me, and I learned about myself as a scholar through the studies of Advanced Qualitative Research. Not only did I learn about my ontological and epistemological views, but I also learned how to be vulnerable and settle with being uncomfortable. During this class, I had a unique sense of imposter syndrome, feeling particularly out of place and not able to keep up with my classmates. Although the urge to be competitive and “fake it until you make it” was strong, I was honest about where I felt insecure and shared my feelings with classmates and my instructor.

I am often surprised that I have come to the end of this journey, wondering where the time has gone. I am still the curious, sometimes skeptical student who came in wanting to change with the world with my advisor, but what I have learned is that I can impact people in little ways every day. Maybe it’s just a smile in the hallway or an encouraging word for a colleague on a challenging day. It may not always be life-changing, earth-shattering research that I am engaging in, but I can always choose to be present and positive with those around me. It is with this spirit that I leave my graduate studies and continue on the next journey.

“What we know matters but who we are matters more.” – Brené Brown, Daring Greatly: How the Courage to Be Vulnerable Transforms the Way We Live, Love, Parent, and Lead

APPENDIX

Appendix A: Expanded Qualitative Methodology

Case Study as a Methodology

Merriam describes the case study has an "unit around which there are boundaries" and states that this concept is the single, unifying definition that is present in all explanations of case study methodology.[1] The case study is typically holistic and intensive in nature, seeking to describe and understand the uniqueness of a phenomena of that bounded unit.[1-3] What a case is can vary greatly from each study, with some defining case as an individual, a group of individuals, or a program.[1, 4] However, as long as the case can be defined with boundaries and with some unifying properties, case study as a methodology can be utilized.[1, 4]

Merriam also describes that case studies are typically defined as particularistic, descriptive, and heuristic.[1] Particularistic indicates that it is focused on that specific phenomena or case at hand.[1] This can provide rich insight for qualitative researchers seeking more information on an everyday practice, such making food choices, by diving deeply into one case and concentrating heavily on the problem at hand.[1] Case study research is also descriptive, providing readers with details of the case, fully highlighting the contexts that surround the inquiry. Lastly, the heuristic nature of case studies allows the researchers and readers to better understand as well as make new meanings from the uniqueness and novelty of the case at hand.[1]

Within the methodology described by Merriam (as well as Stake), there are several descriptors that can be used to further identify the type of case study being conducted.[1] Intrinsic case study research allows researchers to describe the uniqueness of a case.[2, 4] Although intrinsic case studies are often difficult to describe as generalizable or applicable to theory due to the unique nature of the case, there is still

ability for the research to support theories as well as develop new themes to be explored further.[1, 2] Case studies are considered descriptive in general, but this is also a term that can used to classify the type of research being done. Stake notes that a descriptive case study is one that provides thick, rich descriptions of a case, complete with multiple contexts.[2] Up to this point, the concept of case study has been quite singular in nature, but there is the ability to study multiple cases and do cross-case analysis.[1, 5] However, for the purposes of this inquiry, the adolescent participants attended one high school can be defined as one case, making it a single case study.[1, 4]

Further, there are some noted strengths and limitations to use of case studies. One of the greatest strengths of case study methodology is the ability of the researcher to use any methods to address the problem.[1] Because the methodology is also based on real-life situations, it offers a rich, thick description of the case or cases studied.[2] However, there are some arguments that case study research is not able to be generalizable or relevant to greater populations and policy makers. As always, another issue that is often brought up when employing case study research is the subjectivity of the researcher as well as the rigor of the methods.[1, 6] In order to better address the limitations often cited, the principal investigator has taken great efforts to analyze biases, subjectivity, and positionality during data analysis. In addition, previous literature and theory were analyzed a priori and findings from the inquiry were compared to these following the study to serve as an additional form of rigor as well as looking for broader themes and concepts.[1]

Qualitative Study Design

This study employed an descriptive, intrinsic case study approach, utilizing a pragmatic, design-based methodology.[1, 2, 4, 7, 8] The pragmatist approach that informed the ontological and epistemological questions related the study allows flexibility based on the context of the particular research question.[7, 8] In this case, the unique nature of this particular high school in the southeastern U.S. and the experiences related to food environment and food choice dictated that the case study approach be used.

Description of Case Study Methods Utilized

As the bricoleur would design a quilt, bricolage has been described by Denzin and Lincoln a as a method for qualitative research.[9, 10] The bricolage has often been used to describe narrative inquiry studies, but this method can be utilized when the qualitative researcher attempts to use a mixture or many methods in one study in order to best tell the story of the research.[11] Being a bricoleur qualitative researcher also demands that new methodological tools may be used that are not commonly used within specific methodologies in addition to using emergent and deductive methods of analysis to interpret and reinterpret data.[9-11]

Weaving together methodology and methods to meet the need of the qualitative study, Merriam states that a case study researcher is able to employ any method necessary to better describe the case.[1] There are some methods that are more heavily utilized compared to others, such as field observations, interviews, and analysis of population documents.[1, 2] Focus groups, or focused interviews, are less common in the realm of case study methodology. However, Stewart et al. cites that original focus group methods were used to "learn how respondents talk about a phenomenon of interest."[12]

Thus, making the use of focus groups as method appropriate to use when discussing the uniqueness of an event or case.[13]

Focus Groups

Focus groups were originally developed by Merton, Fisk, and Kendall during World War II to assess radio and film-based programming, and the methodology has been widely used in education, marketing, and social science fields to allow individuals to interact and focus on a particular topic.[14, 15] The focus group is typically led by a moderator, whose direction of the interactions can be broad or quite specific on a topic.[13, 16] Thus, the data generated from focus groups can be described as emic or etic. Emic data is often noted as being more natural with topics arising naturally with minimal input from the moderator. Etic data is more directed in nature from the moderator. However, focus group data generation should be thought of more on spectrum of emic and etic, with the research questions influencing which side it is more closely aligned.[13]

There are some strengths and limitations that exist from using focus group methods. A great strength of focus group methods is the use of group dynamics to generate more emic data.[13] However, the group dynamics can ultimately affect qualitative results, positively or negatively. Focus groups can often go awry when moderators are unable to engage all participants in the discussion, particularly those who are less inclined to speak in groups.[13, 17] This might be particularly apparent in the adolescent population as the unique nature of an increased need for peer acceptance and social support is apparent.[18] There is another possibility of homogeneity in the qualitative data as participants may be more likely just to agree with other more extroverted participants in the group.[17] Lastly, some of the most important questions

and/or information collected from the study participants may be sensitive in nature, and participants, particularly adolescents, seeking approval from their peers, may be unlikely to share information about foods in their home or potential food security issues.[19]

Researchers

The research team was made up of one graduate student, four undergraduate students, and seven PhD researchers with a wide range of expertise, including nutrition education, obesity prevention, food environments, adolescent development, qualitative research, public health, and statistics. The principal investigator (PI) is a graduate student with training in community nutrition, nutrition education, obesity prevention, and food environment research. The qualitative inquiry will not only provide further information related for the PI's a dissertation project but also inform the PI's future research.

Prior to developing the moderation guide and collecting data, the PI evaluated some of the tacit theories and biases held as a nutrition science researcher to attempt to prevent contamination in the project. Assumptions of the role of food environments in food choice and perspectives as well as the importance of health were discussed with the rest of the research team to reduce social desirability bias in the population. Additionally, there is also a social positionality and power relationship that may exist with the use of undergraduate college students as note takers and the PI serving as moderator. Concerns over the potential that participants may feel pressure to answer questions less honestly or try to seem appealing to the older students and their peers were discussed with the research team as well as addressed during assistant moderation training.

Another potential issue is that the PI and trained undergraduate students had worked with the target population extensively in the six months prior to the focus groups, and many of the potential participants might have been aware of the research that had already occurred in the high school. Extensive discussions and assessments of contamination were conducted with the liaison at the high school as well as the research team. To eliminate as much contamination and socially desirable responses as possible, the focus groups were conducted four months post-intervention. In addition, the PI and entire research team had minimal contact with the target population following the intervention.

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VITA

Kristin Riggsbee was born in Bradenton, Florida to Theresa Greene. She is the granddaughter of Ann and Norman Moll, who shaped her life significantly. She attended elementary school in Bradenton but moved to Tennessee when she was seven. She went on to attend the remainder of her elementary years, as well as middle and high school in Portland, Tennessee. She graduated from Portland High School in 2004. In the summer of 2008, Kristin began her nursing education, training to become a licensed practical nurse (LPN). She graduated in April 2009 and become an LPN in the state of Tennessee two months later. She began practicing in long-term care in Spencer, TN. Kristin married her husband, Jonathon, in August 2009 and had her first son, Jack, in 2010. In 2011, she started attended Tennessee Technological University and graduated in 2014 with a Bachelor of Science in Human Ecology and Food, Nutrition, and Dietetics. After college, Kristin moved to Knoxville, Tennessee to begin her graduate studies at the University of Tennessee, Knoxville. During her time completing her graduate degree, Kristin had another son, Desmond, in April 2017. She completed her Doctor of Philosophy in Nutrition Science with a focus on Community Nutrition in 2019.