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Digital Object Identifier: <https://doi.org/10.13023/ETD.2017.479>

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THE SCHOOL FOOD ENVIRONMENT AND ITS ASSOCIATION WITH DIETARY
INTAKE AMONG RURAL ADOLESCENTS

THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of
Science in Nutrition and Food Systems in the College of Agriculture, Food and
Environment at the University of Kentucky

By

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Lexington, Kentucky

Director: Dr. Alison Gustafson, Assistant Professor of Dietetics and Human Nutrition

Lexington, Kentucky

2017

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ABSTRACT OF THESIS

THE SCHOOL FOOD ENVIRONMENT AND ITS ASSOCIATION WITH DIETARY INTAKE AMONG RURAL ADOLESCENTS

The school food environment has the ability to increase the consumption of fruit and vegetables in rural adolescents. This study used a survey to allow adolescents in seven rural counties to self-report their fruit and vegetable intake as well as utilizing the USDA Mathematica tool and the School Nutrition and Meal Cost Study audits to evaluate what food and beverage products were actually available to adolescents. By using these two measures, associations between fruit and vegetable intake and availability of healthy and unhealthy foods were determined. The availability of healthy snacks and beverages was found to be associated with sugar-sweetened beverage intake in adolescents ($p < 0.001$); the availability of unhealthy snacks and beverages was associated with fruit and vegetable intake in adolescents ($p < 0.001$); the school marketing of water bottle stations and/or water dispenser availability was associated with sugar-sweetened beverage intake in adolescents ($p < 0.001$). Increasing the availability and school marketing of healthy foods and beverages in rural schools may be an effective way to improve fruit and vegetable consumption in adolescents.

KEYWORDS: Obesity, adolescents, rural, dietary outcomes, school food environment

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December 1, 2017

The School Food Environment and Its Association with Dietary Intake Among Rural
Adolescents

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ACKNOWLEDGMENTS

I would like to thank everyone who helped make this thesis possible. I want to thank my committee chair, Dr. Alison Gustafson, for her guidance, encouragement and constant support throughout this entire process. I would also like to thank my committee members, Dr. Tammy Stephenson and Dr. Dawn Brewer for taking an interest in my research and giving me additional feedback throughout my writing. The DHN Department has been nothing but encouraging and helpful throughout my graduate career. I would also like to thank the UK Cooperative Extension Agents for assisting and allowing us to go into the schools to distribute surveys and conduct audits. Additionally, the principals, teachers and staff were outstanding and we could not have done this without all of their assistance. Lastly, I would like to thank my parents for always being there for me and pushing me to reach my goals. This entire experience would not have been possible without their constant love, support and encouragement.

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Chapter 1: Introduction

Obesity among children and adolescents has been a growing problem in the U.S. in the past 40 years. This has been true for disadvantaged populations, especially those who live in rural areas without access to an overall healthy dietary pattern (Adams et al., 2016). Correlated with a poor dietary pattern are the parallel high obesity rates among this population. It is estimated that in the U.S. one in five school-aged children (2-19 years old) are obese as well as more than 17% of youth (6-11 years old) (Ogden et al., 2014). Of particular concern is the dietary patterns and obesity rates among rural populations.

Rural communities and those that are geographically isolated are at disadvantages for many reasons. Studies found that rural community residents (39.6%) have higher rates of obesity when compared to urban community residents (33.4%) (Befort et al., 2012). Rural populations also face challenges with adopting health-related behaviors that can prevent chronic diseases. Only 10% of health care professionals practice medicine in rural communities, which also contributes to the higher rate of obesity in these communities (Matthews et al., 2017). Although there are many causes and consequences to living in remote areas, one possible environment may influence dietary intake, namely the school food environment.

Recent studies have shown how influential the school environment is on dietary intake and diet quality in children and adolescents. Studies show that what is offered to children at home and what is offered to them at school influences the kind of food choices that child will make. If there is availability of low nutrient or high fat snacks at schools, children are often choosing these options over fruits and vegetables (Kubik et al.,

2003). It was also discovered that schools that offered French fries or sides of this kind once or more per week had a higher risk for obesity in children as well as a higher BMI (Fox et al., 2009). There is clear evidence to show how influential the school food environment is on dietary outcomes in children and adolescents. However, what remains unknown is how the various factors of the school food environment (vending, a la carte, and cafeteria meals) is associated with dietary intake among rural adolescents. The goal of this study is to understand how the availability of these unhealthy and healthy options in school vending machines and in the cafeteria a la carte items is associated with adolescents' dietary outcomes.

Problem Statement

Research suggests that rural school food environments are less healthy when compared to urban school environments. This also reaches into the school food environment when looking at what vending machines and cafeterias offer to adolescents in these rural county schools. Efforts at rural high schools may be needed to promote better food choices. However, further research is needed to examine the school food environment in relation to obesity status and dietary intake in rural communities.

Purpose Statement

The purpose of this study is to understand how the availability of food and beverages in vending machines, a la carte items, and cafeteria offerings of healthy items, across seven different rural high schools in Kentucky and North Carolina is associated with dietary outcomes among 14-15-year-old adolescents. The objectives of this study are to (1) determine the association between the availability of healthy and unhealthy food and

beverages summed across all three types of food offerings and the intake of fruits and vegetables, (2) to determine if there is an association between school marketing such as placement and appearance, and the dietary outcomes of rural adolescents.

Research Questions

1. Is there an association between the availability of unhealthy and healthy food and beverages in vending machines, la carte items, and cafeteria offerings and the dietary outcomes of rural adolescents in Kentucky and North Carolina?
2. Is there an association between school marketing and the dietary outcomes of rural adolescents?

Research Hypotheses

1. The school food environment with respect to vending machines, a la carte items, and cafeteria offerings will encourage a decrease in fruit and vegetable consumption in adolescents.
2. The presence of vending machines in schools will encourage an increase in added sugars among adolescents.

Justification

Although obesity rates among adolescents have remained steady over the past 10 years, there is still a cause for concern. Research suggests that living in rural communities also increases the risk for obesity and other chronic diseases. Some studies have compared what rural schools offer in vending machines and what urban schools have offered. As speculated, urban schools are less likely offer sugar-sweetened beverages and rural schools offered more of those options (Adachi-Mejia et al., 2013). With children getting

one to two of their meals a day from school, it can be a critical location to improve dietary outcomes among adolescents. Policy implication from findings can help to improve what is offered in the schools as a way to improve health outcomes among this vulnerable sub population.

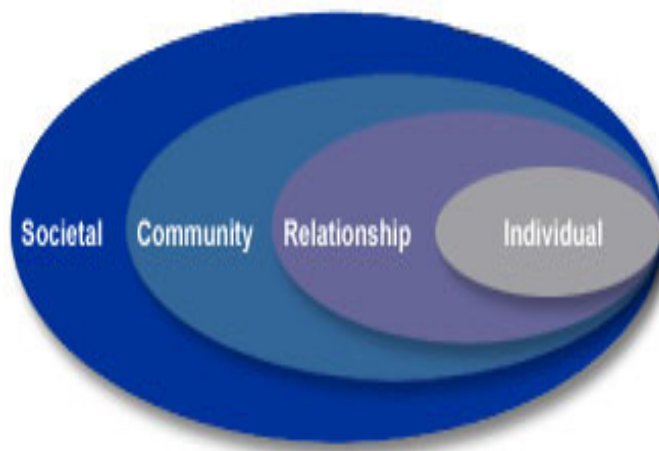
Chapter 2: Literature Review

Introduction

The purpose of this study was to understand how the availability of food and beverages in vending machines across seven different rural high schools in Kentucky and North Carolina is associated with dietary outcomes and body mass index among 14-15-year-old adolescents. The school food environment has a very significant role in influencing what adolescents and children consume on a daily basis. The school environment can help to improve dietary intake; however it may also play a role in promoting less healthy choices. Research suggests rural school food environments are less healthy relative to their urban counterparts, which suggests that efforts at rural high schools may need to be tailored to promote better food choices. The overall goal of this study was to examine the school food environment in relation to obesity status and dietary intake in rural communities. To achieve this goal the following aims are: (1) determine the association between the availability of healthy and unhealthy food and beverages within vending machines, a la carte items, and cafeteria offerings in schools and the intake of fruits and vegetables and (2) to determine the association between school marketing and dietary outcomes among rural adolescents.

Socioecological Model

The Social Ecological Model aids in the understanding of factors that influence health and wellness at different levels surrounding individuals, groups and populations (CDC, 2013). On an individual level, a person's knowledge, beliefs, attitudes and behaviors are thought to affect their dietary choices and outcomes. On this level an adolescents' knowledge, beliefs or attitudes affect how they make food choices and what their dietary outcomes are. When looking at the next level, the interpersonal level; family, peers, and social networking can affect an individual's views and how they make decisions towards a healthful diet. This level is considered one of the biggest influencers in an adolescent's life. The way their family and friends prepares food and how they make dietary choices greatly influences how they will make those same decisions while at school or in other environments. The



institutional/organizational level **Figure 2.1: The Socioecological Model (CDC, 2013)**

includes schools, health care administration, businesses, faith based organizations and institutions. This broader level focuses on how these organizations can influence individuals by policies, rules and regulations, which could reinforce positive behavior or change. As stated before, schools have a very prominent influence on what adolescents will consume during the school week. In some

situations, children will consume 2-3 meals at their school, thus it is very important for schools to be promoting healthy meals and snacks as well as making them available to their students (Cohen et al., 2000). The community level can be looked at as a larger organization (Brown, 2011). The community is able to make changes to policies and provides communication between organizations and institutions. On this level, interventions can be implemented to make a change to the school food environment if there is a problem identified. Lastly, the structures and systems is the broadest level of the socioecological model. This level includes the federal, state, local regulations, laws and the built environment and how they affect the built environment (CDC, 2013). The Socioecological Model provides a framework for researchers to use when looking at the different influences of the eating behavior of individuals. When looking at issues pertaining to this study, the school environment has an opportunity to provide healthy food at affordable prices where adolescents spend a majority of their day. This level of influence can have a large impact on dietary choices (Kubik et al., 2003). The socioecological model is needed to provide a successful intervention for these situations (CDC, 2013).

Dietary intake of adolescents

Over the past decade, the diet quality in adolescents has drastically declined. This may be due to the increase in fast food, soft drinks and decreased fruit and vegetable consumption (Ogden et al., 2010). Fruit and vegetable intake is very important in the diet of adolescents and is a key indicator for the risk of obesity or high BMI. There are high nutritional needs during adolescence and thus eating patterns that are started at a young age may help to influence a better diet as an adult. Research was done to measure fruit

and vegetable consumption in adolescents. The main contributor for fruit intake in adults was whole fruit and for adolescents, fruit juice. Potatoes were the main vegetable observed from the data, especially among adolescents and these often included fried potatoes. Few people met the recommendations for dark green and orange vegetables. These results agree with other recent studies done. There has not been an increase in fruit or vegetable consumption in the statistics observed, which confirms that there is an issue with diet quality in adolescents (Kimmons et al., 2009).

Research was done to pinpoint the determinants of fruits and vegetable consumption. The determinants that were found to be best supported were age, gender, socioeconomic status, preferences, parental intake and home availability. All of these factors influence whether or not children and adolescents get their recommended intake of fruits and vegetables and show how important it is for their environment to support and encourage healthier options. This study states that there is a further need for comparative, longitudinal and theory-based studies that look at personal and environmental factors that influence dietary outcomes in children and adolescents (Rasmussen et al., 2006). From multiple studies, it has been found that if schools offer a snack bar or vending machines, adolescent's fruit and vegetable intake decreases. This validates that the school environment plays a very influential role in what adolescents choose to eat and whether they get their recommended intake of fruits and vegetables. It also confirms that with the increase of sugar-sweetened beverages and fast food consumption children and adolescents are more at risk for obesity and other comorbidities.

Obesity Trends in Adolescents

Obesity has been a growing problem in the United States, especially among children and adolescents. Obesity rates have increased in the past 40 years, especially in disadvantaged populations (Adams et al., 2016). It is estimated that one in five school aged children has obesity. More than one-third of adults and 17% of youth in the United States are considered to be obese. When looking at children aged 6-19 in 1999-2002, 31% were at risk for being overweight or obese and 16% were actually overweight. Trends of obesity for the past 20 years have increased, while in the past 10 years there has been no incidence of change. However, there is a gap in understanding how rural communities and adolescents with extreme obesity may be different (Ogden et al., 2014). The data to date have shown a flat trend yet extreme obesity has risen. Moreover, among certain subpopulations the rates have continued to rise (Befort et al., 2012). In addition to this study there needs to be more research on identifying the behavioral, biological and environmental factors that may be influencing this high BMI in children and adolescents (Ogden et al., 2014). With the high rates of extreme obesity there remains subpopulations that are disadvantaged, such as minority and geographically isolated communities such as rural communities.

Obesity in Rural Communities

Some rural communities are considered a health disparity population because of the lack of access to certain necessities for a healthy lifestyle. This can include lack of facilities for physical activity, lack of grocery store access for healthy foods, and even lack of

healthcare providers in their area. Several studies have been done to see if rural communities are more likely to be overweight and obese. Many results show that the obesity rates were much higher in the rural adults (39.6%) than in urban adults (33.4%) in the United States (Befort et al., 2012). Although obesity is a complex disease with many contributing factors, “place” matters and how the built environment relates to obesity trends (Lovasi et al., 2009). There is importance in the location of food stores, exercise facilities, and public safety for rural citizens. Where people live may influence their daily habits, which in turn is associated with obesity status. When looking at rural and urban adults, 3 out of every 5 adults were considered to be physically inactive during leisure time. It was also found that a slightly larger proportion of rural adults were physically inactive than in urban adults. Because of this high prevalence of obesity and physical inactivity among rural populations, there needs to be further research for interventions that can address this issue (Patterson, P.D. et al., 2004).

All of these studies have the same conclusion; rural populations are at a higher risk for obesity than other communities. Some of the factors that contribute to this may be that there are fewer places of play for children and the high cost of healthy foods or high cost of gas to obtain healthy foods. Families in these rural areas may be food insecure, which means that they have limited access to healthy and affordable foods. In 2006, one in ten households were considered to be food insecure. Kentucky, Tennessee, Arkansas, Louisiana, Mississippi, and Arizona are states that have more food insecure areas than the average for the United States (National Advisory Committee on Rural Health, 2011). With Kentucky being one of these states that has a higher percentage of food insecurity, this may be an indicator as to why there is such a high prevalence of obesity in these rural

communities. With this ever-growing issue of adolescent and childhood obesity in rural communities, it has become clearer the importance and the role of the school food environment in an adolescent's life. This environment has drastic effects on the dietary choices and outcomes of adolescents.

School Food Environment

Several different studies and interventions have been done to identify the determinants of fruit and vegetable intakes and effective strategies to increase the consumption of them. Availability and accessibility to fruits and vegetables was one of the most influential determinants found in the literature. Television viewing, TV advertisement and schools have a snack bar are associated with the lower intakes of fruits and vegetables. When looking at interventions, the study found that school-based programs that used classroom curriculum, parent and food service components showed more promising results among children. Interventions should further improve the availability and accessibility of fruits and vegetables to children and adolescents and should introduce them to these things at an earlier age to improve their taste and preferences for them (Blanchette et al., 2005).

From looking at the determinants of fruit and vegetable intake, we can see that what children and adolescents are offered at school has an impact on whether or not they are getting their recommended intakes of fruits and vegetables. Another concern is the a la carte items and vending machine items that are available to adolescents on a daily basis. A study was done to observe this association between adolescents' dietary behaviors and school vending machines, a la carte programs and fried potatoes being served at school lunch. There were three categories chosen for a la carte items and vending machine results and they were promote, limit, or "items to neither promote or

limit.” The results suggested that a la carte availability was inversely associated with fruit and vegetable intake and vending machines were negatively correlated with fruit consumption. About 80% of the items in the vending machine were “limit” items. This means that the majority of the snacks offered would limit a child’s fruit and vegetable intake. The results from this study support an association between these factors in the school food environment and the dietary intake of adolescents. The high fat snacks offered and sugar-sweetened beverages in the vending machines are thought to replace the fruits and vegetables in adolescents’ diets. If there are low-nutrient options, children are choosing these over fruits and vegetables (Kubik et al., 2003). The school food environment has also been seen to affect children’s BMI because of these “less healthful” food choices being served at lunches and in the vending machines.

When looking at the association between the school food environment practices and children’s body mass index, it was found that schools that offered French fries or sides like this with school meals more than once per week and offering dessert more than once per week had an association with a higher risk for obesity in children. In middle schools, vending machines that had low-nutrient or energy-dense foods available near food service areas had an association with a higher BMI score among adolescents. Also the availability for low nutrient and energy dense foods for a la carte purchase was associated with a lower BMI score. These results suggest that when children have access to lower nutrient and energy dense food at school, they are more likely to be at risk for obesity or a higher BMI score. Limiting these options may help to reduce their total calorie intake and control their BMI (Fox et al., 2009). Along with the issue of low nutrient and energy dense foods being more readily available in schools, it is often the

case that low nutrient foods are more available in vending machines than other snack items. A cross-sectional study examined the prevalence of students that actually buy from these vending machines at public middle schools. Almost all of the respondents (99%) reported to having a snack from a vending machine in school and 89% reported to having a beverage from a vending machine in school. The findings show, once again that if there are unhealthy beverages and snack options available for children most of them are purchasing these things at least once a week. The impact of these statistics is of concern for future adolescent obesity risks. There needs to be further research to show how removing these options affect the dietary outcomes and behaviors of children and adolescents. Although there have been many attempts, more school interventions need to be implemented to make changes to the school food environment and to introduce healthy options to children on a regular basis (Park et al., 2010).

School Nutrition Interventions

There have been many interventions done to increase the intake of healthier foods and to decrease the intake of sugar-sweetened beverages and less-healthy snacks in schools. Research suggests that multicomponent interventions in schools have been successful in increasing fruit consumption among students with increases from 0.2-0.6 servings per day. Environmental interventions have also been successful in encouraging students to choose fruits and vegetables or other targeted foods over the unhealthy option (French et al., 2003). The intervention called TACOS (trying alternative cafeteria options in schools) was trying to increase the sales of lower-fat foods in school cafeterias. The main goal of this intervention was to increase the availability of lower fat foods (5 g or less fat per serving) in cafeteria a la carte areas and to implement promotions of these lower-fat

options school wide. Peer promotions were used as a component of the intervention to encourage students to purchase or choose these lower-fat options at lunch. The intervention had a significant positive effect on the purchase of lower-fat food options. It was observed that because these options were more available to schools that had the intervention, the students were most likely to choose them. Student promotion also encouraged students to choose the lower-fat items at school. These results were also achieved without an educational program or family component as a part of the intervention (French et al., 2004).

There have been other interventions done by changing the pricing and promoting the purchases of low-fat snacks in vending machines instead. One intervention added low-fat snacks to vending machines in secondary schools as well as work sites. There were four pricing levels: equal price, 10% reduction, 25% reduction, and 50% reduction. There were also 3 promotional levels added to these vending machines: none, low-fat label, and low-fat label plus promotional signage. Overall, the reduction of prices resulted in an increase of purchase of these low-fat items in vending machines. This could be a helpful tool for further interventions that are aimed at increasing the purchases of healthier options in schools and in different work place environments (French et al., 2001). More interventions have been done that have reduced the price of healthy options or increased the availability as well. Both of these factors have increased the sales of healthier choices in interventions. Although increasing the availability and reducing the cost of these items are effective, more research needs to be done on how this could affect the overall diet quality and BMI in adolescents (Grech et al., 2015).

When looking at the literature, there are many studies that have been done to evaluate interventions in the school environment, but there are not as many studies that have addressed the availability of these healthier options in vending machines when comparing rural and urban settings. The measurement of the unhealthy and healthy options in these vending machines is vital to determine whether there is availability of a healthier option to children at all. As stated previously, rural communities are more prone to having less access to healthier snacks and beverages when compared to urban communities. This is also thought to affect what is served or offered to children and adolescents in rural county schools. There needs to be further research investigating these differences and what the availability is of these items in rural high schools. Although there is little research to link these indicators, a recent study was done to determine the variation in high school access to sugar-sweetened beverages through vending machines by geographic location (urban, town or rural). The results suggested, when comparing urban schools and town schools, the urban schools were less likely to offer sugar-sweetened beverages. Rural schools also offered more sugar-sweetened beverages than urban schools, but the difference was not considered statistically significant in this case. Town schools also showed more advertising for sugar-sweetened beverages than both urban and rural schools, this could also be associated with the higher consumption of SSB in those schools. Ultimately, rural communities and their adolescents are at a higher risk for obesity because of many contributing factors but more specifically, the school food environment which can either contribute to this problem or help alleviate the issue (Adachi-Mejia et al., 2013).

Conclusion

Although obesity rates among adolescents and children have remained steady over the past decade, there is still a cause for concern. Research suggests that those living in rural communities are at a higher risk for obesity and greater BMI. The availability of healthy food has also been a concern for these rural communities because of their lack of access to fruits and vegetables. In these rural communities, most students are getting one to two of their meals from their schools. This shows the importance of the school food environment and how it can influence the dietary outcomes of children and adolescents. The availability of healthier options in schools plays a vital role on whether or not adolescents are getting their recommended intakes of fruits and vegetables. Schools need to make these healthier options available in their vending machines and a la carte areas to their students and encourage them to choose and purchase these healthy options. Therefore, the purpose of this study is to determine the association of healthy and unhealthy options within vending machines in rural schools between fruit and vegetable intake and BMI status in adolescents.

Chapter 3: Methodology

Study Design

This study used a cross-sectional survey design among (n=425) adolescents across 3 rural high schools in Kentucky and 4 rural high schools in North Carolina.

Study Sites

Three high schools in Kentucky were from Knox, Clinton, and Greenup County. Four High Schools in North Carolina were from Pittsboro, Pike, Tarboro, and Greenville. In the Kentucky counties, the poverty rate ranges from 24-30%. The percentage of students eligible for free and reduced priced lunch in the schools ranged from 50-66%, which is higher than Kentucky's state average (Kentucky Department of Education, 2017). Of the 432 participants 62% were white, 26% black and 12% other. The average age was 15 and 59% was male, 41% female.

Participant Recruitment

Approximately 425 adolescents' ages 14-16 years living in 3 Kentucky counties and 4 North Carolina counties were recruited to participate in the survey. In rural Appalachia Kentucky, high schools were contacted through Cooperative Extension and 3 agreed to participate in the study four schools in rural North Carolina agreed to participate.

Once connections were established with the school principals or superintendents in each county recruitment for study participants was done based on the preference of the school. Some recruitment was done by announcements at school open house nights and parents were instructed to review the consent form while adolescents reviewed the assent form. Recruitment was done in other schools by sending parental permission/consent forms home by homeroom teachers and returned back to that teacher. IRB approval for this study was obtained. Eligibility criterion was established prior to the study.

Adolescents were required to speak English as their primary language. They were also required to not report any serious illness that would alter dietary patterns, such as diabetes or Crohn's disease. Additionally, it was a requirement to have at least one parent or legal guardian agree to let them participate. It was also established that if there were more than one adolescent in the household, the primary caregiver would decide which adolescent would be the participant in the study.

Survey Distribution

Adolescents completed the baseline survey at the beginning of their homeroom class period. This survey was derived from the NHANES 2009-2010, which allowed them to self-report home availability and dietary intake. Trained graduate students used previously tested instruments to measure the school food environment, which included vending machine availability and cafeteria foods and beverages in the participating high schools. A validated USDA Mathematica tool was used to (1) measure the availability of water, (2) marketing of healthy foods at schools, (3) the placement of fruits and vegetables within the cafeteria, (4) the length of time students have to consume lunch, (5) the availability of competitive foods, (6) vending machine availability of beverages, and (7) student stores selling snacks and candy (SNMCS, 2017).

National Health and Nutrition Examination Survey (NHANES) 2009-2010

This questionnaire was used to assess the dietary intake of adolescents. The dietary screener is composed of 26 questions that inquire about the frequency of consumption of foods and beverages in the past month. It captures intakes of fruits and vegetables (cup equivalents), dairy (cup equivalents) and calcium (mg), whole grains

(ounce equivalents) and fiber (grams), added sugars (tsp.), red meat and processed meat (used as qualitative indicators of intake frequency) (Thompson et al., 2009). All of these food items are measured by how often they were consumed in the last month. The measurements include: never, 1 time last month, 2-3 times last month, 1 time per week, 2 times per week, 3-4 times per week, 5-6 times per week, 1 time per day, and 2 or more times per day. The Dietary Screener Questionnaire (DSQ) was included in the NHANES 2009-2010 so that scoring algorithms could be developed for each component of DSQ. These scoring algorithms convert responses to estimate dietary intake for all of the food categories listed previously (National Cancer Institute, 2014).

School Food Environment Measures

School lunches and vending machines were measured by the use of the simplified audits established by collaboration of different experts in the field (SNMCS, 2017). The vending machine audits were separated by beverage and snack machines and included the area that these machines were located, the number of slots visible or available, the number of slots filled, and the number of slots that are empty. The beverage audit captured diet sodas, regular sodas, 100% fruit juice, juice drinks and other sweetened drinks, energy/sports drinks, bottled water, hot or cold chocolate drinks, whole or reduced fat milk (2%), low fat milk (1%), and fat free/skim white milk. The snack machines are described the same as the beverage machines such as area and slots visible or available. The options were broken up into the categories of snacks, baked goods, and other foods. Snacks included the following: low-fat/baked chips, regular chips, pretzels, popcorn, cracker sandwiches, other types of crackers, low-fat granola bars or cereal bars, regular

granola bars, crispy rice bars or treats, candy, gum, nut or seeds, fruit snacks, meat snacks, and other. Baked goods included: low-fat cakes/cupcakes/brownies, regular cakes, low-fat pies/turnovers/toasted pastries, doughnuts, low-fat cookies, regular cookies, breads, and other. Other foods included: yogurt, cheese, frozen fruit bars, milkshakes or smoothies, low-fat ice cream or frozen yogurt, regular ice cream, dried fruit, canned fruit, fresh fruit, vegetables, and other. The number of front slots or buttons for each food item is recorded on the audit column for the particular vending machine being recorded (SMNCS, 2017). Items were counted and given a score for the number of healthy and unhealthy items that it contained. Two trained graduate students conducted each audit for inter-rater reliability.

Procedures

Once the consent and assent forms were brought back to homeroom teachers, the distribution of surveys could be done. Trained graduated students went to each school and administered surveys to freshmen and sophomores in homeroom classrooms. The surveys took each participant 30-40 minutes to complete. Responses were recorded using Research Electronic Data Capture (REDCap).

Trained graduate students also conducted the school food audit and vending machine audits. These audits were conducted during the school day between normal school hours (8:30-3:30). Both graduate students completed an audit for inter-rater reliability. The audits took approximately 45 minutes-1 hour for the cafeteria audits and 20-30 minutes for the vending machine audits. Graduate students stayed for the entire lunch period to evaluate the process of the school lunch line.

Data Analysis

Demographic information such as age, race and gender was included in the baseline survey and obtained from all participants. Variables such as dietary intake, BMI, age, and availability of healthy and unhealthy foods in vending machines were treated as categorical variables. Other demographic characteristics and food shopping behaviors were treated as categorical variables. To analyze the data, the relationship of dietary intake and the availability of healthy and unhealthy items in vending machines and a la carte stations will be evaluated. Vending machine and a la carte items were categorized as “very healthy” and “very unhealthy” when looking at the data. Healthy beverages consisted of milk, 100% fruit juice, diet soda, water, and low-calorie sports drink. Unhealthy beverages consisted of regular soda, fruit drink, sweet-tea, lemonade, sports drinks. Healthy snacks consisted of baked chips, pretzels, fruit, low-fat granola bars or cereal bars, dried fruit, popcorn and nuts and seeds. Unhealthy snacks consisted of regular chips, regular granola bars, candy, fruit snacks, meat snacks, and baked goods. The relationship between vending machine and a la carte item consumption was analyzed using multiple regression models with the demographic and BMI variables as confounding variables. By using STATA, school marketing and healthy and unhealthy items were assessed by using a multiple regression. A significance level of 0.05 ($\alpha=0.05$) was used.

Chapter 4: Results

A total of 432 adolescents were recruited to participate in this study. Descriptive statistics were obtained from the sample (Table 4.1). Of the adolescent subjects, 41% were female and 59% were male. The average age of all participants was 15 years old. When looking

at Body Mass Index, the average BMI was 24, which is considered to be normal weight. Frequencies for BMI were 55% normal weight, 24% overweight, and 21% obese.

Table 4.1: Study Sample Characteristics

Demographics <i>n=432</i>	
Race	
White	62%
Black	26%
Other	12%
Average Age in Years	15
Gender	
Female	41%
Male	59%
BMI	
Normal	55%
Overweight	24%
Obese	21%
Average BMI	24

Results for the cafeteria and a la carte availability were obtained from the School Food Environment audit derived from the School Nutrition and Meal Cost Study (SNMCS, 2017). The results from this audit are shown in Table 4.2. From the school audits, the majority of cafeterias observed had fruits and vegetables as well as grains, meat options and milk options available for adolescents. However it was observed that most cafeterias did not have fruits displays in multiple places (20%), vegetable serving lines such as a salad bar (0%), or an entrée that includes a vegetable served first in the serving line (0%). It was also observed that most cafeterias did not offer white fat-free milk (0%), but white low-fat milk was offered (90%) and white skim milk was offered as well (70%). All of the cafeterias did not offer a bottled water station free of charge, but

20% had bottled water stations at additional charges. On average half of cafeterias offered a filtered water dispenser and only 10% offered a pitcher of water for students.

Table 4.2: Descriptive Statistics of Food Availability in High School Cafeterias

Fruit Option Available	
Checked	90%
Not Checked	10%
Vegetable Option Available	
Checked	100%
Grains Option Available	
Checked	90%
Not Checked	10%
Meat Option Available	
Checked	100%
Milk Available	
Checked	100%
Fruit display visible at the register	
Checked	30%
Not Checked	70%
Fruit display in one location of cafeteria	
Checked	60%
Not Checked	40%
Fruit display in multiple locations in cafeteria	
Checked	20%
Not Checked	80%
Fruit multiple not near	
Not Checked	100%
No fruit display available	
Checked	10%
Not Checked	90%
Vegetables are available in the serving line	
Checked	50%
Not Checked	50%
Vegetable food station available (ex. Salad bar)	
Not Checked	100%
Vegetables displayed first/most prominently in serving line	
Checked	50%
Not Checked	50%
Entrée that includes vegetable served first	
Not Checked	100%

White skim milk offered	
Checked	70%
Not Checked	30%
White low-fat milk offered	
Checked	90%
Not Checked	10%
White 2% milk offered	
Not Checked	100%
Flavored milk offered	
Checked	60%
Not Checked	40%
Low-fat flavored milk (1%) available	
Checked	40%
Not Checked	60%
Fat-free/skim flavored milk available	
Checked	10%
Not Checked	90%
Drinking Fountain in cafeteria available	
Café	90%
Within 20ft	10%
Bottled water offered at no charge	
Not Checked	100%
Bottled station available	
Checked	20%
Not Checked	80%
Filtered water dispenser available	
Checked	50%
Not Checked	50%
Pitcher of water available	
Checked	10%
Not Checked	90%
Other sources of water available	
Checked	20%
Not Checked	80%

*“Checked” means that these items were observed while doing the audits and were available to students.
 “Not Checked” means that these items were not available to students.

Table 4.3 shows the range of scores for total healthy and unhealthy beverages and snacks in vending machines across the seven high schools examined. A validated USDA Mathematica audit tool was used to determine the number of healthy and unhealthy items in each vending machine at schools.

Table 4.3: Vending Machine Range of Scores of Total Healthy and Unhealthy Beverage and Snacks Available in Schools

Total healthy beverages	(10-56)
Total unhealthy beverages	(13-216)
Total healthy snacks	(2-8)
Total unhealthy snacks	(0-5)

*Each vending machine was audited and a score was tabulated for total healthy and unhealthy items. The range of scores was calculated from these audits.

Table 4.4 shows the descriptive statistics of the school marketing in the cafeteria. School marketing is described as attractive displays, signage or placement of food items used to encourage fruit and vegetable consumption in adolescents. A majority of the schools had a fruit display at the register and/or a vegetable serving line (73.96%). The same conclusion was drawn for water bottled stations and/or a water dispenser (81.34%).

Table 4.4: Descriptive Statistics of School Marketing in the Cafeteria

School marketing: fruit display at register and vegetable serve line	
Present	73.96%
Not Present	26.04%
School marketing: water (water bottled station and water dispenser)	
Present	81.34%
Not Present	18.66%

Table 4.5 shows the relationship between school food availability and dietary outcomes in adolescents. Only two associations were found between food availability in vending machines and a la carte items and dietary outcomes. There was a significant relationship found between the total healthy snacks and beverages available and sugar-sweetened beverage intake in adolescents (95% CI: -.001, -6.92e-06). There was also a

significant relationship between the total unhealthy snacks and beverages and fruit and vegetable intake in adolescents (95% CI: -.001, -.0001). These results suggest that when healthier snacks and beverage options are available, SSB intake is decreased in those observed. It is also determined that as the unhealthy snacks and beverages increase, the fruit and vegetable intake of adolescents decreases. The total healthy snacks and beverages available were not found to have a significant relationship with total sugar intake (95% CI: -.019, .02), total fruit intake (95% CI: -.001, .001) or fruit and vegetable intake (95% CI: -.002, .001). Total unhealthy snacks and beverages available were not found to have a significant relationship with total sugar intake (95% CI: -.01, .004), sugar-sweetened beverages (95% CI: -.0001, .0001), or fruit and vegetable intake (95% CI: -.001, -.0001).

Table 4.5: Associations Between School Food Availability and Dietary Outcomes Among Adolescents

	Total Sugar Intake		Sugar-Sweetened Beverage Intake		Total Fruit Intake		Fruit and Vegetable Intake	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Total Healthy Snacks and Beverages	0	(-.019, .02)	-0.001	(-.001, -6.92e-06) *	0	(-.001, .001)	-0.001	(-.002, .001)
Total Unhealthy Snacks and Beverages	-0.0004	(-.01, .004)	0	(-.0001, .0001)	0	(-.001, -.0002) *	-0.001	(-.001, -.0001) *

*Indicates p-value <0.05

*The linear regression model is to examine the association between the predictor and adolescent dietary outcomes

Table 4.6 shows the relationship between the school marketing in cafeterias and the dietary outcomes of adolescents. None of the relationships were found to be significant. School marketing (a fruit display at the register in the cafeteria) did not have a significant relationship with total sugar intake (95% CI: -1.06, .83), sugar-sweetened

beverage intake (95% CI: -.04, .01) or total fruit intake (95% CI: -0.02, .07). School marketing (bottle water station or water dispenser available in the cafeteria) also did not have a significant relationship with total sugar intake (95% CI: 0.07, -2.04), sugar-sweetened beverage intake (95% CI: 0.98, -0.030), or total fruit intake (95% CI: .93, -.05).

Table 4.6: Associations Between School Marketing and Dietary Outcomes in Adolescents

	Total Sugar Intake		Sugar-Sweetened Beverage Intake		Total Fruit Intake	
	β	95% CI	β	95% CI	β	95% CI
School Marketing (Fruit display present at the cafeteria register)	-0.11	(-1.06, 0.83)	-0.01	(-.04, .01)	0.03	(-.02, .07)
School Marketing (Water: School Cafeteria has a bottle water station or water dispenser available)	-0.99	(-2.04, 0.064)	0	(-0.029, 0.029)	0.002	(-.048, 0.052)

*Indicates p-value <0.05

*The linear regression model is to examine the association between the predictor and adolescent dietary outcomes

Chapter 5: Discussion

The purpose of this study was to understand how the availability of food and beverages in vending machines, school lunches and a la carte items in cafeterias across seven different rural high schools in Kentucky and North Carolina is associated with dietary outcomes and body mass index among 14-15-year-old adolescents. Adolescents completed a survey during their homeroom class period, which allowed them to self-report home availability and dietary intake. Validated instruments were also used to conduct school environment audits to measure unhealthy and healthy snacks and beverages available in schools. The results of this study suggest that the school food environment plays an influential role on the dietary outcomes of rural adolescents. Not

only does the food that is offered in the cafeteria (via vending, school lunch, or a la carte) affect what adolescents choose to eat, but the how these food options are presented and marketed also affects these choices. Other study results concur with the current study that unhealthy snacks and beverages in vending machines have a significant influence on the fruit and vegetable intake in adolescents (Kubik et al., 2003).

School cafeterias were assessed and scored by a School Food Environment audit derived from the School Nutrition and Meal Cost Study (SNMCS, 2017). Vending machines were assessed and scored by using the USDA Mathematica tool. The availability of fruits and vegetables and other healthy items are a significant determinant when looking at the dietary outcomes of observed adolescents. Research suggests that what children and adolescents are offered at school has a major impact on whether or not they are getting the recommended intakes of fruits and vegetables. If there are low-nutrient items available for adolescents, these foods are replacing fruits and vegetables (Kubik et al., 2003). Research suggests that competitive foods or foods sold outside of federally reimbursed school meals, are available in secondary schools. The availability of these types of foods is related to high intake of total calories, soft drinks, total fat, and lower intake of fruits and vegetables (Story et al., 2009). From the USDA Mathematica scores, there is a much larger range of unhealthy beverages than healthy beverages available in vending machines across schools. However, when looking at snacks instead, the ranges for healthy (2-8) and unhealthy (0-5) were comparable. In the results there was a significant association found between the total healthy snacks and beverages available and sugar-sweetened beverage intake. There was also a significant association found between unhealthy snacks and beverages and fruit and vegetable intake. This suggests

that as the availability of healthier snacks and beverages increase in schools, the sugar-sweetened beverage intake then decreases in adolescents. The results also suggest that when there is more availability of unhealthy snacks and beverages, the fruit and vegetable intake is decreased in adolescents. Both of these results are supported by other research that healthy snacks and beverages deter children from drinking sugar-sweetened beverages and unhealthy snacks and beverages deter children from eating fruits and vegetables (Park et al., 2010, Fox et al., 2009). Although these two relationships were found to be significant, there were no relationships found between healthy items and total sugar intake, total fruit intake, or fruit and vegetable intake. This was also the case for the relationships between unhealthy items and total sugar intake, total fruit intake, and SSB intake. Other studies have shown that when schools offer unhealthy snacks and beverages, adolescents are more likely to consume them. It has also been shown that if students have access to snack bars with these unhealthy items, they consume more sugar-sweetened beverages, high-fat vegetables and fewer fruits (Cullen et al., 2011, Neumark-Sztainer et al., 2003).

Not only is the availability of healthy and unhealthy items significant, but the relationship between school marketing and dietary outcomes was also observed in this study. When looking at the cafeteria descriptive statistics of the schools observed, a majority of the schools had a fruit and vegetable item available, but the placement of these items is very important. About 74% of schools had a fruit display at the register and a vegetable serve line present and around 81% of school cafeterias had a water bottled station or water dispenser available. After analysis of school marketing and placement, the only significant relationship found was between the placements of water bottled

stations or a water dispensers and the sugar-sweetened beverage intake in this case. Further research shows that if water is offered in school cafeterias, adolescents are likely to drink more water throughout the day on average. Although other studies that looked at these same variables did not find associations between water stations and decreased SSB intake (Loughridge et al., 2005, Patel et al., 2011). Other school environment studies looked at food placement and salad bar introduction to the school cafeterias. These studies found that the addition of salad bars and the placement of these items do help to increase healthy eating patterns among adolescents (French et al., 2003, Lassen et al., 2004, Glanz et al., 2004, Adams et al., 2005).

The results of this study have similar conclusions when compared to previous research and reiterate the importance of the school food environment when looking at dietary outcomes. Schools are a favorable environment to promote dietary changes in adolescents because of the reliance on school lunches in rural communities. Further interventions and programs need to be implemented to encourage the availability and sales of healthy snack and beverage items, which in turn have the potential to encourage healthier diet choices.

Limitations

There are some limitations to this study. First, the cross-sectional study design was used for this study, which does not allow for the assumption of causality. Additionally, the surveys administered were self-reported by adolescents and were subject to the effects of social desirability. The survey used to measure dietary intake only collected data over a one-month period, which may not show the full range of an adolescent's diet. Finally, the sample size and homogenized sample limits the generalizability of the study to all rural

residents in Kentucky and North Carolina. These limitations should be considered when analyzing and interpreting these results.

Implications

This study evaluated the influence of the school food environment on fruit and vegetable intake in adolescents in rural Kentucky and North Carolina counties. These counties have obesity rates greater than 40%. The school food environment may be a significant setting to encourage an increase in fruits and vegetables in adolescents. This study provides evidence that increasing the availability of healthy snacks and beverages as opposed to unhealthy snacks and beverages is important for increasing these dietary outcomes. This study also suggests that social marketing or placement and visual appeal of food items can help to encourage the consumption of healthier foods and beverages.

Recommendations for Future Studies

There is a need for further research in rural communities because of the health disparities and lack of access to healthy foods in these areas. In addition, the school food environment and its association with adolescent food choices should be further examined as well as the measurements of environmental influences. Future research on school interventions is also highly needed in rural and low-income populations. There are few studies that have addressed the availability of healthy and unhealthy food items in vending machines when comparing rural and urban settings. The measurement of the unhealthy and healthy options in these vending machines is needed to determine whether there is availability of healthy options to children and adolescents in schools.

Appendix A

During the last month how often did you eat these types of food?	Never	1-2 times/month	1-2 times/week	3-4 times/week	5 or more times/week
Hot or cold cereals type(s):					
Fruit, including fresh, frozen or canned NOT juices					
Green leafy/lettuce salad, with or without other veggies					
Any type of fried potatoes, French fries, home fries, or hash browns					
Any other type of potatoes, like baked, boiled, mashed, sweet, or potato salad					
Refried beans, baked beans, beans in soup, pork and beans or any other type of cooked/dried/canned beans					
Brown rice or other cooked whole grains, such as bulgur, crack wheat or millet NOT white rice					
Other vegetables (not including green salads, potatoes, cooked/dried beans)					
Mexican-type salsa with tomato					
Pizza, including frozen, fast food, and homemade pizza					
Tomato sauces such as with spaghetti or lasagna Do NOT include tomato sauce on pizza					
Cheese, including cheese as a snack, cheese on burgers, sandwiches, cheese in food like quesadillas or casseroles, Do NOT include cheese on pizza					
Red meat, such as beef, pork, ham, sausage, veal, or lamb Do NOT include chicken, turkey or seafood Include red meat you had in sandwiches, lasagna, stew and other mixtures					

During the last month how often did you eat these types of food?	Never	1-2 times/month	1-2 times/week	3-4 times/week	5 or more times/week
Whole grain bread, including whole wheat, rye, oatmeal and pumpernickel, including toast rolls and in sandwiches NOT white bread					
Chocolate or any other types of candy Do not include sugar-free candy					
Doughnuts, sweet rolls, Danish, muffins, pan dulce or Pop-Tarts Do not include sugar-free items					
Cookies, cake, pie or brownies Do not include sugar-free kinds					
Ice cream or other frozen desserts Do not include sugar-free kinds					
Popcorn					

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