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# The Effect of the Expanded Food and Nutrition Education Program on Participants' Diet Quality: Does Supermarket Access Matter?

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The Effect of the Expanded Food and Nutrition Education Program on Participants' Diet  
Quality: Does Supermarket Access Matter?

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
Master of Science in Agricultural Economics

by

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University of Georgia  
Bachelor of Science in Environmental Health, 2011

May 2016  
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This thesis is approved for recommendation to the Graduate Council.

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## **Abstract**

This project assesses the effectiveness of the Expanded Food and Nutrition Education Program (EFNEP) within the context of supermarket access. EFNEP is a national community nutrition education program that strives to give participants the tools to live healthier lives. Analysis was performed on participants from 16 Arkansas counties that completed EFNEP during 2013 or 2014. The program outcome is measured in terms of the change in Healthy Eating Index (HEI) as calculated from 24-hour diet recalls at program entry and exit. Supermarket locations were obtained from the USDA Food Nutrition Service's SNAP Retail Locator and represent the food environment near the midpoint of our two-year study period. Each participant's census block of residence was characterized as being supermarket accessible or non-accessible based on the availability of supermarkets within one mile (ten miles) of the center of urban (rural) census blocks. Linear regressions are used to model changes in HEI scores as a function of program graduation, defined as completing eight or more EFNEP lessons. Our models are estimated with educator fixed effects and include controls for nutrition assistance, age, gender, educational attainment, race, and ethnicity. The key finding is that the effect of graduation on HEI was higher for participants with access to supermarkets. This finding holds across urban and minority subsamples and is robust to measurement of program exposure as graduation or in terms of lessons completed. The implication is that limited access to affordable and healthy foods is a crucial barrier that may impact goals of EFNEP and other educational interventions. Moreover, understanding the role of the food environment enables educators to tailor curriculum to the constraints facing lower-income audiences.

## **Acknowledgments**

This project was made possible through collaboration and partnership. Through my committee I have been fortunate to work with excellent professors from the University of Arkansas Department of Agricultural Economics and Agribusiness and also from the Cooperative Extension Service in Little Rock. I am grateful for the opportunity to work on a project that extends beyond the Northwest Arkansas community, and one with the potential to contribute to the body of knowledge regarding EFNEP in Arkansas. I would like to thank Dr. Serena Fuller from University of Arkansas Cooperative Extension for her participation on my committee. Her contributions to the evaluation of the focus of this project, and her overall knowledge about the Expanded Food and Nutrition Education program has been invaluable to this research. I am also thankful for the support and input provided by Dr. Rudy Nayga. I have been lucky to have him both as an instructor and a committee member. Thank you, Dr. Nayga for providing perspective on this project and in your assistance in fine-tuning our analysis and empirical model.

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## **Introduction**

The objective of this thesis is to assess the effectiveness of the Expanded Food and Nutrition Education Program, subsequently referred to as “EFNEP,” within the context of the commercial food environment and specifically within the context of whether participants in the program have access to supermarkets, the primary source of affordable and nutritious foods in the commercial food environment. The thesis focuses on the EFNEP program in Arkansas, which is administered and implemented by the University of Arkansas Cooperative Extension Service.<sup>1</sup> That said, the topic is of much broader interest because the program is a federal and state partnership that operates through land-grant universities in all fifty states and six territories.<sup>2</sup> The program aims to help participants attain the knowledge, skills, and behaviors necessary to follow a healthy lifestyle by working to address the health disparities associated with societal challenges such as obesity, hunger, malnutrition, and poverty.<sup>2</sup>

### *Need for this Research*

How access to healthy foods affects programs such as EFNEP is important because obesity and malnutrition are pressing problems both at a national level and in the state of Arkansas. The Centers for Disease Control and Prevention reports that as of 2013, 34.6% of adults in Arkansas self-report as obese, or having a body mass index of 30 or higher.<sup>3,4</sup> Arkansas also displays some of the highest prevalence of food insecurity in the nation. The United States Department of Agriculture (USDA) Economic Research Service estimates that 21.2% of Arkansas households are food insecure, and 8.4% can be classified as having very low food security, meaning that “At times during the year, these households were uncertain of having, or unable to acquire, enough



food to meet the needs of all their members because they had insufficient money or other resources for food”<sup>5</sup>.

Programs like EFNEP address these issues by empowering citizens to make healthy food choices. However limited access to affordable and healthy foods is a crucial barrier that may impact the effectiveness of EFNEP and other educational interventions in bringing about actual change. Food, especially access to healthy food, has been a big topic for discussion in recent years. Food and health have caught the attention of policy makers with First Lady Michele Obama setting an example by planting a garden on the White House lawn.<sup>6</sup>

The term “food environment” has evolved from a growing body of research that goes beyond asking the direct question of how what people eat impacts human health. Researchers are starting to ask how the environment in which someone lives affects food choice and diet quality. How does where someone shops influence the decisions they make about the foods they eat? How does access to different types of retail outlets – supermarkets, convenience stores - impact public health and community nutrition? Questions such as these are at heart of what this study seeks to investigate.

### *Features of the Arkansas EFNEP Program*

Students in EFNEP work through variety of lessons covering topics such as good nutrition and food resource management. FNEP serves low-income individuals and families. Table 1.1 lists the Arkansas counties that participated in EFNEP during the study years, 2013 and 2014. Trained paraprofessionals in each county deliver the EFNEP curriculum. Recruitment for the program is targeted toward limited income households with children, many of whom may also qualify for SNAP benefits.

**Table 1.1: Arkansas Counties Participating in EFNEP During the Study Years**

County	Program Year 2013	Program Year 2014
Benton	✓	✓
Chicot	✓	✓
Craighead		✓
Crittenden	✓	✓
Desha	✓	✓
Drew	✓	✓
Hempstead		✓
Jefferson	✓	✓
Lee	✓	✓
Mississippi		✓
Monroe		✓
Phillips	✓	✓
Phillips-Monroe		✓
Pulaski	✓	✓
Saline		✓
Sevier	✓	
St. Francis	✓	✓
Union	✓	✓
Washington	✓	✓

EFNEP in Arkansas uses the Eating Smart-Being Active curriculum. The curriculum was developed by EFNEP staff at Colorado State University and University of California at Davis, and is designed for low-income adults. The curriculum focuses on nutrition education and obesity prevention and consists of consists of eight, 60 to 90 minute core lessons designed to be delivered in order.<sup>7</sup>

Lessons are consistent with the 2010 Dietary Guidelines for Americans. Each lesson includes a period of physical activity; worksheets and hands-on reinforcement activity; food preparation, demonstration, or tasting; information about food safety and saving money; an enhancement gift; and a parenting tip related to the lesson. Class emphasis is placed on learning skills needed to make healthy choices. Participants also learn how to select, purchase, prepare, and store food while observing safety and sanitation guidelines. EFNEP also engages

participants in learning to manage food budgets and related resources provided through different food assistance agencies.

### *Overview of the Study*

EFNEP participants complete a 24-hour dietary recall, which is calculated as their Healthy Eating Index, and a validated Behavior Checklist at the start and completion of the program<sup>1,8</sup>. Dieticians have a framework to convert information from the dietary recall into a Healthy Eating Index, a score from zero to 100 that quantifies how healthy a person eats, with larger scores indicating healthier diets.<sup>9</sup> To measure program effectiveness, the change in the Healthy Eating Index is computed using the beginning and ending dietary recall surveys. As explained in the next chapter, this change is largely how EFNEP measures the effectiveness of the program, but this project asks a deeper question.

Knowing that more researchers are finding that the food environment plays a role in what people eat, this research asks: Does supermarket access impact the effectiveness of EFNEP? Program years 2013 and 2014 comprise the study sample for this project. This question is relevant not only for the goal of improving the health of Arkansans, but in doing so in a way that best fits the context of the local realities in which the program functions. The state of Arkansas invests public funds in these types of programs, and understanding the role of the food environment enables educators to better tailor curriculum to the environmental constraints facing lower-income individuals and families, thereby contributing to program effectiveness.

To understand the role of supermarket access in program effectiveness, it was necessary to link the residential location of EFNEP participants to the locations of supermarkets. Supermarkets are the environmental feature of interest in this study because supermarkets

provide a broad array of foods, including healthy foods, at price points that are low in comparison to other retail formats.<sup>10-12</sup> For privacy reasons, the home locations of all the EFNEP students were first translated into the center point of the census blocks of residence. Maps showing the distribution of residential census block across the state are included in the methods section of this thesis. To measure supermarket locations, public data from the US Department of Agriculture were used. With knowledge of the residential locations and supermarket locations, sample participants were classified as one of two categories: (1) those with access to a nearby supermarket, and (2) those without access to a nearby supermarket. Participants were assigned to these categories based on existing food access research.<sup>13</sup> Urban participants are classified as having supermarket access if they live within one mile of a supermarket. Rural participants were classified as having supermarket access if they lived within ten miles of a supermarket.

Econometric models are used to estimate the improvement in HEI that can be attributed to completion of the EFNEP program. These models control for differences in county and educator effects along with a variety of other socioeconomic factors. The model is first estimated for all participants in the sample and then again for samples comprised only of those participants with and without access to supermarkets. The primary finding is that **positive changes in the Healthy Eating Index measure are consistently higher for the study population that has access to supermarkets**. This finding is particularly strong in a subsample of African American participants. Thus, the findings of this research suggest that access to supermarkets matters, especially within the context of the healthy eating education taught by EFNEP. These results reinforce the narrative that the food environment matters when programs seek to help people eat healthy and that such programs may need to be tailored to address food access constraints in order to help people make long-term changes to live healthier lives.

### *Organization of this Thesis*

The remaining portions of this thesis consist of four chapters. First, a literature review chapter positions this project in the context of earlier work on the food environment and on EFNEP program evaluation. This chapter also summarizes previous findings on program benefits and the effectiveness of the *Eating Smart-Being Active* curriculum being used by the Arkansas EFNEP program. Next, the methods chapter describes the sources of data, documents the preparation of the study sample, and explains steps taken to ensure data quality. The methods chapter also presents the empirical model used to analyze whether access to retailers with healthy foods impacted program effectiveness during the 2013 and 2014 program years. The third chapter presents the characteristics of the study sample and reports estimation results from the empirical model. Results are presented for the entire study sample and for subsamples consisting only of African American participants and only of urban participants. The final chapter concludes the thesis by connecting the key findings back to the larger picture of the EFNEP program in Arkansas and nationwide.

The thesis includes two appendices. Appendix A provides additional documentation of sources of data and the development of the study sample from these data. Appendix B provides estimates from a broader sample including data points from diary surveys that are suspect due to excessively high or low total food energy numbers. These additional results demonstrate that the key findings of the thesis are robust to inclusion or exclusion of these potentially suspect observations.

Throughout the thesis, efforts have been made to avoid excessive use of acronyms and abbreviations. Nevertheless, some acronyms are necessary and in some cases, programs are

better known by acronyms than by their complete names. Table 2 provides a list of abbreviations that are commonly used throughout the thesis.

**Table 1.2: Relevant Abbreviations**

Abbreviations	Full Name	
EFNEP	Expanded Food and Nutrition Education Program	A Federal Extension, community outreach program employing a holistic nutritional education approach in every U.S. state, the District of Columbia, and 6 U.S. Territories.
SNAP	Supplemental Nutrition Assistance Program	A federally funded program that provides low-income and families an Electronic Benefits Transfer card to purchase food every month. <sup>14</sup>
WIC	Women, Infants, and Children Program	Federally funded, state managed program providing food and nutrition education for low-income women that pregnant, breastfeeding, or have infants and children up to five years old. <sup>15</sup>
HEI	Healthy Eating Index	Explained in Chapter 3: Methods
USDA	United States Department of Agriculture	Federal agency that provides funding for EFNEP.
BMI	Body Mass Index	Used to measure weight status; a person's weight in kilograms divided by their square height in meters. <sup>16</sup>
ESBA	Eating Smart Being Active	Curriculum currently used by Arkansas EFNEP.

## **II. Literature Review**

This thesis examines the effectiveness of the EFNEP program within a geographical context, a way that has not previously been explored. By examining whether EFNEP participants have access to supermarkets this research seeks to provide additional insight into the environmental contexts and their role on program outcomes.

The goal of this chapter is to situate this study within the context of the broad yet growing field of research into the role of the food environment on diet and health. This chapter also provides a brief overview of research relevant to food access constraints nationally and in Arkansas specifically. The latter half of the chapter reviews the ways in which EFNEP has been evaluated in the past, including cost-benefit analyses, curriculum and education-based studies, and evaluation of the Arkansas EFNEP program.

### *Defining Food Access*

The term “food desert” refers to areas in which people lack access to food, particularly healthy and affordable food. Food deserts are characterized in a variety of ways ranging from the absolute absence of retail outlets selling food to more nuanced constraints including geography, transportation, affordability, availability, and accessibility.<sup>17</sup> This research employs a definition of food access comparable to the definition of food deserts used by the USDA Economic Research Service. Specifically, EFNEP participants are classified as having low access to supermarkets if the centroid of the census block in which they reside is more than one mile away from a supermarket for urban residents or more than ten miles away for rural residents. These one and ten mile thresholds reflect USDA ERS methodology.<sup>13</sup>

A review of food desert literature in the United States indicates that nine measures have typically been used to assess issues related to food access. These methods of analyses have included explorations utilizing: (1) business lists/directories and census data, (2) focus groups, (3) food store assessments, (4) food use inventories, (5) GIS technology and census data, (6) interviews, (7) inventory for measuring perceptions of food access, (8) questionnaires, and (9) surveys.<sup>11</sup> Investigation of food deserts through those lenses has thus far yielded five key areas impacting food deserts and healthy food access, including: “Access to supermarkets, racial and ethnic disparities in food deserts, income and socioeconomic status in food deserts, difference in chain versus non-chain stores, cost of food, availability of food items”.<sup>11</sup>

Earlier literature also suggests that people in urban and rural areas tend to have less access to grocery stores than people in suburban areas; there may be more convenience stores in urban and rural areas.<sup>18</sup> The literature has also established that access to fewer grocery stores often translates to less access to fruits and vegetables and other healthy foods. This finding supports the focus on supermarket access investigated in this project.

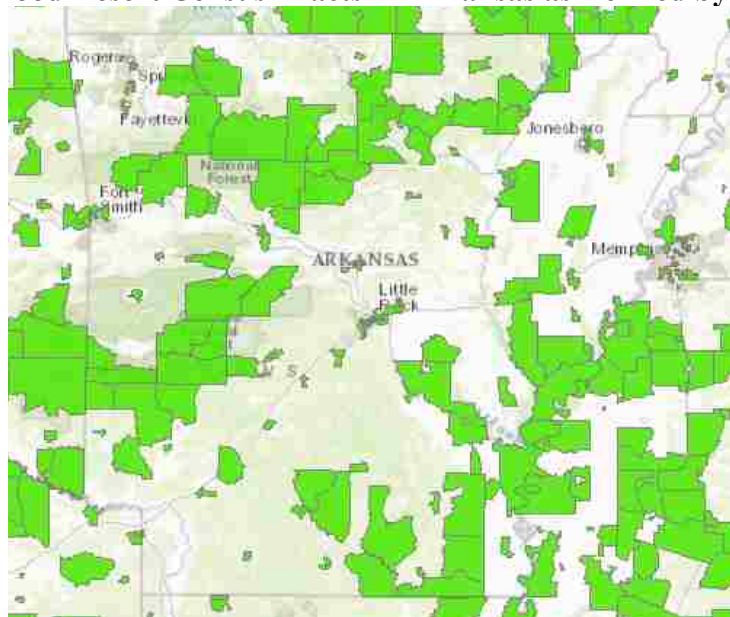
Also, an empirical analysis of access to grocery stores and grocery store prices in the inner city and suburban areas in the Minneapolis-Saint Paul metropolitan area in Minnesota found an overall disparity in grocery prices.<sup>19</sup> Researchers found that grocery prices on average tended to be higher in inner city neighborhoods when compared to suburban neighborhoods, though they attributed that difference to more affordable groceries available for sale through chain stores that were more prolific in the suburban neighborhoods. Another study looking at stores and consumer attitudes in four low-income communities, two urban and two rural, in the Minneapolis area found that rural residents encountered more barriers to accessing food than their urban counterparts, but were more likely to be satisfied by the quality of the food available



in their communities.<sup>12</sup> Urban residents, overall, encountered higher prices, less variety of food offerings, and reported more dissatisfaction with quality than their rural counterparts.<sup>10</sup> Research reviews have determined that residents of low-income, minority, and rural communities are at the highest risk of having low access to supermarkets.<sup>11</sup> These findings support a compartmentalized approach to examining the impact of the commercial food environment. Examining the impact of access to supermarkets may prove useful as opposed to the stores comprising the food environment in aggregate. The literature also supports analyzing program outcomes for urban and rural residents separately.

Previous research about food deserts in Arkansas suggests that, “there is evidence that residents in higher-minority urban areas face larger densities of convenience stores and fast-food restaurants, retail formats that generally provide unhealthy food options.” Furthermore, “Arkansans in low-income rural areas with declining populations may be specifically at risk for low access to healthy food options”.<sup>20</sup> Figure 2.1 shows a map of Arkansas food deserts as defined by the USDA Economic Research Service.

**Figure 2.1: Food Desert Census Tracts in Arkansas as Defined by USDA ERS\***



\*Shaded census tracts indicates food deserts as defined by USDA ERS.

As noted above, this research employs a definition of food access comparable to the definition used by the USDA Economic Research Service in their food desert research. This study classifies EFNEP participants as having low access to supermarkets if the centroid of the census block in which they reside is more than one mile away from a supermarket for urban residents or more than ten miles away for rural residents. The one and ten mile thresholds reflect USDA ERS methodology.

The definition of food deserts and previous research on the topic is important towards the goal of understanding the foundation for food access and food environment research. Food deserts are relevant because EFNEP targets lower income individuals where access to supermarkets may be an important barrier to improvements in diet. This study specifically examines the moderating effect of the food environment on EFNEP program outcomes. The role of the food environment is characterized as food access as opposed to a study of strictly food deserts because EFNEP participants are lower income.

### *The Health Impact of Food Environments*

A 2009 review article linking neighborhood characteristics, access to healthy foods, and diet quality found lower levels of obesity and overall healthier diets present in residents living in neighborhoods with fewer convenience stores and better access to supermarkets.<sup>12</sup> The review cites a study of more than 10,000 adults living in four different U.S. states. Within that population, the census tracts lacking supermarkets exhibited the highest levels of obesity.<sup>12</sup> A study of a population in Glasgow, Scotland found that proximity to supermarkets was positively associated with increased consumption of fruits and vegetables, but was not significantly

associated with body mass index.<sup>21</sup> A 2008 Multi-Ethnic study of adults in the U.S found that participants lacking supermarket access in proximity to their residence were 25-46% less likely to have a healthy diet than the study comparison group with access to stores.<sup>22</sup>

In 2013 the Centers for Disease Control and Prevention conducted a review of research evaluating supermarket-based interventions aimed at improving a variety of health or behavioral outcomes. They found that leveraging culturally sensitive supply- and demand-side strategies was successful toward the goal of positively influencing food-related behaviors in communities lacking access to healthful foods.<sup>23</sup> However, they also cite mixed results towards the overall goal of improving food choices in stores amongst their study sample, which surveyed 58 articles and 33 interventions.<sup>23</sup> A more recent study of households in two underserved Pittsburgh, Pennsylvania neighborhoods specifically examined the effects of introducing a supermarket to one of those neighborhoods while using the other as a comparison group.<sup>24</sup> In comparing changes in Healthy Eating Index as well as Body Mass Index measures, the researchers found no improvements to either one. The researchers did, however, find that dietary improvements in the intervention group manifested as a decrease in the consumption of fats, alcohol, added sugars, and daily kilocalories rather than, as hypothesized, an increased intake of fruits and vegetables. Surveys administered as part of the same study suggested that residents in the neighborhood that gained a supermarket reported a positive difference in perception about their ability to access healthy food. Interpreting their findings, the researchers of this Pittsburgh, Pennsylvania study do not deny the possibility of positive diet changes as a result of supermarket introduction to underserved areas, but they do highlight the need for further research. They also draw attention to the reality that a deeper understanding of how consumers make choices about purchasing healthy foods in stores is needed, and the introduction of a normal supermarket without the

addition of any other community-based or education based resources about making healthy choices might not be enough to impact change.

A number of federal funding streams and grant programs have been created to support solutions targeted at the alleviation of food deserts and barriers to healthy food access.<sup>25</sup> With federal resources aimed at learning more about the scope of this issue, it stands to reason that increased understanding of how the food environment impacts program outcomes for existing, funded community nutrition education programs like EFNEP will be useful in determining the most effective strategies for tailoring programming to meet community needs. Furthermore, studying the question of food access through the lens of EFNEP is unique within the scope of current food desert research. The work presented here is novel because it does not examine the food environment in isolation, but within the context of a program that seeks to educate participants about the healthy habits, healthy eating, and the practices that support healthy lifestyle goals.

#### *Previous Evaluation of the EFNEP Program*

Because the EFNEP program is implemented in a variety of environmental contexts across the nation, it presents an excellent opportunity to combine the study of food deserts with the impact of nutrition education in a real world context. Previous studies have examined food deserts and food environment with a focus on health outcomes, but at the time of this report no research has been identified that considers environmentally shaped health outcomes with the added complexity of a nutrition education program in place.

As a federally funded program, EFNEP has been evaluated in a number of ways since its inception in 1969. A review of EFNEP research found that the geographic distribution of

program evaluation in the South includes studies from land-grant universities in Louisiana, North Carolina, and Tennessee. The same review described general, temporal trends in the research conducted around EFNEP. These trends are as follows: In the early years of the program, studies centered around curriculum and education effectiveness, and in the 1970's the role of food assistance programs became a focus with a number of studies looking at the role of food stamps. The 1990's saw the emergence of research about EFNEP, weight, and obesity. In the late nineties and early years of the 2000's, research began to incorporate topics of hunger, poverty, cost benefit analysis, and physical activity.<sup>26</sup> Knowing the broad historical context of research around the EFNEP program is helpful in determining the context for this research project. Linking the chronology of EFNEP evaluation with the timeline of the emergence of food desert research, history would suggest that now is the time for research regarding holistic questions such as how the food environment impacts EFNEP. The geographical distribution reflected in the earlier EFNEP literature also illustrates the opportunity and need to examine this question in the South.

Studies have examined effectiveness of EFNEP by determining the impact of nutrition education on food security status and food-related behaviors. A 2013 study of a low-income and multicultural EFNEP population in Massachusetts found that before being part of EFNEP, 40% of the sample classified themselves as having high rates of food insecurity, with 60% of participants reporting food secure status.<sup>27</sup> After receiving EFNEP education that number shifted to 71.7% of participants reporting high and marginal food security status.<sup>27</sup>

Other studies have viewed the EFNEP program through a cost-benefit lens. A recent 2013 study used national data to examine the maximum average cost calculation, "the maximum amount that any state could spend per outcome improvement," of three different outcomes of

EFNEP education, which are food resource management practices, food safety practices, and nutritional practices. Comparing the maximum average cost calculations for each of these domains allowed the authors to draw broad conclusions regarding the efficiencies of the various outcomes. They found that the maximum average cost calculation was \$634 for food resource management practices, \$848 for food safety practices, and \$594 for national practices. The authors also include state-by-state data and report that those maximum average cost figures for Arkansas were at the time of the study were \$345, \$428, and \$337 respectively. They conclude that EFNEP is generally most efficient in influencing improvements to the nutritional practices domain, a finding that applied to Arkansas as well.<sup>28</sup>

An earlier study conducted a cost-benefit analysis of EFNEP by comparing participants' food expenditure savings with costs associated with program implementation. In the study, EFNEP participants recorded and reported monthly food costs upon program entry and exit. The researchers found that on average, the EFNEP per participant program cost was calculated at \$338. Participants reported that after EFNEP, their food expenditures decreased on average by \$10-20 per month or \$124-234 over a year.<sup>29</sup> The researchers noted that their results showed the EFNEP program to be cost-beneficial; participants reported saving more money on food after being part of the program, but they also reported a variety of positive nutritional and food resource outcomes, such as using less salt, increased vitamin and fiber intake, reading food labels more, and higher food security status.

A 2002 cost-benefit analysis conducted in Virginia reported a benefit/cost ratio of \$10.64/\$1.00, meaning that their calculations attest that every dollar spent on EFNEP programming has the potential to save over ten dollars in future healthcare costs.<sup>30</sup> In 2003, researchers applied this same cost-benefit analysis framework from the Virginia study to

Oregon's smaller EFNEP population. The Oregon research reported a lower benefit/cost ratio of \$3.61/\$1.00. The researchers conduct a variety of sensitivity analyses and provide reasoning as to why the ratio is lower in Oregon than in Virginia. They particularly point to the use of more current disease incidence data that is more specific to the low-income population.<sup>31</sup> In interpreting the results of both these studies, it should be noted that healthcare costs have likely changed in many states since the time period reflected in the research due to the implementation of the Affordable Care Act. Nevertheless, their finding reinforces the idea that EFNEP, in general, represents a good investment in public health.<sup>32</sup>

Literature also contains specific analysis of the effectiveness of the Eating Smart-Being Active (ESBA) curriculum, which at the time of this study, is used by Arkansas EFNEP. A multi-state study from 2015 found that ESBA was, on average, associated with statistically significant, behavioral improvements in the domains of food resource management, food safety, nutrition and physical activity level in states using the curriculum.<sup>7</sup> The same study also emphasized that the use of the ESBA curriculum lead to higher post-program levels of mean fruit and vegetable consumption. The states examined in this study were Arkansas, California, Colorado, New York, and Ohio. Researchers compared program outcomes from a window of years during which a previous curriculum was used to program outcomes from the first year of ESBA implementation. Arkansas adopted ESBA in 2009.

Evaluation of the EFNEP program in Arkansas has primarily focused on changes in scores for the program using the "Behavior Checklist," which provides a pre and post snapshot of participant's attitudes and behaviors regarding food preparation and procurement. Significant differences were identified between entry/exit checklist items indicating that behavior change had occurred. Positive behavior change in shopping with a grocery list was predictive of positive

behavior change in not running out of food at the end of the month. Positive behavior change in how often participants thought about healthy food choices when deciding what to feed the family was predicted by preparing food without added salt; using Nutrition Facts labels to make food choices; eating more than one kind of fruit; and eating more than one kind of vegetable. These analyses provide valuable information regarding behavior change in the areas of food resource management, nutrition practices, and food security. Specifically, previous evaluation of the Arkansas EFNEP program found a number of improvements when examining Behavior Checklist items and their assigned behavioral categories.<sup>8</sup>

In sum, this literature review suggests that opportunity exists to evaluate Arkansas EFNEP within the context of food access. Findings within the field of food desert research support both the definitions of food access used in this study, as well as this study's focus on access to supermarkets in particular. Viewing EFNEP through a food access lens is incredibly relevant given both the public investment in this program as well as the need to understand more about the landscape of consequences surrounding how food environments impact public health.



### III. Materials and Methods

At the beginning of this project, a partnership was established with the State Administrator of EFNEP at the University Cooperative Extension Service in Little Rock, Arkansas. This partnership proved crucial in shaping the methods and goals of this project and ensuring access to data. Through this partnership, permission to access the EFNEP database containing participant information was obtained. The database, named webNEERS, provided the information necessary to populate a dataset of EFNEP participants in program years 2013 and 2014.

This chapter begins with an overview of the empirical model used to analyze the change in HEI within the context of supermarket access. This section defines the outcome variable as well as the variables included in the empirical model. The subsequent section goes into further detail about the HEI, the measure on which the outcome variable is based, and the methods EFNEP educators use to gather the dietary information needed for this measure in the course of program delivery. The chapter also addresses in detail the geocoding processes used to measure the food environment and map EFNEP participants' home census block centroids. Lastly, the chapter provides an overview of the steps taken to prepare the final study sample for analysis.

#### *Empirical Model*

To determine if supermarket access impacts EFNEP effectiveness, a linear regression model is defined. Change in the HEI is used as the outcome measure. The model involves regressing the change in HEI from entry to exit of the EFNEP program on explanatory variables described in Table 3.1. The coefficient of interest is on the measure of whether the program was completed by the EFNEP participant. The model is specified in equation 1:

$$(1) \quad \Delta HEI = \alpha + \beta \mathbf{Complete} + \sum \gamma_i X_i + \nu_j + \varepsilon$$

The coefficient of primary interest is  $\beta$ . The variable, “complete”, measures whether a participant graduated from EFNEP by completing eight or more EFNEP lessons. The  $X_i$  are control variables and each is summarized in table 3.1. These include the following: “Income” was self-reported by each participant in dollars per month. “EdLevel” is a binary variable indicating whether the participant had completed a high-school-level education. “SNAP” and “WIC” variables are also binary, indicating if participants self reported receiving Supplemental Nutrition Assistance Program benefits or Women, Infants, and Children benefits, respectively. “Race,” “Hispanic,” “Gender,” and “Age” are demographic measures captured from EFNEP surveys. Finally  $v_j$  are fixed educator effects. Fixed effects control for differences between educators. Though one county may contain more than one educator, in program years 2013 and 2014 there was no crossover of educators between counties. Thus, the fixed effects capture differences attributable to both educator and county.

**Table 3.1. Variable Definitions from Linear Regression Model**

Variable	Type	Explanation
Change in HEI	Continuous	Change in Healthy Eating Index, calculated from dietary surveys
Complete	Binary	1 if participant completed $\geq 8$ lessons
Income	Continuous	Self-reported income in dollars per month
EdLevel	Binary	1 if highest grade completed is reported as $< 12^{\text{th}}$ , 0 if otherwise
SNAP	Binary	1 if participant receives Supplemental Nutrition Assistance Program benefits, 0 if not
WIC	Binary	1 if participant receives Women, Infants, and Children benefits, 0 if not
Race	Categorical	Race codes imported from EFNEP codebook, These enter the model as binary variables. Categories are: white, African American, and Other.
Hispanic	Binary	1 if self-reported Hispanic, 0 if not
Gender	Binary	1 if female, 0 if male
Age	Continuous	Self-reported age in years
Staff	Categorical	Fixed effects for educators within county

### *Subsample Analysis*

In order to determine how supermarket access impacts the study sample, subsample analysis was conducted. The larger sample was divided into two groups: EFNEP participants that have access to supermarkets, and EFNEP participants that do not have access to supermarkets. These divisions were based upon whether participants in urban areas had a supermarket within one-mile of their census block of residence and whether rural participants had a census block within ten-miles of their census block. The linear regression model was also applied to subsamples comprised only of participants with supermarket access and of participants without supermarket access. This analysis was repeated for a sample comprised of African American participants and for a sample of participants living in urban-classified census blocks.

### *The Healthy Eating Index*

Participants' change in Healthy Eating Index serves as the outcome variable for the empirical model in this research. Strictly defined, the Healthy Eating Index (HEI) "is a measure of diet quality in terms of conformance to Federal dietary guidance."<sup>33</sup> The HEI for EFNEP program years 2013 and 2014 was based on the 2005 Dietary Guidelines for Americans, as opposed to the most recent 2010 guidelines. The HEI provides a helpful mechanism for monitoring overall dietary quality, as well as measuring changes in nutritional practices as influenced by nutrition education programs. The HEI measure is also useful for conducting program evaluation, studying health-related program outcomes as they compare to dietary expenditures, or determining the quality of other food assistance programs. The HEI scores of EFNEP participants are determined from a 24-hour dietary recall upon entry to and exit from the program. These scores are based upon consumption of the food groups shown in Table 3.2.

The HEI is a cumulative score based on these food groups. Higher HEI scores indicate better overall diet quality. A score of 100 points is the maximum value for the HEI. The HEI was updated in 2010 to reflect changes to the USDA dietary guidelines, and the HEI measure used in this research reflects the 2005 Dietary Guidelines for Americans. This is due to the algorithm found in the WebNEERS program. A 2015 evaluation of EFNEP in the Mountain Region, as defined by the US Census Bureau, provides support for using HEI as an indicator of overall diet quality.<sup>34</sup> In this study, HEI is used to capture change in overall dietary quality, and positive changes in HEI are interpreted as a positive change to diet. The Eating Smart Being Active (ESBA) curriculum teaches healthy eating practices across all food groups therefore using a measure that reflects the overall quality of an individual's diet is a useful measure to assess education outcomes.<sup>34</sup>

**Table 3.2 Food group scores contributing to Healthy Eating Index**

HEI 2010 Component	Maximum	Standard for Maximum Score	Standard for Minimum Score of Zero
Adequacy (higher score indicates higher consumption)			
Total Fruit	5	$\geq 0.8$ cup equiv. / 1,000 kcal	No fruit
Whole Fruit	5	$\geq 0.4$ cup equiv. / 1,000 kcal	No whole fruit
Total Vegetables	5	$\geq 1.1$ cup equiv. / 1,000 kcal	No vegetables
Greens and Beans	5	$\geq 0.2$ cup equiv. / 1,000 kcal	No dark-green vegetables, beans, or peas
Whole Grains	10	$\geq 1.5$ ounce equiv. / 1,000 kcal	No whole grains
Dairy	10	$\geq 1.3$ cup equiv. / 1,000 kcal	No dairy
Total Protein Foods	5	$\geq 2.5$ ounce equiv. / 1,000 kcal	No protein foods
Seafood and Plant Proteins	5	$\geq 0.8$ ounce equiv. / 1,000 kcal	No seafood or plant proteins
Fatty Acids	10	(PUFAs + MUFAs*) / SFAs > 2.5	(PUFAs + MUFAs) / SFAs < 1.2
Moderation (higher score indicates lower consumption)			
Refined Grains	10	$\leq 1.8$ ounce equiv. / 1,000 kcal	$\geq 4.3$ ounce equiv. / 1,000 kcal
Sodium	10	$\leq 1.1$ gram / 1,000 kcal	$\geq 2.0$ grams / 1,000 kcal
Empty Calories	20	$\leq 19\%$ of energy	$\geq 50\%$ of energy

\*poly- and monounsaturated fatty acids; *USDA Center for Nutrition and Policy Promotion*<sup>9</sup>

### *Geocoding the locations of EFNEP Participants*

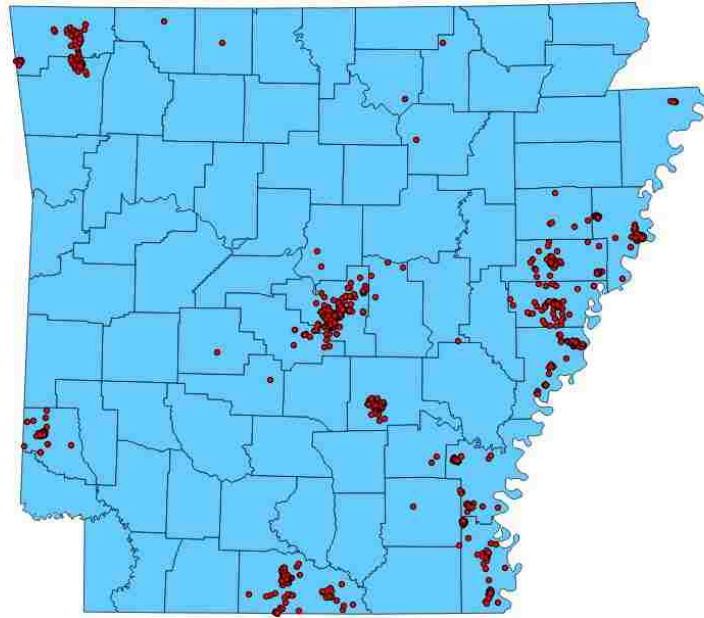
In order to determine the initial coordinates of a given participants residence, a manual geocoding process was used. To start, the address, taken from webNEERS, was entered into Google Maps. This not only provided the ability to manual extract the latitude and longitude coordinates from the Google Maps URL, it also facilitated a way to ensure legitimacy of addresses during the geocoding process. If an address was entered and Google Maps was unable to return a result, the address was checked for any errors. Lacking errors, if coordinates could not be found, that participant identification number was recorded on a list of addresses that could not be geocoded and was not included in the study sample. A lack of any initial participant address in webNEERS precluded inclusion in the study sample as well.

For those participants that had a valid address, the latitude and longitude coordinates were obtained from Google Maps and were entered into an R function that was written to assign participants into a census block based on geographic coordinates. R Studio software was used to execute this function in batches of fifty to one hundred records. The records were processed in the order they appeared in webNEERS. The database also subdivides records by county, thus the records for each county were processed in the same manner. For instance, all records for Pulaski County were processed in the order they appeared in webNEERS. The output from R Studio provided a text file containing the participant ID and census block of the participant's residence.

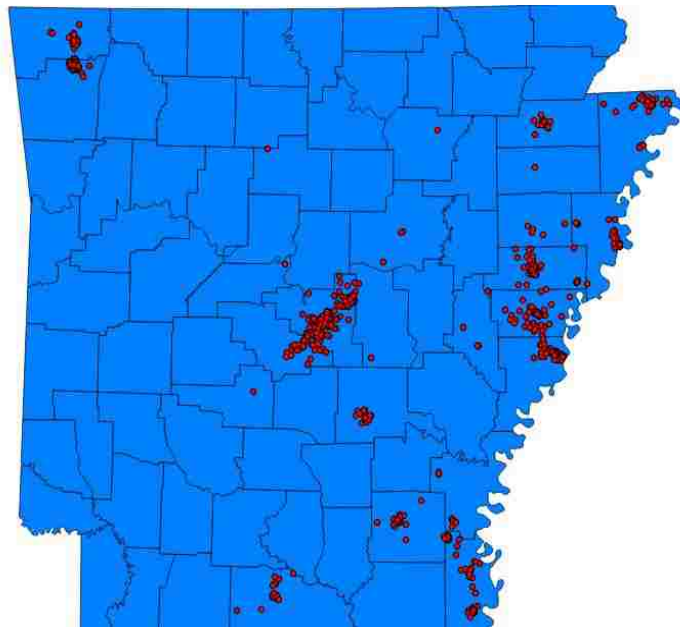
After all records in webNEERS were processed in this manner, records were mapped. The program QGIS was used to map the census blocks contained in the data set, and to determine the centroid of each census block. The centroid coordinates were used as a proxy for the exact home addresses of participants in order to protect participant privacy. The idea for this

change emerged during the Institutional Review Board renewal application process for this project. Census blocks were selected as a unit of interest because they are the smallest unit measured by the United States Census Bureau, and most closely reflect residential neighborhoods. To illustrate the ubiquity of census blocks, consider that Arkansas has 75 counties, 686 census tracts, 2,147 census block groups, and 186,211 census blocks. The census blocks of EFNEP participants in program years 2013 and 2014 are presented in figures 3.1 and 3.2, respectively.

**Figure 3.1. Census Block Centroids for EFNEP Participants in Program Year 2013**



**Figure 3.2. Census Block Centroids for EFNEP Participants in Program Year 2014**

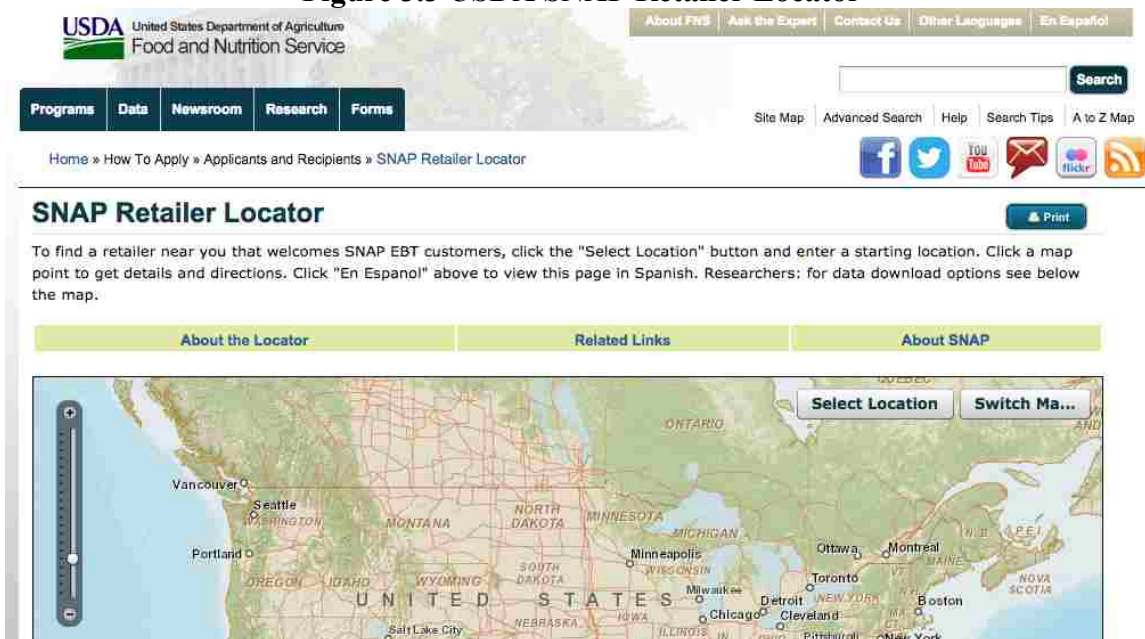




## Measuring Food Access

The United States Department of Agriculture Supplemental Nutritional Assistance Program's (SNAP) Retailer Locator was used to capture a snapshot of the food environment during the study years. This data set is publicly available,<sup>35</sup> and contains a record for every retail establishment accepting SNAP benefits in the state of Arkansas.

**Figure 3.3 USDA SNAP Retailer Locator**

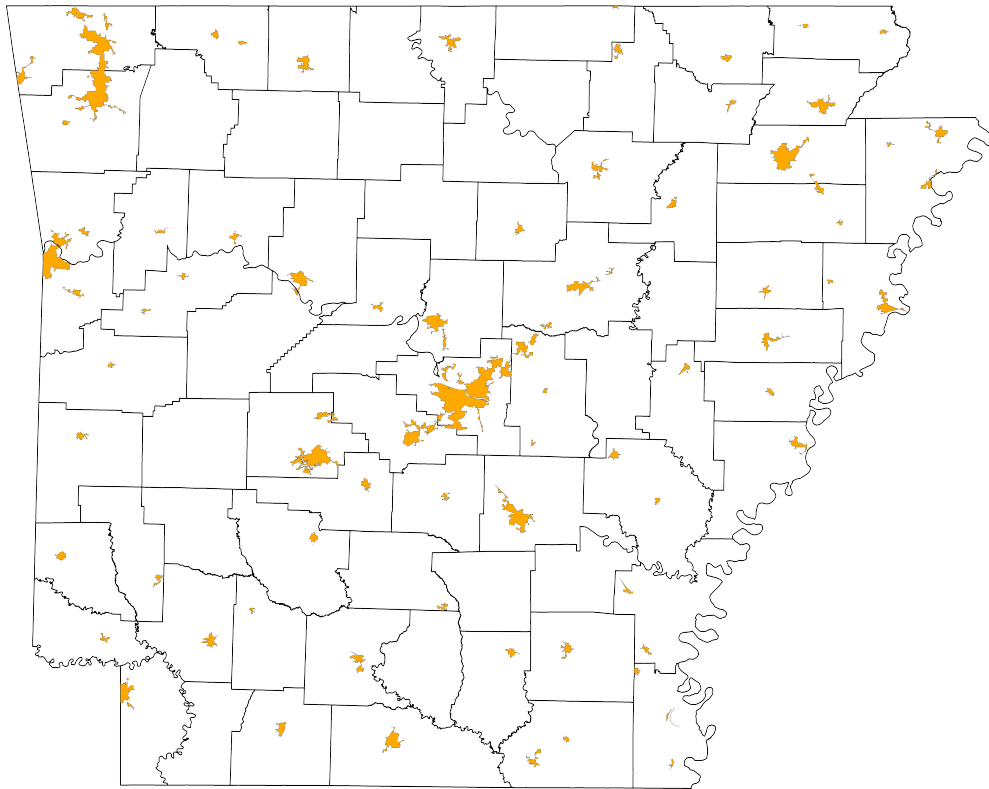


Because the historical data from the Retailer Locator is not available for download, the data set for Arkansas was downloaded from the USDA website in January of 2014 to most closely reflect the retail food environment in the study years. This data was downloaded as a .csv file, and opened in Microsoft Excel. Within Excel, the retailers were manually classified as one of six categories: supermarkets, convenience stores, dollar stores, specialty stores, farmers markets, or

other. Supermarkets were the key category of interest for this study. For the purposes of this research, a supermarket was defined as a store containing a fresh produce department.

Census blocks were classified as urban or rural, the urban definition being a census-defined categorization. The U.S. Census Bureau defines urban in two different ways: “Urbanized” areas consist of populations equal to or in excess of 50,000 people. “Urban clusters” consist of “at least 2,500 and less than 50,000 people.”<sup>36</sup> In order to classify census blocks as urban for the purpose of this research, this project relied on pre-existing maps and census block designations created by staff at the University of Arkansas’ Agricultural Economics and Agribusiness Department. These maps and designations utilized the 2010 Census, translating national information about urban areas and clusters into a data set delineating those areas for Arkansas specifically. Figure 3.4 illustrates the urban-designated areas in Arkansas.

**Figure 3.4: Urban Census-Designated Areas in Arkansas**

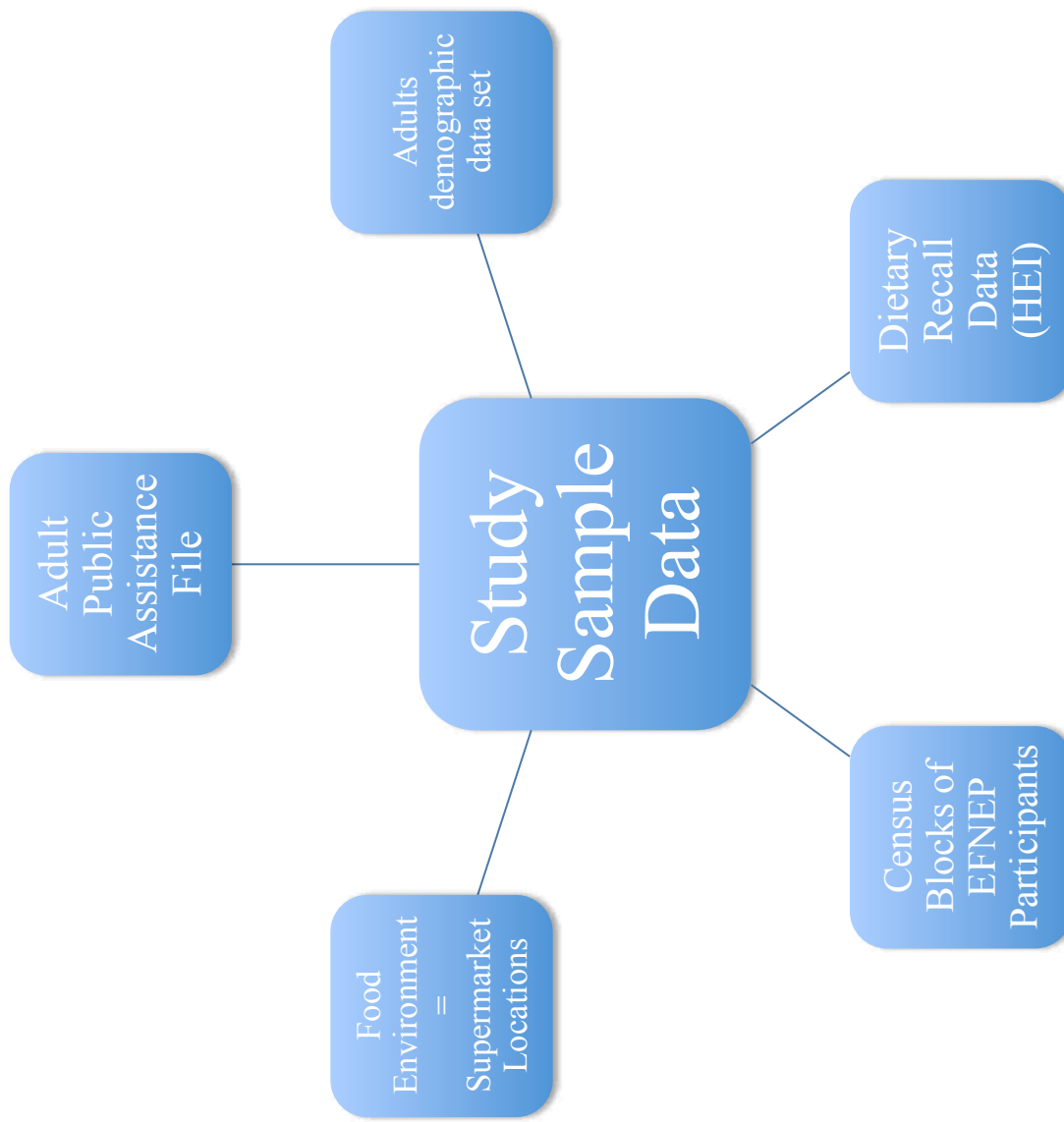


Participants residing in urban census blocks classify as having access to supermarkets if they lived within one mile of a supermarket. Participants residing in rural census blocks were classified as having access if they lived within ten miles of a supermarket. Those classified as having low access to supermarkets had no supermarkets within one and ten mile radiuses of the census block of residence for urban and rural residences, respectively. Distance from the centroid of the census block of residence to the nearest supermarket was measured radially with GIS software.

### *Preparation of the Study Sample*

In order to create a cohesive dataset containing information from all EFNEP participants in program years 2013 and 2014, it was necessary to reconcile three different files provided by the EFNEP Program Administrator. One file contained demographic information regarding the program participants, as well as information detailing their levels of engagement in EFNEP, including number of lessons and sessions per participant. Another file contained information about types of public assistance received. This contained self-reported information about government benefits such as SNAP, WIC, child nutrition (the school lunch program), Temporary Assistance for Needy Families (TANF), The Emergency Food Assistance Program (TEFAP) or commodities, and Head Start. A third file contained the entering and exiting 24-hour recall data used to calculate each participant's HEI, as well as that value. These three files were merged together in order to create a full picture of each EFNEP participant's demographics, experience in the program, 24-hour recall survey responses, and types of public assistance utilized. Figure 3.5 provides a visual representation of the individual files that were compiled in order to create the overall study sample.

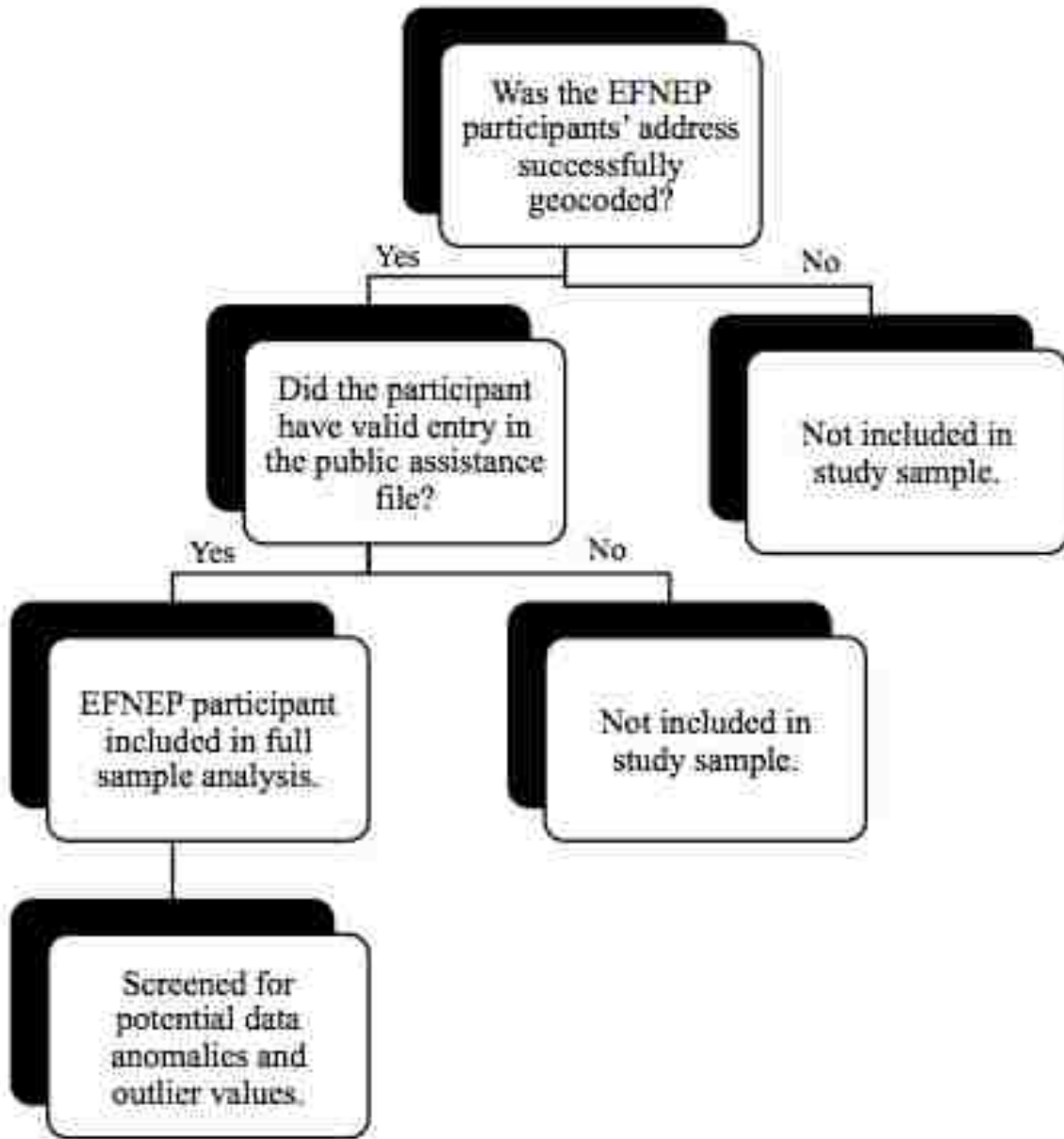
**Figure 3.5: Individual Data Sets Reconciled to Create Final Study Sample Data**



All steps in preparing the study sample were performed with R software. The R program that creates the study sample from these three input files is presented in Appendix A. Files were merged based on a common participant identification number, referred to as “Adult\_Custom\_ID” within the R code. Though there were other identifiers present in the data set, this field was determined to be the descriptive identifier most unique to each participant. A companion code was also created in R Studio to translate participant identification numbers, matched with the longitude and latitude of their reported residence, into coordinates containing that same identification number matched with the census block number in which they resided during the EFNEP program. The full text of this companion code can also be found in Appendix A.

Figure 3.6 illustrates the data management process after the three files from the EFNEP administrator were merged. As previously described, each EFNEP participant present in the EFNEP WebNEERS database from years 2013 and 2014 was examined and geocoded. If the geocoding was successful, meaning that the participant had a valid address in WebNEERS and that Google Maps returned a valid, residential search result when a search on the address was performed, that participant was included in the larger study sample. If no address was reported or if an address could not be geocoded by a Google Maps search, that participant was not included in the larger study sample.

Figure 3.6: Study Sample Preparation Flowchart



Only the participants with valid addresses moved on to the next stage of verification. After reconciliation of the aforesaid EFNEP program documents took place, a decision was made that only participants with entries in the adult public assistance file would proceed to the next stage of validation. While this decision did decrease the number of records that qualified for the final data set, it was based on quality of data in each of the separate data sets. With the exception of HEI calculations, the majority of the data collected in the EFNEP files was self-reported. The participants that self-reported data in the public assistance file also had fuller and more quality records in the other two files. Additionally, participants included in this file inherently had proof of additional resources with which to access food, thus may have the greatest ability to change as a result of EFNEP programming. Thus, subsequent analysis focused only participants with records in the public assistance file.

That study sample was then screened for potential data anomalies, including biological plausibility and income. Biological plausibility was based on the food energy measure in the file containing dietary recall data. This measure asked participants to self-report the food items they consumed in the past day, resulting in a calculation of calories. For the final sample, food energy values of less than one thousand calories or more than five thousand calories were excluded. These values reflected the lower first and upper third quartile of the data for this measure. Responses for income were also examined. This measure asked participants to report their monthly income in dollars. Ultimately, records reporting a monthly income of greater than four thousand dollars per month were excluded. While this was arguably a subjective choice, it is important to note that this decision did not exclude a substantial amount of records. EFNEP does have an income qualification to participate in the program, and it is targeted toward low-income individuals. Thus, that population was reflected in the final sample population. The value of



including a control for income in the model exceeded skepticism about the accuracy of the income measures. Beyond these screens for biologically implausible values or excessively high self-reported income measures, all self-reported measure were accepted at face value.

## **IV. Results**

This section presents main results of this thesis project. First, key features of the study sample as described in the previous chapter are outlined. Next, the results from the application of the empirical model to the study sample are discussed. Analysis of the entire sample is presented first, followed by the results from the subsample analysis for the African American and urban populations. The chapter ends with a summary and interpretation of key results.

### *Characteristics of the Study Sample*

Table 4.1 presents summary statistics of the final study sample of EFNEP participants from program years 2013 and 2014. It is evident from these statistics that a positive change in HEI occurs as a result of receiving EFNEP education. The average HEI of all participants at the start of the program is 51.24. The average HEI upon program exit is 56.76. This yielded an average positive change of 5.524 HEI points. Though the average entering HEI among the African American subsample is below average at 49.06, the average improvement to HEI upon exit is 6.782 points and is greater than the sample as a whole. More than half of the participants in the sample (57.98%) receive SNAP benefits, and about a third (33.66%) receive WIC benefits. Of the EFNEP participants included in the final study sample, the majority (82.71%) reside in census blocks classified as urban, the definition of which is explained in chapter 3 of this thesis. Slightly less than half of the sample (48.22%) was classified as having low access to supermarkets. The members of the low access sample are those urban participants not living within one mile of a supermarket or rural participants not living within ten miles of a supermarket. Table 4.1

displays descriptive statistics for the sample as a whole, as well as the African American and urban subsamples.

**Table 4.1: Descriptive Statistics**

	Entire Sample	African American Subsample	Urban Subsample	No Access to Supermarkets	Access to Supermarkets
HEI at Entry	51.24	49.06	51.28	51.3	51.18
HEI at Exit	56.76	55.84	57.08	55.33	58.1
Change in HEI	5.524	6.782	5.794	4.027	6.918
SNAP recipients	57.98%	70.55%	57.50%	57.12%	58.79%
WIC recipients	33.66%	29.59%	34.50%	33.96%	33.39%
Classified as Urban	82.71%	80.46%		89.54	76.36%
Classified as Low Access	48.22%	45.38%	52.20%	51.3	51.18
Race					
White	36.06%	-	37.60%	40.48%	31.95%
African American	61.79%	-	60.10%	58.15%	65.17%
Other	2.15%	-	2.30%	1.37%	2.87%
Hispanic	26.14%	0.40%	30.20%	29.67%	22.84%
Female	84.53%	85.81%	83.00%	85.59%	83.54%
Male	15.47%	14.19%	17.00%	14.41%	16.45%
Income (\$/month)	\$1,007.00	\$954.40	\$1,012.60	\$1,029	\$985.50
Age (years)	37.79	39	36.99	37.54	38.03%
Sample Size	1,209	747	1,000	583	626.00

The sample is also largely African American (61.79%), with 36.06% reporting race as white, and 2.15% are classified as other race respectively. Of the entire sample population, 26.14% report as Hispanic as ethnicity. The urban sample is proportionally even more Hispanic, with 30.20% identifying as such. The urban sample, like the sample at large, is majority African American (60.10%). The participants in the sample are overwhelmingly female (84.53%), with only 15.47% identifying as male. Average monthly income is \$1,007 per month, though members of the African American subsample report earning, on average, slightly less (\$954) and members of the urban subsample report earning, average, slightly more (\$1,012.60). The average ages of each of the entire sample, the African American subsample, and the urban subsample are not widely dispersed, ranging from 37 to 39 years of age. Ages of participants in the sample range from 16 years to 90 years of age. In total the sample consists of 1,209 participants. The African American subsample reflects 747 participants, and 1,000 participants comprise the urban subsample. Subsamples analysis by race and urbanity are completed, in part, because of differences in percentages of African American and urban participants across the samples with and without supermarket access.

### *Findings from the Entire Sample*

Table 4.2 presents results from the regression model with all EFNEP participants in the final study sample. The first three columns present results estimated from all participants without regard to supermarket access. The next three columns present results for the subsample with no access to supermarkets. The final three columns present findings for

the subsample with access to supermarkets. Overall, there is a statistically significant improvement in HEI for participants that graduate from EFNEP among the full sample. On average, the estimated effect for having completed the program (the coefficient estimate for “complete”) is 4.022 HEI points and is positive and statistically significant. When the sample is homogenized to include only those participants without access to supermarkets the effect continues to be positive but is smaller at 3.407 HEI points. Moreover, the estimate from the sample without supermarket access is only significant at the 10% level. The estimate for program completion is larger when estimated from the population having access to supermarkets. The last three columns of Table 4.2 show the effect of program completion to be 4.882 points. As in the full sample, this change is statistically significant at the 1% level. One key point from the results in Table 4.2 is that graduation from the EFNEP program matters. Participants experience a statistically significant increase in HEI upon graduating from the program regardless of supermarket access. The other key point is that supermarket access is, nevertheless, important to the effectiveness of the program. The effect of completing EFNEP is higher for those participants with access to supermarkets, suggesting that food access might play an important role in further increasing the effectiveness of EFNEP education.

**Table 4.2: Entire Sample Analysis**

	Entire Sample			No Access to Supermarkets			Access to Supermarkets		
	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value
Intercept	-5.322	4.842	-1.099	-5.157	7.078	-0.729	-10.851*	6.066	-1.789
Complete	4.022***	1.423	2.827	3.407*	2.264	1.505	4.882***	1.812	2.695
Income	0.000	0.001	-0.381	-0.002*	0.001	-1.687	0.002	0.001	1.536
Highest Grade Less than 12th	-1.285	1.050	-1.223	0.247	1.551	0.159	-2.439*	1.481	-1.647
SNAP	1.110	0.988	1.124	0.568	1.438	0.395	2.461*	1.299	1.894
WIC	-0.678	1.015	-0.668	-1.217	1.549	-0.786	-0.343	1.348	-0.255
African American	2.254	1.451	1.554	3.000	2.316	1.295	2.859	1.943	1.471
Other Race	3.761	2.603	1.445	12.859***	3.753	3.426	-1.147	3.097	-0.370
Hispanic	2.023	2.462	0.822	0.367	3.290	0.112	5.312	3.882	1.368
Gender	0.630	1.225	0.514	0.038	1.868	0.020	0.068	1.602	0.042
Age	-0.092***	0.038	-2.447	-0.088	0.058	-1.523	-0.079	0.049	-1.593
Sample Size	1,209			583			626		

Heteroscedasticity robust standard errors are reported; Significance codes:  $p \leq 0.1$  \*;  $p \leq 0.05$  \*\*;  $p \leq 0.01$  \*\*\*

While the primary goals of the model are to determine the effect of program completion on dietary improvements and whether this effect depends on access to supermarkets, it is useful to address estimates from other model covariates. With few exceptions these estimates are not significantly different from zero. In the sample of all participants regardless of educational attainment, there is a small but statically significant and negative effect of age. The point estimate for SNAP participation is positive regardless of supermarket access. Those reporting as “other race” and having no supermarket access exhibited statistically significant improvement in HEI. However, only 2.15% of the overall sample reported as race as other than white or African American and so it would seem that this population may have experienced positive program effects not captured by this model.

#### *African American Subsample Analysis*

Table 4.3 reflects the results of analysis for the African American subsample. Again the table presents estimates the African American subsample and from models containing participants without and with access to supermarkets. Among this group there is no significant graduation effect except in the sample with access to supermarkets. The first three columns of table 4.3 report the effect of completing EFNEP for the entire African American subsample, regardless of food access. The estimated effect of having completed the program is 2.812 HEI points, but this is not statistically different from zero at conventional levels of significance. Graduation had no measurable effect among the African American sample with no access to supermarkets as shown in the middle three columns of Table 4.3. The effect amongst the African American population without

access to supermarkets is very close to zero (-0.056). However, the effect estimated from the subsample with access to supermarkets reported in the final three columns of the table is positive and statistically significant. The estimated HEI improvement of having completed the program among the African American sample with access to supermarkets is 4.884 and is almost identical to the corresponding estimate reported earlier in Table 4.2. Again, as in the entire sample, there is evidence from the African American subsample that the benefits of completing EFNEP depend on the food environment.



**Table 4.3: African American Subsample Analysis**

	Entire Sample			No Access to Supermarkets			Access to Supermarkets		
	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value
Intercept	-8.491	5.548	-1.530	-9.327	8.844	-1.055	-10.038	6.313	-1.590
Complete	2.812	1.772	1.587	-0.056	3.097	-0.018	4.884**	2.219	2.201
Income	0.001	0.001	0.620	-0.001	0.002	-0.354	0.001	0.002	0.917
Highest Grade Less than 12th	-0.212	1.510	-0.140	0.522	2.358	0.221	-1.322	2.018	-0.655
SNAP	2.441**	1.245	1.960	2.442	1.887	1.294	4.065**	1.612	2.522
WIC	-0.826	1.382	-0.598	-2.550	2.261	-1.128	0.564	1.746	0.323
Hispanic	14.979***	4.833	3.099	15.946***	5.053	3.156	23.897**	3.559	6.714
Gender	4.426***	1.626	2.722	5.095*	2.879	1.770	3.097	1.980	1.564
Age	-0.067	0.046	-1.462	-0.088	0.073	-1.204	-0.031	0.058	-0.536
Sample Size	747			339			408		

Heteroscedasticity robust standard errors are reported; Significance codes:  $p \leq 0.1$  \*,  $p \leq 0.05$  \*\*,  $p \leq 0.01$  \*\*\*

Across the estimates reported in Table 4.3, the coefficient estimate for being a SNAP recipient is positive and is statistically significant in the entire sample of African Americans and for the subsample with access to supermarkets. This is evidence that SNAP benefits are positively associated with changes in HEI from entry to exit of the program. Because SNAP benefits provide users with increased income per month with which to purchase food, this finding may suggest that for this African American subsample, food buying capacity and resources matter in addition to the food environment. Among the African American subsample, the coefficient estimate for Hispanic seems startlingly high, it should be noted that only 0.40% of the members of this subsample report as Hispanic, meaning that these number reflect HEI change for a group of fewer than 3 individuals.

Overall, the idea that food access matters is reinforced by the findings reported for the African American subsample. In fact, the importance of supermarket access is even more pronounced than in the analysis of the entire study sample. Members of the subsample with no access to supermarkets, i.e., rural participants who did not have a supermarket within ten miles of their residential census block and urban participants who did not have a supermarket within one mile of their residential census block, experienced no statistically significant completion effect unless they had access to supermarkets.

#### *Urban Subsample Analysis*

The pattern of food access making a difference continues to manifest in the analysis of the urban subsample. Table 4.4 displays the results estimated from subsamples

homogenized to include only urban participants. In the urban subsample, there is, on average, a statistically significant improvement in HEI by 3.946 for those completing EFNEP. However, consistent with findings reported above, the graduation effect, is even larger among the sample with access to supermarkets. In fact, the estimated completion effect 5.169 HEI points, is the largest reported from any subsample. This estimate is statistically significant at the 5% level. The completion effect is lower at 3.471 HEI points for the sample without access to supermarkets, again providing strong evidence to suggest that food access matters to program effectiveness among the urban population of this study.

**Table 4.4: Urban Subsample Analysis**

	Entire Sample			No Access to Supermarkets			Access to Supermarkets		
	Coefficient	Standard Error	t-value	Coefficient	Standard Error	t-value	Coefficient	Standard Error	t-value
Intercept	-4.742	5.570	-0.852	-4.679	7.268	-0.644	-14.860***	3.716	-3.999
Complete	3.946**	1.590	2.483	3.471	2.354	1.475	5.169**	2.205	2.344
Income	0.000	0.001	-0.371	-0.001	0.001	-1.251	0.001	0.001	0.839
Highest Grade Less than 12th	-0.592	1.164	-0.509	0.747	1.708	0.437	-1.601	1.626	-0.984
SNAP	0.442	1.079	0.410	0.621	1.503	0.413	1.252	1.468	0.853
WIC	-0.747	1.109	-0.674	-1.548	1.638	-0.945	0.134	1.514	0.089
African American	1.665	1.735	0.960	2.476	2.653	0.933	2.708	2.250	1.203
Other Race	3.391	2.880	1.178	13.781***	4.024	3.424	-1.648	3.332	-0.495
Hispanic	-0.240	2.328	-0.103	0.508	3.264	0.156	1.315	3.816	0.345
Gender	0.730	1.332	0.548	0.412	1.957	0.211	-0.281	1.785	-0.158
Age	-0.117***	0.045	-2.596	-0.112*	0.064	-1.747	-0.083	0.061	-1.358
Sample Size	1,000			522			478		

Heteroscedasticity robust standard errors are reported; Significance codes:  $p \leq 0.1$  \*;  $p \leq 0.05$  \*\*;  $p \leq 0.01$  \*\*\*

The urban subsample population reporting race as other than white or African American and lacking access to supermarkets exhibited a positive change in HEI by 13.781 and was statically significant at the 10% level. Nevertheless, only 2.30% of this 1,000-person subsample falls into the “other race” category. Thus, this finding could reflect a large change amongst a small number of individuals.

As in the sample as a whole, there is a statistically significant and negative impact of age on change in HEI. The coefficient for age for the entire urban subsample is -0.117 and is -0.112 for the sample without access to supermarkets. These estimates are statistically significant at the 10% and 5% respectively. Though the average age of the urban subsample is 36.99, the results suggest that EFNEP participants who join the program at older ages experience a lower HEI change. Because EFNEP welcomes participants of all ages, this finding may suggest that participants of varying ages receive varying levels of benefits from participating in the same program and learning from the same curriculum.

### *Summary of Results*

The final study sample from Arkansas EFNEP program years 2013 and 2014 was largely urban and largely African American. For this reason, models were estimated from African American and urban subsamples in addition to the full study sample. Across the estimated models, there is robust evidence that the effect of graduation from EFNEP, as represented by the “complete” coefficient in tables 4.2 to 4.4 is positive in terms of changes to HEI. Without regard to supermarket access, the positive change in HEI was 4.022 in the entire sample and 2.812 points in the African American subsample and 3.946 in the urban subsample, respectively. Again, this

is without regard to supermarket access. These estimates for the entire sample and urban subsample were statistically significant, at the 1% and 5% levels respectively.

Though results show that graduation from the EFNEP program, on average, positively impacts change in HEI, it is also apparent that the food environment plays a role shaping those same program outcomes. In the full sample, there is a more pronounced change in HEI for the population that has access to supermarkets when compared to those that do not. In the African American subsample there is no significant effect of completing EFNEP unless the participants had access to a supermarket. A similar pattern emerges in the urban subsample. While the entire sample improves on average, it can be observed that the population with access to supermarkets experienced more dramatic and more statistically significant improvement in HEI. These results support the hypothesis that food environment when measuring EFNEP effectiveness.

Appendix B of this thesis presents tables analogous to the ones discussed here – for the entire sample, and for the African American and urban subsamples. These tables in the appendix include results from a study sample that including data points deemed outliers for this analysis. Specifically, these tables show results from a study sample where no outliers were excluded on the basis of self-reported monthly income or biological plausibility of calories consumed in the dietary recall period. The rationale for excluding outlying observations can be found in the third chapter of this report. While the estimates reported in the appendix differ in magnitudes and significance levels from those reported above, the overall conclusions remain unchanged. These are that: (1) On average changes in HEI are larger for those that complete EFNEP, and (2) The program is even more effective amongst populations with access to supermarkets.

## V. Conclusions

Viewed as a whole, the participants in this study sample show an improvement in HEI after their graduation from the EFNEP program. The positive graduation effect, however, is more pronounced in the populations that have access to supermarkets. That result is particularly strong and statistically significant in the African American subsample, and also holds true in the subsample of urban-classified census blocks. The only members of the African American population included in this study that displayed improvement in HEI after graduating from EFNEP had access to supermarkets. The conclusion of this thesis is that participation in EFNEP leads to an improvement in diet upon program graduation, but also that food access matters to the magnitude of this improvement. Specifically, there is evidence that participants who have access to supermarkets experience a higher level of program effectiveness as measured in improvement to their HEI.

The conclusions of this study will serve to inform decisions regarding the administration of the EFNEP program in the state of Arkansas, and will be broadly applicable to the national body of research examining EFNEP and other nutrition education programs. By determining the impact of the commercial food environment on program outcomes, the administrators of EFNEP will achieve a deeper level of understanding about how the implementation of this nutrition education holistically impacts individuals and communities. This increased understanding can lead to adjustments in program implementation, or adaptations in the allocation of resources to facilitate of maximum impact.

From a policy perspective, this thesis research suggests three things: **(1) That the EFNEP program is a good investment in public health.** Not only does previous literature show that EFNEP is cost effective, this thesis corroborates the assertion that graduation from

EFNEP leads to improvements in participants' diets. Previous research supports the linkage between improvements in diet, decreased risk of chronic disease, and thus decreased potential for healthcare spending in the future.<sup>25</sup> Currently, the EFNEP program exists in a minority of Arkansas' 75 counties. The findings of this study provide a basis to conclude this program has the potential to benefit more participants with an increased reach within the state.

**(2) EFNEP is more effective for participants with access to supermarkets. EFNEP should consider integrating the food environment into their holistic approach to community nutrition education.** This approach for this integration merits further study and exploration, but could include programming that seeks to educate participants about food-buying options compatible with their geography, income, and preferences. Integrating the food environment into EFNEP could extend to including lessons such as *Cooking Matters at the Store* as part of ESBA curriculum.<sup>37</sup> EFNEP administrators and professionals should also consider the role that local food system interventions such as school or community gardens, farmers markets, and offering SNAP redemption at farmers markets, can play in increasing access to healthy foods in underserved, low access food areas. While such interventions may be outside the scope of the EFNEP program, the opportunity could exist to form innovative partnerships with other state, local, or federal programs seeking to increase food access.

**(3) Future research is needed to further understand the role of food access as it impacts nutritional behaviors in general and change in HEI specifically.** It was outside the scope of analysis in this thesis to include all components of the food environment. Future research should consider the impact that access to convenience stores, dollar stores, specialty and ethnic stores, and farmers markets has on dietary outcomes as well as the role of supermarkets. Also, this study focused primarily on secondary, empirical data, but a study that included data



collection directly from participants, such as focus groups, could potentially gain more insight into participants' perception about access to healthy food in Arkansas. It would also be useful to apply this research framework to a larger sample of the EFNEP population. Because EFNEP operates in every state, a national or regional analysis of the role of food access in EFNEP would provide an even broader evidence base from which to draw conclusions. Furthermore, because the question of food access is a national one, EFNEP as a program could benefit from a concerted effort to promote, support, and curate projects such as these seeking to address questions related to the food environment.

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## Appendix A

*This code was used to geocode EFNEP participants to find the census block of residence reported during the EFNEP program. Geocoding is described in-depth in the chapter 3: methods.*

```
#load required package libraries
library(rjson)

library(stringr)

#define the function

get.block <- function(ID,lat,lon) {
temp1 <- substr(fromJSON(file =
paste("http://data.fcc.gov/api/block/2010/find?format=json&latitude=",
      lat,
      "&longitude=",
      lon,
      sep=""),
      method = "C", unexpected.escape = "error" )[1],14,28)
temp2 <- str_pad(ID,width=6,pad="0")
out <- t(c(temp1,temp2))
write(out,file="/Users/rachelspencer/Documents/AGEC/Thesis Topic
Research/EFNEPoutput.txt",append=TRUE)
out
}

#the function call

get.block(xx,yy)
```

***This code was used to reconcile the different EFNEP Datasets and create one file containing the study sample for final analysis. The methods chapter outlines further details about the steps contained within this code text. Code for the program year 2013 is presented below. Similar code was executed for program year 2014.***

```
####Commands for creating R objects/read in 2013 EFNEP data
```

```
recall2013<-
```

```
read.csv(file="/Users/rachelspencer/Documents/AGEC/Recalls2013.csv",head=TRUE, sep=",")
```

```
adultpublicassistance2013<-
```

```
read.csv(file="/Users/rachelspencer/Documents/AGEC/AdultPublicAssistance2013.csv",head=TRUE, sep=",")
```

```
childnut<-adultpublicassistance2013[which(adultpublicassistance2013$PubAsstProg=="Child Nutrition"),]
```

```
childnut$childnutrition=1
```

```
childnut$childnutritiontype=childnut$PubAsstType
```

```
childnut<-
```

```
subset(childnut,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","childnutrition","childnutritiontype"))
```

```
fdpir<-adultpublicassistance2013[which(adultpublicassistance2013$PubAsstProg=="FDPIR"),]
```

```
fdpir$fdpir=1
```

```
fdpir$fdpirtype=fdpir$PubAsstType
```

```
fdpir<-
```

```
subset(fdpir,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","fdpir","fdpirtype"))
```

```
headstart<-adultpublicassistance2013[which(adultpublicassistance2013$PubAsstProg=="Head Start"),]
```

```
headstart$headstart=1
```

```
headstart$headstarttype=headstart$PubAsstType
```

```
headstart<-
```

```
subset(headstart,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","headstart","headstarttype"))
```

```
other<-adultpublicassistance2013[which(adultpublicassistance2013$PubAsstProg=="Other"),]
```

```
other$other=1
```

```
other$othertype=other$PubAsstType
```

```
other<-
```

```
subset(other,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","other","othertype"))
```

```
snap<-adultpublicassistance2013[which(adultpublicassistance2013$PubAsstProg=="SNAP"),]
```

```

snap$snap=1
snap$snatype=snap$PubAsstType
snap<-
subset(snap,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","snap","snatype"))

tanf<-adulpublicassistance2013[which(adulpublicassistance2013$PubAsstProg=="TANF"),]
tanf$tanf=1
tanf$tanftype=tanf$PubAsstType
tanf<-
subset(tanf,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","tanf","tanftype"))

tefap<-adulpublicassistance2013[which(adulpublicassistance2013$PubAsstProg=="TEFAP - Commodity"),]
tefap$tefap=1
tefap$tefaptype=tefap$PubAsstType
tefap<-
subset(tefap,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","tefap","tefaptype"))

wiccsfp<-
adulpublicassistance2013[which(adulpublicassistance2013$PubAsstProg=="WIC/CSPF"),]
wiccsfp$wiccsfp=1
wiccsfp$wiccsfpftype=wiccsfp$PubAsstType
wiccsfp<-
subset(wiccsfp,select=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID","wiccsfp","wiccsfpftype"))

##merged all the counts of program binaries from above --> repeat for 2014

adulpublicassistancefixed2013<-Reduce(function(x,y)
  merge(x,y,by=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID"),all=TRUE),
  list(childnut,fdpir,snap,headstart,other,tanf,tefap,wiccsfp))

##replacing NA values with 0--> repeat for 2014

adulpublicassistancefixed2013[is.na(adulpublicassistancefixed2013)]<-0

temp<-
merge(adulpublicassistancefixed2013,adul2013,by=c("Region_ID","Region_Name","Adult_ID","Adult_Custom_ID"),all=TRUE)
summary(temp)

temp[which(is.na(temp$snap)),c("Adult_ID","Adult_Custom_ID","snap")]
adulpublicassistance2013[which(adulpublicassistance2013$Adult_Custom_ID==119198),]

```

```
#####rename Adult Custom ID on the Adult 2013 file
```

```
adult2013rename<-adult2013  
names(adult2013rename)[names(adult2013rename)=="Adult_Custom_ID"]<-  
"Adult_Custom_ID2"  
names(adult2013)  
names(adult2014)
```

```
#Rename Adult custom ID on the recall2013 data, also rename Is_Nursing and Is_Pregnant  
because these variables/columns are in the  
#adult2013 file and the recall file  
#Adult 3 for 3 EFNEP files
```

```
recall2013rename<-recall2013  
names(recall2013rename)[names(recall2013rename)=="Adult_Custom_ID"]<-  
"Adult_Custom_ID3"  
names(recall2013rename)[names(recall2013rename)=="Is_Nursing"]<- "Is_Nursingrecall"  
names(recall2013rename)[names(recall2013rename)=="Is_Pregnant"]<- "Is_Pregnantrecall"
```

```
#merge three files together  
combined2013<-  
merge(adultpublicassistancefixed2013,adult2013rename,by=c("Region_ID","Region_Name","A  
dult_ID"),all=TRUE)  
combined2013<-  
merge(combined2013,recall2013rename,by=c("Region_ID","Region_Name","Adult_ID"),all=T  
RUE)
```

```
## checking to make sure custom ID's match  
combined2013$check<-  
ifelse(combined2013$Adult_Custom_ID2==combined2013$Adult_Custom_ID3,1,0)  
summary(combined2013$check)
```

```
#get rid of the ID's leading in "p", got rid of the extra backtick  
#removed all leading trailing spaces  
combined2013$pid<-sub("\s+$","",sub("^\s+","",combined2013$Adult_Custom_ID2))  
combined2013$pid<-gsub("p","",combined2013$pid)  
combined2013$pid<-gsub("","",combined2013$pid)
```

```
#padding with 0 -> added 4 zeroes to everything, then need to take the last 7 digits, extracting the  
last end characters from the string  
combined2013$pid<-paste("0000",combined2013$pid,sep="")  
combined2013$pid<-substr(combined2013$pid,nchar(combined2013$pid)-  
6,nchar(combined2013$pid))  
table(nchar(combined2013$pid))
```



```

####Read in the csv file containing the census block IDs, and pad 0 if necessary
####census2013
census2013<-
read.csv(file="/Users/rachelspencer/Documents/AGEC/EFNEPOutput2013.csv",head=FALSE,

col.names=c("Adult_Custom_ID","GEOID10"),colClasses=c("character","character"),sep=",")

census2013$pid<-paste("0",census2013$Adult_Custom_ID,sep="")
census2013$pid<-substr(census2013$pid,nchar(census2013$pid)-6,nchar(census2013$pid))
table(nchar(census2013$pid))

census2013<-census2013[,c("pid","GEOID10")]
census2013<-census2013[which(census2013$GEOID10!="ULL"), ]

geo2013<-merge(combined2013,census2013,by="pid",all=TRUE)
#aded year for clarification <- for 2014 as well
geo2013$year=2013
##Up to this point, everything must be replicated almost exactly
#foreign characters like the p and the backtick may be an issue

stores<-read.dbf("/Users/rachelspencer/Documents/AGEC/Thesis Topic
Research/Blocks_Analysis.dbf", as.is = TRUE)
summary(nchar(stores$GEOID10))
stores2013<-merge(geo2013,stores,by="GEOID10",all=TRUE)

table(stores2013$Supr_ct_h,stores2013$snap)
table(nchar(stores$GEOID10))
table(nchar(geo2013$GEOID10))
geo2013$GEOID10
nchar(table)
table(stores2013$snap)

table(adultpublicassistance2013$PubAsstProg)

combined2013[,c("Adult_Custom_ID","Adult_Custom_ID2","Adult_Custom_ID3")]
subset(combined2013,select=c("Adult_Custom_ID","Adult_CustomID2","Adult_Custom_ID3")
)

combined2013$Adult_Custom_ID3

summary(combined2013$Adult_Custom_ID2)
combined2013$check

#reading in Grant's .dbf file
summary(read.dbf("/Users/rachelspencer/Documents/AGEC/Thesis Topic
Research/Blocks_Analysis.dbf"))

```

```
table(adultpublicassistance2013$PubAsstLevel,adultpublicassistance2013$PubAsstProg)
summary(adultpublicassistance2013$FoodAsst)
```

```
fixedpubasst2013<-merge(childnut,fdpir,headstart,other,snap,tanf,tefap,wiccsfp)
```

```
adult2013<-
read.csv(file="/Users/rachelspencer/Documents/AGEC/Adult2013.csv",head=TRUE,
          sep=",")
```

```
summary(as.data.frame(table(adult2013$Adult_ID)))
summary(as.data.frame(table(adult2013$Adult_Custom_ID)))
```

## APPENDIX B

These tables, discussed above in chapter 4 include sample participants having implausible (outlier) values for income or calorie consumption. These results suggest that the conclusion that food access contributes to EFENEP effective is robust to the inclusion of implausible values.

**Table B.1: Entire Sample Analysis**

	Entire Sample			No Access to Supermarkets			Access to Supermarkets		
	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value
Intercept	-6.191*	3.500	-1.769	-2.844	5.369	-0.530	-12.825***	4.537	-2.827
Complete	2.983**	1.281	2.329	2.246	1.951	1.151	3.765**	1.668	2.257
Income	0.000	0.001	-0.059	-0.002**	0.001	-1.955	0.002**	0.001	1.963
Highest Grade Less than 12th	-0.869	0.970	-0.896	0.210	1.384	0.152	-1.820	1.375	-1.324
SNAP	1.477*	0.900	1.640	0.106	1.293	0.082	3.115**	1.232	2.529
WIC	-0.617	0.932	-0.662	-0.568	1.370	-0.414	-1.180	1.295	-0.911
African American	2.050	1.279	1.603	2.230	1.879	1.187	3.180	1.774	1.792
Other Race	3.842	2.650	1.450	11.546***	3.804	3.035	0.825	3.150	0.262
Hispanic	2.239	2.526	0.887	-1.142	3.558	-0.321	7.541	3.577	2.108**
Gender	0.111	1.174	0.095	-0.493	1.752	-0.281	-0.568	1.549	-0.367
Age	-0.053	0.033	-1.591	-0.028	0.048	-0.569	-0.063	0.045	-1.412

Significance codes:  $p \leq 0.1$  \*;  $p \leq 0.05$  \*\*;  $p \leq 0.01$  \*\*\*

Table B.2: African American Subsample Analysis

	Entire Sample			No Access to Supermarkets			Access to Supermarkets		
	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value	Estimate	Standard Error	t-value
Intercept	-7.376*	3.872	-1.905	-4.329	6.870	-0.630	-11.675***	4.319	-2.703
Complete	1.770	1.562	1.133	-0.199	2.491	-0.080	3.825*	2.019	1.895
Income	0.001	0.001	1.156	0.000	0.001	0.114	0.002	0.001	1.045
Highest Grade Less than 12th	1.352	1.367	0.989	2.192	2.109	1.040	0.166	1.846	0.090
SNAP	1.215	1.119	1.086	-0.024	1.664	-0.014	3.011*	1.535	1.962
WIC	-0.732	1.261	-0.581	-2.081	1.941	-1.072	0.012	1.684	0.007
Hispanic	14.751***	2.966	4.973	16.048***	3.672	4.370	20.066***	6.341	3.164
Gender	2.836*	1.631	1.739	2.624	2.855	0.919	1.963	1.959	1.002
Age	-0.036	0.040	-0.889	-0.041	0.060	-0.671	-0.008	0.053	-0.151

Significance codes:  $p \leq 0.1$  \*;  $p \leq 0.05$  \*\*;  $p \leq 0.01$  \*\*\*

Table B.3: Urban Subsample Analysis

	Entire Sample			No Access to Supermarkets			Access to Supermarkets		
	Coefficient	Standard Error	t-value	Coefficient	Standard Error	t-value	Coefficient	Standard Error	t-value
Intercept	-3.841	3.932	-0.977	-3.042	5.543	-0.549	-11.134**	5.148	-2.163
Complete	2.454*	1.432	1.714	2.040	2.024	1.008	3.301**	2.007	1.644
Income	0.000	0.001	-0.101	-0.001	0.001	-1.185	0.001	0.001	1.098
Highest Grade Less than 12th	-0.615	1.071	-0.574	0.823	1.503	0.548	-2.251	1.561	-1.442
SNAP	0.708	0.975	0.727	0.591	1.355	0.436	1.538	1.391	1.105
WIC	-0.831	1.028	-0.809	-1.107	1.467	-0.755	-0.874	1.440	-0.607
African American	0.937	1.546	0.606	1.662	2.201	0.755	2.663	2.228	1.195
Other Race	1.510	2.708	0.558	12.777***	4.134	3.091	-2.663	3.095	-0.860
Hispanic	-0.875	2.451	-0.357	-2.298	3.754	-0.612	2.952	3.330	0.887
Gender	-0.208	1.265	-0.164	-0.659	1.834	-0.359	-0.950	1.688	-0.563
Age	-0.071*	0.039	-1.795	-0.040	0.055	-0.731	-0.096*	0.057	-1.696

Significance codes:  $p \leq 0.1$  \*;  $p \leq 0.05$  \*\*;  $p \leq 0.01$  \*\*\*