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Assessing the Effectiveness of the Expanded Food and Nutrition Education Program on Diet Quality as Measured by the Healthy Eating Index 2005

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ASSESSING THE EFFECTIVENESS OF MAINE EXPANDED FOOD AND NUTRITION EDUCATION PROGRAM ON DIET QUALITY AS MEASURED BY HEALTHY EATING INDEX 2005

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An Abstract of the Thesis Presented
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Background: The Expanded Food and Nutrition Education Program (EFNEP) is a federally funded program through the United States Department of Agriculture that offers nutrition education to low income families across the U.S.

Purpose: This study assessed the effectiveness of Maine EFNEP on food-related behavior change and diet quality as measured by the Healthy Eating Index-2005 (HEI). This study also explored the relationship between the results on the HEI and participation in food assistance programs such as Supplemental Nutrition Assistance Program (SNAP) and Women, Infants, and Children (WIC), as well as the number of hours spent in the program.

Methodology: This study was a pre-post-secondary analysis of data gathered from WebNEERS, the database utilized by EFNEP. Diet recall data from fiscal years 2013-2016 were utilized to derive a healthy eating index score and sub-scores for each food group. T-tests and Ordinary Least Squares regressions were used to analyze data. Statistical analysis was conducted using STATA Special Edition 14.1.

Results: Total HEI score and sub-scores improved pre- to post-EFNEP at the 1% level, except for saturated fat, which improved at the 5% level. Sodium and total grains scores decreased post-EFNEP (p=.003) and (p=.05) respectively. Women, Infants, and Children (WIC) or Supplemental Nutrition Assistance Program (SNAP) participation had no effect on HEI scores. Less than 7 hours in the program was associated with a smaller improvement in total HEI score (p=.05) and a reduction in the sodium score (p=.03), when compared to spending 7-16 hours in the program.

Conclusion: EFNEP is effective in improving the diet quality of Maine participants

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CHAPTER 1

INTRODUCTION

Food security is defined as access by all people at all times to enough food for an active, healthy lifestyle.[1] In the United States, not all Americans have access to enough food to feed themselves or their household. This is known as food insecurity. As of 2016, 12.3% (15.6 million) of American households were reported as food insecure. Within this population, 4.9% (6.1 million) of those households are classified as very low food security.[1] The prevalence of household food insecurity in the state of Maine is significantly above the national average at 16.4%, with 7.4% having very low food security.[1] The adverse outcomes of food insecurity are well established. Individuals and families who are food insecure are at a higher risk for physical and mental health disparities, such as obesity, diabetes, and depression, as compared to those who have consistent access to healthy food.[2] Often, the food insecure population consumes calorie-dense, highly processed foods rather than nutrient-dense foods such as fruits, vegetables, and whole grains. Processed, high-calorie foods are often within reach of food insecure families due to their abundance and low price. The relationship between food insecurity and health disparities warrants public health action in the forms of education and public assistance.[3]

The Expanded Food and Nutrition Education Program (EFNEP) is a federally funded program through the United States Department of Agriculture's (USDA) National Institute of Food and Agriculture (NIFA) that offers nutrition education to low income families across the United States.[4] EFNEP operates through Cooperative Extension at Land-Grant Colleges and Universities (LGUs) to reach over 500,000 limited-resource families per year. The program was developed in 1969 to aid the low-income population in acquiring the knowledge, skills, and

behaviors necessary to facilitate a healthy diet, and improve the overall well-being of participants and families.[4] EFNEP utilizes a paraprofessional model when recruiting and educating low-income families in the community setting.[4] This educational model allows for local paraprofessionals to deliver a series of interactive nutrition education lessons. The use of local paraprofessionals is justified on the premise that education from members of one's community will help enhance rapport and credibility of the program with its participants,[5] thus, facilitating behavior change and the improvement of one's dietary intake. Maine EFNEP uses the Eating Smart, Being Active (ESBA) curriculum to deliver nutrition education. ESBA was created based on the Adult Learning Theory and Social Cognitive Theory.[6] This curriculum is evidence-based and tailored to focus on the core areas of EFNEP: diet quality, physical activity, food resource management, food safety, and food security.[4] EFNEP uses a pre-test and post-test for all graduates to assess diet and behavior change related to nutrition.

To evaluate the effectiveness of EFNEP, all paraprofessionals nationally collect the same information from adult participants to allow for national analysis. Information collected upon entry includes demographic information, a behavior checklist, and a 24-hour diet recall. Exit surveys include the same behavior checklist and 24-hour diet recall. The behavior checklist is intended to assess behavior change, while the 24-hour diet recall is designed to identify a change in diet quality using the Healthy Eating Index (HEI). The HEI is an index created by the USDA to determine conformance to the Dietary Guidelines for Americans.[7] In 2016, the nation's average HEI score was 59 out of 100; increasing by nearly 10 points since 1999.[7] Because the percentage of food insecure people in Maine is higher than the national average of 12.3%, nearly 95,000 households in Maine are at risk for health disparities that can be prevented or delayed by a nutritious diet.[1] Assessing the effectiveness of EFNEP on food-related behavior change and the

diet quality of Maine's low income population is key to ensuring program longevity and improved population health and well-being.

Research Question

How does the Maine Expanded Food and Nutrition Education Program (EFNEP) affect the diet quality of participants, as measured by Healthy Eating Index (HEI)?

Research Sub-Questions

Among Maine participants who completed and graduated from EFNEP

1. What are the demographic, socio-economic, and geographic characteristics?
2. What are the results of the HEI pre-EFNEP?
3. What are the results of the HEI post-EFNEP?
4. What is the difference in HEI score and sub-scores from pre- to post-EFNEP?
5.
    A. Does participation in SNAP or WIC affect the HEI score or sub-scores of Maine EFNEP participants?
    B. Was there a difference in HEI score or sub-score change for EFNEP participants who also participated in WIC, SNAP, or both?
6.
    A. Do number of hours in the program affect the HEI score or sub-score of Maine EFNEP participants?
    B. Was there a difference in HEI score or sub-score change between those who participated in the program for less than 7 hours or more than 16 hours as compared to those that spent 7-16 hours in the program?

CHAPTER 2

LITERATURE REVIEW

Food Insecurity and Diet Quality

In 2006, the USDA created new language to describe the broad spectrum of food insecurity. The USDA labels to describe the severity of food insecurity include: high food security, marginal food security, low food security, and very low food security.[8] High and marginal food security are both categorized as food secure, with minimal indication of food access problems or limitations. Low food security is characterized by reports of reduced quality, variety, or desirability of diet, and little to no indication of reduced food intake. Very low food security is described by reports of multiple indications of disrupted eating patterns and reduced food intake. Very low food security was formerly labeled as food insecurity with hunger.[8] Upon the adoption of this new language, the Committee on National Statistics (CNSTAT) suggested that the USDA make a clear distinction between food insecurity and hunger. The USDA moved to define food insecurity as the condition assessed in the food security survey and represented in USDA food security reports as a household-level economic and social condition of limited or uncertain access to adequate food, while defining hunger as an individual-level physiological condition that may result from food insecurity. Also, the CNSTAT concluded that the term hunger should be used to refer to discomfort, illness, weakness, or pain that goes beyond the typical sensation, due to prolonged, involuntary lack of food.[8]

Food insecurity has a considerable effect on diet quality. Food insecurity can be defined by a range of circumstances; one being the lack of geographical access to healthy food, or inability to purchase healthy food. Many food insecure individuals and families opt to purchase less-expensive, energy-dense foods with little nutritional value. Food insecurity has been

associated with decreased consumption of fruits, vegetables, and whole grains.[2] According to the USDA Economic Research Service, in 2016, 76% of low food security individuals and 94% of very low food security individuals stated that they could not afford a balanced meal.[8] Poor diet quality can leave a person malnourished or nutrient-deficient and at risk for health disparities such as Type 2 diabetes, cardiovascular disease, and obesity.

The link between diet quality and health disparities can be attributed to minimal consumption of whole, nutrient-dense foods, and overconsumption of processed, energy-dense foods.[9] Energy density is the amount of energy, or calories, per gram of food. Energy-dense foods provide a significant amount of macronutrients per gram from carbohydrates, protein, and fats. In addition, many energy-dense foods are rich in saturated fats and simple carbohydrates, and are deficient in essential nutrients. In contrast, nutrient-dense foods provide a significant amount of micronutrients per gram, with a moderate amount of energy. Micronutrients, or vitamins and minerals, are required by the body to support essential bodily functions such as blood pressure regulation, brain function, digestion, hormone production, and immune function. Processed, energy-dense foods provide a suboptimal ratio of essential nutrients to energy. Therefore, increasing the risk of nutrition-related diseases.[10] To achieve optimal health, the proper combination of macronutrients and micronutrients is essential.[10]

The perception that whole foods, such as fresh produce and meats, are more expensive and out of reach for food insecure families is widely accepted along with the idea that processed foods are more affordable.[11] Therefore, many food insecure families choose processed foods when shopping because they lack knowledge about how to shop healthy on a budget. The notion that a healthy diet is entirely out of reach for low-income families is false. Rao and colleagues conducted a systematic review and meta-analysis of prices of healthy versus unhealthy diet

patterns. The researchers concluded that the price difference between a healthy diet and a processed, unhealthy diet was about $1.50 per day per person.[11] This amount is a hardship for low-income families to overcome, however, the fiscal gap can be closed or decreased with education. Educational interventions that teach shopping skills can improve nutrition outcomes, which have been shown to increase overall quality of life. [12]

Nutrition and Quality of Life

Meeting nutritional needs has a considerable effect on physical wellness. A nutritionally sound diet can prevent disease and promote optimal physical function. However, the power of good nutrition has been shown to reach much further than positive physical outcomes. Adequate nutrition can increase, or stabilize, a person's overall quality of life and well-being. Health-related quality of life (HRQOL) encompasses physical, mental, and emotional well-being and is a primary marker of life satisfaction.[12] In many cases, a diminished HRQOL can be prevented and treated through various interventions, including nutrition education and medical nutrition therapy (MNT). It is important that healthcare professionals inquire with their patients about their HRQOL due to its subjective nature. It is also vital for healthcare professionals to recognize that HRQOL cannot simply be addressed by assessing physical and mental health; emotional and social well-being must also be considered.[12] For example, the amount of choice one has related to their own food consumption, or how much they enjoy the food they eat can impact their emotional well-being. In a paper centered on the relationship between nutrition and quality of life in the elderly population, Amarantos and colleagues suggest that good nutrition can dramatically improve one's quality of life.[12] A sound diet promotes the longevity of one's functional status and prevents dietary-related diseases. In addition, a quality diet contributes to sensory and psychological pleasures. The authors highlight the relationship between meal times

and a person's sense of security, meaning, and daily structure. Access to and consumption of quality food contributes to feelings of independence and control over one's own life. In contrast, the authors suggest that excessive dietary intake can decrease HRQOL and trigger mental health problems in obese adults.[12] This indicates that diet quality, on both ends of the spectrum, has a considerable effect on well-being.

Health Disparities within the Low-Income Population

The relationship between diet and disease is one that has been studied and researched across the world for decades. Diet quality largely determines a person's health, growth, and development. Everyday behaviors such as physical activity and tobacco use can modify the health outcomes of a person's diet for better or worse. A person's dietary pattern and lifestyle behaviors are a result of his or her social, cultural, and economic environment.[9] As a result, specific chronic diseases are more prevalent in some areas of the world than others. Food insecure individuals are at higher risk for nutrition-related health disparities such as obesity, Type 2 diabetes, and cardiovascular disease than food secure individuals. These conditions are highly preventable if healthy behaviors are adopted and maintained throughout the course of one's life. However, if a proper diet is not followed and unhealthy lifestyle behaviors are continued, a person could be left highly susceptible to chronic disease. Chronic disease risks begin in the early stages of the life cycle and continue into old age. The manifestation of chronic disease, typically in adulthood, is ultimately the culmination of damaging lifelong behaviors. There has also been evidence that maternal dietary intake during pregnancy has an impact on the chronic disease risk of her offspring. In addition, there is increasing evidence that the use of infant formula over breastfeeding can increase risk factors for cardiovascular disease[7]. The diet-disease risk correlation continues throughout each stage of the life cycle. Although lifelong

factors have a substantial contribution to the risk of chronic disease in adulthood, there remains an opportunity for acquired risk factors to be reversed through diet and behavior change.

The obesity epidemic in the United States has increased dramatically over the past 30 years. Over one-third (36.5%) of American adults are obese, with women having a higher prevalence rate (38.3%) than men (34.3%).[13] There are major differences in the prevalence of obesity by race. Obesity prevalence is highest among non-Hispanic black Americans (48.1%) and lowest among non-Hispanic Asian Americans (11.7%). The significant differences by sex within racial groups are among non-Hispanic black and Hispanic Americans. The prevalence of obesity among non-Hispanic black women is 56.9% while the prevalence in men is 37.5%. In addition, the prevalence of obesity in Hispanic women is 45.7%, and the prevalence in men is 39.0%.[13] Obesity trends have been attributed to increasing industrialization and urbanization in the United States. Increased production of processed foods decreases diet quality, while technological advances facilitate sedentary lifestyles.[9] Both trends contribute to unhealthy lifestyle behaviors that lead to obesity. Mass production and availability of processed foods allow them to be sold in the market at a competitive price, making them fiscally attainable for low-income families. The risk of other health disparities such as cardiovascular disease and Type 2 diabetes is significant in overweight and obese individuals. Therefore, the prevention of obesity can, in turn, prevent the manifestation of chronic diseases.[9]

Cardiovascular disease (CVD) can be characterized by numerous problems related to atherosclerosis. Atherosclerosis is defined as a condition that develops when plaque builds up in the walls of arteries, restricting blood flow. This condition can cause a blood clot and lead to heart attack or stroke. CVD can also cause heart failure, arrhythmia, and heart valve problems. CVD has become increasingly detrimental to the health of humans. The World Health

Organization (WHO) attributes one-third of all global deaths to CVD. Further, the prevalence of CVD related deaths is increased in low-income populations.[9] WHO also suggests that risk factors for CVD have a "lag-time" effect; meaning that present mortality rates are directly related to previous exposure to CVD risk factors. Risk factors for CVD include poor nutrition, lack of physical activity, central obesity, high blood pressure, dyslipidemia, and diabetes. Dietary habits that contribute to CVD include over-consumption of saturated fats, refined carbohydrates and sodium. In addition, poor consumption of fruits, vegetables and whole grains contribute to CVD risk.[9] Avoidance of dietary habits that contribute to CVD requires access to healthy food, which has been noted to be a hardship for 76% of low food security families.[8]

Type 2 diabetes remains one of the top health concerns for the low-income population. Access to enough food does not guarantee food security if access to healthy food is out of reach. Limited food budgets can lead to decreased attainability of healthy food, and can lead to the purchase of cheap, energy-dense food with little nutritional benefit. Unhealthy food purchases among the food insecure population can contribute to weight-gain, hyperglycemia, and eventually Type 2 diabetes.[14] Type 2 diabetes is a result of insulin resistance, or the decreased ability of cells to utilize insulin. This occurs when the body fails to remove glucose from the bloodstream efficiently. The pancreas compensates by increasing the secretion of insulin, but eventually, it cannot keep up and glucose continues to build in the bloodstream. The onset of diabetes is due to a combination of genetic and environmental factors. However, rapidly increasing prevalence rates over the past decade indicate that the onset can be largely attributed to environmental factors.[9] According to the WHO, lifestyle modification is the cornerstone for treatment and prevention of Type 2 diabetes. Education promoting a healthy lifestyle combined with motivational techniques are essential in combating this disease. Examples of nutrition

education programs include EFNEP, the Supplemental Nutrition Assistance Program- Education (SNAP-Ed), and Women, Infants, and Children (WIC).

EFNEP History

EFNEP began in 1969 to assist low income families in acquiring the knowledge and skills necessary to maintain a healthy diet. The genesis of this program stemmed from reports and Congressional Hearings highlighting the growing issue of poverty in the United States.[15] Millions of Americans living at or below the poverty level were struggling to nourish themselves and their families adequately. In response, the Extension Service of the USDA collaborated with State Cooperative Extension Services to develop and implement a new nutrition education program. The goal of EFNEP was "To help families living in or near poverty, especially those with young children, to acquire knowledge, skills, and changes in behavior to achieve adequate diets providing normal nutrition."[15] The USDA and Extension Services created a program that was set apart from welfare and food assistance programs. Rather than providing families with food, EFNEP would educate the low-income population on how to utilize their resources efficiently for a nutritionally sound diet.[15]

EFNEP Structure

The National Office for EFNEP is part of the Institute of Food Safety and Nutrition (IFSN) at the National Institute of Food and Agriculture (NIFA). NIFA is an agency under the Under Secretary for Research, Education, and Economics (REE); a priority area for the USDA.[4] EFNEP requires partnerships at the federal, state, and local level to maintain its effectiveness as a program. The National Office oversees and provides leadership for EFNEP State Coordinators, who then provide leadership for the program at the state level. The EFNEP Coordinator is responsible for hiring, training, monitoring, and developing staff, overseeing program

implementation at the local level, and state-wide data management.[4] EFNEP Coordinators collaborate with other personnel across the state to train, supervise, and evaluate paraprofessional staff. Paraprofessional staff are peer educators hired to implement EFNEP in the communities in which they live. Paraprofessionals deliver interactive, evidence-based nutrition lessons that are tailored to meet the needs of participants. They also work to recruit families to participate through referrals, neighborhood contacts, community organizations, and human service agencies. Local paraprofessionals link healthcare professionals and people of low socioeconomic status, who lack adequate healthcare. A majority of paraprofessionals have experienced similar cultural and social life experiences; therefore, the paraprofessional model is intended to facilitate comfort and trust for the participant. The introduction of paraprofessionals in health education began in the 1960s; EFNEP being the first to implement the educational model.[16] Since then, the use of paraprofessionals in nutrition education has spread to other programs including SNAP-Ed, formerly known as the Food Stamp Nutrition Education Program (FSNE).

In 2009, Perez-Escamilla and colleagues were first to conduct a systematic review of the effectiveness of peer nutrition education on dietary behaviors and health outcomes in the Latino population. The authors concluded that peer nutrition education does have a positive influence on nutrition knowledge and dietary intake among their target population.[16] These findings were similar to results of studies conducted with non-Latino, White and Black adults. Researchers reiterated the importance of using paraprofessionals in health education and suggested that the use of peer education has the potential to address health disparities among minority groups.[16] The structure of EFNEP and its utilization of paraprofessionals is unique to the program, while its curriculum, Eating Smart Being Active (ESBA), has been adopted by many community nutrition education programs.

Eating Smart, Being Active Curriculum

Nationally, state EFNEP coordinators choose the curriculum to be used in their state. Maine EFNEP utilizes the Eating Smart, Being Active curriculum to deliver nutrition education. ESBA is an evidence-based, interactive curriculum developed in 2005 for paraprofessionals to teach low-income adults. ESBA was developed in response to the release of the 2005 Dietary Guidelines for Americans and MyPlate. The development of ESBA was warranted after a needs assessment was conducted to identify state EFNEPs needing new curricula because of the change in dietary guidelines. The curriculum has since been updated in 2010 and revised in 2017 to comply with current dietary guidelines.[17] Developers utilized the Social Cognitive Theory, Socio-Ecological Model, and Adult Learning Principles when creating ESBA.[6] Curriculum content is based directly off the *2015-2020 Dietary Guidelines for Americans* and *MyPlate* and includes nine lessons taught in sequential order that each incorporate dialogue-based lessons and hands-on activities.[17] Lesson content is limited to the core areas of EFNEP: diet quality and physical activity, food resource management, food safety, and food security. Table 1 lists each lesson title and focus.[17]

Table 1: ESBA Lesson Titles and Focus

Lesson Number	Title	Focus
1	*Welcome to Eating Smart, Being Active*	Overview, relationship building between paraprofessional and participants
2	*Get Moving!*	Physical Activity is part of a healthy lifestyle
3	*Plan, Shop, $ave*	How to stretch your food dollars
4	*Fruits & Veggies: Half Your Plate*	How to increase amount and variety of fruits and vegetables

Table 1 Continued

Lesson Number	Title	Focus
5	*Make Half Your Grains Whole*	Identify whole grain foods and why whole grains are beneficial
6	*Build Strong Bones*	Calcium rich foods and weight bearing activity help build strong bones
7	*Go Lean with Protein*	Choosing lean sources of protein and how to keep food safe
8	*Make a Change*	Choosing foods low in fat, sugar, and salt
9	*Celebrate! Eat Smart and Be Active*	Review of key concepts, how to involve family in good food choices and celebrate

In addition, ESBA offers three supplemental lessons focused on maternal and infant nutrition. These lessons are provided to participants as needed. Table 2 lists each lesson title and focus.[17]

Table 2: ESBA Maternal & Infant Nutrition Lessons

Title	Focus
Eating Smart and Being Active During Pregnancy	Designed to be taught early in pregnancy. Covers topics about seeing a healthcare provider, eating healthy, being active, and combating pregnancy discomforts.
Feeding Your New Baby	Designed to be taught late in pregnancy. Covers information on breastfeeding, formula feeding to help women decide how to feed their babies.
Feeding Your Baby Solid Foods	Designed to be taught to mothers of infants. Covers when and how to introduce solid foods.

Initially, the ESBA curriculum was piloted for six months in four states: California, Colorado, Iowa, and South Carolina. After evaluation, the 2007 version of ESBA was created

and implemented by EFNEP and SNAP-Ed programs nationally. ESBA is currently used in over 40 states and US territories by either nutrition education program.[17]

Since its implementation, ESBA has been evaluated numerous times to assess its effectiveness on dietary and behavior change. Auld and colleagues compared EFNEP outcomes of the ESBA curriculum to EFNEP outcomes of prior non-ESBA curricula across five states.[6] To determine whether ESBA was effective in multiple settings, they chose states of varying geographic region and program size: Arkansas, California, Colorado, New York, and Ohio. Researchers reviewed behavior checklists and 24-hour diet recalls to determine the effectiveness of ESBA compared to previously used non-ESBA curricula. Statistical analyses supported the effectiveness of the ESBA curriculum with increasing self-reported positive changes in dietary intake in all states.[6] There were statistically significant reported increases in fruits and vegetables. The average daily fruit consumption of participants after non-ESBA education was 1.1 cups, while the average daily fruit consumption of ESBA participants was 1.3 cups ($p < 0.001$). In addition, vegetable consumption of non-ESBA participants was 1.3 cups, and the average daily consumption of vegetables for ESBA participants was 1.5 cups ($p < 0.001$). Overall, when ESBA program outcomes were compared with other curricula, it was found that ESBA was equal to or more effective than non-ESBA program outcomes.[6]

Evaluation of Diet Quality

24-Hour Diet Recalls

Auld and colleagues utilized pre- and post- behavior checklists and 24-hour diet recalls to assess the effectiveness of ESBA in their study. Today, each EFNEP participant still completes a pre-and post- behavior checklist and 24-hour diet recall. The behavior checklist is intended to identify behavior change related to diet quality, physical activity, food resource management,

food safety, and food security as a result of the program. The 24-hour diet recalls strictly evaluate the participants' diet quality before and after program completion. The 24-hour diet recall has been used as an evaluation technique since the program's initiation in 1969.[18] At that time, paraprofessionals worked one on one with EFNEP participants in their own homes. Paraprofessionals gathered diet recall information by asking probing questions to help the clients recall foods and amounts eaten.

In 1980, a report from the United States General Accounting Office (GAO) suggested that the EFNEP program expand its delivery methods to a group setting for cost efficiency.[18] Since the program's evolution to a group education model, millions of participant-recorded group-administered 24-hour diet recalls have been collected. To compare the validity of individually-administered diet recalls to the validity of group-administered diet recalls, Extension specialists and research teams comprised of Registered Dietitians and nutrition students conducted a research study.[18] The study involved meal observation at nine university dining halls and subsequent completion of an individual or group administered diet recall the following day. Subjects were randomly assigned to a group or individual recall. Results compared each diet recall method to actual food intake and suggested that group-administered diet recalls were just as effective in assessing intake as individually-administered diet recalls.[18]

Healthy Eating Index

The Healthy Eating Index (HEI) was created in 1995 by the Center for Nutrition Policy and Promotion (CNPP) to monitor the diet quality of the US population. The HEI measures diet quality by assessing conformance to the *Dietary Guidelines for Americans*. In 2016, the nation's average HEI score was 59 out of 100; increasing by nearly 10 points since 1999.[7] Since its inception, the HEI has been updated as dietary recommendations have changed throughout the

past years. Updates to the HEI were done in collaboration with the National Cancer Institute (NCI) to reflect the 2005, 2010 and 2015 *Dietary Guidelines for Americans*. Although HEI versions differ, key aspects have remained the same. All versions of the HEI have food group intake targets and limitations, use a density approach to set standards, and utilize standard recommendations that are easiest to achieve. HEI-2005 was used to measure diet quality for EFNEP participants in this study. Table 3 lists the 2005 HEI components and scoring standards.[19]

Table 3: HEI-2005 Components and Scoring Standards

Component	Maximum Points	Standard for Maximum Score	Standard for Minimum Score of Zero
Adequacy			
Total Fruits	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruits	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Dark Green and Orange Vegetables and Legumes	5	≥0.4 cup equiv. per 1,000 kcal	No Dark Green Vegetables or Legumes
Total Grains	5	≥3.0 oz equiv. per 1,000 kcal	No Total Grains
Whole Grains	5	≥1.5 cup equiv. per 1,000 kcal	No Whole Grains
Dairy	10	≥1.3 oz equiv. per 1,000 kcal	No Dairy
Protein Foods	10	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
Oils	10	≥12 g/1,000 kcal	No Oils

Table 3 Continued

Component	Maximum Points	Standard for Maximum Score	Standard for Minimum Score of Zero
Moderation			
Saturated Fat	10	≤7% of energy	≥15% of energy
Sodium	10	≤0.7 of g/1,000 kcal	≥2.0 grams per 1,000 kcal
SoFAS	20	≤20% of energy	≥50% of energy

To calculate a total HEI score, the HEI scoring algorithm is applied to the 24-hour diet recall. A score for each dietary component is identified by calculating the ratio of component intake to component standard. Once each component is scored individually, the scores are summed to calculate the total HEI score.[20] The validity of the HEI score has been evaluated with the release of each updated index. Upon each HEI update, NCI scored diet recalls from the most recent National Health and Nutrition Examination Survey (NHANES). Results showed that HEI-2005, HEI-2010, and HEI 2015 all included components that properly reflected the Dietary Guidelines. In addition, results showed that high quality diets received a high HEI score, while low quality diets scored low, therefore, indicating that HEI is a valid measuring tool. Finally, researchers concluded that the tool was reliable and internally consistent.[20] The Healthy Eating Index is a common measure of EFNEP outcome success.

EFNEP Outcomes

In 2015, researchers Guenther and Luick explored the effectiveness of EFNEP on the diet quality of participants in eight states of the US Census Mountain region.[21] In addition, the researchers investigated whether a shift to healthier diet created additional cost for participants.

Researchers chose to exclude men from the analysis because diet quality is known to differ between men and women and a majority of EFNEP participants are women. Diet quality was assessed using HEI-2005. [21] The mean total HEI score upon entry to EFNEP was 49.1, which improved to 55.2 ($p < 0.001$) at exit. Intake of total fruit, whole fruit, total vegetables, dark green vegetables, orange vegetables, and legumes increased significantly ($p < 0.001$). Intakes of saturated fat, alcoholic beverages and added sugars decreased significantly ($p < 0.001$). Consumption of total grains, meat, beans, and oils did not change. Finally, median energy intake increased by 50 kcal/day after EFNEP participation ($p <0 .001$). Analysis of estimated daily cost of diet showed that daily cost increased by 13% at exit ($p < 0.001$). Overall, the evaluation of EFNEP indicated that the program was effective in improving diet quality.[21]

Researchers from the Division of Nutritional Science at Cornell University sought to evaluate the immediate and long-term effectiveness of EFNEP.[22] Researchers randomly selected a sample of 59 recently graduated participants from both rural and urban areas in New York state. All participants were women. Researchers utilized pre- and post- data and followed up one year after graduation with personal interviews. The same paraprofessional conducted the data-analysis at all three points.[22] Results showed that food behavior practices improved significantly ($p < 0.05$) between entry and graduation. In addition, there was no significant difference between graduation and follow-up, indicating that improved food behaviors were maintained. General nutrition knowledge questions revealed that knowledge was improved from entry to graduation, and nutrition knowledge remained the same or improved at follow-up. Analysis of changes in nutrient intake showed that vitamin C, folate, and fiber intake were increased from entry to exit; improved vitamin C and folate intake were not maintained at the one year follow-up, but fiber

intake was sustained. Finally, when asked about their perceived health at follow-up, families shared that they felt healthier, had more energy, and had less illness within the family.[22]

Non-EFNEP Nutrition Education Programs

In addition to EFNEP, other efforts have been made to provide nutrition education to low income families. The Supplemental Nutrition Assistance Program (SNAP) serves to decrease hunger in America by offering food assistance to eligible individuals whose monthly income falls at or below 130% of the federal poverty line (FPL). SNAP benefits can buy food for the household to eat, and seeds and plants that produce food for the household to eat. SNAP participants are also eligible to participate in SNAP-Ed nutrition education classes. The goal of SNAP-Ed is to give participants the education and tools they need to maintain a healthy diet on a limited food budget.[23] The behavioral outcome objectives recommended by the USDA's Food and Nutrition Service Agency are that participants will make half their plate fruits and vegetables, increase physical activity, and maintain energy balance. In addition, the Healthy, Hunger-Free Kids Act of 2010 established SNAP-Ed as the Nutrition Education and Obesity Prevention Grant Program, requiring SNAP-Ed to emphasize obesity prevention.[23] SNAP remains the cornerstone of USDA's nutrition assistance programs, while its education component, SNAP-Ed works to improve the likelihood of SNAP beneficiaries making healthy choices.

Women, Infants, and Children (WIC) is a nutrition assistance and education program developed in 1974 for low income women, infants, and children up to age five who are at nutritional risk.[24] WIC is available nationwide to pregnant, post-partum and lactating women, and children up to the age of five, living at or below 185% of the FPL. In addition, women must be at "nutritional risk." The two major types of nutrition risk recognized by WIC are medically-

based risks and dietary risks. Medically-based risk factors include anemia, history of pregnancy complications, and being underweight. Dietary risks include inappropriate nutrition and feeding practices or failure to meet the *Dietary Guidelines for Americans*.[24] WIC offers food packages that include specific foods to reduce common nutrition-related risks of their specific population. WIC also offers nutrition education, and referrals to other health and social services. One of WIC's major focuses is the promotion of breastfeeding. Mothers are educated on the benefits of breastfeeding and are encouraged to breastfeed their baby unless medically contraindicated. For women who are unable to breastfeed their baby, WIC provides iron-fortified infant formula. WIC has been shown to provide a range of positive outcomes for its participants, including safer pregnancies and improved dietary outcomes for both mothers and children.[24] Both WIC and SNAP-Ed have similar eligibility requirements to EFNEP. Therefore, many EFNEP participants also participate in, and receive benefits from these additional programs. All three of these programs have documented success in improving diet quality and nutrient intake in adults.[21,24,25]

Adult Nutrient Requirements

Energy requirements are the amount of dietary energy intake needed by individuals to sustain a stable body weight. Proper energy intake is consistent with long-term health that allows for adequate levels of physical activity to maintain social, cultural, and economic well-being.[26] A person's energy needs are based on basal metabolic rate (BMR), thermic effect of food (TEF) and physical activity. About 60% of daily energy expenditure is attributed to the function of the brain, liver, gastrointestinal tract, heart, and kidneys.[26] The most common method used to estimate a person's energy requirements is the Mifflin-St. Jeor Energy Estimation Formula. See Figure 1 for the formula.[26]

Figure 1: Mifflin-St. Jeor Energy Estimation Formula

Males: Resting Energy Expenditure = (10 X wt) + (6.25 X ht) – (5 X age) + 5
Females: Resting Energy Expenditure = (10 X wt) + (6.25 X ht) – (5 X age) - 161

Once Resting Energy Expenditure (REE) is determined, the value is multiplied by an activity factor to identify the estimated daily calorie expenditure.[26] The estimated daily calorie expenditure is the amount of energy a person needs to consume per day to maintain energy balance. The Institute of Medicine (IOM) has identified Acceptable Macronutrient Distribution Ranges (AMDR) for adults. Recommendations include 20-35% of calories from fat, 45-65% of calories from carbohydrates, and 10-35% of calories from protein.[26] In addition, the USDA's MyPlate breaks down intake recommendations for each food group.[27]

The Food and Nutrition Board of the IOM developed Dietary Reference Intakes (DRIs) as a guide for good nutrition.[28] The nutrient values are based on age, gender, and life stage. Certain nutrients often fall below the recommended intake in the adult population. These include fiber, calcium, vitamin D, vitamin A, vitamin E, and iron.[26] Fiber slows gastric emptying and contributes to satiety, inhibiting overconsumption of calories. In addition, fiber promotes gastrointestinal health and decreases the risk of obesity, Type 2 diabetes, and cardiovascular disease.[26] Inadequate vitamin D intake decreases calcium bioavailability; increasing the risk of inadequate calcium stores in the bones and the onset of osteopenia and osteoporosis.[26] Vitamin A and vitamin E have strong antioxidant properties that stop free radicals from damaging cells in the body. Vitamin A and E have also been shown to protect against certain cancers.[26] Finally, insufficient intake of iron can lead to depletion of iron stores, in turn, causing iron-deficiency

anemia. Iron depletion lowers the body's ability to perform cognitive, reproductive, and immune essential functions.

Women of childbearing age have additional nutrient requirements. Properly nourished women have been shown to have much higher fertility rates than undernourished women. In addition, excessive or inadequate body fat has been linked to decreased fertility.[26] Two nutrients of concern for women of childbearing age are folate and iron. Insufficient iron status prior to pregnancy increases the risk of iron-deficiency anemia during pregnancy, and low iron stores in the infant.[26] Building up iron stores during pregnancy is more difficult than before pregnancy, therefore, it is essential that women of childbearing age consume adequate amounts of iron. Folate status prior to conception is important because inadequate folate during preconception is strongly linked to neural tube defects (NTDs).[26] The neural tube is developed between the third and fourth week of pregnancy, when many women may not know they are pregnant. In addition, adequate folate status prior to conception lowers the risk of the infant being small for gestational age. The risks of insufficient folate do not reduce when folate status is improved after conception.[26] Adequate folate status is essential for all women of childbearing age to ensure the birth of a healthy baby.

Need for the Study

Food insecurity affects diet quality. Food insecure families may be under the impression that eating healthy is more expensive and may be more focused on purchasing high-energy foods for themselves or their children to prevent hunger; foods that may not always be nutrient-dense. The consumption of nutrient-dense foods is key to good nutrition, optimizing physical function and ultimately quality of life. Persons of lower income may not be able to attain the optimal

quality of life due to their increased risk of health disparities. Without adequate nutrition, this population is vulnerable to chronic diseases such as obesity, Type 2 diabetes and CVD.

Programs have been developed in the United States to address knowledge deficit relating to good nutrition in the low-income population. EFNEP is unique in its delivery of curricula by utilizing the paraprofessional model. The program has been successful in encouraging behavior change in EFNEP participants, leading to improved diet quality. EFNEP participant outcomes have been measured. Among the tools used to measure outcomes, are the 24-hour diet recalls to compare changes in the HEI pre-and post- EFNEP curricula completion as well as changes in actual food group consumption. The State of Maine's prevalence of food insecure, low-income, individuals is higher than the national average, putting Mainers at higher risk of health disparities relating to suboptimal nutrition. Additionally, EFNEP curricula delivery in Maine has never been formally evaluated in a research setting. The purpose of this study is to assess the effectiveness of Maine EFNEP on food-related behavior change and diet quality as measured by HEI. Evaluation of the program is key to ensuring program longevity and improved population health and well-being in the State of Maine.

CHAPTER 3

METHODOLOGY

This study was designed to assess the effectiveness of Maine EFNEP on food-related behavior change and diet quality as measured by Healthy Eating Index 2005 (HEI-2005). This study also explores the relationship between the results on the HEI and participation in food assistance programs such as SNAP and WIC.

Study Sample

The study participants include all adult graduates of Maine EFNEP from 2013 to 2016. Participation in the program is voluntary and all adult participants who completed and graduated EFNEP were included in the study except those that did not have pre- and post-program data, those with values that indicated data entry error, and participants who were under 18. Participants were also dropped if they were missing values that were pertinent to the analysis. Additionally, the data retrieved from Waldo county in 2013 was dropped because there were no participants from Waldo country in any other year of the study. Maine counties included in the study sample were Oxford, York, Penobscot, Hancock, Somerset, Kennebec, Androscoggin, Sagadahoc, Aroostook, and Cumberland.

Study Design

This study was a secondary data analysis of de-identified data gathered from WebNEERS (version 1.2, Clemson University, SC, 2012), the database utilized by EFNEP. The method of data collection was retrospective and descriptive where the principal investigator (PI) retrieved data from 2013-2016 from the WebNEERS database.

Study Instruments

Study participants, before beginning any education, complete a demographic questionnaire. For the purpose of this study, demographics gathered from the questionnaire included age, sex, race, region type, highest education-level achieved, household income, number of children in household, and public assistance programs utilized.

Study participants also complete a 24-hour diet recall pre-EFNEP**.** Participants are provided with the diet recall. The paraprofessional guides them through completion. Participants self-report intake including actual foods consumed, portion sizes, and other descriptors of the food.

On the day of graduation, participants complete a form that assesses any changes to their demographic information. Participants also complete another 24-hour diet recall with the same methodology as the pre-EFNEP 24-hour diet recall. The data from the demographic questionnaire and the diet recalls are entered into WebNEERS by Maine EFNEP administrative staff.

The diet recall information is utilized to derive the HEI score and sub-scores for each food group. Food groups measured by the HEI are total fruits, total vegetables, total grains, protein foods, dairy, saturated fat, sodium, whole grains, oils, solid fats and added sugars (SoFAS), whole fruits, and dark green and orange vegetables and legumes. Data gathered from 2013-2016 were scored using the HEI reflective of the 2005 Dietary Guidelines for Americans.

Data Coding

Each study participant is assigned a unique identification number once their data are entered into WebNEERS. Institutional Review Board (IRB) was not necessary, in this case, as data were de-identified before being accessed by the PI.

Data coding involved the following changes. The category of race was combined into two variables: white and non-white. The combination of multiple races into "non-white" was necessary because of the small number of participants that were non-white. Region type was described using the variables rural and non-rural. Some counties were combined if they did not have at least 80 participants. Counties that were combined were Oxford/York, Penobscot/Hancock, Somerset/Kennebec, and Androscoggin/Sagadahoc. Additionally, household income was re-coded to real income by adjusting for inflation using the 2015 Consumer Price Index. The variable of highest grade achieved was coded into three categories: less than high school (grade 11 or below), high school (grade 12, GED, or some college), and post-secondary (2-year, 4-year or post-graduate degree). The variable of number of hours spent in the program was coded into three categories: less than 7 hours, 7-16 hours, and 17 or more hours. The variable of number of children was coded into two categories: 0-2 children and 3 or more children.

Statistical Analysis

Statistical analysis was conducted using STATA software (Special Edition 14.1, StataCorp LLC, College Station, TX, 2015)**.** The data were exported from WebNEERS for the years 2013-2016. For each year, the data sets that were exported were adult demographics, diet recall, and public assistance program participation. The data were downloaded in the form of Excel spreadsheets. The data sets were converted to CSV format. For each year, adult demographics, diet recall data, and public assistance data were merged into one master data file. Once files were merged, the data were sorted to list adult identification numbers in numerical order. Any adult identification numbers that did not have both pre- and post-data were excluded

from the study. Each yearly data set was then merged into one final master file which included the years 2013-2016.

Analysis by Sub-Question

Among Maine participants who completed and graduated from EFNEP

Sub-question 1

What are the demographic, socio-economic, and geographic characteristics?

For categorical variables (sex, race, county, year, and public assistance programs utilized, highest education-level achieved, number of children in household, rural vs. urban status) frequency distributions (n and %) were calculated. For continuous variables (age and real income) descriptive statistics of mean, median, range and standard deviation were calculated.

Sub-question 2

What are the results of the HEI pre-EFNEP?

The results of the HEI pre-EFNEP relating to total score, total fruits, total vegetables, total grains, protein foods, dairy, saturated fat, sodium, whole grains, oils, solid fats and added sugars (SoFAS), whole fruits, and dark green and orange vegetables and legumes were calculated utilizing descriptive statistics of mean, median, range, and standard deviation.

Sub-question 3

What are the results of the HEI post-EFNEP?

The results of the HEI post-EFNEP relating to total score, total fruits, total vegetables, total grains, protein foods, dairy, saturated fat, sodium, whole grains, oils, SoFAS, whole fruits, and dark green and orange vegetables and legumes were calculated utilizing descriptive statistics of mean, median, range, and standard deviation.

Sub-question 4

What is the difference in HEI score and sub-scores from pre- to post-EFNEP?

The difference in HEI scores from pre- to post-EFNEP was calculated utilizing a paired t-test with a significance level of ≤ 0.05.

We also addressed this question using Ordinary Least Squares regressions considering statistical significance at the 5% level, with a dummy variable for before and after. We included a full set of covariates in the model which are gender, race, county, year of participation, public assistance, education level, number of children in the household, age, income, hours in the program, and whether they resided in an urban or rural area.

Sub-question 5a & 5b

A. Does participation in SNAP or WIC affect the HEI score and sub-scores of Maine EFNEP participants?
B. Was there a difference in HEI score and sub-score change for EFNEP participants who also participated in WIC, SNAP, or both?

These questions were addressed using Ordinary Least Squares regressions considering statistical significance at the 5% level. Specifically, we created dummy variables for whether people participated in WIC, SNAP or both as well as interactions with our before and after dummy variable. We also included a full set of covariates in the model, as described above in sub-question 4.

Sub-question 6a & 6b

A. Do number of hours in the program affect the HEI score and sub-scores of Maine EFNEP participants?
B. Was there a difference in HEI score or sub-score change between those who participated in the program for less than 7 hours or more than 16 hours as compared to those that spent 7-16 hours in the program.

These questions were addressed utilizing Ordinary Least Squares regressions considering statistical significance at the 5% level. Specifically, we created dummy variables for less than 7 hours and more than 16 hours in the program, with our comparison group being participants who spent 7-16 hours in the program. In a similar fashion to the methodology of sub-question 5b, we looked at the interaction effects with our before and after dummy variable. We also included a full set of covariates in the model, as described above in sub-question 4.

CHAPTER 4

RESULTS

This study was designed to assess the effectiveness of Maine EFNEP on food-related behavior change and diet quality as measured by Healthy Eating Index 2005 (HEI-2005). This study also explored the relationship between the results on the HEI and participation in food assistance programs such as SNAP and WIC as well as the number of hours spent in the program. This study is a pre-, post-secondary analysis of data gathered from WebNEERS, the database utilized by EFNEP. Diet recall information was utilized in WebNEERS to derive a HEI score and sub-scores for each food group. For this study, HEI score data and demographic data from EFNEP fiscal years 2013-2016 were utilized. Statistical analysis was conducted using STATA Special Edition 14.1**.** The study included 507 participants who completed pre- and post-demographic surveys and 24-hour diet recalls. A complete set of data were available for all participants. Results are reported by sub-question.

Analysis by Sub-Question

Among Maine participants who completed and graduated from EFNEP

Sub-question 1

What are the demographic socio-economic and geographic characteristics?

As outlined in Table 4, the average age of participants was 32 (SD 9.7) years and the mean monthly income of participants was $1121.1 (SD 748.8) (2015 dollars). A majority of the participants were female (n = 433, 85.4%) and were white (n = 431, 85%). More than half of participants resided in a rural community (n = 351, 69.2%). When participants were asked about the number of children in their household, 77.5% (n = 393) reported that they had 0-2 children and 22.5% (n = 114) reported that they had 3 or more children. The highest education level

achieved by a majority of the participants was grade 12, GED, or some college education (n = 368, 72.5%). When participants were asked about the public assistance programs their family uses, 69.8% (n = 354) reported receiving SNAP benefits, and 51% (n = 259) reported receiving WIC benefits. Moreover, 36.9% (n=187) of participants were in both SNAP and WIC while enrolled in EFNEP. A majority of participants spent between 7 and 16 hours in the program (n=318, 62.7%). One hundred and thirty-four participants (26.4%) spent less than 7 hours in the program, and 55 participants (10.8%) spent more than 16 hours in the program.

Table 4: Demographic, Socio-Economic and Geographic Characteristics of Maine Adult EFNEP Participants (n = 507)

Age	Mean (Standard Deviation) in Years	32.0 (9.7)
Monthly Household Income	Mean (Standard Deviation) in 2015 Dollars	1121.1 (748.8)
Sex	Male	74 (14.6%)
	Female	433 (85.4%)
Race	White	431 (85.0%)
	Non-White	76 (15.0%)
Residence	Rural	351 (69.2%)
	Urban	156 (30.8%)
County	Oxford/York	63 (12.4%)
	Penobscot/Hancock	57 (11.2%)
	Somerset/Kennebec	48 (9.5%)
	Androscoggin/Sagadahoc	96 (19.0%)
	Aroostook	146 (28.8%)
	Cumberland	96 (18.9%)
Highest Education Level Achieved	Less Than High School	53 (10.5%)
	High School	368 (72.5%)
	Post-Secondary	86 (17.0%)
Number of Children in Household	0 to 2 Children	393 (77.5%)
	3 or More Children	114 (22.5%)
Public Assistance Programs Utilized	SNAP	354 (69.8%)
	WIC	259 (51.0%)
	Both SNAP and WIC	187 (36.9%)
	Head Start	137 (27.0%)
	Child Nutrition	136 (26.8%)
	TANF	96 (18.9%)
	TEFAP	34 (6.7%)
	Other	94 (18.5%)
Number of Hours Spent in Program	<7 hours	134 (26.4%)
	7-16 hours	318 (62.7%)
	>16 hours	55 (10.8%)

Sub-question 2

What are the results of the HEI pre-EFNEP?

The mean total HEI score for the sample was 52.6 out of a possible 100 points pre-EFNEP (SD = 13.7, range = 14.5-85.6). The mean total fruit score was 2.0 out of a possible 5

points (SD = 2.2, range = 0-5) and the mean total vegetable score was 3.3 out of 5 (SD = 1.8, range = 0-5). The mean protein foods score was 8.0 out of 10 (SD = 2.9, range= 0-10), dairy score was 4.8 out of 10 (SD = 3.8, range = 0-10), and whole grains score was 1.5 out of 5 (SD = 1.9, range = 0-5).

Table 5: HEI Scores Pre-EFNEP (n=507)

HEI Component	***Mean***	***SD***	***Range***	***Median***
HEI Total	52.6	13.7	14.5-85.6	53
Total Fruits	2.0	2.2	0-5	0.6
Total Vegetables	3.3	1.8	0-5	3.7
Total Grains	4.5	1.0	0-5	5
Protein Foods	8.0	2.9	0-10	10
Dairy	4.8	3.8	0-10	4.6
Saturated Fat	2.0	3.5	0-10	0
Sodium	2.8	2.9	0-10	1.9
Whole Grains	1.6	1.9	0-5	0.3
Oils	4.9	4.0	0-10	4.4
SoFAS	15.7	4.8	0-20	17.2
Whole Fruits	1.8	2.3	0-5	0
Dark Green and Orange Vegetables and Legumes	1.3	1.9	0-5	0

Sub-question 3

What are the results of the HEI post-EFNEP?

The mean total HEI score for the sample was 59.8 out of 100 post-EFNEP (SD = 13.2, range = 24.3-93). The mean total fruit score was 2.9 out of 5 (SD = 2.2, range = 0-5) and the mean total vegetable score was 3.9 out of 5 (SD = 1.6, range = 0-5). The mean protein foods score was 8.6 out of 10 (SD = 2.6, range= 0-10), dairy score was 6.2 out of 10 (SD = 3.7, range = 0-10), and whole grains score was 2.3 out of 5 (SD = 2.1, range = 0-5).

Table 6: HEI Scores Post-EFNEP (n=507)

HEI Components	***Mean***	***SD***	***Range***	***Median***
HEI Total	59.8	13.2	24.3-93	59.7
Total Fruits	2.9	2.2	0-5	3.8
Total Vegetables	3.9	1.6	0-5	5
Total Grains	4.4	1.2	0-5	5
Protein Foods	8.6	2.6	0-10	10
Dairy	6.2	3.7	0-10	6.9
Saturated Fat	2.4	3.7	0-10	0
Sodium	2.2	2.6	0-10	1.2
Whole Grains	2.3	2.1	0-5	1.9
Oils	5.2	3.8	0-10	5.2
SoFAS	17.3	3.8	0-20	19.4
Whole Fruits	2.8	2.4	0-5	5
Dark Green and Orange Vegetables and Legumes	1.7	2.0	0-5	0.5

Sub-question 4

What is the difference in HEI score and sub-scores from pre- to post-EFNEP?

A. A paired t-test was utilized to test the relationship between the mean HEI score and sub-scores pre-EFNEP and post-EFNEP. Mean total HEI score pre-EFNEP (M= 52.61, SE = 0.61) increased significantly post-EFNEP (M=59.79, SE=0.59) t (506) = 9.06, p <.001. Similarly, total fruit score pre-EFNEP (M=2.00, SE=0.97) increased significantly post-EFNEP (M=2.94, SE=0.96) t (506) = 7.45, p <.001. Total vegetable score pre-EFNEP (M=3.27, SE=0.08) increased post-EFNEP (M=3.98, SE=0.69) and the difference was significant t (506) = 6.13, p <.001. Whole grain score pre-EFNEP (M=1.56, SE=0.86) increased significantly post-EFNEP (M=2.27, SE=0.92) t (506) = 6.22, p <.001. All other sub-scores were significantly changed from pre- to post-EFNEP except for oil consumption. Table 7 presents the results of the difference in HEI scores pre- to post-EFNEP utilizing a t-test.

Table 7: Difference in HEI Scores from Pre- to Post-EFNEP (T-Test)

HEI Component	***t***	***p***	***% change***
HEI Total	9.06	<.001	13.64%
Total Fruits	7.45	<.001	46.76%
Total Vegetables	6.13	<.001	18.91%
Total Grains	-2.03	.04	-3.81%
Protein Foods	3.25	.001	6.76%
Dairy	6.78	<.001	28.53%
Saturated Fat	2.00	.05	22.37%
Sodium	-2.99	.003	-18.29%

Table 7 Continued

HEI Component	*t*	*p*	*% change*
Whole Grains	6.22	<.001	46.23%
Oils	0.89	.37	4.24%
SoFAs	6.11	<.001	10.09%
Whole Fruits	7.39	<.001	56.65%
Dark Green and Orange Vegetables and Legumes	3.28	.001	28.75%

B. A multivariate analysis was also used to test the relationship between mean HEI score and sub-scores pre-EFNEP and post-EFNEP (Table 8). Total HEI score increased significantly pre- to post-EFNEP ($p<.001$). Similarly, total fruit intake and total vegetable intake increased significantly pre- to post-EFNEP ($p<.001$) and ($p<.001$) respectively. Whole grain intake increased significantly pre- to post-EFNEP ($p=.05$). Sodium intake, on the other hand, increased significantly ($p=.003$). All other sub-scores were significantly changed pre- to post-EFNEP except for oil consumption.

Table 8: Differences in HEI Scores of Maine Adult EFNEP Participants from Pre- to Post-EFNEP, Adjusted for Individual Characteristics (n=507 Pre- and Post-EFNEP)

Outcome	*Coefficient on Post-EFNEP*	*P-Value*	*R-Squared*
Total HEI	7.18	<.001	0.13
Total Fruits	0.94	<.001	0.10
Vegetables	0.62	<.001	0.08
Total Grains	-0.14	.05	0.03

Table 8 Continued

Outcome	*Coefficient on Post-EFNEP*	*P-Value*	*R-Squared*
Protein Foods	0.54	.001	0.04
Dairy	1.37	<.001	0.15
Saturated Fat	0.44	.05	0.05
Sodium	-0.50	.003	0.04
Whole Grains	0.72	<.001	0.10
Oils	0.21	.38	0.03
SoFAS	1.58	<.001	0.09
Whole Fruits	1.02	<.001	0.10
Dark Green and Orange Vegetables and Legumes	0.37	.001	0.06

Sub-question 5a

Does participation in SNAP or WIC affect the HEI score and sub-scores of Maine EFNEP participants?

As outlined in Table 9, there were no significant differences in the total HEI or sub-scores between people who participated in WIC, SNAP or both and those who did not.

Sub-question 5b

Was there a difference in HEI score and sub-score change for EFNEP participants who also participated in WIC, SNAP, or both?

There were no significant differences in changes in total HEI score or sub-scores as a result of participating in EFNEP for people who were also on SNAP, WIC, or both. In other terms, being in these programs did not give any added benefit to participants in terms of changes in total HEI score or sub-scores (Table 9).

Table 9: Effect of Participation in WIC, SNAP or Both on HEI Scores and Changes in Scores of Maine Adult EFNEP Participants, Adjusted for Individual Characteristics (n=507 Pre- and Post-EFNEP)

Outcome	*Coefficient on Post-EFNEP (P-Value)*	*Coefficient on WIC (P-Value)*	*Coefficient on SNAP (P-Value)*	*Coefficient on Both WIC and SNAP (P-Value)*	*Coefficient on Post-EFNEP x WIC (P-Value)*	*Coefficient on Post-EFNEP x SNAP (P-Value)*	*Coefficient on Post-EFNEP x Both WIC and SNAP (P-Value)*	*R-Squared*
Total HEI	9.03 (<.001)	-0.40 (.86)	1.64 (.39)	-0.40 (.88)	-2.03 (.47)	-2.09 (.38)	1.74 (.61)	0.13
Fruits	1.06 (.002)	0.54 (.15)	0.12 (.68)	-0.38 (.38)	-0.72 (.10)	0.02 (.96)	0.62 (.25)	0.10
Vegetables	0.68 (.007)	0.15 (.62)	0.17 (.51)	-0.07 (.84)	-0.30 (.46)	-0.00 (.99)	0.28 (.56)	0.09
Total Grains	-0.29 (.14)	-0.15 (.35)	-0.07 (.62)	0.00 (.99)	0.13 (.62)	0.07 (.76)	0.08 (.80)	0.03
Protein Foods	0.83 (.02)	0.11 (.83)	0.20 (.63)	-0.18 (.75)	-0.53 (.37)	-0.28 (.56)	0.48 (.51)	0.04
Dairy	1.91 (<.001)	0.56 (.36)	0.85 (.09)	-0.97 (.18)	-1.08 (.15)	-0.76 (.23)	1.49 (.10)	0.15
Saturated Fat	1.23 (.02)	-0.19 (.71)	0.67 (.16)	0.11 (.87)	0.28 (.73)	-1.07 (.11)	-0.50 (.60)	0.06
Sodium	-0.14 (0.76)	0.21 (.66)	-0.09 (.81)	0.32 (.57)	-0.30 (.62)	-0.17 (.77)	-0.24 (.74)	0.04
Whole Grains	0.79 (.01)	-0.26 (.42)	-0.17 (.54)	0.38 (.33)	0.14 (.76)	-0.23 (.53)	0.07 (.89)	0.10
Oils	0.22 (.70)	-0.61 (.37)	0.15 (.79)	0.11 (.89)	0.27 (.74)	0.02 (.98)	-0.43 (.67)	0.03
SoFAS	1.21 (.05)	-0.91 (.28)	-0.09 (.89)	0.49 (.60)	0.82 (.37)	0.41 (.60)	-0.89 (.43)	0.10
Whole Fruits	1.03 (.004)	0.57 (.89)	-0.20 (.53)	-0.12 (.79)	0.44 (.40)	0.11 (.80)	0.39 (.53)	0.11
Dark Green and Orange Vegetables and Legumes	0.49 (.08)	0.10 (.76)	0.10 (.70)	-0.08 (.83)	-0.28 (.52)	-0.18 (.60)	0.40 (.43)	0.06

Sub-question 6a

Do number of hours in the program affect the HEI score and sub-scores of Maine EFNEP participants?

The multivariate analysis demonstrated that there were no significant differences in total HEI score between people who spent less than 7 hours or more than 16 hours in the program as compared to those who spent 7-16 hours in the program (Table 10).

Sub-question 6b

Was there a difference in HEI score or sub-score change between those who participated in the program for less than 7 hours or more than 16 hours as compared to those that spent 7-16 hours in the program.

Participants who spent less than 7 hours in the program had a smaller improvement in total HEI score from pre- to post-EFNEP compared to those who were in the program for 7 to 16 hours (4.65 versus 8.44) ($p = .05$). Additionally, participants who spent less than 7 hours in the program had a small increase in total grains from pre- to post-EFNEP compared to a small reduction among those who spent 7 to 16 hours in the program ($p = .02$). Similarly, participants who spent less than 7 hours in the program did not experience a significant change in their dark green and orange vegetables and legumes score, compared to an increase among those who spent 7 to 16 hours in the program ($p = .04$). Finally, those who spent less than 7 hours in the program had a significant reduction in their sodium score (which indicates higher quantities) compared to those who spent 7 to 16 hours in the program ($p = .03$). Changes in scores of participants who spent more than 16 hours in EFNEP were not significantly different from those who spent 7 to 16 hours (Table 10).

Table 10: Effect of Hours Spent in EFNEP on HEI Scores and Changes in Scores of Maine Adult EFNEP Participants, Adjusted for Individual Characteristics (n=507 Pre- and Post-EFNEP)

Outcome	*Coefficient on Post-EFNEP (P-Value)*	*Coefficient on <7 Hours (P-Value)*	*Coefficient on >16 Hours (P-Value)*	*Coefficient on Post-EFNEP x <7 Hours (P-Value)*	*Coefficient on Post-EFNEP x >16 Hours (P-Value)*	*R-Squared*
Total HEI	8.44 (<.001)	1.01 (.55)	0.01 (.10)	-3.79 (.05)	-2.35 (.34)	0.14
Total Fruits	1.14 (<.001)	0.32 (.28)	0.02 (.96)	-0.52 (.07)	-0.61 (.12)	0.10
Vegetables	0.59 (<.001)	-0.23 (.29)	-0.55 (.06)	0.05 (.84)	0.14 (.70)	0.09
Total Grains	-0.25 (.006)	-0.14 (.24)	-0.05 (.81)	0.38 (.02)	0.10 (.71)	0.04
Protein Foods	0.65 (.001)	-0.41 (.31)	0.06 (.91)	-0.45 (.30)	0.13 (.82)	0.04
Dairy	1.46 (<.001)	0.49 (.34)	-0.41 (.52)	-0.44 (.35)	0.21 (.76)	0.15
Saturated Fat	0.77 (.006)	0.37 (.42)	0.50 (.34)	-0.91 (.09)	-0.79 (.24)	0.06
Sodium	-0.19 (.38)	0.51 (.18)	0.70 (.15)	-0.82 (.03)	-0.88 (.11)	0.04
Whole Grains	0.79 (<.001)	-0.16 (.52)	-0.16 (.59)	-0.26 (.35)	0.10 (.80)	0.10
Oils	0.16 (.61)	-0.33 (.51)	0.77 (.23)	0.41 (.45)	-0.52 (.50)	0.03
SoFAS	1.72 (<.001)	0.38 (.52)	-0.60 (.45)	-0.63 (.30)	0.26 (.79)	0.10
Whole Fruits	1.07 (<.001)	-0.01 (.97)	-0.03 (.94)	-0.07 (.82)	-0.22 (.61)	0.11
Dark Green and Orange Vegetables and Legumes	0.55 (<.001)	0.22 (.37)	-0.25 (.42)	-0.56 (.04)	-0.25 (.49)	0.06

CHAPTER 5

DISCUSSION

The goal of the study was to assess the effectiveness of Maine EFNEP on food-related behavior change and diet quality as measured by Healthy Eating Index 2005 (HEI-2005). The study also explored if participation in food assistance programs such as SNAP and WIC, or number of hours spent in the Maine EFNEP program, had any impact on the HEI score or score change for graduates. HEI score data and demographic data were gathered from WebNEERS for participants who graduated during fiscal years 2013-2016. A complete set of data were available for all participants included in the study (N=507). Assessing the effectiveness of EFNEP on food-related behavior change and the diet quality of Maine's low-income population is key to ensuring program longevity and improved population health and well-being. Upon entry into Maine EFNEP, the average total HEI score was 52.6 out of a possible score of 100, which is below the national average of 59.[7] When diet recalls were analyzed post-EFNEP, the average total HEI score was 59.8, similar to the national average. The change in HEI scores from pre- to post-program were analyzed utilizing paired t-tests and Ordinary Least Squares regressions. The 7.2 score increase in HEI was found to be statistically significant ($p<.001$). Several crucial HEI sub-scores such as fruits, vegetables, and whole grains increased significantly ($p<.001$). These three sub-groups are at the core of EFNEP nutrition education and an increased intake of these food groups is consistent with improved health outcomes.[26] This study focused on the EFNEP core value of diet quality and has provided insight about the effectiveness of EFNEP participation. According to the multivariate analysis, almost all of the HEI sub-groups exhibited significant and positive change as a result of the program. This outcome exemplifies that Maine EFNEP is reaching one of its major goals of diet quality improvement and demonstrates the need

for EFNEP in Maine communities. The food behavior change exhibited by Maine EFNEP participants is comparable to the results from a study conducted by Arnold et al.[22] While Arnold and colleagues did not use the HEI score to assess behavior change, they elicited the same results and demonstrated program effectiveness. The results of our study are consistent with the results of a study conducted by Guenther and Luick.[21] Guenther and Luick utilized HEI-2015 to assess the effectiveness of EFNEP in the Mountain Region of the United States. Results of this study found that the average total HEI score upon entry to EFNEP was 49.1 and improved to 55.2 ($p < .001$) at exit. Additionally, average intake of total fruit, whole fruit, total vegetables, dark green vegetables, orange vegetables, and legumes increased significantly ($p < .001$) from entry to exit; intake of saturated fat and added sugars decreased significantly ($p < .001$).[21] The significant increase in total HEI score and several crucial sub-scores mirror the results of our study with Maine EFNEP, demonstrating that EFNEP is effective in increasing the diet quality of participants. These positive findings also reinforce the importance of EFNEP funding on a national level.

Another important finding from the current study was that there were no significant differences in total HEI score or sub-scores between people who participated in WIC, SNAP or both programs and those who did not. Additionally, people who participated in WIC, SNAP, or both, did not experience different changes in HEI scores from pre- to post-EFNEP. This suggests that, while WIC and SNAP-Ed (the educational program associated with SNAP) provide valuable nutrition education, the improvements in diet quality found in this study were likely attributable to EFNEP. Continued study is needed to confirm these findings in other groups and across states.

A key finding in this study was the relationship between time spent in the program and HEI score. It was found that spending less than 7 hours in the program was not as effective at encouraging positive dietary behavior change as spending 7 to 16 hours in the program. While a higher dosage of nutrition education is thought to produce a more positive dietary behavior change, based on these results, there appears to be a 'threshold' of education hours necessary to elicit this positive change. This could be used to inform national and state EFNEP leaders about standardizing educational delivery models.

Education through EFNEP was successful in improving intake of many food groups, however, some food groups were not affected by program participation. Participants had no change in their score for the HEI sub-group of oils from pre- to post-program. EFNEP education on the oils sub-group is focused on the intake of healthy, unsaturated fats. An ideal outcome of program participation would have been an increase in the oils score. Moreover, there was a significant decline in the sodium score, which means that participants consumed more sodium after completing the EFNEP program. Similarly, participants had a decline in total grains from pre- to post-EFNEP, however it is believed that this was mitigated by a significant increase in their whole grains sub-score. We surmise that participants substituted whole grains for total grains; this is a positive outcome of the program. These findings do provide an opportunity for further investigation and potentially improved educational interventions to enhance intake of healthy, unsaturated fats versus saturated fat and decrease intake of sodium.

This study has the ability to largely affect Maine EFNEP. No other evaluation of Maine EFNEP on diet quality using the HEI has been completed. The prior lack of program evaluation on this core value has led to limited knowledge on the effectiveness of Maine EFNEP on diet quality change. Both strengths and weaknesses of the program were identified. Strengths

highlighted included improvements in total HEI scores and key sub-scores such as fruits, vegetables, and whole grains. Weaknesses of the program included an insignificant change in healthy, unsaturated oil intake and a significant decrease in sodium score. A program impact 'threshold' was also revealed. The results of this study have the capacity to assist Maine EFNEP coordinators and paraprofessionals in reshaping the program to make it more educational and effective. One area that could benefit from change may be the number of hours required for program graduation. Currently, paraprofessionals are only required to have four sessions and cover all eight lessons to graduate participants, however, there is no time requirement for each session.

Our interpretation of the results of this study lead us to believe that lessons on fruit, vegetables, protein, and whole grains are likely being covered with more depth than others. It appears that Maine EFNEP provides more skills that apply to changes in these food groups. This is evidenced by the significant positive HEI score change for these food groups pre- to post-EFNEP. On the other hand, the program had no significant effect on intake of healthy, unsaturated oils and sodium intake actually increased. This result demonstrates a probable lack of focus on Lesson 8 titled "Make a Change". This ESBA lesson focuses on choosing foods low in fat, sugar, and salt. Maine EFNEP educators can use this information to focus the curriculum on areas which were not found to be improved by the current EFNEP curriculum. Overall, many of the results of this study can be utilized to better the effectiveness of Maine EFNEP.

Barriers/Limitations

There were some barriers and limitations in this study. The representation of African American, and Asian American race was very small within the study sample. Thus, this study sample may not have represented a generalizable sample of all EFNEP participants nationally.

Sampling bias was also a potential limitation to this study as it was conducted using a convenience sample. Additionally, we only included study participants who had graduated from EFNEP; many individuals began the program but did not graduate and therefore were not included in the study. Thus, the study lacks data on the outcomes of participants who received some EFNEP education but did not complete the program. Similarly, unreported data was a barrier to this study. Each EFNEP participant was required to have all demographic data reported for pre- and post- surveys. Those that were missing data were not included in the study, limiting the sample size.

Twenty-four-hour diet recalls were self-reported by study participants and collected in varied settings. Some diet recalls were collected in a group setting, while others were collected one on one. The diet recalls rely on the participants' memory and self-reporting skills. The literature includes many studies that show participants typically underreport on items they wish to eat less and overreport on items they wish to consume more. Additionally, paraprofessionals were not observed during data collection and while the validity of the group administered 24-hour diet recall has been confirmed,[18] there is still a possibility of variability in data collection. Finally, the effect of type of class provided (individual or group) was not considered during this study. It is possible that participants who received one-on-one education from paraprofessionals had different outcomes than participants who received education in a group setting.

Implications for Practice

The results of this study, in agreeance with similar investigations,[21,22] demonstrate that EFNEP is highly effective in increasing diet quality in program graduates. Accelerating improvements in global health and well-being through food and nutrition is one of the major goals of the Academy of Nutrition and Dietetics (The Academy) and its member Registered

Dietitian Nutritionists (RDN).[29] Thus, the longevity and effectiveness of EFNEP nationwide is aligned with key strategies of the Academy. EFNEP is a federally-funded program, which requires re-authorization on a regular basis. Armed with knowledge on the positive impact of EFNEP on program participants' HEI, RDNs and other health professionals can advocate for the continuation of funding for this program for years to come. RDNs are the experts in nutrition and dietetics and should be heavily involved in public policy efforts surrounding nutrition initiatives and legislation. Calling upon RDNs to take an active role in public policy as it pertains to the field of dietetics is key in securing continued EFNEP funding.

Future Considerations

While this study demonstrated the effect of Maine EFNEP program participation on HEI score, the lack of effect from simultaneous participation in EFNEP and other federally-funded programs such as SNAP and WIC, and the effect of hours participating in EFNEP programs, other questions were left unanswered. This investigation was a pre-, post- secondary analysis of data that were collected post-EFNEP, immediately after graduation from the program, therefore this study does not inform on whether the dietary change elicited from the program was maintained. A follow-up survey and 24-hour recall, six months or one year after graduation would be useful to determine whether dietary change elicited from the program was maintained. Additionally, it would be interesting to investigate whether changes in the socio-economic status of some participants due to job opportunities or economic advances, might influence their eating behaviors and diet quality. Finally, all HEI data for this study was calculated using HEI-2005, however, a more current HEI-2015 has been developed in response to the 2015-2020 *Dietary Guidelines for Americans*. HEI-2015 was implemented into EFNEP in 2017. Due to the

differences between HEI-2005 and HEI-2015, evaluation of EFNEP on diet quality measured by the current HEI-2015 is warranted.

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AUTHOR'S BIOGRAPHY

Sarah Perkins was born in Beverly, Massachusetts on September 8th, 1995. Her parents quickly relocated after her birth to Merrimack, New Hampshire, where she resided for the next eighteen years. Sarah graduated from Merrimack High School in 2013 with great intent to pursue higher education in the medical field. She subsequently moved to Orono to attend the University of Maine where she decided to study nursing; However, Sarah quickly realized her true passion lied in the field of dietetics. She transferred to the School of Food and Agriculture with a goal of becoming a Registered Dietitian. Upon completion of her Bachelor's Degree in Food Science and Human Nutrition, she was accepted into the University of Maine's highly competitive Dietetic Internship Program, where she would also achieve a Master's Degree in Food Science and Human Nutrition. Throughout her graduate school career, Sarah worked closely with faculty and undergraduate students as a Teaching Assistant for three semesters. She went on to complete her Dietetic Internship in Augusta, Maine and plans to use her clinical nutrition experience to practice Medical Nutrition Therapy in Maine as a Registered Dietitian. Sarah is a candidate for the Master of Science Degree in Food Science and Human Nutrition from the University of Maine in August 2019.