

THE EFFECTS OF A FRUIT AND VEGETABLE PRESCRIPTION (FVRx) PROGRAM FOR
LOW-INCOME ADULTS

by

NICHOLAS WILLIAM SLAGEL

(Under the Direction of JUNG SUN LEE)

ABSTRACT

Fruit and Vegetable Prescription (FVRx)[®] Programs[®] are multi-level interventions combining healthcare generated produce prescription with nutrition education and local food system settings to improve dietary and health outcomes for low-income patients with diet-related conditions. This dissertation describes the development, implementation, and evaluation of preliminary and expanded FVRx models combining produce prescription with culturally tailored direct nutrition and financial literacy education, and health screenings. Mixed methods approaches and non-randomized controlled study design were used to examine the impact of the programs on low-income adults' food and nutrition behaviors, health outcomes, and experiences in local food settings. The process and outcome evaluations of the Pilot FVRx Program combining produce prescription and nutrition education in a community- and clinic-setting demonstrate the essential role of a unique university-community-clinic partnership established for program development, implementation, and rigorous evaluation. The Pilot FVRx program showed significant improvements in participants' fruit and vegetable intake, food purchasing practices, food budgets, but limited changes in food security and clinical outcomes. Building upon these findings, the Expanded FVRx Program included augmented nutrition and financial

literacy education programs, clinical biomarker assessments, and an ad-hoc comparison group. The produce prescription combined with intensive education showed enhanced financial and food resources, healthy food purchasing practices, as well as improved knowledge, preference, and consumption of locally grown produce over nutrition education alone. In addition, the multi-level components of the Expanded FVRx program model allowed participants to emerge with new local food system values, perceptions, and experiences. These transformations empowered participants to continue to access local foods, and purchase and consume fruits and vegetables even after the program participation. The findings of this research suggest that community- and clinic-based multi-level interventions are feasible and effective for addressing barriers to consuming adequate fruits and vegetables in low-income adults disproportionately affected by poverty, unhealthy food environments, and healthcare disparities. The findings of this study underscore the need for multi-level strategies to address health disparities in medically underserved low-income populations and suggest potential models and recommendations for the design and implementation of effective and sustainable FVRx programs applicable in both community and clinical settings.

INDEX WORDS: Produce Prescription, Nutrition Education, SNAP-Ed, Financial Literacy Education, Food Security, Fruit and Vegetable Intake, Food Purchasing Practices, Local Food System, Mixed Methods

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DEDICATION

This dissertation is dedicated to the individuals for whom the Fruit and Vegetable Prescription (FVRx) Program and Supplemental Nutrition Assistance Program-Education (SNAP-Ed) are intended to serve. I also dedicate this work to my late Grandfather, Sylvester. He unknowingly inspired me to help others reconnect with their families and communities through locally grown food and sharing culinary traditions.

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CHAPTER 1

INTRODUCTION

Consuming adequate amounts of fruits and vegetables is vital for diet quality and chronic disease prevention and management [1, 2]. However, low-income households, particularly Supplemental Nutrition Assistance Program (SNAP) recipients, are at an increased risk for poor fruit and vegetable consumption and developing diet-related chronic diseases [3, 4]. This may be due in part to low affordability and availability of fruits and vegetables [5, 6], especially in local food systems [7-9], and the cost-related trade-off decisions negatively affecting the management of chronic conditions [10, 11]. Low-income populations frequently report geographical, social, and cost-related barriers to local food systems, which are also associated with low consumption of fruits and vegetables [7-9, 12]. Despite the socioeconomic and geographic barriers, low-income populations are interested in accessing and purchasing locally grown produce [13, 14]. Multi-level interventions guided by the Social-Ecological Model (SEM) framework aim to address the barriers to healthy eating by reinforcing positive behaviors across multiple levels (i.e., individual, social, environmental, systems, sectors, and policy), and to reduce diet-related health disparities among low-income populations.

Fruit and Vegetable Prescription (FVRx)[®] Programs[®] are multi-level interventions combining healthcare provider generated produce prescription for locally grown produce, health screenings, and nutrition education for low-income patients with diet-related conditions. Prior studies of produce prescription programs consistently demonstrate the increased purchase and consumption of fruits and vegetables in primarily clinic-based populations [15-17]. Despite the

increasing number of programs [18], there is limited information about the program and partnership building processes of both community- and clinic-oriented FVRx programs. There is also insufficient evidence on how combining education interventions with produce prescription interventions supports the various levels of influence for dietary behaviors. Key factors influencing dietary behavior and health outcomes of low-income include financial and food resources, food security, food purchasing practices, nutrition knowledge, and local food system experiences and perceptions. Because the multi-level approach of the FVRx intervention aligns with the SEM framework, it is critical to understand how this approach can leverage the various domains of behavioral influence over single-level interventions alone.

The purposes of this dissertation were to examine how the partnerships and processes of multi-level produce prescription programs combining culturally tailored direct nutrition and financial literacy education influence low-income adults' nutrition behaviors, health outcomes, and experiences in local food settings. The specific aims of this study were to: 1) examine the partnership building and development of a Pilot FVRx, as well as the program impact on fruit and vegetable consumption, food purchasing practices, food security, and diet-related disease management compared to a control group, 2) examine the effect of an FVRx program with expanded nutrition and financial literacy education for low-income adults on dietary intake, food purchasing practices, food insecurity, food and nutrition-related attitudes, and clinical outcomes compared to a nutrition education program and a control group, and 3) understand how participants in an FVRx program navigate their local food system, purchase food, and prepare or eat fruits and vegetables compared to the nutrition education group and control group participants.

This dissertation describes the development, implementation, and evaluation of the preliminary and expanded FVRx models combining produce prescription with nutrition education, financial literacy education, and health screenings using mixed methods approaches and non-randomized controlled study design. Chapter 2 includes a review of the literature, which highlights how poverty increases food insecurity risks such as poor diet, food purchasing practices, and chronic disease management, as well as how multi-level interventions using local food systems can improve food security, dietary behaviors, and health outcomes in low-income adults. Chapter 3 includes findings and results from the Athens Pilot FVRx Program. Chapter 4 includes results from the Expanded Athens FVRx Program. Chapter 5 includes findings on low-income adults' experiences with local food systems before and after participation in the Expanded Athens FVRx Program. Chapter 6 discusses findings from the entire dissertation and provides general conclusions and implications for future FVRx programming, research, and policies.

CHAPTER 2

LITERATURE REVIEW

Food Insecurity

Food insecurity, as defined by the USDA, “is a household-level economic and social condition of limited or uncertain access to adequate food [19].” In the U.S., affordability of food is central to the definition of food insecurity, which can lead to reduced diet quality and food intake. Food insecurity has been measured by asking about the individual or household experiences and feelings about food situations, such as uncertainties in the ability to purchase food, worrying food would run out, food not lasting, a reduction in the size or number of meals, or the inability to afford balanced meals. The nationally validated U.S. Household Food Security Survey Module (US HFSSM) has been used to determine four levels of food security: 1) High food security, 2) Marginal food security, 3) Low food security, and 4) Very low food security. High food secure households have no problems or anxiety with being able to access adequate food at all times. Marginally food secure households had difficulties at times or were anxious about obtaining food, but quality, variety, and quantity did not significantly decrease. Low food security is characterized by households where diet quality and food variety are affected, but a limited reduction in food intake has occurred. Very low food insecurity is the most severe level of food insecurity and is characterized by one or more household members having reduced food intake and altered eating patterns due to a lack of resources for food (USDA ERS, 2017).

In 2018, about 11.1% of households in the U.S. reported food insecurity in the past 12 months [20]. This is an improvement from 2011, where 14.9% of U.S households were estimated to be food insecure. Additional data collected in the US HFSSM asked how frequently various food insecurity conditions occurred throughout the year, whether they occurred 30 days prior to the survey, and if so, how many days. These data demonstrate that for a majority (75%) of the very low food secure households, the conditions recurred in three or more months of the year. For food-insecure households and very low food secure households, 25% and 33% respectively experienced the conditions almost every month. Furthermore, the following sociodemographic and economic groups experienced higher rates of food insecurity: 1) Those who had incomes below 185% of the poverty threshold (35.3%), 2) Households headed by African American/Black (21.2%) or Hispanic (16.2%) adults/individuals, and 3) Households with children (13.9%). In Clarke County, GA, a large proportion (20.6%) of households considered themselves food insecure, which is higher than those of the national and state average (11.1% and 14.4%, respectively) [19, 21]. As the data demonstrated, poverty and income are tightly linked to food insecurity outcomes. Financial strains can exacerbate food insecurity, especially with a limited income for essential expenses. In the face of financial strain, practicing financial management skills such as paying bills on time, use of a budget, or reviewing expenses are associated with an increased likelihood of reporting food security [22]. A related study demonstrated that lower ratios of assets to maintain household finances are also associated with an increased risk of food insecurity[23].

Food insecurity is negatively associated with the purchase and consumption of healthy foods, like fruits and vegetables, that promote positive health outcomes [24, 25]. Food insecurity increases the likelihood of purchasing or acquiring calorically dense and satiating foods, which

are associated with weight gain and obesity [26]. Independent of diet, food insecurity is also positively associated with obesity for specific age and gender groups [27]. One potential relationship of obesity with food insecurity is the increased risk of exacerbating chronic conditions [28, 29]. These relationships may be due to the medical costs associated with obesity and chronic diseases and can also be considered another risk factor for food insecurity [30-32]. Medical cost considerations and lower rates of insurance, private or public, among low-income individuals, can also contribute to further development or mismanagement of obesity or chronic conditions [33]. Also, having a low-income or food insecurity and a chronic disease increases one's risk for taking less of their prescribed medications due to cost, called cost-related medication non-adherence (CRN). Common practices of CRN include skipping doses, avoiding refills or new prescriptions, splitting pills, or discontinuing medications [10, 34, 35]. Not being able to afford medications for managing diet-related chronic conditions intersects with an individual's ability to manage their condition through dietary means. Often, health providers provide diet plans or recommendations to help their patients manage or prevent health conditions, and these recommendations tend to incorporate foods that food-insecure individuals may leave out of their diet due to high costs [36]. The income and financial-based risk factors associated with food insecurity as well as the many potential downstream diet and health-related consequences should constitute food insecurity as a high priority public health issue. This multifaceted problem requires a comprehensive framework for understanding and developing solutions.

Social-Ecological Model

The Social-Ecological Model (SEM) is a theoretical framework created to assist the development of health promotion and disease prevention solutions [37]. The social-ecological model considers individual, interpersonal, institutional/organizational, community, social, policy, and systems factors nested in varying levels of behavioral influence [37]. In this model, each level reciprocally influences the other and is dependent on the life stage of the individual. Interventions designed to reduce the adverse health impacts of having a low-income can either focus on one level at a time or address multiple levels. This model has been adapted and applied by various government agencies, public health departments, and researchers to support their goals and desired outcomes more effectively. Key factors described below are based on the SEM that was modified by the United States Department of Agriculture (USDA) 2015-2020 Dietary Guidelines for Americans (DGA) [38].

Individual Factors

Individual factors include socio-demographics (e.g., age, gender, race/ethnicity), economic status, physical abilities, and health status, and other factors focusing on expressed behavior choices or psychosocial and cognitive factors (e.g., attitude, knowledge, skills, and personal preferences). At this level, the use of direct nutrition education can improve knowledge, skills, and attitudes towards eating and shopping healthfully. The outcomes of individual-level interventions have the potential to support individuals to make healthy choices in a variety of social situations and settings with which they interact. For example, nutrition education for low-income adults delivered both in person or online can improve fruit and vegetable intake, reduce sugar-sweetened beverage consumption, and increase physical activity [39, 40]. Similar nutrition

education interventions have helped participants maintain food security through financial and nutrition-focused lessons [41, 42].

Settings

Settings in which individuals participate can include the home, school, work, food service, and retail establishments, hospitals or health clinics, and churches or other community settings. These settings can determine what kinds of food and physical activity opportunities to which individuals are exposed. Settings that offer healthy food options at affordable prices or safe and convenient opportunities to engage in physical activity can improve the likelihood that more individuals will make healthier choices. For example, nutrition related-interventions can target retail food settings and improve offerings of healthful foods [43]. If these strategies are integrated with individual and multiple sector strategies, there is potential for broader population-level impacts.

Sectors

Sectors include the broader systems in which settings and individuals interact. Systems can include government and policy, education, health care, or transportation. Businesses and industries include agriculture, food, beverage, retail, and entertainment. Sectors also include organizations that serve public health, community, or advocacy interests. The addition of policies or institutional changes in each of these sectors could potentially support those interventions that improve the knowledge and skills taught by intervention targeting individuals [44]. One policy solution tested is the use of monetary rebate incentives for SNAP recipients who purchase fruits or vegetables with the benefits. This intervention improves individual and household level consumption of fruits and vegetables and has a broader reach than some individual or setting-based interventions [45].

Social and Cultural Norms and Values

These factors are often considered higher social orders that have long-standing and broader assumptions of what healthy or accepted behaviors in a given society are. These are reflected in the way laws and policies are formed, how people develop food preferences and attitudes or values towards health.

The SEM approach to improving the health outcomes of individuals and populations is a push against the neoliberal motives of the current healthcare system. The U.S. still has a two-tier system of public and private sectors that leave many unable to afford insurance or underinsured [46]. The framework and intervention used in this study have the potential to address multiple and related issues where the current healthcare system falls short. Because of the complex and interdependent nature of nutrition, health outcomes, food security, and food purchasing practices, the SEM framework will be used to support the exploration of previous research and serve as a theoretical framework for the proposed study. Throughout the review, a social-ecological perspective will be to explain how the issues described, and the solutions tested to align with the various levels of the model.

Food Purchasing Practices of Low-Income Populations

Food purchasing practices can be defined by strategies and habits that an individual uses to afford or buy food. Strategies are diverse and contextual on many factors such as income level, participation in governmental and emergency food assistance programs including SNAP or the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), food environment, geography (rural vs. urban), and transportation [47]. Aside from the policy and

environmental factors that influence food purchasing practices, common strategies at the individual level include food resource management (FRM) strategies. These can consist of using coupons, buying sale and store special items, buying in bulk, shopping once a month, using food pantries or food banks, and shopping at multiple store locations [48].

Typically, energy-dense foods are less expensive than other foods considered healthier and potentially contribute to reduced diet quality in low-income populations. Foods such as processed-grains, fats, and sweets are cheaper than more healthful foods such as lean meats, whole grains, and fresh vegetables [49]. When cost is prohibitive to purchasing nutritious foods, adherence to dietary guidelines is less likely and has the potential to reduce diet quality [50]. Individuals with low income are more likely to diverge from purchasing patterns associated with meeting public health nutrition recommendations, which include fewer purchases of fruits and vegetables and more purchases of foods higher in fat

Multiple studies have shown that the food environment available to low-income households is associated with the purchase of certain foods. Food environments can be defined by geographic access to food (e.g., community level), as well as the various types and costs of foods available various food retailers or markets (e.g., consumer-level) [51]. Cassady et al. found that food prices for healthful foods, especially fruits and vegetables, are more expensive in lower-income neighborhoods [52]. Webber and colleagues also describe how primary shoppers of low-income households are influenced by the store venue, internal store environment, product quality, product price, and their relationships with the stores when purchasing food. These findings indicate that in addition to costs, other food environment perceptions influence the type and amount of produce they purchase at various stores [53]. Furthermore, studies also show that low-income populations have disparately low access to direct-to-consumer markets like farmers

markets, which are characterized as healthier food venues with high amounts of fresh produce [14, 54-56].

Some studies refer to food purchasing practices, FRM strategies, and food acquisition practices synonymously. Food resource management strategies are what households use to afford and buy food, while food acquisition practices can encompass both receiving and purchasing food, which can influence food purchasing practices. Food purchasing practices as determined by Walker and Lee are: 1) where food is purchased, 2) when and how often food is purchased, 3) types of food purchased, 4) financial resources used, 5) amount spent, and 6) strategies for maximizing resources [47]. Food security is a critical factor that can affect food acquisition practices. In one study, when low-income households were faced with concerns of having an adequate food supply, diverse food acquisition practices were reported, which varied in frequency and potential risks. The most common food acquisition practices of the study participants were: 1) went to the food pantry (96%), 2) made meals with low-cost foods (96%), 3) bought food items on sale (95%), and 4) skipped meals (68%). Of the 78 food acquisition responses provided to each participant, 62% of participants reported engaging in practices that were considered a risk [57]. Similar results were found when examining food acquisition and FRM strategies practiced or witnessed by Extension nutrition educators who serve low-income populations. Other common food acquisition and food management practices include compromising the quality of foods purchased, illegal practices (e.g., stealing food or selling assistance benefits) and less severe practices included creating low-cost meals, limiting second portions, or preserving food through freezing [58]. A related study describes that food-insecure caregivers utilize three strategies to manage household food availability: 1) change foods purchased or obtained for household, 2) use monetary shopping strategies (buy only according to

price), and 3) adapt preparation methods of meals. As a result, protein foods, fruits, and vegetables were purchased less than foods with grains, starches, or mixed foods [7]. As these studies demonstrate, households use both FRM strategies and food acquisition strategies as part of their food purchasing practices for maintaining food security. These studies have also shown that household and consumer environment characteristics, financial constraints, and adaptive behaviors all significantly contribute to food purchasing practices of low-income households. The resulting strategies reported in these studies are a result of uncertainties related to persistent income and how or where to get the next meal. When facing these food-insecure situations, families shift their purchasing behaviors to accommodate the amount and type of food they purchase, the ways in which they acquire food, and ultimately how they eat.

Diet Quality and Fruit and Vegetable Consumption

Overall diet quality can be a measure of how well an individual or population adheres to healthful eating patterns as defined by national recommendations, which considers foods such as fruits and vegetables as part of a healthful diet. Considering the current DGA, a healthy diet is an eating pattern that accounts for all foods and beverages at an appropriate calorie level [38]. One way to assess diet quality is through self-reported or interviewer-administered 24-hour dietary recalls. A single recall can be used to provide a detailed snapshot of an individual's diet quality. A review of research using various self-reported diet assessment methods has shown that food frequency questionnaires (FFQ) may better reflect usual intakes that vary from day to day, week to week, month to month, and beyond compared to a 24-hour diet recall. One method to accurately assess usual intake and diet quality is to collect dietary recalls over three different

days of a given week; however, the respondent burden increases as the amount of recalls increases, which is an essential consideration in low-income audiences [59]. On the other hand, other validation studies have shown that FFQs used to screen for the intake of specific foods such as fruits and vegetables may overestimate actual consumption more than 24-hour dietary recalls [60]. These and other self-reported methods are subject to biases and human error due to issues such as respondent burdens, low literacy, or motivation. Despite these limitations, dietary-recalls and FFQs are cost-effective and have a relatively small respondent burden, which is essential for longitudinal or epidemiological studies [61].

The Healthy Eating Index – 2015 (HEI-2015) is a widely used tool that uses density-based measures from 24-hour dietary recalls comparing against common standards that align with the DGA recommendations for a healthy eating pattern. Based on consumption recommendations, the index creates a standardized score for nine different components of adequacy and three components of moderation to total 100 points. A score for each component is provided based on how close an individual is to consuming the standard cup, ounce, gram, or energy equivalents per 1,000 calories provided by population studies [62]. Using a nationally representative sample from the U.S. population, the USDA estimates that the average total Healthy Eating Index-2010 (HEI-2010) score was 57.8 out of 100 in 2009-2010. This score reflects a trend of very low fruit, vegetable, and dairy consumption, and excessive added sugars, saturated fats, and sodium compared to current recommendations [63]. Diet quality among low-income and food-insecure populations is consistently lower than in higher-income counterparts. Leung and colleagues [64] demonstrated that compared to very low food secure households, the relative diet quality of food secure households was significantly different (4% difference, $p<0.001$). Results also indicate few adults in this study met the national dietary guidelines for

fruit (2%) and vegetables (0%). Lastly, very low food insecure adults consumed 12% fewer servings of vegetables than food-secure adults. Taylor et al.'s study further demonstrated that food-insecure groups tended to consume more mixed dishes contributing to a more substantial proportion of total energy and nutrient intake and overall diet score than their counterpart [65].

In a recent study, 24-hour dietary recall data from NHANES 2007-2010 and 2011 BRFSS fruit and vegetable consumption data were used to estimate the percentage of the population meeting fruit and vegetable consumption recommendations. The investigators estimate that 14 % of the total population met fruit consumption recommendations, and 8.2% met vegetable consumption recommendations [66]. These results are similar to previous analysis by the National Cancer Institute (NCI), which estimated that 75% of the population had fruit intakes below the minimum recommendations, and 87% did not meet minimum vegetable intake recommendations [67]. Due to the role of demographic and socioeconomic factors such as race, ethnicity, age, sex, and household income on diet quality, these studies controlled for these factors in their analyses. Another study that used 2009 BRFSS dietary recall data found a significantly lower percentage of those living at the greatest poverty level consumed fruits at least two times daily or vegetables three times daily than those with lower poverty levels [68].

Based on the evidence presented thus far, it is apparent that food costs and income disparities lead to poor diet and health outcomes. These outcomes are often a result of the physical food environments one interacts with and the food acquisition strategies used as a result of uncertain financial and food resources. These findings are important when considering recommendations and development of interventions to improve food insecurity, consumption of fruits and vegetables, and diet quality [65].

Medical Services for Low-Income Populations

Low-income populations face disparate access to healthcare, increasing the risk for poor health outcomes, and mismanagement of chronic disease [69, 70]. Limited access to healthcare among low-income individuals is often a result of no healthcare coverage, health illiteracy, or limited access to safety-net clinics [71, 72]. The Affordable Care Act (ACA) of 2010 sought to improve healthcare access through policy reform. It made health insurance more affordable for more people through tax credits and the expansion of Medicaid. By 2016, health care coverage was at an all-time high; however, many Americans still lacked coverage or did not seek care due to high out-of-pocket costs, enrollment issues, or perceived costs [73-76]. In states that did not expand Medicaid, many are still unable to gain affordable and consistent care limiting the potential impact of the ACA [76].

Safety-net clinics currently serve a vital role in healthcare, serving both uninsured and Medicaid or Medicare recipients. Safety-net clinics serving low-income populations relieve cost and care burdens on the healthcare system as a whole. The use of safety-net clinics is associated with lower emergency room visits among uninsured populations and can provide free medications to patients with existing chronic conditions [77, 78]. Varying types of safety-net clinics exist to support the variety of vulnerable populations. Federally Qualified Health Centers (FQHCs) are clinics that receive reimbursement for free or reduced costs services as long as 30% or more of their patients receive Medicaid or Medicare. Charity care programs or free clinics serve only the uninsured, therefore do not qualify for Medicaid or Medicare reimbursement. Despite the increase in the number of individuals covered by private or public insurance programs, free clinics continue to serve those who remain or become uninsured. Free clinics

operate through donations, fundraising, or grants, and as a result, rely heavily on volunteer staff [77].

These funding limitations can hinder the ability of free clinics to provide consistent specialty or preventive services such as medical nutrition therapy services by registered dietitians. These services would likely be volunteer-based, limiting the number of patients seen, as well as the number of follow up visits, which are important for improving and maintaining diet-related disease management behaviors. Due to challenges for receiving reimbursement for nutrition counseling through Medicaid and Medicare, even FQHCs are unlikely to staff registered dietitians to provide medical nutrition therapy to patients.

However, safety-net clinics are resourceful, and often partner with local community services or Medicaid Managed Care Organizations to close funding gaps for providing patients preventive care such as nutrition counseling [79]. Because safety-net clinic patients are at high risk of food insecurity and have high rates of diet-related conditions, partnerships with local food assistance resources and community-based nutrition education organizations such as local Extension Offices can help fulfill patients' food and education needs for reducing food insecurity and disease risks [4, 80].

Nutrition Education for Low-Income Adults

Nutrition education can involve any combination of educational strategies, accompanied by environmental supports, designed to facilitate voluntary adoption of food choices and other food – and nutrition-related behaviors conducive to health and well-being. Furthermore, implementing education through different venues that consider the different levels of the SEM is

encouraged [81]. Nutrition education interventions tailored to low-income adults with limited access to healthful foods can empower individuals to make healthier food choices [82].

Two of the largest federally-funded programs that provide nutrition education for low-income populations are the Supplemental Nutrition Assistance Program-Education (SNAP-Ed) [83] and the Expanded Food and Nutrition Education Program (EFNEP). Since 1969, EFNEP has implemented its program through Land Grant Universities using a holistic nutrition educational approach. SNAP-Ed, formerly the Family Nutrition Program and Food Stamp Nutrition Education, started in 1988 by allocating state and local funding that was matched by the USDA to expand the reach of the already existing EFNEP. By 2004 all 50 states were conducting SNAP-Ed independently or in cooperation with private or non-profit contractors [84].

Low-income individuals that participate in SNAP-Ed or EFNEP interventions that focus on content and skill-building on food resource management for low-income households have demonstrated improvements in food security and food resource management skills. Three separate studies of different nutrition education programs have all demonstrated the positive impact of tailored food resource management education for low-income audiences. One study of a SNAP-Ed curriculum, ‘Plan, Shop, Save, and Cook,’ demonstrated significant increases in the use of Nutrition Facts Labels and a significant decrease in instances of running out of food at the end of the month by participants who were SNAP recipients [85]. Similarly, the content related to food resource management practices taught by EFNEP showed significant increases in food resource management scores [86]. Lastly, the ‘Cooking Matters’ curriculum for low-income adults showed long-term changes in the self-efficacy of food resource management skills [87]. SNAP-Ed and EFNEP programs have also demonstrated improved health behaviors such as increased fruit and vegetable intake, reduced sugar-sweetened beverage (SSB) intake, and more

frequent physical activity [39, 86, 88]. As these evaluation studies demonstrate, direct nutrition education for low-income adults is an effective individual-level intervention for improving key behaviors that improve the likelihood and intentions of purchasing and eating healthier foods.

The UGA SNAP-Ed program provides direct and online nutrition education programs as individual-level interventions. Under SNAP-Ed guidance, UGA SNAP-Ed also provides multi-level interventions to achieve the goals of increasing the likelihood that SNAP-Ed eligible adults will make healthy food choices within a limited budget and choose physically active lifestyles. One way UGA SNAP-Ed adheres to this goal is by creating a direct nutrition education curriculum to be used at farmers markets. The ‘Food Talk: Farmers Market’ curriculum is an adapted version of the program’s flagship Food Talk, which highlights local produce typically grown and seen at farmers markets in Georgia through cooking demos, recipes, and dietary principles. The intent of this curriculum is to further enhance the effectiveness of environment-level interventions at farmers markets to increase low-income adults’ access to and consumption of fruits and vegetables. Recent evidence from other SNAP-Ed programs demonstrates the need for nutrition education to support the effective use of farmers markets by SNAP-Ed eligible audiences. One study of a SNAP-Ed farmers market program used a quasi-experimental design and mixed methods to evaluate the impact of nutrition education dosage at a farmers market that participated in a fruit and vegetable incentive program for SNAP recipients. The approach of this intervention was based on the SEM to combine individual-level behavior change with policy-based incentives and a farmers market environment to further promote the knowledge and skills learned. Over the course of each market day, a dietitian, culinary educator, and translator provided six 30-minute workshops that included topics such as portion sizes, budgeting, nutrition label reading, meal planning, and recipe demonstrations that highlighted seasonally available

produce found at the market. Findings demonstrated a positive dose-response relationship between farmers market education participation and fruit and vegetable consumption. Those who participated in two or more farmers market education courses consumed 0.5 cup of fruits and vegetables more per day than the groups who attended none or one class. The same group also reported improved attitudes towards consuming and self-efficacy to prepare and purchase fresh fruits and vegetables featured during the classes. Findings from focus groups with participants include learning to eat healthier, improved attitudes towards cooking and eating healthy, improved health, and changes in shopping, cooking, and eating behaviors [89]. In another study, investigators compared perceptions among SNAP and non-SNAP beneficiaries who were provided educational content through SNAP-Ed at a farmers market in Utah. Education materials included recipe samples, cooking demonstrations, informational posters, and recipe cards for all market patrons. The results indicate that recipe cards significantly influenced the amount of produce purchased during their market visits and increased the likelihood of planning for future purchases as a result. SNAP recipients were also more likely to agree that the informational posters resulted in an increase in nutrition knowledge. In a follow-up survey of study participants, 70% agreed that they were unlikely or extremely unlikely to make the recipe at home unless there was a sample [90]. These studies are the only two to date that attempt to assess the impact of direct SNAP-Ed nutrition education interventions at farmers markets. Based on the SEM, these studies demonstrate an effective supporting role of direct-nutrition education for food environment interventions such as farmers markets. However, there is limited research as to what type and format of nutrition education are needed at various farmers market settings from the perspective of its participants.

Local Food System and Interventions

Food System

Food systems play a critical role in food access and consumption to achieve food security. As defined by the Food and Agricultural Organization [91] of the United Nations (UN), a food system encompasses “the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal of food products. Food systems comprise all food products that originate from crop and livestock production, forestry, fisheries, and aquaculture, as well as the broader economic, societal, and natural environments in which these diverse production systems are embedded [91].” Food systems are also defined by the geographic region in which they operate (e.g., local to global), the methods that they use to produce food (e.g., industrial, conventional, organic, sustainable), and the methods in which the markets are arranged (i.e., direct-to-consumer or direct-to-retail). The supply chain for larger food systems involves large homogenous farms producing bulk quantities of the same product, then selling those goods to an industry buyer or wholesaler to process and then distribute to a retailer from which consumers can purchase the goods [14]. To expand upon these definitions, the conceptual framework developed by Nesheim and colleagues describes the food system as “a supply chain that operates within broader economic, biophysical, and sociopolitical contexts [92].” Restated, the individual, biological, and social contexts people face day to day are constantly shifting decisions of what, how, and why a particular food is purchased and eaten. Further complicating these decisions are the broader environmental and economic contexts, including national agricultural production policies, global

trade policies, and the natural environment of the world we live in that dictate food prices, trends, and availability.

A sustainable food system, as defined [91] by the Food and Agriculture Organization of the UN, is a “food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised.” This vision of a sustainable food system would assist in maintaining food security for all people while conserving resources and creating supportive economies. Because the most common issue of food insecurity and hunger results from the inability to afford food, sustainable food systems could also support a reduction in poverty disparities. A growing number of policies and programs in the U.S. are aligning these concepts of sustainability to increase the access and consumption of locally grown fruits and vegetables for low-income households.

Local Food System

Local food systems are made up of more small farms and producers with more heterogeneous products and typically sell directly to the consumer or retailer. On top of growing and producing, they often perform their own marketing functions such as advertising or sales, storage, packaging, transportation, and distribution. Farmers markets, Community Supported Agriculture associations (CSA), and farm stands are various forms of what the USDA considers a direct-to-consumer market where the farmer sells directly to the individuals who will prepare and consume the goods. Direct-to-consumer markets have been growing due to increased demand for more local and organic production practices and support from federal policies and are often considered more sustainable.

Farmers Market

Each year the number of farmers markets increases in a linear trend, with more rapid growth in periods of strong support from federal and state grant programs. The number of farmers markets increased from 2,140 in 1996 to 4,685 in 2008 [14]. Most recent data from 2019 show there are 8,771 registered farmers markets in the U.S. [94]. The growth of farmers markets and other direct-to-consumer markets was slow until the USDA Agricultural Marketing Service passed the Farmers Market Promotion Program (FMPP) under the 2002 Farm Bill. Under this funding, more markets and small farms were supported to promote their direct-to-consumer services [13]. Despite the growth in alternative and smaller markets, the use of these markets by low-income and SNAP populations prior to this period was declining. The overall percentage of SNAP redeemed at farmers markets dropped from 26.7% in 1996 to 7.8% in 2004. One factor in this trend was the transition from voucher-based SNAP redemption to the EBT system. Farmers markets were overlooked in the logistics and support process of this transition. It was not until after 2009 that the redemption rates of SNAP at farmers markets increased [95]. In 2012, Congress approved funding through the USDA Food and Nutrition Service (FNS) to increase the number of direct-to-consumer markets that accept EBT from SNAP recipients. The current grant program provides markets with free equipment and pays for service fees needed to process transactions for the first three years of use. These initiatives have supported the continued resurgence in SNAP transactions following an all-time low in 2007. Of the 8,600 markets that now exist in the U.S., 7,377 markets are now authorized to accept SNAP benefits [96, 97].

During these initial changes in SNAP redemption practices, the FNS administered the WIC Farmers Market Nutrition Program (FMNP) and the Senior Farmers Market Nutrition Program (SFMNP) starting in 1992. Recipients of WIC or seniors who receive SNAP would be

provided coupons to be used at participating markets in addition to their standard benefit allotment. The push for these programs was to increase the access of low-income households to healthy foods such as fruits and vegetables. Studies have also shown that low-income adults have disparately low access to direct-to-consumer markets and consumption of healthier foods like fruits and vegetables [13, 55, 64, 66, 98]. Reasons most often cited by low-income adults for reduced access to farmers markets are transportation barriers, limited market hours, perceptions that fresh produce is more expensive in general and at farmers markets [54, 99, 100]. Despite these barriers and perceptions, studies have demonstrated that when low-income populations shop at farmers markets, they increase fruit and vegetable intake and shift their perception towards improved access to fruits and vegetables [12, 101]. Most studies to date have aimed to increase the access and purchase of fruits and vegetables at farmers markets by WIC FMNP participants. These studies of WIC FMNP programs have shown promise at reducing the barriers for low-income populations who receive supplemental nutrition assistance. These interventions improve the redemption of vouchers for the purchase and consumption of locally grown produce, as well as address primary access barriers [102-104].

Community Supported Agriculture (CSA)

An alternative local food system intervention includes the use of CSAs. These are marketing arrangements in which their members purchase a share of a farmer's yields before they plant the season's crops. Typically each week during the growing season, the members pick up their share at predetermined locations [13]. Prior to the 2014 Farm Bill, CSA venues were not able to accept SNAP benefits as a form of payment. CSAs have also seen a steady increase in growth from 1996 to 2007, with a leveling off in recent years to about 12,617 farmers markets

through CSAs, which equates to about 6,500 CSAs total. It is also important to note that the majority of farmers using CSAs also sell through farmers markets [14, 105].

One recent innovation to connect low-income households to local produce is the use of a sliding-scale CSA model. Anecdotally this is now becoming a more common practice locally and throughout the nation. One report describes the effort of one farm in Boston, MA., that partnered with local housing and public health sectors. In order to accept SNAP benefits, the program has built in the flexibility to allow people to pay for shares weekly instead of all at once. The model, in general, is similar to that of a health care clinic for patients without health insurance.

Depending on the household or individual's income, the rate for the weekly share will increase linearly based on household size, and an increase in income [105]. For example, the sliding scale program for the local Collective Harvest CSA in Athens, GA share allows those in the lowest income category to purchase their CSA for around \$3.50-\$5.00 a week depending on household size. CSA shares through Collective Harvest typically range from \$18-36 a week without the discount. These innovations in providing fresh and local produce to low-income households are essential for awareness of local food systems, market growth, and ultimately the health of the local economy, environment, and people.

Fruit and Vegetable Incentives

As previously demonstrated by the WIC FMNP and SFMNP, the use of incentives as a policy intervention can support access to direct-to-consumer markets by low-income households. A recent expansion in the use of incentive models to increase the access to and purchase of fruits and vegetables by low-income households has shown promise. Incentives come in the following common forms: 1) Direct subsidies providing the funds directly to the consumer in the form of money or a voucher, 2) Indirect subsidies requiring spending a certain amount of one's own

money or benefits to receive a certain amount in addition to what was spent, or 3) Rebate incentives where participants spend their own money or benefits and then are provided a certain amount of money back onto their benefits for every dollar spent on certain items. However, before incentive programs for SNAP recipients were supported through federal grant programs like the FMNP, they were initially funded and piloted as grass-root efforts of non-profit organizations and local government agencies. Interestingly, during the piloting of these programs, there was specific regulation by the USDA that did not allow retailers to single out SNAP users for special treatment in any way. This required any agency interested in offering incentives to SNAP recipients to apply for a waiver with the USDA FNS [106]. It wasn't until after the passing of the 2008 Farm Bill that the USDA amended this regulation and authorized \$20 million for the Healthy Incentive Pilot Program (HIP) [107, 108]. Following the success of this pilot program and other grass-roots efforts, the Food Insecurity Nutrition Incentive (FINI) grant program was established to expand initiatives that incentivized or supported SNAP recipients to purchase and consume more fruits and vegetables.

Until 2011, there have been very few studies to explore the implications of incentivizing low-income adults that receive SNAP benefits to purchase more fruits and vegetables with financial subsidies. The HIP, a novel study funded by the USDA, examined the use of targeted incentives to increase the purchase and consumption of fruits and vegetables in SNAP recipients. This study provided SNAP participants with \$0.30 for every EBT dollar they spent on qualified fruits and vegetables [45]. The findings suggested the participants increased both the purchase and consumption of qualified fruits and vegetables. However, participants did not shift their primary shopping stores or other common purchasing practices as a result of the subsidy.

In response to the efforts performed by the HIP, the USDA FINI grant expanded, allowing further exploration of alternative fruit and vegetable incentive methods for SNAP recipients. First, the introduction of doubling SNAP benefits at farmers markets was explored in various urban cities in the U.S. One study developed and tested validated measurements to assess fruit and vegetable intake, food security, and shopping habits of participants of a SNAP matching program at a farmers market [109]. This program matched up to \$10 of SNAP purchases per visit to the farmers market. As a result, the mean score of food security significantly decreased from 3.0 to 2.3 ($P < .05$) after participating in the Double-Up Food Bucks (DUFEB). Following the intervention, the mean consumption score for vegetables significantly improved, however fruit consumption did not. A DUFEB program in New York utilized mixed methods and a quasi-experimental design to assess the impacts of nutrition education at farmers markets participating in the matching program [89]. The investigators compared three groups: 1) No education, 2) One education class, and 3) Two or more education classes across measures of fruit and vegetable consumption, attitude towards fruit and vegetable consumption, self-efficacy to prepare fruits and vegetables, incentive participation, and market attendance. Findings suggest those who participate in two or more classes consumed an additional 0.5 cup/day of fruits and vegetables compared to one or no class at all ($p < .001$). Almost all participants (97%) usually or always used Health Bucks coupons to buy the fruits or vegetables featured in the FM classes. Participants started eating new types of produce and attempted to prepare them at home. Findings from the focus groups highlighted participants' increased nutrition knowledge from both their interaction with the nutrition education and reinforcement of the market. Participants also reported the classes and attending the market changed the attitudes among the children, and their family members had better diets by way of modeling healthy eating. Most farmers market incentive

interventions report providing the incentive in the form of a subsidy prior to purchasing the fruits and vegetables. Depending on the capacity of the market and vendors to receive certain forms of payment, as well as limitations of the intervention or program, the amount and duration of the subsidies vary widely.

Studies and programs that have consistently shown increased access and use of farmers markets are associated with higher fruit and vegetable intakes for shoppers of all income levels [12, 55, 110]. To date, there are very few existing multi-level interventions or studies that have attempted to understand how direct nutrition education combined with environmental interventions such as farmers market access interventions can support more effective utilization and outcomes. Furthermore, there is limited but growing evidence and support for produce prescription programs that support food-insecure households through provider-generated prescriptions for fruits and vegetables. These produce prescription programs vary in structure by providing different levels of health screenings, amount of produce provided, the mode of providing produce (e.g., farmers market, CSA, mobile market, or commercial retailer), and whether other supportive education interventions are provided. Despite the recent development and evaluation of these programs, they have the potential to support each pillar of sustainability through the SEM approach of behavior change.

Fruit and Vegetable Prescription (FVRx) Programs

Produce prescription programs are a new breed of multi-level produce incentive interventions for low-income populations. These interventions typically include a provider-generated produce incentive and health screening or counseling by the clinic providers. The non-

profit organization Wholesome Wave has taken the produce incentive model and developed a more extensive fruit and vegetable prescription (FVRx) program. What sets these programs apart from other incentive programs are they require agencies that implement the program to provide nutrition education and health screenings in combination with the produce prescription. The produce prescriptions implemented by FVRx programs are direct subsidies that are redeemed for locally grown produce at farmers markets, community gardens, or CSAs. The subsidy amount is typically set at \$1/day per household member, so the participant is able to provide enough produce for their entire household each week. FVRx programs are relatively new, and only a handful of studies have been conducted to examine the impact of produce prescription or FVRx programs using rigorous study design and valid measures.

Intervention Models

All interventions, but one focused the incentive or subsidy on fruits and vegetables only. Only two studies tested the use of the subsidy or incentive at a retail market setting, rather than a farmers market or CSA program [17, 111]. These studies varied in the types and amounts of incentives provided, which are also related to intervention duration and model. Some interventions provided as low as \$50 total over 22 weeks. Others provided \$6/week for 13 weeks, \$10/month for four months, and even as much as \$1/day per household member for 22 or more weeks. Most of these studies utilized direct subsidies for the purchase of fruits and vegetables, but some of them limited the amounts in an attempt to determine the influence on subsequent purchases with one's own monetary resources. One CSA-based intervention provided 25 weeks of CSA shares valued at \$20/week but was valued at \$5-10 for clinic patients [112]. Another CSA-based intervention provided \$300 towards a \$480 CSA share that covered two growing seasons (18 months) [113]. The incentives in both of these studies required the patient

to use their own money or SNAP benefits to purchase the weekly share. The most common healthcare site for participant recruitment is FQHCs, and other common sites include WIC clinics, public hospitals, community health clinics, and standard primary health clinics.

Many of these interventions utilized varying degrees of supporting education or counseling in conjunction with health screenings and produce incentives. Most often, clinic staff received training or created materials to provide the participants the majority of education cues. The most common education supports were recipes tailored to fruits and vegetables, goal setting for dietary and health outcomes, and handouts of materials that were covered in either counseling or group education sessions. Only two of these interventions utilized registered dietitians to provide dietary counseling and with only minimal follow-up, and those interventions that utilized group education varied in content, frequency of delivery, and were provided by trained clinic staff. None of these interventions or studies have assessed the mode and to what degree nutrition education supports various outcomes related to the produce prescription program. Furthermore, there is no mention of these interventions tailoring their curricula to low-income audiences with evidence-based practices and content. Despite the evidence that nutrition education and food resource management curricula alone are effective at improving dietary outcomes, food security, and food purchasing practices, there is still no study that assesses the impact of these educational resources in combination with an FVRx program or in a farmers market setting.

Study Design and Measures

To date, there have been three randomized controlled trials of produce prescription programs [113-115]. The study by Berkowitz et al. is the most comprehensive and robust controlled trial with 122 total subjects and a comparison group that received a cash-matched incentive. The most common study design is a one-group repeated measures design; one study

used a two-group repeated measure design with no comparative analysis; and another study used a retrospective case-control design [15-17, 112, 116-118]. Two of these studies utilized mixed methods to evaluate program processes and experiences with either the participants or the program providers. Two qualitative studies of a single produce prescription intervention for hypertensive patients assessed participants' overall program experiences as they related to perceived barriers and benefits [119, 120].

Common measures across the quantitative and mixed methods studies included outcomes such as fruit and vegetable consumption, diet-quality, nutrition-related attitudes and behaviors, and food security. Common process evaluations assessed prescription redemption, program attendance, or partnership development processes. The majority of studies assessed fruit and vegetable intake showing consistent increases in either total fruit or vegetable intake or increases in only fruits or vegetables. These studies utilized various FFQ tools to assess fruit and vegetable intake ranging from two items to 19 items and modified from sources like the NNCI Eating at America's Table study (EATS), the BRFSS module, or the Fruit and Vegetable Checklist. Only one study to date has used dietary recall to assess both fruit and vegetable intake and diet quality [113]. This study used telephone-based 24-hour dietary recalls using the Automated Self-Administered 24-Hour (ASA-24) Dietary Assessment Tool system. Participants completed three dietary recalls that occurred during each growing season, and three occurred during the nongrowing season, in addition to a single baseline recall. Four studies to date have utilized clinical measures, Hemoglobin A1C (HbA1c), cholesterol, glucose, and vitamin nutriture (Vitamin C, E, and folate) to determine effects of the intervention and have found mixed results with regards to changes in HbA1c and no changes detected in cholesterol or vitamin nutriture measures [15, 17, 113-115]. Only one study to date has shown significant decreases in BMI

[116], and no study has shown any significant changes in blood pressure [113, 121]. Only two studies (one adult and one pediatric patient population) using validated food security measures have demonstrated significant decreases in food insecurity [113, 117]. A mixed-methods study by Trapl et al. used surveys to examine the redemption practices, attitudes, and beliefs towards fruits and vegetables and experiences at farmers markets of the participants and utilized qualitative assessments with providers to improve program processes [118]. Another study utilized a process evaluation to describe the development of a program that used a partnership between a FQHC, a university, and various retailers for a healthy food prescription. The prescription, in this case, was an indirect subsidy in the form of a coupon to be used at either local farmers markets or partnering stores (Walgreens and CVS) [111]. The majority of studies also utilize methods to assess the redemption practices of the participants [122-125]. The remaining studies either assessed attendance only or attendance in combination with the amount of incentive redeemed to assess the proportion of prescription used. However, only one study to date has utilized methods to assess the actual foods purchased and with which source it was purchased with (voucher, cash, EBT, or debit/credit) [16]. Furthermore, there is only one study that assessed any part of participants' perceptions and experiences with the use of the redemption site, farmers market, prior to and following the intervention. It should also be noted that the sample in this study included a unique group of pregnant women [118]. The findings from Schlosser et al. indicate that participants continued to experience transportation and economic constraints that warranted concern for the use of farmers markets as part of produce prescription programs. However, the program structure, geography, and patient population are unique and do not provide insight into their experience with the farmers markets or local food systems in general. There is also limited evidence as to whether FVRx programs alter the way in which

participants navigate and perceive their local food system because of their access and use of direct-to-consumer markets. These are needed to improve both the long-term purchase and consumption of fruits and vegetables by program participants, as well as to improve the viability of the various direct-to-consumer markets with which these programs are collaborating. Furthermore, this information is vital to understanding the potential viability of using both nutrition education and farmers markets as individual and environmental supports for these types of SEM interventions.

Rationale and Specific Aims

Nutrition education alone has proven to be an effective intervention by improving attitudes and self-efficacy towards nutrition-related behaviors such as purchasing, cooking, and consuming fruits or vegetables; however, there are limitations in long-term behavior change [82, 126]. This may be due in part to a single-level intervention approach that often lacks positive behavioral reinforcement through social, environmental, or policy changes [127]. Produce prescription programs are comprehensive multi-level interventions that use healthcare provider-generated produce prescriptions as policy and systems interventions paired with access to healthy food retailers. FVRx program models have expanded this approach by requiring nutrition education and the use of locally grown produce in addition to the healthcare generated produce prescription. The studies done to date have demonstrated consistent increases in the purchase and consumption of fruits and vegetables, but mixed clinical outcomes in primarily low-income patient populations. Very little is known regarding the partnership development and processes required to implement community- and clinic-based FVRx programs or how the unique program

structure and settings influence participant outcomes. Specifically, there is little information available on how intensive education combined with produce prescription for farmers markets affects participants' financial and food resources, food purchasing practices, food security, nutrition-related knowledge and behavior, and clinical outcomes. Furthermore, no previous studies examined if the key intervention components of FVRx programs and the use of local food systems influence participant perceptions and experiences with local food systems.

The purposes of this dissertation are to examine how the partnership and program processes of a unique multi-level produce prescription program combining culturally tailored direct nutrition education interventions influence individual-level nutrition behaviors, health outcomes, and experiences with local food systems of low-income individuals. For the purposes of this dissertation, two separate studies were conducted. The first study was a non-randomized control trial of a Pilot FVRx Program. This study examined a Pilot FVRx program and partnership development and implementation processes, as well as the intervention effects on fruit and vegetable consumption, nutrition-related knowledge and behavior, and food purchasing practices of low-income adults. The second study used a non-randomized control trial design of an Expanded FVRx Program with mixed methods approaches. This expanded study examined the effects of produce prescription combined with nutrition and financial literacy education on food security, food purchasing practices, food and financial resource management, as well as dietary behaviors and clinical health outcomes. Additionally, qualitative interviews were conducted to examine low-income adults' experiences and perceptions of local food systems and whether these experiences and perceptions were changed in relation to key FVRx intervention components over time.

The specific aims of this dissertation are as follows:

- *Specific Aim 1:* Examine the partnership and processes of a Pilot FVRx program and the intervention impacts on fruit and vegetable consumption, food purchasing practices, food security, and diet-related disease management compared to a control group. *It is hypothesized that the FVRx program will increase fruit and vegetable consumption, improve food purchasing behaviors, food security, and diet-related disease management during and after the intervention period.*
- *Specific Aim 2:* Examine the impact of an Expanded FVRx program for low-income adults on dietary intake, food purchasing practices, food insecurity, food and nutrition-related attitudes, and clinical outcomes compared to a nutrition education program and a control group. *It is hypothesized that compared to the control group, the FVRx and the nutrition education group will show significantly improved dietary intake, food purchasing practices, food security, food and nutrition-related attitudes, and clinical outcomes after the intervention period.*
- *Specific Aim 3:* Understand low-income adults' local food system experiences and perceptions and whether key FVRx intervention components alter these experiences and perceptions over time.

CHAPTER 3

A PILOT FRUIT AND VEGETABLE PRESCRIPTION (FVR_x) PROGRAM IMPROVES FRUIT AND VEGETABLE CONSUMPTION, NUTRITION KNOWLEDGE, AND FOOD PURCHASING PRACTICES¹

¹ Slagel, N., Newman, T., Sanville, L., Thompson, J., Dallas, J., Cotto-Rivera, E., Lee, JS. To be submitted as a Research Article in *Health Promotion Practice*

Abstract

Introduction: Little is known about the feasibility of Fruit and Vegetable Prescription (FVRx) programs conducted in both community and clinic settings. This study examined the process and outcomes of a pilot community- and clinic-based FVRx program combining produce prescriptions, direct nutrition education and health screening on dietary intake, nutrition knowledge and behavior, and food purchasing practices in low-income adults.

Methods: A six-month non-randomized controlled trial of an FVRx program was pilot tested with 54 SNAP-eligible adults (mean age 47.33 (SD 11.44) years, 79.6% female, 57.4% white) with diet-related chronic conditions based on a university-community-clinic partnership. The intervention group received produce prescriptions redeemable at a farmers market, a monthly SNAP-Ed nutrition class, and health screenings. Process and outcome evaluation was conducted with respective samples using administrative program data (recruitment, retention, and prescription redemption) and self-administered surveys with validated measures on dietary intake, nutrition knowledge and behavior, and food purchasing practices. Descriptive statistical analyses were conducted.

Results: The FVRx program retained 77.3% of participants who spent \$8,421 in prescriptions out of \$9,424 redeemed (89.4%). After the intervention, the FVRx group reported significantly increased total intake of fruits and vegetables, knowledge of fresh fruit and vegetable preparation, use of a farmers market for purchasing fresh fruits and vegetables, and significantly altered food purchasing practices compared to the control group.

Conclusion: Combining produce prescription with nutrition education at both clinic and community sites was feasible and improved the consumption and preparation of fresh fruits and vegetables and access to the local food system.

Keywords: Produce prescription, nutrition education, farmers market, SNAP-Ed, food purchasing practices, nutrition knowledge, food access

Introduction

Adequate fruit and vegetable consumption is vital for diet quality and chronic disease prevention and management [1, 2]. However, low-income households, particularly Supplemental Nutrition Assistance Program (SNAP) recipients, are at an increased risk for poor fruit and vegetable consumption and developing diet-related chronic diseases [3, 4]. This may be due in part to lower affordability and availability of fruits and vegetables [5, 6] and cost-related trade-off decisions negatively affecting the management of chronic conditions [10, 11].

Produce prescription programs are clinic-based interventions designed to support SNAP-eligible households through provider-generated “prescriptions” that are exchanged for free- or reduced-price produce at food retailers [117, 125]. The Fruit and Vegetable Prescription (FVRx) Program is one of many program models that focuses on providing produce prescriptions, direct nutrition education, and health screenings for low-income patients with existing diet-related chronic diseases. The documented positive impact of nutrition education on attitudes and self-efficacy towards nutrition-related behaviors supports its use as a critical component of FVRx programs (e.g., purchasing, cooking, and consuming fruits and vegetables) [82, 126]. However, until recently, nutrition education or counseling was not typically required or implemented by most produce prescription programs. Also, the role of farmers markets in produce prescription programs has only recently been explored [18, 117, 125]. Few studies report the process and outcomes of FVRx programs and their impact on nutrition-related knowledge, behaviors, and food purchasing decisions in low-income patients [125], [117, 121].

This study reports the process and outcome evaluation of the Athens Pilot FVRx program, which provided produce prescriptions combined with culturally-tailored direct nutrition

education and health screenings for low-income adult patients in safety-net clinic, community, and farmers market settings. In particular, this study examined changes in participants' fruit and vegetable consumption, nutrition-related knowledge and behavior, and food purchasing practices while employing a non-randomized controlled trial design.

Methods

Study Setting

The Athens Pilot FVRx Program was implemented in Clarke County, Georgia, where a substantial proportion of households are living under the poverty line (34.4%), are food insecure (21.6%), and have lower access to grocery stores (21.0 %) compared to national and state levels. About one-fourth of the county residents reported poor or fair health status (23%) and are uninsured [128, 129].

Intervention, Study Design, and Study Sample

Intervention

The Athens Pilot FVRx program was established and implemented based on a unique partnership among Wholesome Wave Georgia (WWG), University of Georgia Supplemental Nutrition Assistance Program-Education (UGA SNAP-Ed), University of Georgia Cooperative Extension (UGA CE) Athens Clarke County Extension Office, Athens Farmers Market, Athens Nurses Clinic, and Pinewoods Hispanic community. The Athens Pilot FVRx program provided produce prescriptions, nutrition education, and health screenings. Participants received a monthly produce prescription worth \$1/day per household member. These prescriptions could be redeemed up to once a week for tokens to be spent with produce vendors at a local farmers

market. Each produce prescription expired at the end of every month and was renewed by the safety-net clinic's nurse practitioner during the monthly health screening and nutrition education classes. The nutrition education included six-monthly, group-based, Food Talk program lessons taught by peer educators from UGA SNAP-Ed. The Food Talk curriculum was developed explicitly for low-income Georgian families and guided by the Health Belief Model and Dietary Approaches to Stop Hypertension diet [130]. For example, while reviewing ways to eat healthier when eating out, southern food chains were referenced. This approach was used for each aspect of the curriculum, which included a didactic lesson, interactive activities, a cooking demonstration, and food tasting opportunities. The demonstration recipes featured traditional and seasonal Georgian agricultural products such as peaches, seasonal varieties of greens, tomatoes, peppers, and onions. Lesson content also encouraged participants to increase the intake of fruits and vegetables and low-fat dairy and to limit dietary sodium [130]. Before each nutrition education session, trained safety-net clinic staff and researchers conducted a monthly health screening assessing blood pressure and anthropometrics for each participant.

Study Design

This study employed a non-randomized controlled trial design. The FVRx group was recruited, screened, and enrolled at the clinic and community sites using a purposive sampling method. The control group was recruited using a convenience sampling method at the same safety-net clinic to reach those with similar characteristics to the FVRx group. Control group participants only received their standard health care from the safety-net clinic. After completing post-assessments, control participants received \$40 gift cards for their participation and were provided information about ongoing SNAP-Ed classes. All participants consented to study procedures upon enrollment. The intervention period was six months, from June – December

2017. The University of Georgia Institutional Review Board approved the study (STUDY # 00004504).

Measures

Process evaluation was used to monitor and document program development and implementation of program elements [131]. For this study, process evaluation describes the program partnership development, implementation (including participant recruitment), program retention measured by the attendance for nutrition education and health screening sessions, and prescription redemptions. Outcome evaluation examines progress toward intended outcomes. Outcome measures were collected at baseline and post-intervention and included dietary intake, nutrition knowledge and behaviors, and food purchasing practices of both FVRx and control groups. The FVRx group also reported fruit and vegetable intake and food purchasing practices monthly during the program. The supporting clinic staff and researchers utilized the same instruments and techniques for measuring blood pressure and anthropometrics at both the clinic and community sites [132].

Dietary Intake

Dietary intake for both groups was assessed using two methods: 1) an interviewer-administered 24-hour dietary recall and 2) a two-item fruit and vegetable screener. Dietary recalls were entered into the Automated Self-Administered – 24-Hour (ASA-24) Dietary Assessment Tool to calculate cup or ounce equivalents for various foods or food groups, nutrient values, as well as 2015 Healthy Eating Index (HEI) scores [133]. A two-item fruit and vegetable screener, modified from the National Cancer Institute (NCI)'s 10 item fruit and vegetable (FV) screener [134], was collected and processed following the NCI guidelines for converting the frequency and amount of each fruit and vegetable group into average daily servings.

Nutrition Knowledge and Behaviors

Self-reported nutrition knowledge and behaviors were assessed using measures developed by WWG, as well as validated measures used by UGA SNAP-Ed following the SNAP-Ed Evaluation Framework [135]. As determined by the framework, measures included short- and medium-term nutrition-related behaviors and knowledge. The following questions were used: 1) 'think about healthy food choices when deciding what to feed my family' 2) 'plan meals ahead of time' and 3) 'know how to prepare fresh fruits and vegetables.' Likert Scale responses ('Do Not Do – Always' and 'Know Nothing – Know A Lot') were collected.

Food Purchasing Practices

Food purchasing practice measures were adapted from key constructs of food purchasing practices identified in a systematic review of low-income older adults [47]: 1) *where* participants purchased the majority of their food, 2) *the frequency* of shopping at that location, 3) *amount of money* spent on food purchases. Drawing on the structure of this farmers market-based FVRx program, participants were also asked 4) *whether* they purchased the majority of fruits and vegetables at their preferred food store or the farmers market, and 5) *how frequently* they ate out (e.g., fast food, sit down restaurants, food truck). Participants were also asked whether they changed the amount of purchasing following items in the previous month: 1) all food, 2) fruits, 3) vegetables, 4) processed food (i.e., canned, boxed, bagged), and 5) non-food items (e.g., household item, cleaning supplies, pet food).

Prescription Redemption

Participants redeemed their produce prescriptions for tokens at the farmers market; the tokens were then used to purchase fruit and vegetables from vendors. Prescription redemption rates were calculated to help monitor participation and program effectiveness. Prescription

redemption rates were calculated based on the total number of prescription redemptions over the entire FVRx intervention period (26 weeks). Prescription spending rates were calculated to show how successful the program was in getting participants to spend their tokens on produce.

Prescription spending rates were calculated by dividing the total tokens spent at the farmers market during the intervention period by the total amount of prescription redeemed at the market.

Analytic Sample

The process evaluation sample included the full intervention and control sample (n=54). The outcome evaluation sample (n=24) included 16 intervention participants and 8 control group participants (**Figure 3.2.**). At baseline and post-intervention, the intervention group included a higher percentage of individuals with Hispanic ethnicity, but no other significant differences were found between intervention and control groups. Within the outcome evaluation sample, those who completed the intervention were more likely to be Hispanic than those who withdrew. All other demographic characteristics were similar between the process and outcome evaluation samples at baseline and post-intervention.

Data Analysis

Descriptive statistics were calculated for sociodemographics, dietary intake, nutrition knowledge and behaviors, and food purchasing practices for the study sample and by group across the intervention period.

To examine changes in categorical variables (e.g., frequency), post-intervention responses were subtracted from the baseline response and then trichotomous change variables were created: 1) 'More' - increase in frequency, 2) 'Less' - decreased frequency, and 3) 'No change' – same frequency. Similarly, the difference between baseline and post-intervention to examine the change in continuous variables over six months. For example, post-intervention total

fruit and vegetable intake was subtracted from the baseline total fruit and vegetable intake for each individual. Changes between or within the intervention and control groups were performed using Chi-square or Fisher's exact tests for categorical variables and independent or paired *t*-tests for continuous variables. For independent *t*-tests, if the *F* statistic determined variance to be significantly different, the Welch-Satterthwaite method was used to correct for this variance. All analyses were conducted using SPSS Statistics for Windows (Version 24, Armonk, NY: IBM Corp.). The significance level was set at $P < .05$.

Results

Process Evaluation

Partnership and Program Development

The Athens Farmers Market manager, in connection with UGA SNAP-Ed, UGA CE, and other community partners, coordinated initial interest meetings to develop a partnership. Initial planning meetings were attended by representatives from three organizations, one safety-net clinic, university faculty, UGA SNAP-Ed, and UGA CE. As the primary funding organization, WWG provided training to communicate best practices and program requirements for program planning and funding. WWG required the programs to conduct monthly health screenings, nutrition education, provide participants Georgia-grown produce prescriptions, and support the collection of WWG evaluation measures. Given the required intervention components, each partnering organization contributed resources and support for the pilot program implementation. For example, the safety-net clinic supported the recruitment of both intervention and control samples and staffed the monthly health screenings for the FVRx group. The community site

supported recruitment through fliers and word of mouth and provided space for nutrition education. UGA SNAP-Ed and UGA CE tailored nutrition education to both English and Spanish speaking participants and adapted the curriculum to fit a monthly class format. The farmers market served as the site for produce prescription redemption and facilitated the distribution and spending of produce prescriptions. UGA SNAP-Ed and UGA faculty, staff, and graduate research assistants coordinated with the farmers market, clinic, and community partners to develop the final program and evaluation plans. Program recruitment was conducted from April-June, and implementation proceeded from June-November 2017 (**Figure 3.1**). In addition to ongoing communication and program support, the Athens FVRx program coordinators provided monthly updates to program partners, set up partner meetings, and provided WWG with monthly evaluation measures.

Sample Recruitment

Recruitment for the FVRx program began one month before the program start date (**Figure 3.2**). The total FVRx enrollment for the clinic and community sites was 14 and 8, respectively. Most of the process evaluation sample (n=54) were female (79.6%), White (57.4%), uninsured (90.7%), and low-income (98.1% with an annual household income $\leq$ \$25,000). FVRx group program retention was 77.3%. The average attendance for the nutrition education classes and health screenings was 4.36 (SD 1.76) and 4.68 (SD 1.78) (out of six sessions), respectively. Five FVRx participants did not complete the program due to moving out of state, illness, loss of personal transportation and reluctance to use transportation provided by the program, and family obligations. Recruitment and enrollment of the control group took place following the completion of the FVRx enrollment at the participating safety-net clinic. Control

group retention was 47.1%. A total of 9 control participants did not complete the study due to relocation, illness, incarceration, or inability to contact.

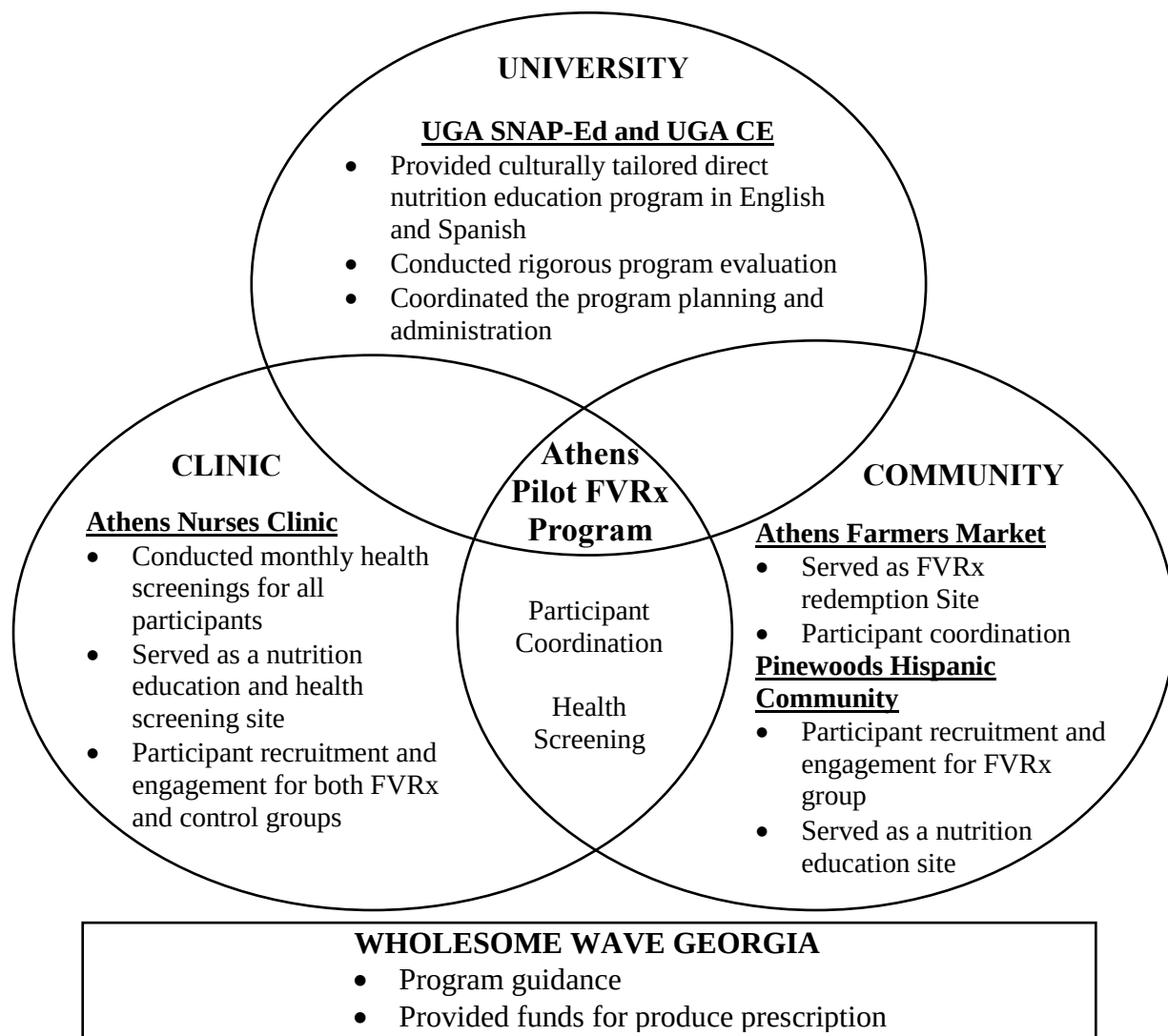


Figure 3.1. 2017 Athens Pilot FVRx Program Partnership Model. The Venn diagram shows what each program partner contributes to establishing the partnership and program structure. Abbreviation: FVRx; Fruit and Vegetable Prescription, UGA SNAP-Ed: University of Georgia Supplemental Nutrition Assistance Program Education, UGA CE: University of Georgia Cooperative Extension

Prescription Redemption

The participants who completed the FVRx program (n=17) had a redemption rate of 65.4% and made up 89.4% of total prescription spending (\$8,421.50) over the intervention

period. Over six months, those who completed the program (n=17) spent an average of \$495.38 (SD 333.07) in prescription, which is equivalent to \$19.05 (SD 12.81) per week. Accounting for each participant's household size, the average amount spent in prescription per person was \$5.98 (SD 4.33) per week

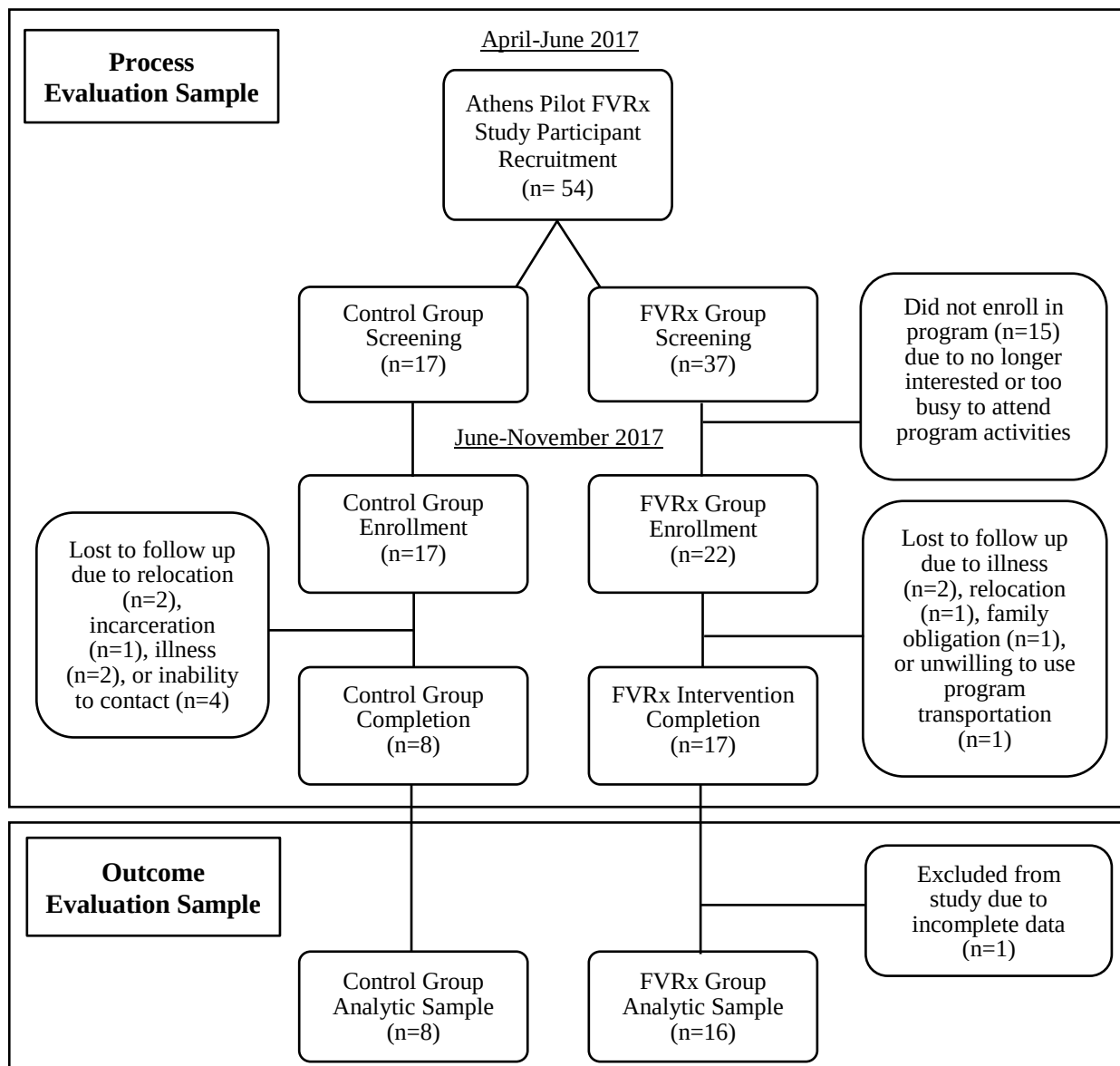


Figure 3.2. 2017 Athens Pilot FVRx Study participant enrollment and follow-up.
Abbreviation: FVRx; Fruit and Vegetable Prescription

Outcome Evaluation The characteristics of the outcome evaluation analytic sample (n=24) are shown in **Table 3.1**.

Table 3.1: Baseline Characteristics of the Outcome Evaluation Analytic Sample: 2017 Athens Pilot FVRx Study

Characteristic	Intervention (n=16), No. (%) or mean (SD)	Control (n=8), No. (%) or mean (SD)
Age in years	47.50 (11.3)	46.75 (10.4)
Female	10 (62.5%)	7 (87.5%)
Hispanic Ethnicity ^a	6 (37.5%)	0
Receiving Federal Assistance	11 (68.8%)	8 (100%)
Household size	3.3 (1.6)	2.5 (1.1)
Uninsured	14 (87.5%)	7 (87.5%)
Food Insecure	13 (81.2%)	7 (87.5%)
BMI (kg/m ²)	33.1 (8.4)	32.2 (4.5)
Overweight or obese	14 (87.5%)	8 (100%)
Self-Reported Health Condition		
Obesity	11 (68.8%)	7 (87.5%)
Diabetes	4 (25.0%)	3 (37.5%)
Hypertension	11 (68.8%)	6 (75.0%)

Abbreviations: SD, standard deviation; BMI, Body Mass Index

^a Significantly different between the FVRx and Control group at $P < .05$ based on Chi-Square or Fisher's Exact test

Dietary Intake

Baseline total fruit and vegetable intake and HEI-2015 Total Vegetable and Fruit Scores were not significantly different between the FVRx and control groups (**Table 3.2**). Based on the NCI FV screener, the FVRx group significantly increased total fruit and vegetable intake (0.81 (SD 0.91) serving/day) compared to the control group (-0.25 (SD 0.99) servings/day) ($P = .02$) (**Table 3.2**). There were increases in the FVRx group's total vegetable and dark green vegetable intake as well as HEI-2015 Total Vegetable ($P = .005$) and Greens and Beans ($P = .03$) scores following the intervention; however, these changes did not reach statistical significance when compared with those in the control group. Following the intervention, the FVRx group showed a

slight reduction in fruit intake; however, this change was not statistically significant within the FVRx group or compared to the control group. There were no significant changes within the control group for any dietary measures.

Table 3.2: Changes in Dietary Intake: 2017 Athens Pilot FVRx Study

Dietary Intake	Intervention (n=16)			Control (n=8)		
	Baseline, mean (SD)	Post, mean (SD)	Change, mean (SD)	Baseline, mean (SD)	Post, mean (SD)	Change, mean (SD)
Total Fruit and Vegetable Intake (<i>average servings/day</i>) ^a	1.68 (0.96)	2.49 (0.95)	0.81 (0.91) ^{c,e}	2.34 (1.08)	2.09 (0.81)	-0.25 ± 0.99
Total Vegetable Intake (<i>cup equivalents</i>) ^b	1.21(0.76)	1.86(1.17)	0.66 (1.03) ^c	1.16 (0.69)	1.03 (1.10)	-0.14 ± 1.28
Total Dark Green Vegetables (<i>cup equivalents</i>) ^b	0.06 (0.16)	0.46 (0.58)	0.40 (0.60) ^c	0.18 (0.43)	0.32 ± 0.71	0.14 ± 0.29
Total Fruit Intake (<i>cup equivalents</i>) ^b	1.71 (2.68)	1.19 (1.66)	-0.52 (0.60)	0.01 (0.03)	0.29 (0.19)	0.28 ± 0.19
HEI-2015 - Total Vegetable Score (0-5) ^b	3.32 (1.68)	4.24 (1.18)	0.93 (1.14) ^c	3.40 (1.73)	2.60 (2.16)	0.80 ± 2.56
HEI-2015 - Greens and Beans Score (0-5) ^b	0.99 (2.00)	3.06± 2.32	2.07 (3.52) ^c	0.90 (1.83)	1.25 (2.31)	0.35 ± 0.99
HEI-2015 – Total Fruit Score (0-5) ^b	2.78 (2.30)	2.54 (2.24)	-0.24 (2.27)	0.05(0.14)	1.00 (1.89)	0.96 ± 1.92
HEI-2015 – Total Diet Score (0-100) ^b	51.99 (3.79) ^f	55.15 (2.59)	3.16 (3.52)	38.75 (4.81)	45.18 (6.37)	6.43 ± 4.96

Abbreviations: SD, standard deviation; NCI FV, National Cancer Institute Fruit and Vegetable; ASA-24, Automated Self-Administered – 24-Hour (ASA-24) Dietary Assessment Tool

^aData were collected by modified 2-item NCI FV screeners

^bData were collected by interviewer-administered 24-hour recalls entered into ASA-24

^cSignificantly different changes in consumption between pre- and post-intervention within the FVRx group at $P < .05$ based on a paired t -test

^dSignificantly different changes in consumption between pre- and post-intervention within the control group at $P < .05$ based on a paired t -test

^eSignificantly different changes in consumption between FVRx and control groups at $P < .05$ based on an independent t -test

^fSignificantly different baseline consumption values between FVRx and control groups at $P < .05$ based on an independent t -test

Nutrition Knowledge and Behaviors

Compared to the control group, the FVRx group were significantly more likely to ‘Think about healthy food choices when deciding what to feed your family’ ($P = .04$) and ‘Plan meals ahead of time’ ($P = .04$) after the intervention. Compared to the control group, the FVRx group were significantly more likely to increase self-reported knowledge of how to prepare fruits and vegetables ($P = .02$).

Food Purchasing Practices

At baseline and post-intervention, FVRx and control group participants shopped for most of their food at grocery stores (e.g., Kroger, Publix) or mass merchandisers (e.g., Walmart, Target). The FVRx group increased spending on food overall after the intervention; however, this difference did not reach statistical significance compared to the control group (**Table 3.3**). Following the intervention period, the FVRx participants were significantly more likely to increase purchasing the majority of fruits and vegetables at the farmers market compared to the control group from 6.3 % to 75.0 % ($P = .001$). The FVRx participants also reported a marginally significant increase in the amount of fresh vegetables purchased compared to the control group following the intervention ($P = .05$). Within the FVRx group, significant reductions in the frequency of eating out ($P = .01$) and shopping at a preferred store ($P = .03$) were reported; however, the likelihood of these changes was not significantly different from those in the control group.

Table 3.3. Changes in Food Purchasing Practices: 2017 Athens Pilot FVRx Study

Food Purchasing Practices ^a	Intervention (n=16), No. (%) or mean (SD)			Control (n=8), No. (%) or mean (SD)		
	Baseline	Post	Change	Baseline	Post	Change
Amount of money spent on food last month (including SNAP)						
	\$236.94 (154.97)	\$284.63 (222.59)	\$47.69 (221.67)	\$237.63 (164.60)	\$230.88 (115.92)	-\$6.75 (223.68)
Amount of food purchased last month^b						
More	2 (12.5%)	2 (12.5%)	3 (18.7%)	0	1 (12.5%)	1 (12.5%)
Less	8 (50.0%)	6 (37.5%)	8 (50.0%)	6 (75.0%)	4 (50.0%)	6 (75.0%)
No Change	6 (37.5%)	8 (50.0%)	5 (31.3%)	2 (25.0%)	3 (37.5%)	1 (12.5%)
Amount of processed foods purchased last month^b						
More	3 (18.7%)	1 (6.3%)	3 (18.7%)	1 (12.5%)	0	1 (12.5%)
Less	8 (50.0%)	7 (43.8%)	10 (62.6%)	5 (62.5%)	2 (25.0%)	5 (62.5%)
No Change	5 (31.3%)	8 (50.0%)	3 (18.7%)	2 (25.0%)	6 (75.0%)	2 (25.0%)
Amount of non-food items purchased last month^b						
More	5 (31.3%)	1 (6.3%)	3 (18.7%)	1 (12.5%)	0	1 (12.5%)
Less	3 (18.7%)	4 (25.0%)	7 (43.8%)	4 (50.0%)	4 (50.0%)	6 (75.0%)
No Change	8 (50.0%)	11 (68.7%)	6 (37.5%)	3 (37.5%)	4 (50.0%)	1 (12.5%)
Frequency of eating out last month^{b,c}						
More	2 (12.5%)	0	0 (0.0%)	0	0	0
Less	8 (50.0%)	10 (62.5%)	11 (68.7%)	4 (50.0%)	1 (12.5%)	4 (50.0%)
No Change	6 (37.5%)	6 (37.5%)	5 (31.3%)	4 (50.0%)	7 (87.5%)	4 (50.0%)
Amount of times you shopped at your preferred store last month^{b,d}						
More	2 (12.5%)	1 (6.3%)	1 (6.3%)	0	1 (12.5%)	1 (12.5%)
Less	6 (37.5%)	7 (43.8%)	9 (56.2%)	4 (50.0%)	7 (87.5%)	3 (37.5%)
No Change	8 (50.0%)	8 (50.0%)	6 (37.5%)	4 (50.0%)	0	4 (50.0%)

Abbreviations: SD, standard deviation; SNAP, Supplemental Nutrition Assistance Program

^aData were collected using a self-reported survey administered by program staff

^bResponses were collected as 3-point Likert scale responses from Less to More. Change variables were coded based on the change from pre-post intervention

^cSignificantly different changes between pre- and post-intervention in the FVRx group at $P < .05$ based on Fisher's Exact test

^dSignificantly different changes between pre- and post-intervention in the control group at $P < .05$ based on Fisher's Exact test

Discussion

To the authors' knowledge, this is the first controlled study to evaluate the processes and outcomes of an FVRx program model that provided produce prescriptions and culturally-tailored direct nutrition education. The findings demonstrate positive and complementary changes through increases in access and purchase of produce from a local farmers market, dietary intake of fruits and vegetables, and nutrition knowledge and behaviors. Furthermore, the unique university-community-clinic partnership strengthened the development and implementation processes of an FVRx program model for low-income adults with diet-related conditions in both clinic and community settings.

Unlike previous studies utilizing healthcare provider-based nutrition counseling, this study relied on SNAP-Ed and County Extension (CE) to provide nutrition education activities and content to FVRx participants. For this FVRx program, SNAP-Ed provided activities such as demonstrations of simple and produce-centric recipes, tastings, and handouts that include seasonal produce found at the farmers market. The nutrition education was also group-based, as well as culturally and regionally tailored to the seasonal produce available at the partnering farmers market. The tailored SNAP-Ed curriculum activities and format may have reduced common access barriers by increasing familiarity with local produce and improving the cultural acceptability of the market [9, 136, 137]. These activities likely promoted prescription redemption at the farmers market and may have increased the amount and variety of fresh vegetables purchased and consumed by participants. The support from SNAP-Ed and CE was also instrumental in improving program outcomes, such as knowledge of fruit and vegetable preparation, food purchasing practices, and food resource management behaviors like eating out

less and planning meals ahead of time. These outcomes may be beneficial for program participants' long-term behavior change beyond the produce prescription program period. Because SNAP-Ed and CE provided the nutrition education and supported program coordination, the time required of clinic staff and volunteers was greatly reduced. This was vital in promoting participant retention and attendance of each program component. Given these findings, SNAP-Ed and CE agencies could serve as vital partners to produce prescription programs, given their mandate and capacity to serve low-income families in both community and clinic program settings [138].

This study also highlights the value of university-community-clinic partnerships to support FVRx program implementation and research. This partnership supported the recruitment of the desired target population at high risk for food insecurity and healthcare burden. Effective participant coordination, data collection, and resource management resulted in high prescription redemption rates and participant retention rates compared to other Georgia FVRx programs [139]. The Athens Pilot FVRx program enhanced participant success by allocating funding for transportation and social support from a community-based participant coordinator during nutrition education sessions, health screenings, and farmers market visits. Connecting participants to each aspect of the FVRx program model through organizational and community support is essential for reducing barriers and increasing participants' abilities to purchase, cook, and consume fresh and locally grown produce [140].

Although statistical significance was not reached, FVRx participants reported an increase in monthly spending on food or non-food items. Participants purchased significantly more locally grown and seasonal fruits and vegetables, as well as shifted food purchasing practices (e.g., eating out less and shopping less at preferred food store). In particular, the FVRx group

significantly increased their total vegetable and dark green vegetable intake, but not fruit intake. Considering the seasonality and geography of the farmers market, these findings may be due to the higher availability, affordability, and cultural acceptance of green leafy vegetables and the lower availability of fruit towards the end of the intervention period (November). The prescription amount provided was intended to support the entire household of each participant. Because of the increased monthly spending on food and improved food purchasing practices, it is possible that household financial resources shifted during the intervention period. Because food security is tightly linked to income and financial management [22], more research is needed to understand how produce prescriptions combined with nutrition education impacts household finances, food security, and food resource management behaviors. Continued access to produce prescriptions and nutrition education for food-insecure patients could lead to sustained improvements in fruit and vegetable purchasing and consumption, food security, as well as chronic disease prevention and management in low-income populations. Permanent funding under the Farm Bill could contribute to sustained program access and research efforts to build needed evidence and capacity of produce prescription programs for proving cost-effective chronic disease prevention. Until secure funding is in place, university-community-clinic partnerships have the potential to effectively harness other critical resources to administer the programs, conduct research, and demonstrate program impact and viability for future funding.

This study is not without limitations. Given the vulnerability of the target population, the use of a randomized controlled trial was not feasible. For the same reason, it was a challenge recruiting and retaining a comparable control group at both community and safety-net clinic sites. However, combining community and clinic-based recruitment with a controlled study design was feasible and critical in demonstrating the impact of the intervention. The use of

purposive and convenience sampling methods made recruitment feasible but did not allow us to control for potential biases between groups. The findings from process evaluation demonstrate unique challenges to conducting controlled trials to study FVRx and produce prescription programs in low-income and medically underserved populations. Other limitations include low final sample size and the use of primarily self-reported data.

Despite these limitations, findings from this study suggest positive impacts of a community- and clinic-based FVRx program on dietary intake of fruits and vegetables, nutrition-related knowledge and behaviors, and food purchasing practices. The findings also indicate that group-based and culturally-tailored nutrition education focused on locally and regionally available produce is feasible and may enhance the direct benefits provided by produce prescriptions. Finally, university-community-clinic collaborations can address challenges in participant recruitment and retention and effectively coordinate program implementation for a medically underserved and food insecure population. These findings are noteworthy given the growing interest of connecting medically underserved populations with diet-related conditions and food insecurity to locally-sourced fruits and vegetables [140].

CHAPTER 4

THE EFFECTS OF AN EXPANDED COMMUNITY-AND CLINICAL-BASED FRUIT AND VEGETABLE PRESCRIPTION (FVRx[®]) PROGRAM[®] FOR LOW-INCOME ADULTS²

² Slagel, N., Dallas, J., Cotto-Rivera, E., Moore, J., Roberts, A., Lee, JS., To be submitted as a Research Article in *Journal of Hunger and Environmental Nutrition*.

Abstract

Background: FVRx programs combining produce prescription and nutrition education have the potential to improve dietary behaviors and food purchasing practices of low-income adults. This study examined the effects of an FVRx program with expanded nutrition education and financial literacy education on dietary intake, food security, food purchasing practices, food and financial resources, and clinical outcomes in low-income adults.

Methods: This is a six-month non-randomized controlled trial with two comparison groups (Control group and Nutrition Education, ad-hoc comparison group). The study sample included 36 low-income or food insecure adults with at least one diet-related condition (mean age 53.8 ± 12.2 years, 91.7% female, 33.3% Black). The FVRx intervention group received produce prescriptions redeemable at a farmers market, two SNAP-Education programs with 10 weekly lessons, four monthly financial literacy lessons, and monthly health screenings. The Nutrition Education group received one SNAP-Education program. Self-administered surveys were used to assess dietary intake, food security, food purchasing practices, and financial and food resource management. Clinical biomarkers (blood lipid and HbA1c) and biometric measures (BMI, waist circumference, and blood pressure) were assessed. The differences in changes in outcome measures among the study groups were analyzed.

Results: Following the intervention, FVRx participants significantly improved the consumption of vegetables (especially dark green $+0.36 \pm 0.72$ cup-/day) and knowledge and purchase of seasonal produce at a farmers market compared to the comparison groups. Healthful food purchasing practices and the ability to afford more bills (e.g., utilities, phone, gas) were significantly improved among FVRx participants compared to the comparison groups. Limited changes were observed in clinical biomarker and biometric assessments between groups.

Conclusion: Combining expanded nutrition and financial literacy education with produce prescription improves low-income adults' financial and food resources, preference, knowledge, purchase, and consumption of locally grown vegetables.

Keywords: Produce Prescription, Nutrition Education, SNAP-Ed, Financial Literacy Education, Financial Resources, Food Purchasing Practices, Mixed Methods

Introduction

Produce prescription programs are expanded incentive programs to provide free- or reduced-price fresh produce for low-income or food-insecure households in the form of a healthcare provider-generated prescription [113, 117, 122, 125, 141, 142]. These programs are policy and setting-based interventions designed to promote healthy food access and food-related decisions for improved fruit and vegetable intake [110, 143, 144]. These multi-level interventions consistently demonstrated improvements in the purchase and dietary intake of fruits and vegetables, with limited improvements in food security or clinical health outcomes in low-income adult populations [125, 141].

The basis for these multi-level interventions is derived from Social Ecological Model (SEM) principles [37], which delineate how individual characteristics, environmental settings, sectors of influence, and social norms explain differences in health behaviors and outcomes [38]. Produce prescription programs vary in program structure in order to link multiple intervention components across multiple levels of the SEM. Therefore, it is critical to assess how the interplay of multiple intervention components of the SEM impacts multiple factors of influence on health behaviors and outcomes in low-income populations.

The Fruit and Vegetable Prescription (FVRx) Program, a widely used produce prescription model, requires the use of the produce prescription in combination with direct nutrition education and health screenings for low-income patients with diet-related conditions. Recent evidence suggests an FVRx program combining produce prescription and culturally-tailored nutrition education for low-income adults improves multiple behaviors supportive of purchasing and consuming locally grown fruits and vegetables over standard health care alone

[145]. These findings suggest that produce prescriptions as a policy, systems, and environmental intervention combined with group-based, direct nutrition education as individual-level support improves multiple levels of influence for dietary behaviors. However, there is still little understanding as to how intensive direct education combined with produce prescription can improve dietary and health behaviors over single-level interventions. In particular, financial resources, food security, and food purchasing practices are all factors that influence behavior and health outcomes. Yet, little is known about how produce prescription programs influence these various factors and which intervention components and program structures best support positive outcomes.

This study reports the outcomes of the 2018 Athens FVRx Study that assessed the effects of an expanded community- and clinic-based FVRx program combining intensive education (nutrition and financial literacy education) with produce prescription. The objective was to examine whether the multi-level FVRx intervention model that uses intensive education, with a setting-based (farmers market) and policy and systems-based (produce prescription and healthcare system) approach, supports critical behaviors related to dietary and health outcomes. Specifically, this study examined changes in food security, food purchasing practices, food and financial resource management, dietary behaviors, and clinical health outcomes while using a non-randomized controlled study design with ad-hoc comparison groups to examine the effects of the FVRx program's unique intervention components on outcomes of interest.

Methods

Study Setting

The 2018 Athens FVRx Study took place in Clarke County, Georgia where a substantial proportion of residents are food insecure (21.6%), have lower access to grocery stores (21.0 %), high rates of being uninsured (25%), and poor or fair health status (23%) than national and state averages [21, 128, 129].

Study Design

This study expanded on a previously reported non-randomized controlled study design by adding an ad-hoc comparison group. The three study groups include: 1) The FVRx Intervention group, 2) Nutrition Education group, and 3) Control group. The University of Georgia Institutional Review Board approved the study (STUDY # 00004504).

Study Sample and Recruitment

Eligibility criteria included being adults (>18 years and older), being SNAP-eligible or food insecure, with a diagnosis of one or more of the diet-related chronic conditions: 1) overweight and obesity, 2) diabetes, 3) pre-diabetes, 4) hypertension, and 5) hyperlipidemia. The FVRx intervention group participants were recruited, screened, and enrolled at one safety-net clinic and two community sites using a purposive sampling method. Purposive sampling is a nonprobability sampling technique typically used when randomization is not ethical or feasible, and when a specific population with particular characteristics are desired [146]. The safety-net clinic and Community site #1 were partnering sites from the Athens Pilot FVRx Program. A subsidized housing community (Community site #2) was added to recruit and implement the program. Recruitment for the FVRx Intervention began in April 2018 and continued three weeks

following program start date to allow for attrition and reach maximum participation (**Figure 4.1**). The final enrollment by the site for the FVRx Intervention was: 1) Clinic site (n=8), 2) Community site #1 (n=14), and 3) Community site #2 (n=9). The Control group participants were recruited at the participating safety-net clinic using a purposive sampling method. With the support of the clinic staff (i.e., interns, nurses, administrative, nurse practitioners), a researcher (NS) approached clinic patients during regular visits to screen and enroll any participants who expressed interest to the clinic staff. All Control participants recruited were enrolled in the study (n=16). The Nutrition Education group participants were recruited through a convenience sampling method during the ongoing University of Georgia Supplemental Nutrition Assistance Program Education (UGA SNAP-Ed) direct education programming in Bartow and Gilmer County. The Nutrition Education and Control group participants were recruited in June 2018 following completion of FVRx Intervention enrollment. The final enrollment by site for the Nutrition Education group was: 1) Gilmer County (n=4) and 2) Bartow County (n=6). The characteristics of the final enrollment sample (n=60) were primarily female (90.0%), low-income (70.0% annual income of $\leq$ \$15,600), food insecure (66.7%), and uninsured (69.8%).

Intervention

The 2018 Athens FVRx program expanded the Athens Pilot FVRx program model to include: 1) Augmented education component including both nutrition and financial literacy education, 2) Increased intensity of nutrition education from monthly to weekly, and 3) the clinical biomarker assessments. The 2018 Athens FVRx program was implemented from May 15 – November 8, 2018.

The FVRx intervention included a produce prescription worth \$1/day per household member. Once a month, before each nutrition education or financial literacy lesson, the clinic

staff and researchers conducted a monthly health screening assessing blood pressure and anthropometrics (i.e., height, weight, and waist circumference). Two UGA SNAP-Ed direct education programs were provided in both English and Spanish: Food Talk and Food Talk: Better U. The ‘Food Talk’ program consists of six 60 minute-weekly lessons explicitly developed for low-income Georgian families guided by the Health Belief Model and Dietary Approaches to Stop Hypertension diet [130]. Each lesson includes a didactic lesson, interactive activities, a cooking demonstration, and a food tasting opportunity that introduced participants to seasonal produce found at the farmers market. The ‘Food Talk: Better U’ program provides four 90 minute-weekly lessons focusing on healthy weight management for SNAP-Ed eligible adult Georgians based on the Expanded Health Belief Model and the Social Cognitive Theory [147]. This program includes physical activity guidance, interactive activities, and goal setting in addition to nutrition-focused lessons and activities [147]. In addition to the UGA SNAP-Ed programming, the UGA Cooperative Extension (CE) Clarke county office provided four monthly financial literacy lessons. Each lesson was developed by UGA Extension Specialist and included: 1) Healthy Eating on a Budget 2) Tracking Expenses, 3) Banking Basics, and 4) Understanding Credit. By design, participants from Community site #2 were provided the financial literacy curriculum the first four months of the program, then finished the remaining 10 weeks with the two UGA SNAP-Ed curricula.

Nutrition Education group participants were provided either the ‘Food Talk’ or ‘Food Talk: Better U’ curriculum only at the beginning of the intervention period. Nutrition Education participants were not provided clinical biomarker assessments, but biometrics and all survey measures were collected at baseline and post-intervention periods. Control group participants were provided clinical biomarker assessments during their appointments and completed all

survey measures at baseline and post-intervention but did not receive any components of the FVRx or Nutrition Education interventions. Following the completion of the post-assessment, both Nutrition Education and Control group participants received \$40 gift cards for their participation.

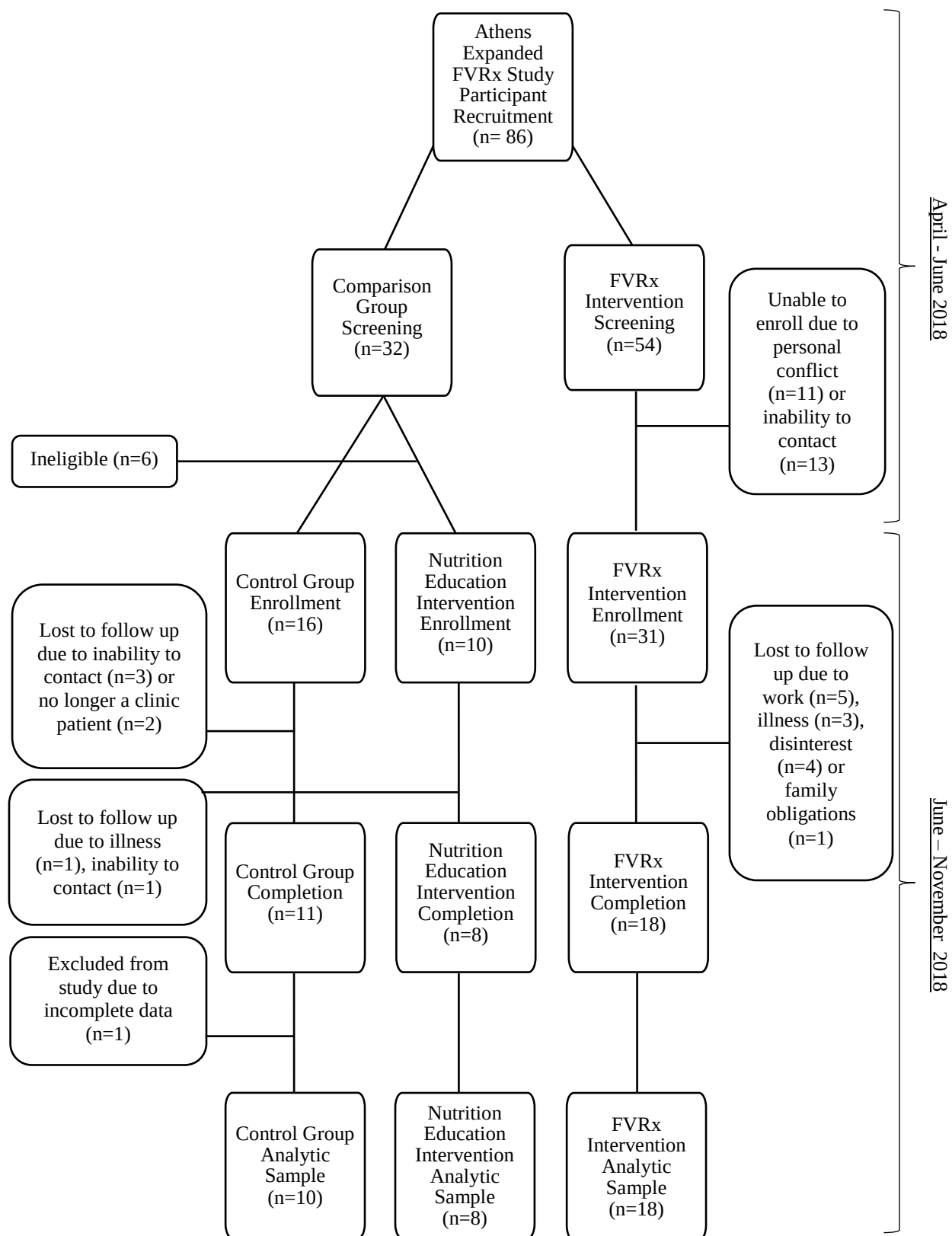


Figure 4.1. Athens Expanded FVRx Study participant enrollment and follow-up.

Measures

All study participants were assessed for dietary intake, food purchasing practices, nutrition attitudes and knowledge, food and financial resource management behaviors, food security, and clinical biometrics at baseline and post-intervention. In addition, the FVRx intervention group was assessed for dietary intake and food purchasing practices monthly during the program. Clinical biomarkers were collected for the FVRx Intervention and Nutrition Education groups at baseline and post-intervention.

Dietary Intake

Dietary intake was assessed through an interviewer-administered 24-hour dietary recall and a fruit and vegetable frequency questionnaire. Dietary recalls were entered into the Automated Self-Administered – 24-Hour Recall (ASA-24) online software to calculate cup or ounce equivalents for various foods or food groups, amounts of nutrients, as well as 2015 Healthy Eating Index (HEI) scores [133].

Food Purchasing Practices, Attitudes, and Knowledge

Food purchasing practice measures were based on key constructs of food purchasing practices tested in the Athens Pilot FVRx Program. Key constructs include the location, frequency, and amount of money spent on fruits and vegetables, as well as all other foods purchased each month. Participants were also asked whether there was a change in the amount of purchasing following items in the previous month: 1) all food, 2) fruits, 3) vegetables, and 4) processed food (canned, boxed, bagged). Food purchasing attitudes and knowledge assessed through measures developed by Wholesome Wave Georgia included: 1) “Fresh fruits and vegetables are easy to find in my neighborhood,” 2) “I can afford fresh fruits and vegetables,” and 3) “I know which fruits and vegetables are grown during different times of the year.” Self-

reported nutrition knowledge and behaviors were assessed using measures developed by Wholesome Wave Georgia and validated measures included in the SNAP-Ed Evaluation Framework [135].

Food and Financial Resource Management Behaviors

Short- and medium-term food resource management practice measures included: 1) comparing prices before buying food, 2) running out of money or another way to get enough food before the end of the month, and 3) adjusting meals to include more budget-friendly items. Changes in ability to afford non-food expenses were assessed by using the following self-reported measures: 1) being able to afford more non-food items (household items, pet food, and cleaning supplies) than usual last month and 2) being able to afford more bills (utility, phone, and gas) than usual last month.

Food Security

The U.S. Department of Agriculture (USDA) 6-item Household Food Security Survey Module was used at baseline and post-intervention for both groups [148]. Responses were dichotomized into two categories ‘Food Secure’ or ‘Food Insecure.’ If two or more affirmative responses were provided, participants were considered ‘Food Insecure.’

Clinical Assessments

Clinical Biomarkers. A blood lipid panel (i.e., LDL, HDL, Triglycerides and Total Cholesterol) and HbA1c were assessed for the FVRx Intervention and Control group participants at baseline and post-intervention. A trained nurse or certified phlebotomist at the clinic site and at the Quest Diagnostic Lab collected blood samples for the FVRx Intervention and Control groups. The main barriers to obtaining clinical biomarkers for the FVRx Intervention were: 1) not all FVRx participants were patients of the partnering safety-net clinic or eligible to become a

patient, and 2) program participation required monthly biometric screening and attendance of nutrition education, but not the clinical biomarker assessments.

Clinical Biometrics. Biometric assessments were collected for all participant groups and included height, weight, body mass index (BMI, kg/m²), and blood pressure. Biometric assessments were required for FVRx participants to renew their prescriptions each month and were coordinated with the ongoing education sessions. The supporting clinic staff, interns, and researchers were all trained to utilize the same instruments and techniques for measuring anthropometrics and blood pressure at both the clinic and community sites [149].

Data Analysis

The analytic sample (n=36) included 18 intervention participants, 8 nutrition education participants, and 10 clinic group participants. The analytic sample had similar characteristics to the enrollment sample. Descriptive statistics were calculated for the sociodemographics, dietary intake, nutrition knowledge and behaviors, and food purchasing practices among the study sample and by group across the intervention period.

To compare differences between or within the intervention and comparison groups, Chi-square, or Fisher's exact tests for categorical variables as well as one-way ANOVA were used for continuous variables. To examine changes in categorical variables of dietary intake and food purchasing practices, dichotomous change variables were created by subtracting the frequency of responses from post-intervention from the baseline responses. For trichotomous variable responses seen in food purchasing attitudes and knowledge, change was categorized by subtracting the frequency response of post-intervention from the baseline response: 1) 'More' - Increase in frequency, 2) 'Less' - Decreased frequency, and 3) 'No change' - Same frequency. To examine the changes for continuous variables over six months, the changes from baseline to

post-intervention were calculated. For example, the post-intervention total vegetable intake (cup equivalents) was subtracted from the baseline total vegetable intake. Post hoc Tukey tests were performed for one-way ANOVA tests when significant differences in changes were observed. If normality assumptions were violated, non-parametric Kruskal-Wallis H Tests were used. To compare differences in clinical biomarkers between the FVRx and Control group, independent t-tests were used. For independent t-tests, if the F statistic determined variance to be significantly different, the Welch-Satterthwaite method was used to correct for this variance. All analyses were conducted using IBM SPSS Statistics for Windows (Version 24, Armonk, NY: IBM Corp.). The significance level was set at $p < 0.05$.

Results

Participant Characteristics

The characteristics of the analytic sample are shown in **Table 4.1**. The FVRx Intervention group reported a higher percentage of Hispanic ethnicity compared to the Nutrition Education and Control groups. The Nutrition Education group was significantly older and had lower rates of being uninsured compared to the other groups. No other significant differences were detected. FVRx program retention was 58.1%. The average attendance for the education classes and health screenings was 12.11 ± 1.60 (out of 14 classes) and 5.72 ± 0.46 (out of 6 screenings), respectively. Participant retention for the Nutrition Education group and Control groups were 84.6% and 62.5%, respectively (see **Figure 4.1**).

Table 4.1. Baseline Characteristics of the Analytic Sample: Athens Expanded FVRx Study

Characteristic (n (%) or mean $\pm$ std)	FVRx Intervention (n=18)	Nutrition Education (n=8)	Control (n=10)
Age in years*	49.28 $\pm$ 9.79	67.38 $\pm$ 11.66	50.90 $\pm$ 8.90
Female	16 (88.9%)	8 (100.0%)	9 (90.0%)
Hispanic Ethnicity*	10 (55.6%)	0	0
Receiving Federal Assistance	10 (55.6%)	2 (25.0%)	5 (50.0%)
Household size	2.31 $\pm$ 2.02	1.63 $\pm$ 1.19	2.20 $\pm$ 2.30
Uninsured*	14 (77.8%)	1 (12.5%)	10 (100.0%)
Food Insecurity	11 (61.1%)	4 (50.0%)	6 (60.0%)
BMI (kg/m ²)	36.80 $\pm$ 9.78	32.88 $\pm$ 12.17	37.54 $\pm$ 7.86
Normal Weight	1 (5.6%)	3 (37.5%)	0
Overweight	1 (5.6%)	1 (12.5%)	2 (20.0%)
Obese (Class 1)	6 (33.3%)	0	1 (10.0%)
Obese (Class 2)	7 (38.9%)	2 (25.0%)	4 (40.0%)
Obese (Class 3)	3 (16.6%)	2 (25.0%)	3 (30.0%)
Self-Reported Health Condition			
Obesity	12 (67.0%)	4 (50.0%)	7 (70.0%)
Diabetes	4 (22.2%)	2 (25.0%)	2 (20.0%)
Pre-Diabetes	5 (27.8%)	1 (12.5%)	0
Hypertension	10 (55.6%)	6 (75.0%)	8 (80.0%)
Hyperlipidemia	9 (50.0%)	7 (87.5%)	7 (70.0%)
Number of Health Conditions			
1-2	9 (50.0%)	3 (37.5%)	5 (50.0%)
≥ 3	9 (50.0%)	5 (62.5%)	5 (50.0%)

* Significantly different at baseline ($p < 0.05$) based on one-way ANOVA or Chi-square test

Dietary Intake

Baseline vegetable intake and HEI-2015 Total Vegetable Scores were not significantly different across the groups. HEI-2015 Total Diet Scores were significantly different between groups at baseline ($p=0.014$) (**Table 4.2**). The post-hoc test shows that the mean HEI-2015 Total Diet Score of the Nutrition Education group was significantly lower than the FVRx Intervention group (38.86 ± 10.98 vs. 57.11 ± 12.90).

After the intervention period, there were significant differences between each group for the frequency of eating ‘other vegetables’ (such as carrots, greens, sweet potatoes, broccoli, green beans, or other vegetables) and dark greens (collards, kale, spinach, chard). Within group

comparison reveals that the FVRx group significantly increased ‘Dark Green Vegetable’ intake (0.36 ± 0.72 cup/day, $p=0.048$) following the intervention. Within group comparisons show, the Nutrition Education and Control groups did not report any significant changes in fruit and vegetable intake measures following the intervention.

Following the intervention, changes in HEI Total Diet Score were significantly different between the groups ($p=0.01$). The post-hoc comparison shows that the Nutrition Education group reported the most significant change in HEI Total Diet Score compared to both the FVRx intervention (-1.10 ± 4.24 , $p=0.001$) and Control group (0.78 ± 14.36 , $p=0.01$). No other changes in dietary intake measures were significantly different between groups.

Table 4.2. Changes in Dietary Intake and Quality: Athens Expanded FVRx Study

Dietary Intake (n (%) or mean $\pm$ std)	FVRx Intervention (n=18)		Nutrition Education (n=8)		Control (n=10)	
	Baseline	Post	Baseline	Post	Baseline	Post
How often do you eat other Non-Fried Vegetables⁺						
Not at all- $\leq$ Once a week	6 (33.3%)	2 (11.1%)	1 (12.5%)	3 (37.5%)	5 (50.0%)	3 (30.0%)
$\geq$ Once a week - $\geq$ Once a day	12 (66.7%)	16 (88.9%)	7 (87.5%)	5 (62.5%)	5 (50.0%)	7 (70.0%)
How often do you eat Dark Greens*,⁺						
Not at all- $\leq$ Once a week	9 (50.0%)	6 (33.3%)	6 (75.0%)	5 (62.5%)	4 (40.0%)	6 (60.0%)
$\geq$ Once a week - $\geq$ Once a day	9 (50.0%)	12 (66.7%)	2 (25.0%)	3 (37.5%)	6 (60.0%)	4 (40.0%)
Total Vegetable Intake (cup equivalents)	1.21 $\pm$ 0.94	1.59 $\pm$ 1.11	1.65 $\pm$ 1.85	1.00 $\pm$ 0.76	1.29 $\pm$ 0.73	1.06 $\pm$ 0.47
Total Dark Green Vegetables (cup equivalents)*	0.01 $\pm$ 0.03	0.37 $\pm$ 0.71	0.00 $\pm$ 0.00	0.14 $\pm$ 0.33	0.43 $\pm$ 0.66	0.34 $\pm$ 0.47
HEI-2015 - Total Vegetable Score (0-5)	3.84 $\pm$ 1.66	4.05 $\pm$ 1.46	3.73 $\pm$ 1.87	3.39 $\pm$ 1.85	3.57 $\pm$ 1.53	3.74 $\pm$ 1.55
HEI-2015 - Greens and Beans Score (0-5)	1.85 $\pm$ 2.34	2.31 $\pm$ 2.49	0.00 $\pm$ 0.00	1.88 $\pm$ 2.59	2.00 $\pm$ 2.58	2.50 $\pm$ 2.64
HEI-2015 – Total Score (0-100)^{+, **}	57.11 $\pm$ 12.90	56.01 $\pm$ 12.73	38.86 $\pm$ 10.98	52.77 $\pm$ 17.00	48.56 $\pm$ 17.46	49.33 $\pm$ 9.77

**Significantly different changes between pre- and post-intervention in the FVRx group at $p < 0.05$ based on paired t-test or Fisher's Exact Test*

^Significantly different changes between pre- and post-intervention in the Nutrition Edu. group at $p < 0.05$ based on paired t-test or Fisher's Exact Test

#Significantly different changes between pre- and post-intervention in the Control group at $p < 0.05$ based on paired t-test or Fisher's Exact Test

+Significantly different changes among all groups at $p < 0.05$ based on one-way ANOVA or Chi-Square

***Post-hoc Tukey test shows Nutrition Edu. is significantly different from FVRx and Control for HEI-Total score*

Food Purchasing Practices, Attitudes and Knowledge

At baseline, there were no significant differences in food purchasing practices among the groups. At baseline and post-intervention, participants in all groups were more likely to purchase the majority of their food at grocery stores or mass merchandisers.

After the intervention period, the FVRx Intervention group and Nutrition Education group reported an increased frequency of being able to easily find fruits and vegetables in their neighborhood ($p=0.03$ and $p=0.02$, respectively) (**Table 4.3**). The FVRx Intervention group reported an increased frequency of being able to afford fresh fruits and vegetables ($p=0.001$); however, this was not significant when compared to the Nutrition Education and Control groups. Compared to the Nutrition Education and Clinic groups, the FVRx intervention group was significantly more likely to purchase the majority of their fruits and vegetables at the farmers market and purchase more fresh vegetables. Other healthful shopping practices associated with the FVRx intervention group included an increased likelihood of reading the nutrition facts labels while shopping ($p=0.02$) and a lower frequency of purchasing of processed foods compared to the Nutrition Education and Clinic groups.

The FVRx intervention group significantly increased their knowledge of which fruits and vegetables are grown during different times of the year compared to Nutrition Education and Control groups after the intervention ($p=0.006$).

Food and Financial Resource Management Behaviors and Food Security

Compared to the Nutrition Education and Control groups, the FVRx Intervention group were significantly more likely (33.3%) to increase their ability to pay for more bills than usual after the intervention period ($p < 0.05$). There were no changes in the ability to purchase more ‘non-food items’ following the intervention for all groups. Lastly, there was no difference in the frequency of ‘comparing prices before buying food’ or ‘adjusting meals to include more budget-friendly items’ among or within groups before or following the intervention period.

After the intervention period, the FVRx Intervention group reported a significant increase (33.3%) in food security ($p < 0.05$). This change did not remain significant when compared against the Nutrition Education (12.5%) and Control groups (20%); however, neither group reported any significant change in food security.

Clinical Assessment

Biomarkers. Clinical biomarkers were only collected for the FVRx Intervention and Control groups. The FVRx intervention group significantly improved HDL cholesterol compared to the Control group following the intervention period (3.83 ± 3.93 vs. -2.5 ± 7.05 , $p = 0.01$). LDL cholesterol decreased in both groups, but those changes between and within groups were insignificant. HbA1c was virtually unchanged in both groups.

Biometrics. Weight was favorably, but insignificantly, reduced in both the FVRx (-1.13 ± 2.91) and Nutrition Education groups (-1.63 ± 2.56) compared to the Control group (1.32 ± 4.50) resulting in small reductions in BMI. At baseline, systolic and diastolic blood pressure measures were significantly different between all groups ($p < 0.05$). Following the intervention, there were no significant differences in systolic or diastolic blood pressures between groups. However,

within group comparisons demonstrate the Control group reported significant reductions in systolic blood pressure (-14.50 ± 16.54 mmHg) following the intervention ($p < 0.05$).

Table 4.3. Changes in Fruit and Vegetable Purchasing Practices, Attitudes and Knowledge: Athens Expanded FVRx Study

Characteristic n(%)	FVRx Intervention (n=18)		Nutrition Education (n=8)		Control (n=10)	
	Baseline	Post	Baseline	Post	Baseline	Post
Purchased majority of fresh fruits and vegetables at...*,+						
Farmers Market	0	13 (72.2%)	0	0	3 (30.0%)	1 (10.0%)
Preferred Store	18 (100%)	5 (27.8%)	8 (100%)	8 (100%)	7 (70.0%)	9 (90%)
Prefer to purchase fruits and vegetables from...+						
Farmers Market	11 (61.1%)	14 (77.8%)	4 (50.0%)	2 (25.0%)	5 (50.0%)	3 (30.0%)
Preferred Store	7 (38.9%)	4 (22.2%)	4 (50.0%)	6 (75.0%)	5 (50.0%)	7 (70.0%)
Purchased more fresh vegetables last month*,+						
Yes	12 (66.7%)	16 (88.9%)	5 (62.5%)	2 (25.0%)	5 (50.0%)	6 (60%)
No	6 (33.3%)	2 (11.1%)	3 (37.5%)	6 (75.0%)	5 (50.0%)	4 (40%)
Fresh fruits and vegetables are easy to find in my neighborhood.*,^						
Always	7 (38.9%)	13 (72.2%)	6 (75.0%)	7 (87.5%)	7 (70.0%)	6 (60%)
Sometimes	9 (50.0%)	5 (27.8%)	1 (12.5%)	1 (12.5%)	3 (30.0%)	4 (40%)
Never	2 (11.1%)	0	1 (12.5%)	0	0	0
I can afford fresh fruits and vegetables*						
Always	3 (16.7%)	8 (44.4%)	4 (50.0%)	4 (50.0%)	4 (40.0%)	1 (10.0%)
Sometimes	14 (77.8%)	9 (50.0%)	3 (37.5%)	3 (37.5%)	6 (60%)	9 (90.0%)
Never	1 (5.6%)	1 (5.6%)	1 (12.5%)	1 (12.5%)	0	0
I know which fruits and vegetables are grown during different times of the year+						
Agree	3 (16.7%)	11 (61.1%)	5 (62.5%)	3 (37.5%)	4 (40.0%)	7 (70.0%)
Sometimes Agree	8 (44.4%)	7 (38.9%)	3 (37.5%)	5 (62.5%)	2 (20.0%)	1 (10.0%)
Disagree	7 (38.9%)	0	0	0	4 (40.0%)	2 (20.0%)

*Significantly different changes between pre- and post-intervention in the FVRx group at $p < 0.05$ based on Chi-Square, McNemar, or Fisher's Exact test

^Significantly different changes between pre- and post-intervention in the Nutrition Edu. group at $p < 0.05$ based on Chi-Square, McNemar, or Fisher's Exact test

#Significantly different changes between pre- and post-intervention in the Control group at $p < 0.05$ based on Chi-Square, McNemar, or Fisher's Exact test

+Significantly different changes between ALL groups at $p < 0.05$ based on Chi-Square, McNemar, or Fisher's Exact test

Discussion

The findings of this study demonstrate combining produce prescription with intensive direct education improves multiple and complementary factors of health behavior change resulting in improved knowledge, preference, purchase, and consumption of locally grown produce. In addition, this multi-level intervention model using a farmers market setting improves financial resources and healthy food purchasing practices, which are key determinants of food security, dietary, and health outcomes.

The priority populations for produce prescription programs are low-income and at high risk of food insecurity, diet-related chronic conditions, unexpected healthcare expenditures, and other financial strains [4, 32]. The shift in financial resources and practices observed in this study suggests produce prescription as a targeted subsidy for locally grown produce could mitigate the negative impacts of food insecurity and poor health in low-income patient populations [150, 151]. These findings are in line with previous research demonstrating the positive impacts of produce incentives on food purchases, diet, and potential healthcare costs among Medicaid, Medicare, as well as SNAP beneficiaries [152, 153].

The role of direct education in produce prescription programs continues to show promise in supporting improved nutrition-related behaviors and diet of low-income patient populations. Our study highlights how nutrition and financial literacy education can extend the benefits of the produce prescription by increasing skills and knowledge to maintain financial and food resources and healthy eating strategies on a limited income [85, 154]. As expected, this study demonstrated produce prescription combined with nutrition education was more supportive of vegetable intake than either nutrition education or standard health care (safety-net clinic) alone [145]. The FVRx participants were more likely to practice healthier food purchasing practices linked to higher diet

quality, such as using nutrition facts labels when shopping and purchasing significantly less processed foods. The FVRx participants were more likely to increase the preference, knowledge, and purchase of locally grown produce that may have supported these shifts in food purchasing practices beyond the program settings [6, 155]. In addition to the education, the produce prescriptions likely supported participants' ability to implement healthy shopping practices in both the farmers market and their usual grocery store. These findings shed light on how multi-level strategies could address financial constraints and their harmful impacts on nutrition and health outcomes of diverse low-income community and clinic populations [156]. The use of education to support individuals accessing novel food environments is an important consideration given the growth of farmers markets that accept other policy-based supports such as SNAP benefits and produce incentives [14, 96, 97].

Primary care providers have often cited lack of time, limited training, or reimbursement as barriers to providing or referring patients to nutrition education or counseling [157, 158]. There is limited evidence for the barriers or implications of safety-net clinic providers addressing dietary and nutrition-related behaviors with patients; however, similar or more barriers may prevent safety-net clinics from providing evidence-based nutrition education or counseling to patients [79, 80]. Given the structural challenges safety-net clinics face and high rates of health disparities among their low-income patients, safety-net clinics could benefit from partnering with community-based organizations offering nutrition education, such as local County Extension Offices to deliver tailored and evidence-based nutrition education [159]. As these organizations expand partnerships with various community food resource organizations (e.g., FVRx programs, food banks, and food pantries), the partnerships formed could improve the likelihood patients will connect with and utilize healthy foods [80, 145, 159].

Although the FVRx intervention group reported significantly increased food insecurity after the intervention period, this change did not reach statistical significance compared to the control and comparison groups. This was likely due to small, but insignificant increases in reporting food security within the control and comparison groups. Similarly, most of the biomarkers (except HDL cholesterol) and biometric assessments showed limited and inconsistent changes between groups following the intervention period. These findings may be due to challenges in the design and conduct of FVRx programs and research evaluation, demonstrating clinically significant changes in participant health outcomes. For example, an 18-month randomized controlled trial of a CSA intervention compared to a cash-matched control condition showed significantly improved diet quality and food security in overweight adult patients from a federally qualified health center [113]. A longer-term produce incentive intervention is required to lead to clinically meaningful increases in diet quality and food security among clinic populations. In addition to extended produce prescription and nutrition education, individual nutrition counseling tailored to the unique health conditions of participants could support more positive clinical outcomes since standalone medical nutrition therapy intervention is proven to improve clinical health outcomes in multiple chronic conditions [160, 161]. Research design to determine the impact of FVRx programs should carefully consider confounding factors in sampling strategies to discern the unique impact of the program, such as stratified sampling based on the type and number of comorbidity with varying disease processes.

One critical consideration for interpreting the findings of this study lies within our ability to compare the expanded FVRx intervention group to an ad-hoc group and control groups. The use of an ad-hoc comparison group made the recruitment of a comparable sample possible, but the collection of serum measures less feasible and implications of our findings less generalizable.

The ad-hoc group received only one of the two SNAP-Ed programs the FVRx Intervention group received (Nutrition Education group) or no SNAP-Ed program (Control group), which limits our ability to make direct comparisons between groups. However, the addition of the Nutrition Education group helped to confirm prior findings and demonstrated the importance of nutrition education in improving multiple behaviors as part of an FVRx Intervention. This study design does not allow discernment of the effect of the produce prescription component alone. Other limitations of this study include a small sample size and the use of primarily self-reported data.

Despite the limitations reported, this study provides critical considerations for future produce prescription programs and policy. Continued funding for produce incentives for SNAP beneficiaries under the USDA Gus Schumacher Nutrition Incentive Program (GusNIP) could promote the nutritional health of low-income patients while addressing the complexities of food insecurity, diet quality, and health in this population [152, 153, 162]. Combining nutrition and financial literacy education with produce prescription has the potential to improve financial and food resources, dietary intake of vegetables, and food security. Supportive policies to expand the FVRx program in the public and private healthcare sectors can increase the likelihood that produce prescriptions and other nutrition interventions are institutionalized and reimbursed as part of standard healthcare practices. For example, reimbursement of produce prescriptions through Medicaid and Medicare has the potential to improve safety-net clinic patient outcomes and reduce healthcare costs [152]. As more policies are making produce prescription and incentives available, federally funded nutrition education targeted to low-income Americans (i.e., SNAP-Ed and EFNEP) could be partnered to provide evidence-based education. Lastly, because of the growth in produce incentive and prescription programs that use local food systems, more research is needed to examine how produce prescription redemption in local food settings

influences participant experiences and outcomes. Findings from such research can continue to guide supportive partnerships, practices, and policies for produce prescription and incentive programs.

Overall, the findings of this study highlight how produce prescription programs combined with intensive nutrition, and financial literacy education can improve multiple levels of behavioral influence over nutrition education or standard health care alone and underscores the need for multi-level interventions addressing food insecurity and nutrition education needs for positive health outcomes among medically underserved low-income patient populations.

CHAPTER 5

PRODUCE PRESCRIPTIONS COMBINED WITH NUTRITION EDUCATION TRANSFORM PARTICIPANTS' LOCAL FOOD EXPERIENCES³

³ Slagel, N., Thompson, J., Lee, JS. To be submitted as a Research Article in the *Journal of Nutrition Education and Behavior*.

Abstract

Background: FVRx programs that combine produce prescription with nutrition education improve nutrition knowledge, financial stability, and purchase and consumption of locally grown fresh fruits and vegetables. More FVRx programs are implemented at the farmers market setting, but little is known about the impact of FVRx programs on participants' local food system perceptions and experiences.

Methods: This qualitative study was conducted as part of the 2018 Athens FVRx program, a 6-month non-randomized clinical trial to examine the impact of produce prescription with expanded nutrition education on nutrition and health outcomes. Guided by constructivist theory, a multiple case-study approach was used to examine the changes in the local food system perceptions and experiences in three separate case groups: 1) FVRx Intervention group, 2) Nutrition Education group, and 3) Control group. The FVRx intervention group received produce prescriptions redeemable at a farmers market, two SNAP-Ed programs with 10 weekly lessons, four monthly financial literacy lessons, and monthly health screenings. The ad-hoc comparison group (Nutrition Education) received one SNAP-Ed program. A total of 47 low-income individuals were included (mean age 55.98 ± 11.6 years, 89.4% female, and 31.9 % Black). Focus group and individual interviews were conducted at baseline and following the intervention period. Interviews were transcribed and analyzed using thematic and constant comparative analytic methods.

Findings: At baseline, participants from all three cases employed price-conscious food purchasing practices due to limited income. These practices and a limited food budget resulted in limited farmers market attendance and unique perceptions; however, the majority of participants

were interested in locally grown food. After the FVRx Intervention, the FVRx group developed positive and unique values, as well as increased knowledge for locally grown foods. These changes were characterized by motivation to shop and eat healthy following program participation at farmers markets and grocery stores. Both the Nutrition Education and Control groups reported continued low access to farmers markets and fresh fruits and vegetables following the intervention period. However, the Nutrition Education group reported improved food resource management skills to shop, cook and eat healthier.

Conclusions:

FVRx programs that use produce prescription and nutrition education tailored for farmers markets helped low-income adults create positive values and perceptions of locally grown food. The transformative experiences of FVRx participants indicate the multi-level FVRx intervention approach is supportive of sustaining positive health behaviors beyond the program.

Keywords: Produce Prescription Program, Nutrition Education, SNAP-Ed, Local Food System, Farmers Market

Introduction

Despite being modifiable and preventable, diet-related chronic diseases continue to increase in the U.S. [163], especially among those with lower socioeconomic status [4]. A diet high in fruits and vegetables supports the prevention and management of such chronic conditions [1] and access to healthy food environments, such as local food systems (e.g., farmers markets or Community Supported Agriculture (CSA)), is associated with increased consumption of fruits and vegetables [101].

Research consistently demonstrates low-income or food insecure populations have limited access to healthful foods, especially in local food systems due to geographical and cost-related barriers [7-9]; however, low-income populations are interested in accessing local food systems [9, 155, 164]. Recent interventions with a goal of improving access to healthful foods and local food systems for low-income populations adopted multi-level strategies as laid out in the Social Ecological Model (SEM). These interventions focused on behavioral and organizational leverage points to reduce food insecurity and chronic disease risks through access and consumption of healthy foods in low-income populations [165-167].

The Fruit and Vegetable Prescription (FVRx)[®] Program[®] intends to reduce food insecurity risks and improve health outcomes through a comprehensive multi-level approach. This program model combines a healthcare provider generated produce prescription for fresh produce with nutrition education and free health screenings for low-income adults with diet-related conditions. This multi-level approach directly aligns with the theoretical framework of the SEM and has the potential to demonstrate improvements in dietary intake, food security, food purchasing practices, nutrition knowledge and behaviors, and local food access [15-17]. Recently, a growing number of FVRx programs use local food systems; however, there are

limited studies centered around FVRx participants' local food experiences. Some FVRx program participants continue reporting barriers to accessing local food [119]. Given the heterogeneity across the produce prescription programming in terms of program design, staffing, and coordination, it is important to understand program participants' experiences and perspectives related to the access and utilization of local food systems before, during, and after participating in the FVRx program and by the intervention component of multi-level FVRx programs.

The purpose of this qualitative multiple-case study was to examine low-income adults' experiences and perceptions of local food systems in relation to key FVRx intervention components over time. Understanding the ways in which FVRx intervention components influence low-income adults' food purchasing practices and the use of local food systems could inform the design and practice of other produce incentive programming.

Methods

Study Design

This study was conducted as part of the 2018 Athens FVRx program and included three SNAP-Ed programming counties in Georgia (May-Nov 2018). This study examined the impact of the expanded 2018 Athens FVRx program model combining produce prescription with nutrition education, financial literacy education, and health screening using mixed methods approaches and non-randomized controlled study with two comparison groups: 1) FVRx Intervention group, 2) Nutrition Education group, and 3) Control group.

The FVRx Intervention group received a monthly produce prescription worth \$1/day per household member, ten weekly nutrition education lessons based on two UGA SNAP-Ed programs in both English and Spanish [130] [168], Four monthly financial literacy lessons, and a

monthly health screening (i.e., blood pressure, height, weight, and waist circumference). More details of the Athens FVRx intervention are discussed elsewhere [169]. The Nutrition Education group received only one of the two SNAP-Ed programs at the start of the intervention period and were not provided any other education or produce prescriptions. Control group participants only received their standard healthcare services provided by the supporting clinic. The University of Georgia Institutional Review Board approved the study (# 00004504).

Quantitative Research Component

The quantitative component of this study used self-reported measures to determine changes in dietary intake, food security, food purchasing practices, and food and financial resource management across the three groups. Clinical assessments (i.e., serum biomarkers and biometrics) were also collected for the FVRx and Nutrition Education groups.

Qualitative Research Component

Theoretical Approach. The qualitative research component used a multiple-case study design informed by a constructivist approach. This epistemological stance recognizes that realities provided by research participants are subjective to each unique individual in each setting, and the researcher is also part of this reality that is being observed [170]. Because this stance theorizes reality as socially constructed, the basis of qualitative inquiry focuses on a co-creation of findings gathered by the researcher and provided by the participants [171]. A multiple case study approach is well suited to describe the varying contexts that are relevant to the phenomena under study [172]. The multiple, or collective, cases in this study include the interventions and settings of three study groups: 1) FVRx Intervention group, 2) Nutrition Education group, and 3) Control group. Each unique case represents how low-income participants perceive and navigate his/her local food system through the strategies used to

purchase and consume local foods. Because of the combined approach from the constructivist paradigm and case study methodology, the participants in each case provide context to the case by their interactions and experiences with the interventions or settings provided.

Study Sample Recruitment

Details on the recruitment procedures for each case group in the overall study sample can be found elsewhere [169] and are briefly described here. The eligibility criteria for the overall study included being adults (>18 years and older), being SNAP-Ed eligible or food insecure, with a diagnosis of one or more of the diet-related chronic conditions: 1) overweight and obesity, 2) diabetes, 3) pre-diabetes, 4) hypertension, and 5) hyperlipidemia. Participants for the FVRx Intervention and Control groups were selected through purposive sampling method. Participants from community sites were recruited and screened by community partners and researchers during recruitment meetings. Clinic staff directly recruited and screened participants during appointment visits. If the community member or patient was eligible, they were provided information about the program and asked to consent for participation in the study. The Control group participants were recruited at the participating safety-net clinic following enrollment of the Athens FVRx Program using a purposive sampling method. The Nutrition Education group participants were recruited by convenience sampling during the ongoing implementation of UGA SNAP-Ed direct education programming in Bartow and Gilmer County.

Study Setting

Clarke County where the FVRx Intervention and Control groups were recruited shows substantially higher proportions of household food insecurity (21.6%) and below the poverty line (38.1%) than Bartow and Gilmer County, Georgia (Bartow: Food Insecurity-11.4%, Poverty-13.6% and Gilmer: Food Insecurity-10.6%, Poverty- 16.9%). Low-income residents of Bartow

and Clarke County have lower access to grocery stores (14.1% and 21.0 %, respectively) compared to low-income residents of Gilmer County (3.3%). Across the three counties, a similar number of farmers markets per 1,000 residents are available, but only the farmers markets in Clarke County accept SNAP benefits. Bartow and Clarke Counties also have more local food options with farms that provide CSA's [21, 128, 129].

Data Collection

Of the 60 participants from the overall study sample, 47 participants participated in interviews. For the FVRx Intervention group, focus groups and individual interviews were scheduled prior to receiving any intervention components. Post-intervention focus groups and individual interviews were scheduled with participants following completion of all intervention activities. Baseline focus groups were conducted at each Nutrition Education group site following their first SNAP-Ed lesson, and post-intervention focus groups were scheduled for six-months following completion of all SNAP-Ed lessons. Upon enrollment, Control group participants were asked to participate in individual interviews following their scheduled appointment. Post-intervention interviews were scheduled for six-months later during patient follow-up appointments at the clinic.

Semi-structured interview guides were created and pilot-tested for the interviews at baseline and at six-months (post-intervention) (**Table 5.1**). Each individual interview and focus group was audio-recorded.

The sociodemographic characteristics of the final qualitative study sample (n=47) included SNAP-Ed eligible or food insecure adults with one or more diet-related conditions (mean age 55.98 ± 11.6 years, 89.4% female, 31.9 % Black). The baseline sociodemographics of participants who participated in baseline interviews are presented in **Table 5.2**. The

characteristics of participants who completed both pre- and post-intervention interviews were not significantly different from those who completed only pre-intervention interviews.

Table 5.1. Sample Semi-Structured Interview Questions: Athens Expanded FVRx Study

Pre-Intervention	Post-Intervention	Additional Probing Questions (post)
Describe the ways you shop for food.	Describe your experience with the (FVRx program, SNAP-Ed classes, clinic).	Tell me more about your experience with shopping at the farmers market.
What have your experiences been, if any, with shopping at a Farmers Market? CSA?	If at all, has the way you shop for food changed since you started (FVRx, SNAP-Ed, or 6-months ago)? Why or why not?	Tell me about your last experience shopping. Describe the ways you shop for food.
Describe your perceptions of shopping at a farmers market or using a CSA.	Over the last 6 months what have your experiences been, if any, with shopping at a Farmers Market? CSA?	Describe your perceptions of shopping at a farmers market or using a CSA. What are your plans for shopping at the farmers market in the future? What would you need in order to continue to shop there?

Table 5.2. Baseline Interview Participant Characteristics by Case Group: Athens Expanded FVRx Study

Characteristic (n (%) or mean±std)	FVRx Intervention (n=14)	Nutrition Education (n=13)	Control (n=9)
Age, years	52.28 ± 7.33	67.54 ± 9.73	53.67 ± 8.15
Female	12 (85.7%)	11 (84.6%)	8 (88.9%)
Hispanic	4 (28.6%)	0	0
African American	7 (50.0%)	1 (7.7%)	4 (44.5%)
<High school graduate	3 (21.4%)	3 (23.1%)	0
Household income <\$1,300	12 (85.7%)	9 (56.25%)	5 (55.5%)
Receiving SNAP	7 (50%)	2 (15.4%)	4 (44.5%)
Uninsured	11 (78.6%)	3 (23.1%)	0 (0%)
Food insecure	12 (85.7%)	6 (46.2%)	5 (55.5%)

Data Analysis

The recordings were transcribed verbatim by the researcher and through a transcription service. After each initial transcription, the researcher reviewed each transcript for accuracy by listening to the audio recording and reading the transcript a second time. Each transcript was sanitized to replace all identifying nouns and names with pseudonyms and participant IDs. Following transcription, cleaning, and sanitization phases, the transcript files were uploaded to the Atlas ti.8 (Windows version 8.0, Scientific Software Development GmbH, Berlin, Germany; 2018) for thematic analysis.

The steps used to analyze the transcripts were informed by the coding strategies and constant comparative analysis methods outlined by Charmaz to generate themes inductive to the participant responses [173]. This process was selected to highlight the unique differences, similarities, and transformations of participants within and between groups over time. Specifically, this method used iterative phases and steps to observe participant responses in fine detail and then recombined the fine details into larger concepts and categories to compare within and between groups at baseline, post-intervention, and over time. The first phase of analysis included the coding of all baseline interviews. The first step in this phase included open coding incident by incident rather than word by word. Incidents are defined by coherent descriptions of an event or experience prompted by a question or one's own thoughts. Initial coding was done with a single transcript from each case. The codes and definitions were created using the words provided by the participants as much as possible to provide a co-construction of their experiences and perceptions. Following the initial coding phase, the investigator analyzed the remaining transcripts from each group separately and used comparative techniques to group similar responses into larger categories. The concept mapping technique was used in the development of

baseline categories and themes within and between cases to assist in the comparison and contrasting of participant experiences and perceptions. Following the coding and thematic development of the baseline interviews, the same process was implemented for the post-intervention interviews. The last step involved merging of codes and transcripts from baseline and post-intervention interviews for final analysis. Concept mapping was used again to track experiences and perceptions by group and overtime to assist the final analysis and interpretation of findings.

Findings

Financial limitations predisposed many participants' baseline experiences in the way they perceived and navigated local food systems and resulted in similar experiences, strategies, and perceptions across each case. Unique baseline experiences and perceptions of local food systems also emerged. Because each case was influenced by a specific intervention and observed over time, unique transformative experiences developed within each group following the intervention period. As a result, three key themes emerged from interviews with all case groups: 1) price-conscious food purchasing practices, 2) local food system perceptions and experiences, and 3) transformative experiences.

Price Conscious Food Purchasing Practices

Participants from all three case groups reported similar food shopping experiences and perceptions about local food systems at baseline. The shared experiences and perceptions were mainly due to their fixed or limited income and led to financial-based decisions around food. The most common food purchasing practice for accommodating a limited income or limited food

budget was to prioritize shopping for the cheapest and most affordable food first. All participants reported they purchased the majority of their foods at grocery stores or mass merchandisers (e.g., Walmart). In line with this practice, participants shopped at certain stores for certain items known to be more affordable. This often resulted in shopping at multiple locations for different items. These improved participants' ability to stretch their food budget further and ensure enough food throughout the month.

“Most of the place[s] I shop [are] Dill’s Food City in Royston, GA., Quality Foods in Anderson, GA., and Piggly Wiggly here. I search because I’m always [driving around] and if I [have] money or if I [have] food stamps I [shop for] good deals, good-buys, and stuff... so that’s basically about it. And the only reason I shop at those places is because it’s cheaper. I would like [to shop at] Kroger and Publix and places like that, but their meat is just so expensive.” (FVRx-26)

“So, it’s always either Walmart or Kroger, Aldi’s, every blue moon, Publix, I’m real big on price shopping.” (Control -02)

“I do Aldi’s and then Walmart if I feel like walking a whole lot, but basically, I like Aldi’s.” (NE-11)

Other common food purchasing strategies included couponing, reduced price specials, ‘markdown’ or ‘manager special,’ shopping with family members, or buying in bulk. When discussing what foods were purchased, many participants stated they were primarily purchasing more processed, filling, less perishable, or convenient foods and perceived them as less healthy. When discussing participants’ perceptions of what healthy foods are, fruits and vegetables were mentioned by virtually all participants; however, they were quick to describe them as less affordable than other foods.

When participants were asked about the way they purchase fruits and vegetables, they often referred to fresh fruits and vegetables as a low priority because of higher prices and the inability to stretch out over time like other foods. Most participants preferred fresh produce; however, many still limited purchases of fresh produce or purchased frozen or canned due to being more affordable or convenient to prepare. Participants from each group describe this experience:

“I look for price and if it's in my budget, okay, I get it. If it's not, I get the 10 for 10 which is not healthy. You get 10 Ramen Noodles for \$5.00. You go to the spinach section and one bag of spinach costs \$3.99. What do you think I'm going to choose when I got a budget of \$75.00 for the month?” (FVRx-20)

“It's easier to get macaroni and cheese for 59 cents than it is to spend \$3 or \$4 than a bag of vegetables” (Control -03)

“Yeah because we are on fixed incomes right now. It's like ok we can afford this and this and this. It's why I can't go and afford to buy fresh vegetables and fresh fruits and stuff.” (NE-01)

“Right, in order to stay on my budget and everything I don't go to the market just to look. I only go when I have to go. Because that can lead to temptation of me buying something that I really shouldn't be spending money for. I would like to go more but I don't.” (Control -06)

Participants from each case group were generally interested in purchasing fresh fruits and vegetables, but they focused on foods that lasted longer or were more affordable. These restrictive purchasing practices also influenced the perceptions and purchasing practices of fruits and vegetables at local food retailers.

Not only did participants from each group perceive fruits and vegetables as expensive, but also, they perceive locally grown produce as more expensive than food from grocery stores. Thus, shopping at local food settings were a lower priority, given the essential needs were to maintain food resources. These priorities, due to financial limitations, influenced current experiences and perceptions of farmers markets.

Local Food System Perceptions and Experiences

The majority of participants from each case group had prior experiences with farmers markets; however, they were not attending farmers markets, nor aware of their local farmers markets at baseline. When providing details about their experience with farmers markets, several participants from each group described their experience with other local food venues instead of ‘USDA defined farmers markets.’ These venues included flea markets, roadside stands, or small grocers or co-ops that sold local food. Regardless of some initial misconceptions, most participants were aware of or had more experiences with larger state farmers market settings, flea markets, or roadside stands compared to smaller local farmers markets. Produce sold at farmers markets, especially smaller local markets, were consistently perceived as more expensive than other local food venues and grocery stores. Participants either perceived local produce as expensive in general or due to it being organic.

“Yes... they’re not that cheap to me. They’re cheaper in the store than they are at the farmers market.” (NE-06)

“Being that I’m not going to buy it just to taste it, when I could put my money somewhere else. But I think expensive is what I’m expecting. Small bunches in the quantity of it.

Umm....I think those are the things” (FVRx-03)

“Yes, they are they’re not they’re not that cheap to me. They’re cheaper in the store than they are at the farmers market.” (Control-06)

Because food costs were the primary reason for the way participants shopped, the majority of participants from all groups did not attend or avoided their local farmers markets. Avoiding the farmers market was a direct result of financial barriers and prompted the common strategy for purchasing the majority of fruits and vegetables at grocery stores or mass merchandisers.

Overall, participants shared positive experiences with farmers markets and other local food venues and preferred the fresh produce sold at these locations over grocery stores. The majority perceived the produce found at farmers markets superior to other venues, and they felt they were directly supporting the farmer who grew it. The following excerpt from participants in the Nutrition Education group summarizes many of the participant experiences from each case:

NE-13: I like the freshness of them [produce].

NE-11: I do too. I like the taste. Injected produce tastes so bad to me.

NE-13: They [farmers] harvest it like Friday, they bring in Saturday morning that's the best.

NE-11: They have a lot to the stuff in the grocery stores because it has to last longer, so they're all injected with all the preservatives and the hurry up and ripen stuff. It's just a lot-

NE-13: And it's good to support the local farmers.

NE-11: Yeah.

NE-12: That's what I was going to say.

Even with limited income and accessibility to local food, these participants had a deep social and personal connection to the idea of purchasing fresh local produce. Past experiences with local food through growing up gardening or on a farm or attending local farmers markets were the most common reasons why participants favored fresh and local produce.

“Well I grew up on a farm, and I was used to going straight to the source and just pulling corn and go cook it. Cut the okra and go cook it. Tomatoes go cook it. And it tastes distinctively better than what you get out of the grocery store.” (FVRx-55)

Control -14: I would shop at the farmers market everyday if I could.

Interviewer: Right and so what are maybe some of the reasons why you would be interested in shopping there more often?

Control -14: Well it's locally grown. It's fresh. It's better for my body. I'm getting all the nutrients out of my fruits and vegetables. More so from the farmers market to me versus a grocery store.

Interviewer: Okay.

Control -14: They're boxed and brought in from who knows where and I'm just big on local.

Interviewer: When did you get into that concept?

Control -14: I've always been this way, pretty much growing up. We always had a garden.

These quotes also demonstrate that participants perceived locally grown produce as healthier compared to produce sold in grocery stores. In the quote provided, this appears to be connected to the perception of freshness in local versus store-bought produce. For the majority of

participants across each case, the positive past experiences with locally grown food created foundational interests and motivations for participants to purchase and eat fresh and local food from farmers markets or other local food settings in the face of financial restrictions.

Transformative Experiences

After the intervention period, FVRx participants experienced a shift in financial and food resources, as well as positive local food experiences as a result of the produce prescription, nutrition education, and financial literacy education. The Nutrition Education group described being empowered to shop, cook, and eat healthy within a limited budget, without improvements in financial and food resources or local food access.

All FVRx participants reported accessing the farmers market with high frequency and being able to purchase more fruits and vegetables as a result of the produce prescription. FVRx participants' access to a local farmers market exposed them to a variety of vegetables, as well as knowledge and appreciation of local and seasonal produce. The positive social interactions enhanced their experience with the program and created value, community, and trust with their food source. Use of a farmers market for a produce prescription program allowed participants to extend upon their prior experiences and perceptions of local food and farmers markets. They developed or renewed values related to the production practices of local and organic produce, as well as direct social connections with the farmers who produced the food.

“The taste is usually a lot more authentic to the actual product and they're raised and grown without pesticides, fertilizers in the soil. These are things that I had never thought too much about in my purchasing history” (FVRx-35)

“For me, it has been very comfortable because they are people eh, um that maybe one doesn't know, and you go meet them and you go and get your vegetables and they say

“hi, how are you?” and they make you feel comfortable, good, so for me it was good.”

(FVRx-17)

“I didn't know the certain ... when you go to the grocery store, you just go and you mindset like you're shopping. People who have more education in that type of field would know that seasonally, certain vegetables or fruits go in certain seasons. I did not know that, that introduced me to the fact that certain vegetables or certain fruits are grow in certain seasons.” (FVRx-43)

As these quotes demonstrate, the produce prescriptions for local produce at a farmers market provide positive experiences that transform perceptions and knowledge of local food of participants. Based on these new experiences and perceptions, participants increased their knowledge of seasonally available produce and created new values surrounding the meaning of local food.

FVRx participants also provide frequent examples of how the prescription improved their financial resources and allowed more financial flexibility during the program.

“Yeah, it makes me have a little more pocket money, I know that. I don't have to buy more stuff in the grocery store, so that leaves me ... you gotta have tissue, laundry detergent, and gas in your car. Got my car payment, my car insurance. I've got all that stuff to do. So, it's been helping me. It really have. I see a big difference in what I spend and what I save.” (FVRx-26)

The produce prescription combined with the education improved participants' food purchasing strategies and decision making at the grocery store.

“...it changed my purchasing habits so because I was getting fruits and vegetables from the farmers market, I would then not focus my purchasing at the grocery store so much on bulk and fillers.” (FVRx-35)

“And learning how to shop smart. To shop smart. Save money and conscious of shopping smart, like I said. And then reading the label, that's back to the food part, reading the label and the ingredients. That's something that I never did before because I never ... like you just went in the store to buy what was cheap. And most of that wasn't good for you. So, all of the goals ties into one. But the financial class, that was awesome.” (FVRx-34)

These participant experiences highlight the possible ways in which produce prescriptions for local produce combined with education can shift financial resources and food shopping strategies beyond the settings of the program. When asking FVRx participants of their intentions for continuing to shop at the farmers market, the majority wanted to continue to shop there given their experiences; however, they still perceived the farmers market as expensive. Despite this continued perceived cost barrier, participants preferred the shopping for their produce at the farmers market after the program as a result of the new values and knowledge of local food. FVRx participants also felt confident that they would be able to maintain some aspect of healthy eating due to the skills and strategies provided during the nutrition education classes.

The recipe demonstrations and tastings during nutrition education sessions were other crucial experiences that influenced participants' experiences and the ability to utilize the farmers market. The nutrition education enhanced the participants' ability to cook with the produce found at the farmers market and increased willingness to try new and novel varieties.

“The cooking portions of the classes got me to really want to be excited about exploring more in cooking, adapting new foods, healthier foods into cooking and got me to be a

little more adventurous in my purchases as well. I started purchasing healthier and newer types of products like there was so many different types of greens that I had only heard of but had never even remotely thought about preparing for myself like collards, Swiss chard, kale, turnips and turnip greens.” (FVRx-35)

“Some of the recipes on how to prepare it, because I like the way they do the ones they were doing here, and then giving us the book to go with it. And then I can always add or take away from the recipe, and we can get it at the farmers market to put into the recipe. Make it taste different.” (FVRx-22)

Nutrition education tailored for seasonal produce found at farmers markets increased participants’ willingness to purchase and cook novel vegetable varieties. In addition to vegetable-centric cooking and recipes, participants also learned preparation techniques they found useful to improve the health of their meals at home.

“The cooking that she [the instructor] do for us you know it's easy and simple. You know it's simple stuff that you can do at home that you should already have at home. You know learning a new way to cook it healthy. Because just like that cabbage out there, I would normally take it and put some fat back grease in it you know and that's the wrong thing to do it's not the healthy thing to do. You know it teaches you a lot of things on how to cook and prepare stuff different that's healthier.” (FVRx-26)

“Some of the recipes on how to prepare it, because I like the way they do the ones they were doing here, and then giving us the book to go with it. And then I can always add or take away from the recipe.” (FVRx-22)

The examples provided demonstrate how each FVRx program component worked in coordination to create novel connections with local food, improved knowledge, and purchase and

preparation of seasonal produce, as well as prepare participants to shop, cook, and eat healthy outside the program settings.

Participants from the Nutrition Education and Control group continued to perceive local food systems, especially farmers markets, out of reach. The majority from these groups still experienced limited ability to purchase fruits and vegetables and did not attend farmers markets over the six-month period. However, Nutrition Education participants indicate the education sessions improved a variety of food resources, food purchasing, and nutrition-related behaviors in light of financial limitations. In particular, the Nutrition Education group shared similar experiences to the FVRx Intervention group regarding learning how to cook and purchase more vegetables on a limited budget.

“That was a great refresher for me. Those ladies, they were showing the use of vegetables to flavor things and the use of the onion and the different spices and stuff. It was a great refresher for me, and I've been working real hard.” (NE- 13)

“I've learned how to cook vegetables in a different way than I've ever cooked them before. Like with your greens and stuff that they're better or less steamed than they are just boiled way down. Just steam 'em 'til they're tender.” (NE-04)

“NE-11: A lot of mine is the cost prohibiting me from buying. If they have vegetables, cans for 30 cents, it's a lot cheaper than \$2 for the fresh. So, trying to figure out what's good for me and I can still afford, that's an issue and that will be an issue, but ...

Interviewer: Yeah. So, were there any strategies that you learned during the class that maybe helped with that, that you can think of?

NE-11: Yeah, just the fact that if you fix your own it's a lot cheaper than going down and buying it. I do more cooking now than I did. I used to just eat out almost every meal and I've not done that as much, but in preparation they made it easy."

As these quotes demonstrate, the Nutrition Education group experienced positive changes in their self-efficacy and motivation to add in more vegetables into their diet without the addition of financial incentive support or increased access to a local farmers market. These positive changes reiterate how nutrition education alone can still improve the likelihood that low-income adults will purchase and consume fruits and vegetables. Control group participants continued to report financial constraints and limited changes in their knowledge, ability, or motivation to purchase and eat more fruits and vegetables. This is likely a result of the limited ability of the safety-net clinic to provide patients with nutrition education or access to subsidized fruits and vegetables as part of their standard healthcare.

Discussion

This study highlights how a multi-level intervention combining produce prescription for free produce at a farmers market setting and nutrition education reduces multiple barriers associated with access, purchase, and consumption of local fruits and vegetables among low-income adults. These changes allow FVRx participants to improve their experiences and values of local food systems as well as motivation to continue to access, purchase, and consume local foods over those who receive nutrition education or standard health care alone.

The majority of participants in each case reported many barriers preventing them from accessing and using farmers markets at baseline. These barriers were similar to those reported in

previous research, such as high cost, lack of awareness, or limited social support [9, 119, 155]. Interestingly, participants often confused farmers markets with other direct-to-consumer markets such as flea markets or roadside stands. These unique perceptions of farmers markets suggest these individuals may have had limited access or awareness of what USDA defined farmers markets are versus other direct-to-consumer markets. Regardless of the commonly reported barriers to accessing farmers markets, the majority of participants from each case shared positive prior experiences with and interest in locally grown food or farmers markets. These interests are not unlike those from mainstream advocates of local food systems, but inequitable access that stems from knowledge, geographic, social, and financial barriers limit the ability of many low-income households to practice these values [155]. These findings highlight a need for continuing efforts to improve knowledge and awareness of various direct-to-consumer market opportunities and benefits for low-income populations as more farmers markets across the U.S. accept SNAP benefits and participate in produce incentive programs [13, 140].

The multi-level intervention components of the expanded FVRx program were able to remove some of these barriers and transform participants' local food system values during the intervention. The produce prescription, as a policy for subsidized fruits and vegetables, supported low-income patients' access to a farmers market and locally grown produce. The produce prescription was vital to improving FVRx participants' financial resources and food budget, which supported subsequent vegetable purchases [169]. At the organizational level, strategic coordination for free transportation reduced geographic or transportation barriers. At the interpersonal level, positive social interactions at the farmers market and education sessions promoted participants' appreciation for local and fresh seasonal produce and motivation to continue attending the farmers market. These interactions also increased participants' preference

for the taste and agricultural practices used by the farmers, and they were gratified to be able to directly support the farmers and the local economy. The intensive education reinforced multiple individual-level factors among FVRx participants, increasing their willingness and preference to try and purchase the produce sold at the farmers market, as well as continue to purchase fresh produce as much as possible following the FVRx program. Our findings underscore the importance of using policy, systems, and environmental change approaches to improve access to and consumption of healthful produce for low-income individuals [167].

The Nutrition Education case shared similar changes to the FVRx group in motivation and self-efficacy of healthy nutrition practices, such as label reading, shopping with a list, and cooking and eating fruits and vegetables. However, both the Nutrition Education and Control case groups (safety-net clinic patients) continued to report barriers to purchasing, cooking, and eating fruits and vegetables, especially from farmers markets. These discernable differences among cases indicate the potential benefits both nutrition education and produce prescription can have for low-income patient populations. This is likely a result of the produce prescription and the farmers market setting reinforcing motivation and skills taught during the nutrition education. Because most safety-net clinics provide limited evidence-based nutrition education or counseling to their patients, partnering with federally funded nutrition education for low-income Americans (e.g., SNAP-Ed) may have the potential to offer more needed nutrition education to underserved patient populations [159, 174]. Both safety-net clinics and SNAP-Ed programs, however, face policy-based barriers to providing produce prescriptions or incentives in combination with nutrition education. For example, SNAP-Ed programs are not allowed to use funds to provide monetary or food incentives to participants [102, 138, 175]. Produce prescriptions are currently not a reimbursable service through any federal or private healthcare programs, which limits the

ability of federally qualified health centers to fund produce prescriptions. Such barriers leave the burden of funding produce prescriptions up to the program partnerships, which may limit the sustainability and impact of programs. Despite these challenges, at a local level, strong university-community-clinic partnerships can overcome many barriers in developing, implementing, and sustaining FVRx programs for medically underserved low-income populations [145]. Also, as federal support for produce incentives and prescriptions among SNAP beneficiaries expands, tailored nutrition education programming can enhance incentive and SNAP redemption in local food system settings.

Although novel findings and insights emerged from this study, there are still limitations that warrant discussion. Because the Nutrition Education group was recruited via convenience sampling, sociodemographics such as age and insurance status were different than the FVRx Intervention and Control groups. Regardless, all participants consistently reported low-income, high rates of food insecurity, and similar baseline experiences and perceptions. Because not all participants from each case group participated in both the baseline and post-intervention interviews, it is likely other unique experiences and perceptions were missed. Strengths of this study include the use of a qualitative multiple-case study approach intending to provide breadth and depth to the existing literature that highlights low-income adult experiences with produce prescription programs that use farmers markets. Comparing and contrasting low-income adults' experiences within and between three cases over time add to existing literature, highlighting the benefits of combining produce prescription for locally grown produce with nutrition education over nutrition education or standard health care alone.

These findings highlight that produce prescription for free locally grown produce is enhanced by nutrition and financial literacy education and improves low-income adults'

preferences, values, and experiences with local food systems supporting changes in multiple dietary and health behaviors. Overall, multi-level interventions using local food systems has the potential to better address the financial, social, and education needs for improving dietary and health outcomes of medically underserved patient populations over single-level interventions alone.

CHAPTER 6

DISCUSSION & CONCLUSION

Summary of findings

This dissertation study examined the effect of preliminary and expanded FVRx models combining produce prescription with nutrition education, financial literacy education, and health screening using mixed methods approaches and non-randomized controlled study design with best available comparison groups. FVRx program models that use both nutrition education and produce prescription in community- and clinic-settings are a relatively new concept. The first study presented in Chapter 3 describes program and partnership processes and unique outcomes specific to the combined intervention. The process and outcome evaluation of the Pilot FVRx program suggests that combining produce prescription with nutrition education in both community- and clinic-settings was feasible, with positive impacts on fruit and vegetable consumption, preparation knowledge, and food purchasing practices [176]. The program partnership was central to the program structure, and effective coordination of program partners and participants was vital for successful program development, implementation, evaluation processes, and participant outcomes. The unique partnership and program structure developed improved FVRx participants' access to a local food system, which supported an increase in the purchase and consumption of local produce. Specifically, the improvements in nutrition knowledge and behaviors, as well as the purchase of local produce underscore the added benefits and value of using nutrition education in FVRx programs. FVRx participants also reported

higher food budgets during the intervention period, suggesting the critical role of prescriptions in shifting other food and non-food purchases. Despite these favorable changes, there were limited improvements in diet quality, food security, and clinical outcomes, which may be due to multiple factors in methodology and intervention design.

The findings and experiences of the pilot FVRx study informed the design and conduct of the Expanded FVRx Program, as reported in Chapter 4. The expanded FVRx program model added augmented nutrition education, new financial literacy education, and second ad-hoc comparison group to the Pilot FVRx Program model. The findings suggest that the expanded FVRx model was more supportive of improving financial resources, and the preference, purchase, and consumption of locally grown vegetables, and healthy food purchasing practices than nutrition education or standard health care alone. In support of these outcomes, the findings from the qualitative interviews described in Chapter 5 indicate many FVRx participants reported increased ability to pay for non-food essentials like bills or gas, improved knowledge of how to budget and track expenses, or purchasing healthier foods at the grocery store. Although statistically insignificant in Chapter 4, findings from Chapter 5 indicate the nutrition education group did improve food resource strategies, as well as self-efficacy and motivation to purchase and consume more fruits and vegetables without a financial incentive or increased access to a farmers market. The control groups in both studies did not improve any food purchasing practices, nutrition-related and dietary behaviors or health outcomes, highlighting the potential benefit of nutrition education alone for low-income patients. In addition to the intensive education, the produce prescription likely played a critical role in the improved behavior changes. Prior research indicates that SNAP recipients often shift income resources otherwise used for food to non-food needs such as utilities or medical bills as a result of the food subsidy

[150, 151]. The produce prescription in the FVRx program likely served as a targeted subsidy for many participants, given about half of the FVRx participants did not receive federal food assistance. For those that did receive federal assistance, the prescription likely served a similar function to farmers market incentives for SNAP and WIC recipients [110, 144].

Another unique trait of the Pilot and Expanded FVRx program models was the use of a farmers market for produce prescription. As highlighted in Chapter 5, FVRx participants described unique transformations concerning their experience with local food systems as a result of the FVRx program. The increased access to a local farmers market as part of an FVRx program reduced participants' perceived barriers improving multiple behaviors and attitudes towards locally grown produce. The majority of participants created new values such as a higher appreciation for social interaction with the farmers, preference for the taste and agricultural practices of the organic produce purchased, and civic-mindedness in knowing they were supporting their local farmers and economy. Furthermore, these values ingrained a sense of empowerment to continue to access the farmers market and to continue to purchase fresh produce as much as possible following the FVRx program. Overall, these findings suggest combining education with produce prescription could better address the financial and educational needs of the low-income to access, purchase, and consume locally grown produce. Additionally, the values and experiences FVRx participants gained by accessing a local farmers market suggest future produce prescription and incentive programs partner with local direct-to-consumer markets and producers.

As in the Pilot FVRx study, there were limited improvements in outcomes such as diet quality, food security, and clinical outcomes. Although produce prescription over a longer duration can improve diet quality and food security, there is still inconsistent evidence for

produce prescription programs improving clinical health outcomes [113, 115, 141, 159, 177].

Improving clinical health outcomes of low-income patient populations is vital for reducing cost-related offset decisions [178, 179] and reducing overall mortality risks, as well as lower economic burdens of chronic disease incidence and mismanagement [180, 181]. Because standalone medical nutrition therapy interventions are effective at improving clinical health outcomes in multiple chronic conditions, the addition of individual nutrition counseling to extended produce prescription and nutrition education could support more positive clinical outcomes among low-income patient populations [160, 161].

Limitations and Strengths

In both the Pilot and Expanded FVRx studies, sample sizes across each group were small, and characteristics were not fully matched, limiting the generalizability of the findings. The process evaluation in Chapter 3 highlights the challenges of conducting controlled studies among medically underserved community- and clinic populations. Attrition in the control group was high due to personal uncertainties, which was common among the patient population of the partnering safety-net clinic. Based on these challenges, the recruitment strategy for the control group in Chapter 4 included a more rigorous and purposive screening process that involved the researcher training and coordinating with multiple clinic practitioners, staff, and volunteers to screen and recruit participants. In Chapter 4, the addition of an ad-hoc comparison group presented similar and additional challenges. The ad-hoc group sample was primarily SNAP-Ed eligible, which limited the ability to recruit an equivalent comparison group given the study eligibility requirements. Additionally, the ad-hoc group did not receive the full education intervention as the FVRx group limiting direct comparisons between groups.

The strengths of this study include the use of non-randomized controlled study designs to assess the effects of multiple FVRx program models across complementary behaviors and outcomes. The addition of the Nutrition Education comparison group helped confirm and expand on prior findings demonstrating the importance of using both local food systems and nutrition education in FVRx programs. The use of mixed-methodology and a multiple-case study approach allowed us to compare and contrast separate cases of low-income adults and their experiences with local food systems prior to and following an FVRx program. Finally, the use of a strong university-community-clinic partnership made the program development, implementation, and unique study design feasible and effective. The strength of the program partnership and the findings from this study have provided a foundation for developing, sustaining, and rigorously evaluating community- and clinic-based FVRx programs.

Implications for Research, Practice, and Policy

Community- and clinic-based FVRx programs are a feasible and practical multi-level approach for improving low-income adults' ability to purchase, prepare, and consume locally grown fruits and vegetables. The critical role of university-community-clinic partnerships for FVRx programs suggest establishing successful partnerships is essential for effective program development, implementation, evaluation, and positive participant outcomes. The use of Community Based Participatory Research (CBPR) methods may help promote sustainable partnerships and programs. CBPR approaches can address challenges in the development, implementation, and evaluation of FVRx programs by creating a balance in power through sharing of resources, co-learning, and decision making and centering outcomes on benefiting the community through local ownership and capacity development [182, 183]. Our study also suggests produce prescription programs partnering with local food system and safety-net clinic

partners can benefit from partnering with existing federally funded nutrition education programs for low-income Americans (i.e., SNAP-Ed, EFNEP). Findings regarding improved food and nutrition-related behaviors, as well as the improved local food system access among FVRx participants, suggest these programs could adapt to the community and program needs and may enhance produce incentives and food assistance redemption in local food system settings.

Currently, produce prescriptions and incentives are term-limited with limited funding, preventing them from providing consistent and reliable access to produce prescriptions. Aside from non-profit fundraising, donations, or community grants, the USDA Gus Schumacher Nutrition Incentive Program (GusNIP) is a major funding source of produce prescription programs. To support long-term access and affordability of locally grown produce for low-income populations, improvements in policies that support the inclusion of produce incentive options for food assistance programs and direct-to-consumer markets are needed. Specifically, the establishment of produce incentives as a standard part of federal assistance programs (e.g., SNAP, WIC) could increase the overall household food budget for beneficiaries, promote the purchase and consumption of fruits and vegetables, and improve both food security and diet quality [153, 184]. Additionally, establishing produce prescriptions as a reimbursable service through Medicaid and Medicare has the potential to improve medically underserved low-income patients' health outcomes and reduce their healthcare costs [152]. Continued expansion of the USDA Farmers Market Promotion Program can improve the market share and resilience of direct-to-market producers. This program could also prioritize funding of markets that participate in produce incentive or prescription programs, as well as those that partner with community-based nutrition education organizations (e.g., local County Extension Offices or SNAP-Ed programs). The alignment of these programs would help increase the awareness, access, and

ability of low-income adults to value their local food system, as well as increase the market share of their local direct-to-consumer producers.

Although extended access to produce prescriptions and nutrition education improve diet quality and food security among low-income, the addition of more intensive nutrition counseling may be needed to improve clinical health outcomes in produce prescription programs. Future research needs to consider strategies in the design and sampling to assess the impact of FVRx programs while controlling for the confounding factors related to participants' various chronic conditions at different disease processes. Additional research using mixed-methods is needed to examine the facilitators and challenges participants face improving their long-term behavior changes. Such evidence is critical to support informed decisions for policymakers, insurance programs, and healthcare services in the investment and implementation of produce prescription programs.

The findings, lessons, and experiences from the FVRx programs examined in this dissertation study underscore the needs for multi-level strategies to address health disparities as a result of poverty, obesogenic food systems, and limited healthcare coverage in medically underserved low-income populations and suggest potential models and recommendations for the design and implementation of effective and sustainable FVRx programs applicable in both community and clinical settings.

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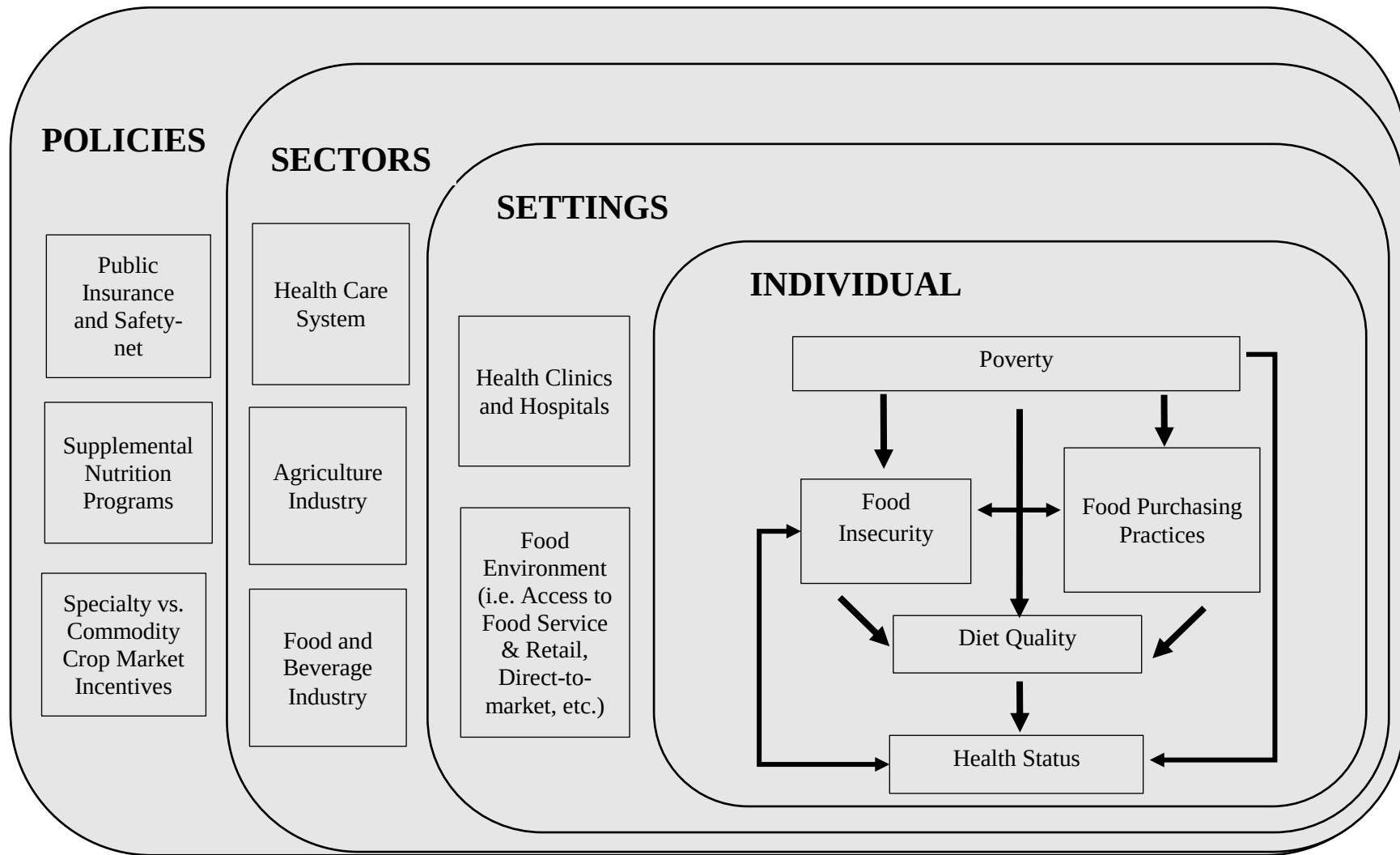
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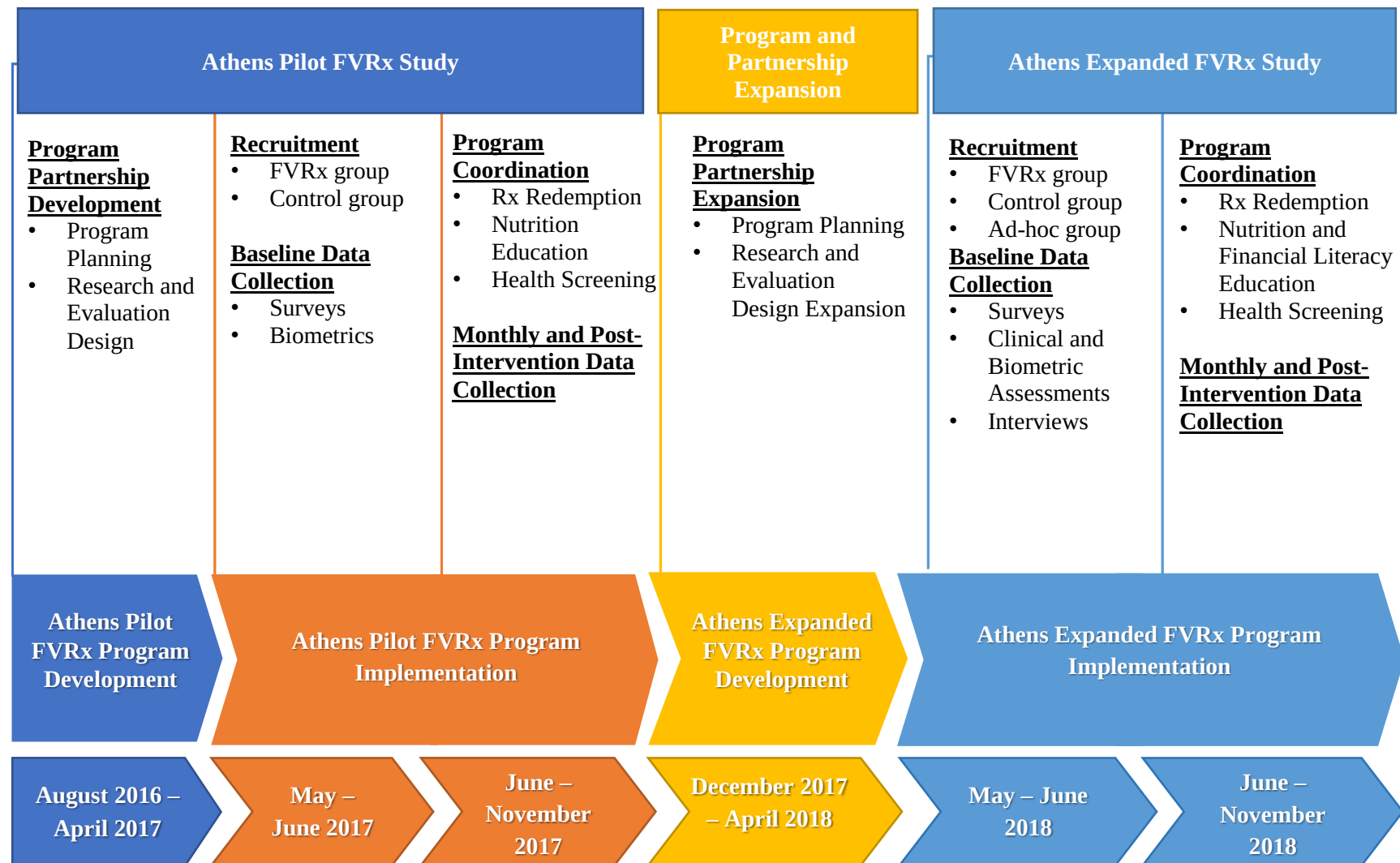
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Appendix A: Conceptual Framework



Appendix B: Dissertation Project Timeline



Appendix C.1 Food Purchasing Practices Survey

Food Purchasing Practices

1. During the last MONTH, where did you do the majority of shopping for FOOD?

(SELECT ONE)

- | | |
|---|---|
| ☐ Bulk Superstore (Costco, Sam's Club)
(Walmart, Super-Target) | ☐ Mass Merchandiser |
| ☐ Grocery store (Ingles, Kroger, Publix, Aldi, Bell's, etc...)
Family Dollar) | ☐ Convenience store (Dollar General, |
| ☐ Farmers market | ☐ Flea market (J&J, Pendegrass) |
| ☐ Other restaurant | ☐ Food pantry or food bank |
| ☐ Friends or family | ☐ Own or other's garden |
| ☐ Other (specify) _____ | |

2.

Once a month	2-3 times a month	Once a week	More than once a week
--------------	-------------------	-------------	-----------------------

Over the last Month,
how often did you shop
for FOOD at this
location? (Select One)

☐☐☐☐

3. How much MONEY did your household spend on food last month, including EBT (food stamp)? _____

4. Where do you PREFER to get the majority of FOOD that you eat? (Select All That Apply)

- | | |
|---|---|
| ☐ Bulk Superstore (Costco, Sam's Club)
(Walmart, Super-Target) | ☐ Mass Merchandiser |
| ☐ Grocery store (Ingles, Kroger, Publix, Aldi, Bell's, etc...)
Family Dollar) | ☐ Convenience store (Dollar General, |
| ☐ Farmers market | ☐ Flea market (J&J, Pendegrass) |

- ☐ Other restaurant
- ☐ Friends or family
- ☐ Other (specify) _____

- ☐ Food pantry or food bank
- ☐ Own or other's garden

5. Why do you PREFER to shop for FOOD at this location? (Select ALL that apply)

- | | |
|--|--|
| ☐ Easy to access | ☐ Affordable prices |
| ☐ Large Selection/Variety | ☐ Accepts EBT/SNAP |
| ☐ My Friends/Family Shop Here | ☐ Produce is High Quality |
| ☐ To Go Foods/Pre-made Meals | ☐ Large Fruit Selection |
| ☐ Atmosphere is inviting | ☐ Large Vegetable Selection |
| ☐ Supports Local Farmers | ☐ Other (specify) |

During the last MONTH, where did you go to get the majority of your fruits and vegetables? (SELECT ONE)

- ☐ Farmers Market
- OR**
- ☐ Preferred Store

Where do you PREFER to get the majority of your fruits and vegetables? (SELECT ONE)

- ☐ Farmers Market
- OR**
- ☐ Preferred Store

4. Why do you PREFER to shop for FRUITS AND VEGETABLES at this location? (Select ALL that apply)

- | | |
|--|--|
| ☐ Easy to access | ☐ Affordable prices |
| ☐ Large Selection/Variety | ☐ Accepts EBT/SNAP |
| ☐ My Friends/Family Shop Here | ☐ Produce is High Quality |
| ☐ To Go Foods/Pre-made Meals | ☐ Large Fruit Selection |
| ☐ Atmosphere is inviting | ☐ Large Vegetable Selection |
| ☐ Supports Local Farmers | ☐ Other (specify) |

5. During the last MONTH, have you...

- | | | |
|---|------------------------------|-----------------------------|
| - Purchased more <i>fresh fruits</i> ? | ☐ Yes | ☐ No |
| - Purchased more <i>fresh vegetables</i> ? | ☐ Yes | ☐ No |
| - Purchased more <i>FOOD</i> in general? | ☐ Yes | ☐ No |
| - Purchased more <i>processed foods</i> (canned, boxed, bagged)? | ☐ Yes | ☐ No |
| - Purchased more <i>non-food items</i> ?
(e.g., household items, cleaning supplies, pet food, etc.) | ☐ Yes | ☐ No |
| - Eaten out more (e.g., fast food, sit down restaurants, food truck)? | ☐ Yes | ☐ No |
| - Shopped <i>more often</i> at your preferred store? | ☐ Yes | ☐ No |
| - Been able to afford more bills (e.g., utility, housing, medical, etc.)? | ☐ Yes | ☐ No |

Appendix C.2: Monthly Biometric and Fruit and Vegetable Screener

FRUIT AND VEGETABLE PRESCRIPTION PROGRAM HEALTH ASSESSMENT FORM

This form should be completed at each monthly clinical visit.

PARTICIPANT ID#: _____ DATE OF
VISIT: _____

MEDICAL STATUS:

Height _____ IN Weight _____ LB Waist Circumference
_____ IN

Blood Pressure _____ / _____ A1C Level _____ Date collected

HDL _____ LDL _____ Triglycerides _____ Total Cholesterol _____ Date collected

1. In the **past week**, how many times did you eat **FRUIT**? *Count any kind of fruit – fresh, frozen, and canned. Include fruit you ate at mealtimes and for snacks. Do not count juices or fruits in syrup.*

☐	☐	☐	☐	☐	☐	☐
Never	1 time per week	2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 or more times per day

2. Each time you ate **FRUIT**, how much did you usually eat? *On average, 1 large banana is equal to 1 cup of fruit and 1 small peach is equal to ½ cup of fruit.*

☐	☐	☐	☐
Less than ½ cup	About ½ cup	About 1 cup	More than 1 cup

3. In the **past week**, how many times did you eat **OTHER TYPES OF VEGETABLES**?

Count any kind of vegetables – fresh, frozen, and canned. Include vegetables

*you ate at mealtimes and for snacks. **Do not count French fries.***

☐	☐	☐	☐	☐	☐	☐
Never	1 time per week	2 times per week	3-4 times per week	5-6 times per week	1 time per day	2 or more times per day

4. Each time you ate **VEGETABLES**, how much did you usually eat? *On average, 2 medium carrots equal 1 cup of vegetables and 1 small tomato is equal to ½ cup of vegetables.*

☐	☐	☐	☐
Less than ½ cup	About ½ cup	About 1 cup	More than 1 cup

Appendix D.1: FVRx Group Interview Guide -Baseline

Interview guide for 2018 FVRx participants – Baseline

Topic Areas:

1. Experiences

- a. Tell me a little about yourself and maybe a little bit about what health means to you.
- b. Describe your experiences with managing your health up to this point.
 - i. What are the challenges to maintaining or improving your health? What have you done in the past, why? What has worked or not worked? Why? What resources do you need to help maintain or improve your health?
- c. Describe the ways you shop for food.
 1. Where do you go? How often? What do you buy (boxed, canned, meat, pre-made, whole food, etc...)? How do you purchase the food?
 2. Why? (prices, location, atmosphere, family/community)
 3. What situations, experiences or information shape this? If at all, has this changed since you started FVRx? Why or why not?
 4. How about Fruits and Vegetables? Is this different from other foods? Why?
- d. Describe your experiences with food.
 - i. What do you consider healthy food? Why?
 - ii. What would you need to eat better, if anything?
 - iii. What about cooking? Is this different?
- e. What have your experiences been, if any, with shopping at a Farmer's Market? CSA?

- i. Where did you go? Why? What was shopping like? What did you buy?
 - ii. If anything, what is important to you about shopping at the farmers market or receiving a CSA?
 - f. *If NONE ask the following:*
 - i. Describe your perceptions of shopping at a Farmers Market or using a CSA.
 - 1. Who or what experiences have influenced this?
2. *Implementation of FVRx program*
- a. Why did you join the FVRx program?
 - i. What are expectations [or hopes] for the FVRx program?
 - 1. Probes: Who or what shaped these expectations? In what ways were they important to you? How did they influence your desire to participate in the FVRx program?
 - b. What are some reasons participating in the FVRx program will be easy for you?
 - c. What are some reasons participating in the FVRx program will be difficult? What are your concerns?
 - i. Probes:
 - 1. Personal: Work, family, health, transportation, how to cook FV's, etc...
 - 2. Program: Location, time of day, rules/requirements (number of classes), unfamiliar with market, amount of Rx \$
 - d. What can the program provide you or teach you to make participation easier?
3. *Outcomes of Program:*
- a. Describe what you hope to learn from the FVRx program.
 - i. Probes: Cooking, recipes, shop/cook on a budget, new FV's... Why is this important to you?
 - ii. What topics do you want to learn about or what interests you? (weight loss, cooking, chronic dx, healthy eating (on a budget))
 - b. Describe the changes you hope to make after participating in the program.

- i. Probes: Weight loss, shopping practices, eating healthy, budgeting skills, health benefits, feel better, enjoy friends, family, community.

Appendix D.2: FVRx Group Interview Guide -Post Intervention

Interview guide for 2018 FVRx participants – 6-month interview

Topic Areas:

4. *Outcomes* of Program:

a. Describe your experience with the program:

i. Probes:

1. What were the remainder of the classes like? What did you learn?

a. What is important about that experience?

b. What does this experience mean to you? Your family?

2. Describe your experience with managing your health during the program.

a. Was the health screenings helpful for you? Why or why not?

b. What are the challenges to maintaining or improving your health? What has worked or not worked? Why?

c. What are resources you need to help maintain or improve your health?

3. Tell me more about your experience with shopping at the farmers market.

a. What did you like about it? What did you dislike?

b. If anything, what was unique or different about shopping there? What does that mean to you?

c. How is shopping here different than other places you shop? Why?

b. If at all, has the way you shop for food changed since you started FVRx? Why or why not?

i. If so how?

- ii. Tell me about your last experience shopping. Describe the ways you shop for food.
 - 1. Where do you go? How often? What do you buy (boxed, canned, meat, pre-made, whole food, etc...)? How do you purchase the food?
 - 2. Why? (prices, location, atmosphere, family/community)
 - 3. What situations, experiences or information shape this? If at all, has this changed since you started FVRx? Why or why not?
 - 4. How about Fruits and Vegetables? Is this different from other foods? Why?**
- c. Describe your experiences with food since starting the FVRx.
 - i. Have you changed the way you eat since you started FVRx?
 - 1. If yes, how?
 - 2. If not, how come?
 - ii. What about cooking? Is this different? How?
 - iii. What do you consider healthy food? Why?
 - 1. Is this different than before FVRx. Why or Why Not?
- d. **If at all, describe any difficulties you faced affording enough food for you and or your family over the last 6 months.**
 - i. **If at all, has the FVRx program help provide more food for you and/or your family?**
 - 1. If yes, how?
 - 2. If not, how come?
 - 3. How might the FVRx program be able to ensure you and your family had access to more food?
 - a. Is it important to be able to afford fresh produce
 - ii. **If at all, has the nutrition education helped you manage your resources to be able to afford more food for you and/or your family?**
 - 1. If yes, how?
 - 2. If not, how come?
 - 3. How might the Food Talk classes be able to ensure you and your family had access to more food?
 - a. Is it important to be able to afford fresh produce?

5. Future

- a. **What are your plans for shopping at the farmers market in the future?**
 - i. **What would you need in order to continue to**
- b. What is that one thing that you learned that you feel confident that you'll be able to implement in your daily life?
- c. Now that the program is over how will you sustain the changes you described? Do you have a plan?
 - i. What do you think will be barriers to sustaining these changes? What do you need to sustain any changes you've made?

6. *Feedback & Implementation of FVRx program*

- a. Now that you completed the program, we'd like to know how the program has – or has not – meet your expectations?
 - i. Probes: Please tell me more. What specific interactions or experiences influenced this? Why? What was unexpected – if anything?
- b. What made participating in the program easy? Difficult?
 - i. Probes: Job, family, transportation, finances, health goals, lack of support, other...
- c. If you were in charge of the FVRx program what would you do differently?
 - i. Probes: Why does that matter? How would you do that? What can make the program better for you and others in the community? How would you change the course schedule?