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THE IMPACT OF A FRUIT AND VEGETABLE FARMERS' MARKET VOUCHER PRESCRIPTION PROGRAM ON A LOW-INCOME RURAL POPULATION

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THESIS

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

By

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ABSTRACT OF THESIS

THE IMPACT OF A FRUIT AND VEGETABLE FARMERS' MARKET VOUCHER PRESCRIPTION PROGRAM ON A LOW-INCOME RURAL POPULATION

Objective: Measures the impact of the Farmers' Market Voucher program on weight, body mass index, waist circumference, during the 2016 summer on a rural, low-income population residing in Appalachian Kentucky.

Background: Rural communities often have limited access to fresh fruits and vegetables (FV) which contributes to low levels of consumption. FV are calorie poor, nutrient dense and are inversely associated with inflammation markers, obesity, hypertension, and high blood glucose levels. Appalachian rural communities have a higher prevalence of obesity, diabetes, strokes, and death by heart attack when compared to the U.S. Farmers' markets

Methods: Pre-experimental intervention design examining FV consumption and variety. T-test used measuring biochemical outcomes, pre and post, participation, and voucher amount.

Results: Medical clinic patients (n=308) and household members (n=89) participated in study. Patients had a decrease in blood glucose and waist circumference ($p=0.0231$, $p=0.0014$ respectively). Patients had greater blood glucose reductions when compared to household members ($p<0.001$). Patients reported consuming more FV with greater variety.

Conclusion: The Farmers' Market Voucher program successfully increased FV consumption and had a positive effect on blood glucose and waist circumference. Future studies should examine cooking methods of this population.

KEYWORDS: Fruits, Vegetables, Farmers Markets, Low-Income, Voucher, Prescription.

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DEDICATION

To my wife, who supported me throughout the writing process.

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CHAPTER 1: Introduction

1.1 Background

Individuals living in rural communities often have limited access to fresh fruits and vegetables (FV) due to scarce availability at local stores, no transportation, and/or lack of finances. These access issues contribute to individuals not consuming the 5 recommended servings of FV per day (Lutfiyya, Chang, & Lipsky, 2012). FV contain phytochemicals found to combat oxidation and inflammation that are associated with chronic disease (Zhang et al., 2015). Obesity, hypertension, and diabetes mellitus are chronic diseases characterized by the presence of pro-inflammatory markers (Calle & Fernandez, 2012; Choi, Joseph, & Pilote, 2013; Hage, 2014). The rural Appalachian population has some of the worst health issues in the U.S. (Halverson, Ma, & Harner, 2004). Compared to national averages, the risk for lifestyle related diseases, such as obesity, hypertension, or pre-diabetes and diabetes, is higher in rural Appalachian communities (McCraken, 2012).

Food deserts are neighborhoods that lack access to healthy food sources by distance, number of stores in an area, low-income, vehicle availability, and lack of public resources such as public transport (United States Department of Agriculture, 2018). Improving the health of the Americans living in food deserts has become a focus of study. Lutfiyya studied food deserts in New York and discovered that those living in rural communities were more likely to suffer from obesity when compared to urban communities (Lutfiyya et al., 2012). As well, those living in rural communities were less likely to consume the recommended five or more servings of FV (Lutfiyya et al., 2012). A study by Gustafson, et al. (Gustafson, Christian, Lewis, Moore, & Jilcott, 2013) observed that living near a farmers' market (FM) increased the odds of FV consumption while living near a grocery store increased the odds of consuming sugar-sweetened beverages. As well, Evans, et al. (Evans et al., 2012) found that the inclusion of farm stands in low-income communities significantly increased in FV consumption.

Previous studies have also shown that proximity to healthy food outlets and price influence purchasing behaviors pertaining to fruits and vegetables. A North Carolina study examined the influence of price and willingness to shop at FMs and learned that low income women were more likely to shop at FMs when they were close and priced well (McGuirt et al., 2014). Rundle conducted a cross-sectional analysis of BMI and proximity and discovered those living closer to healthy food outlets had a lower BMI (Rundle et al., 2009).

Community-based marketing strategies have demonstrated promising results. Studies by Dannefer and Caldwell examined nutrition education and cooking classes as a tool to promote FV intake in adults. Both of their studies show increased purchases in FV for those involved in the cooking class over individuals who only received nutritional information (Caldwell, Miller Kobayashi, DuBow, & Wytinck, 2009; Dannefer et al., 2015). DeWitt studied a more cost-effective version by offering recipe cards with food samples which increased the odds of FV purchases (DeWitt et al., 2017).

FMs are becoming an important tool reaching lower income classes to affect health change. In 2011, the *Food Rx Program* was researched by Goddu et al. (Goddu, Roberson, Raffel, Chin, & Peek, 2015). This program attempted to change behavior by utilizing the use of nutrition prescriptions and incentives to nudge FV purchasing behaviors. Another program, *Fresh Rx Program*, also utilized the concept of prescribing FV as a method to promote healthy behaviors among a low-income group (Bryce et al., 2017). FM's are increasingly being utilized as a community resource for improved health for those of limited income.

1.2 Farmers' Market Voucher Prescription Program

The research on FV consumption with healthy food outlets in a rural, economically underprivileged population has been well-studied. However, there is limited literature validating the effectiveness of increasing the availability of FV on weight, blood pressure, waist circumference, and blood glucose levels. The FARMACY™ is FV farmers' market voucher prescription program designed to promote the consumption of fruits and vegetables while reducing the cost associated with them. Low-income individuals meet with their doctor who prescribe free FV by issuing vouchers that are redeemable at the local farmers market. The objective of this study was to measure the impact of a FV farmers' market voucher prescription program on anthropometric and biochemical measurements among rural low-income participants.

1.3 Background

Increasing FV consumption is a public health priority because of the well-recognized health benefits associated with intake of fresh FV. Unfortunately, for various reasons, few Americans meet the recommended intake of FV. This is particularly the case for low-income populations. People of low-income are particularly afflicted by the common barriers of accessibility and cost contributing to reduced FV intake (O'Dare

Wilson, 2016). The preventive nature of good nutrition is lower in cost compared to medical expenses associated with treatment for diabetes or cardiovascular disease (Gyles et al., 2012).

The purpose of this project was to evaluate the effectiveness of providing free farmers market vouchers to low-income Appalachian residents in Eastern Kentucky who had been diagnosed with obesity, hypertension, and/or diabetes. The project evaluated pre- and post- body weight, BMI, waist circumference, blood pressure, and blood glucose levels.

1.4 Research Questions

1. Did FV farmers' market voucher prescription program participants improve measured health outcomes (weight, body mass index (BMI), waist circumference, blood pressure and finger stick glucose) from baseline in June 2016 to the final measurement in October 2016?
2. Did participants who had higher rates of participation have better improved measured health outcomes than those who participated less?
3. Were improved health outcome measurements among participants associated with higher voucher values as measured from baseline to final measurement?
4. Did participants self-report consuming a greater variety and or quantity of fruits and vegetables as a result of participating in the voucher program?
5. Were there improvements in the measured health outcomes (weight, BMI, waist circumference, blood pressure and finger stick blood glucose) among household

members of participants from baseline in June 2016 to the final measurement in October 2016?

1.5 Hypothesis

1. The FV voucher subsidies will significantly improve measured health outcomes (weight, BMI, waist circumference, blood pressure and finger stick glucose) among participants and household members over a period of 5 months.
2. Program participants with higher rates of participation will experience significantly greater improvements in health outcomes compared to those with lower rates of participation.
3. Program participants with higher voucher values will experience significant improvements in health outcomes over those with lesser voucher values.
4. Program participants will self-report consuming a greater amount of FV.
5. Program participants (clinic patients) will have better health outcomes when compared to non-participant (non-clinic patients) household members.

CHAPTER 2: REVIEW OF LITERATURE

Fruit and vegetable (FV) consumption has been correlated with having a lower weight and reduced risk for chronic diseases. According to the Behavioral Risk Factor Surveillance System (BRFSS), 12.2% and 9.3% of Americans consumed the recommended amount of fruits and vegetables respectively. Kentucky was below the national average with 8.0% for fruits and 6.3% for vegetables (Pickens, Pierannunzi, Garvin, & Town, 2018).

2.1 Weight, Body Mass Index (BMI) and Fruits & Vegetables

The Centers for Disease Control and Prevention (CDC) defines being overweight and obese as having a BMI greater than or equal to 25 and 30 $\frac{kg}{m^2}$ respectively (Centers for Disease Control and Prevention, 2016). In 2017, the prevalence of obesity in adults was approximately 27.4% in the United States. For those living in non-Appalachian Kentucky , 31.6% of adults were obese, while 35.2% of adults in Appalachian Kentucky were obese (Appalachian Regional Commision, 2017). Obesity increases the risks of developing a chronic disease such as cardiovascular disease, type 2 diabetes mellitus (T2DM), and some forms of cancers (Centers for Disease Control and Prevention, 2018b).

When obese individuals lose weight, improvements in blood pressure (Cohen, 2017) and type-2 diabetes mellitus control (Geidenstam, Danielsson, Spegel, & Ridderstrale, 2016) are often noted as well. Therefore, interventions with the aim of weight loss can help reduce a population's risk for chronic diseases, including hypertension and type 2 diabetes mellitus. To aid in weight loss, research suggests that consuming more food that has a lower caloric density can be beneficial (Rolls, 2009).

Fruits and vegetables (FV) are believed to be important components of a weight loss diet due to their often low caloric density. As well, it has been suggested foods that are nutrient-rich and calorie-poor may signal satiety signals which limit calorie intake (Rolls, Roe, & Meengs, 2004; Sartorelli, Franco, & Cardoso, 2008). FV are considered low calorie dense foods because of the high fiber and water content.

Fiber found in FV, promote satiety signals (Rolls, 2009). This satiation is a paradox because food weight increases but calorie intake decreases. In a study conducted by Ello-Martin (2007), participants who consumed a low-fat diet that included FV ate 225g more food daily than the controls (Ello-Martin, Roe, Ledikwe, Beach, & Rolls, 2007). The low-fat FV arm had significantly greater decrease in weight because of lower caloric intake when compared to the control at 6 months, -8.9 kg and -6.7 kg respectively. This experimental group also scored higher in satiation when compared to the low-fat control group, suggesting that water and fiber contributes to sensation of being full.

The role of FV in weight loss has been researched and has been found to either reduce weight or maintain current weight status (Ledoux, Hingle, & Baranowski, 2011; Tapsell, Dunning, Warensjo, Lyons-Wall, & Dehlsen, 2014). Several randomized control studies had positive results in weight loss. de Oliveira (2008) had participants in three arms that consumed either three apples, three pears, or three oat cookies daily (de Oliveira, Sichieri, & Venturim Mozzer, 2008). They all consumed the same amount of fiber, but the caloric-density was greater in the oat cookies. At the end of the 10-week study it was noted the oat cookie arm increased body weight (+0.21 kg) while the apple and pear group decreased weight (-0.92 kg and -0.84kg respectively).

Howard (2006) conducted a less restrictive study over the course of 7 years (Howard et al., 2006). In this two-arm group of post-menopausal women, the intervention group received instructions to reduce fat in-take and consume more FV and cereals. The control group received standard diet-related literature. The intervention group had significantly more weight loss the first year (-2.2 kg). At the end of the seven-years, the intervention group maintained a 1.9 kg weight loss over the control group.

A strategy to help reduce caloric intake is having a salad as first course. Leafy greens are rich in water and fiber while low in calories. Rolls (2004) examined if eating a salad before a meal would reduce over-all caloric intake. In a cross-over design, it was noted that the amount salad consumed prior to main course reduced caloric intake by 7% (1.5 cups) and 12% (3 cups) provided a low-fat dressing was applied (Rolls et al., 2004).

Roe (2012) reproduced Rolls 2004 study to examine differences in caloric intake when a salad was served with the main course instead of the being the first course (Roe, Meengs, & Rolls, 2012). The control group had no salad served with the main course. When compared to the salad with meal arm, the control group consumed more calories. Roe’s study demonstrates vegetables side-dishes can lower the caloric density of a meal, promotes satiation and can reduce weight by displacing calories.

Rodriguez (2008) conducted a two-arm study comparing cereal consumption against vegetable consumption (Rodriguez-Rodriguez et al., 2008). Both arms reduced caloric density and lost weight, however, it was noted that intake from FV consumption displaced the higher energy foods. Fiber and water content of FV lowered the energy density of meals. Thus, participants in both arms felt full and achieved satiety.

There were a small minority of studies that noted the absence of weight gain with an increased FV to the diet. Whybrow (2006) randomized individuals to consume an additional 0 g, 300 g, or 600 g of fruit per day. At the end of the 8-week study, there was no significant impact on weight among the three arms. John (2002) conducted a six-month study in which the intervention arm consumed at least five servings of FV per day. The intervention arm gained a non-significant 0.1 kg.

Implementing FV to the diet increase the weight of food eaten because of the high fiber and water content in this food group. Fiber and water contribute negligible calories to the diet while promoting satiation. Also, FV are low in fat which is 9 kcal/gram compared to the amount of carbohydrates and protein found in FV (4 kcal/gram). FV which have high water content decreases the energy density of the diet, because water adds weight, but not energy. FV is also low in fat. Fiber, water and fat are the most important determinants of dietary energy density. FV are low in energy density due to their fiber and water content with low fat. People regulate energy intake by volume, not calories.

Diets high in FV consumption are related to better weight management (Ledikwe et al., 2006). There is a possible FV dose-response investigated by Sartorelli (2008). A randomized control trial that increased FV consumption in the intervention group favored a 1.4 kg weight loss in six months. Participants were asked to track their food intake and it was noted for every 100 g of FV consumed, participants lost 300 to 500 g of weight after 6 months (Sartorelli et al., 2008). Based on this clinical evidence FV have a positive effect on body weight.

2.2 Waist Circumference and Fruit and Vegetable Consumption

When excess calories are consumed, those calories are stored in adipose cells located in peripheral subcutaneous tissue. When subcutaneous tissue reaches capacity it is stored intra-abdominally (Ibrahim, 2010). This manifest in the ‘apple-shape’ we associate with a large waist circumference. Unfortunately, the location of this fat growth is pro-inflammatory and has a negative impact on blood glucose and HTN (Item & Konrad, 2012). Men should have a waist circumference less than 40 inches, women less than 35 inches (Seidell, 2009).

Fortunately, intra-abdominal fat is sensitive to weight loss. As weight loss occurs, abdominal fat is the primary source of energy when compared to other fat stores in the body (Hall & Hallgreen, 2008). As the intra-abdominal fat decreases, inflammation markers decrease (Corpeleijn et al., 2007).

A meta-analysis examining 17 prospective cohort studies examined 563,277 combined subjects in which waist circumference was measured against fruit, vegetable, and FV consumption. There was a reduced risk of abdominal obesity by 9%, 17% and 17% respectively. Whole fruit was strongly associated with waist circumference reduction. There was a significant association with 100 kcal fruit consumption and a reduction in waist circumference observed over a year (Schwingshackl et al., 2015).

2.3 Blood Glucose Control, Type 2 Diabetes Mellitus (T2DM) and Fruit and Vegetable Consumption

Diabetes mellitus is a metabolic disorder characterized by high blood glucose (≥126 mg/dL or ≥6.5% HbA1c). According to the Appalachian Regional Commission, the prevalence of diabetes in the United States is 9.8% of the population. Kentucky has a higher prevalence compared to the national average with 11.2% of the population but the greatest concentration is in Appalachia Kentuckians with 13.3% prevalence (Appalachian Regional Commision, 2017). Quantifying diabetes has its limitation because nearly 84 million US adults have prediabetes, however, nearly 1/3 of this population are undiagnosed. In the last 20 years the number of adult diabetics has tripled and it is expected to continue to rise (Centers for Disease Control and Prevention, 2018a).

Diabetes increases the risks of microvascular and macrovascular complications. Individuals with diabetes are twice as likely to have a stroke or heart attack. Irreversible diabetic nephropathy contributes to approximately 40% new cases of end-stage renal disease (Franz, 2012). Diabetes also increases the risk of adult on-set blindness and lower-limb amputations (Centers for Disease Control and Prevention, 2018a). Diabetes is a costly disease, depending on age of diagnosis, gender, and co-morbidities, lifetime out-of-pocket costs can range from $61,800 to $130,800 (Zhuo, Zhang, & Hoerger, 2013). Due to the costs and complications associated with this disease, it has become necessary to examine FV role in diabetic health.

T2DM is a condition marked by low-grade inflammatory cytokines (Puglisi & Fernandez, 2008). FV contain vitamins, minerals and phytochemicals that are anti-inflammatory and are thought to have a positive impact on health. A review of prospective studies examining food intake and inflammatory markers noted an inverse association with low inflammation markers and high FV intake (Calle & Fernandez, 2012). A critical review of prospective studies by Boeing examined if FV could directly reduce the risk of T2DM. The findings were not convincing, but were probable for the negating the inflammatory nature of the disease but has no direct impact on T2DM (Boeing et al., 2012). However, FV have an indirect role via treating obesity; which is a risk factor for T2DM.

A case-control study examined dietary phytochemical intake and risk associated with prediabetes. The study controlled for BMI, physical activity, education, caloric intake, and percentage of macronutrients found a low intake of fruits, vegetables, whole grains, and nuts increased the odds of being pre-diabetic (Abshirini et al., 2018). Conversely, a randomized control trial intervention increased FV intake found to reduce fasting blood glucose levels 15 and 8 mg/dl in men and women respectively (Azadbakht, Mirmiran, Esmaillzadeh, Azizi, & Azizi, 2005). Daily average servings of FV for the intervention and control arms were 5.1 and 2.3 per day.

In summary, FV may not directly mitigate diabetes, but their anti-inflammatory components might play a role in combating the inflammation of the disease. The greatest benefit of FV is the ability to combat obesity, especially central adiposity. A diet rich in FV reduces weight; as weight reduces, blood glucose control increases.

2.4 Blood Pressure/Hypertension and Fruits and Vegetables

Hypertension (HTN) is when the vascular regulation malfunctions resulting in an increase of arterial pressure (O'Shea, Griffin, & Fitzgibbon, 2017). A sphygmomanometer is used to measure systolic and diastolic pressures, values ≥140 and ≥90 mmHg respectively defines HTN. Optimal blood pressure values do not exceed 120/80 mmHg. It is a major risk for cardiovascular disease and stroke and if left untreated and can lead to a heart attack, chronic kidney disease or death (National High Blood Pressure Education, 2004).

Kentucky has a higher prevalence of reported HTN compared to the U.S., 30.0% and 27.8% respectively (Kentucky Department for Public Health, 2016). The Appalachian Regional Commission does not track HTN, but does report heart disease deaths in Appalachian Kentucky is 45% higher than the national rate and 32% higher than non-Appalachian Kentuckians (Appalachian Regional Commision, 2017). Also, stroke deaths are 26% higher in Appalachian Kentucky than national rate and 16% higher than non-Appalachian Kentucky. HTN is also known as the 'silent killer' referring to the lack of physical symptoms. In a 2004 world survey, it was noted that 31% of U.S. general population were unaware they were hypertensive (Kearney, Whelton, Reynolds, Whelton, & He, 2004).

Nutritional guidelines for those with HTN include reducing salt (sodium) intake, and increasing potassium and calcium intake (Lennon et al., 2017). The relationship between sodium intake and HTN is very strong and may be the only nutritional change to lead to a lower blood pressure. The DASH diet is a therapeutic eating pattern that has been successful in reducing HTN by reducing dietary sodium and increasing FV consumption (Nowson et al., 2004).

Increasing potassium intake has also been shown to have a positive influence on blood pressure. Huggins modified a DASH diet to have a higher proportion of potassium in combination with reduced sodium intake (Huggins, Margerison, Worsley, & Nowson, 2011). The modified DASH group was compared to a control group using medications to treat HTN. Huggins findings supported a low-sodium and high potassium diet outperformed the control group in lowering total blood pressure. DASH diet was also an arm of study and decreased blood pressure, but the high potassium DASH diet had greater reduction than the DASH arm. This suggests potassium has an important role in reducing HTN.

Plasma lipid levels also can play a role in plaque formation and aggravate HTN by promoting atherosclerosis. FV are naturally devoid of cholesterol and are inherently low in saturated fat. Adding FV to their diet might displace high fat foods and have a positive impact on plasma lipid levels (Rodriguez-Rodriguez et al., 2008; Roe et al., 2012).

2.5 Farmers' Markets

A farmers' market (FM) is defined as a recurrent market at fixed locations where farm products are sold by farmers themselves (Brown, 2001). Though FMs have been around as long as farmers, the modern FM can be traced to California where a farmer took on a regional produce broker and drove his truck into a vacant lot in San Francisco to sell his pears (Brucato, 1948). Since then, FMs have ebbed and flowed with a recent growth in numbers and popularity at the end of the twentieth century. FMs not only benefit of the farmer financially, but have been an instrument to bring FV to low-income neighborhoods (McCormack, Laska, Larson, & Story, 2010). Reasons for this growth are attributed to their potential to increase community-wide FV consumption in food deserts, low-income neighborhoods, or poor access to FV (Larson, Story, & Nelson, 2009; McCormack et al., 2010).

Economic factors contributing to the perceived cost of fresh FV is split. According to a systematic review by Freedman (2016), low income individuals claim FV cost to be fair while other studies cite prices exceeding those of local grocery stores (Freedman et al., 2016). Freedman's study noted seven studies in which economic barriers were cited in urban areas while rural areas only had five. To overcoming this barrier, programs have been implemented to make FV more accessible. 2.51 Farmers Market Based Interventions

Interventions using FM help overcome physical and economic availability. Rural regions may have fewer locations to purchase FV due to geography and limited opportunities for income may make FV unaffordable (Freedman et al., 2016; Robert L. Ludke, 2012). FMs interventions provide an opportunity to help mitigate these barriers thus helping low-income populations obtain FV. Anderson (2001) used a coupon-based intervention among those enrolled in the special supplemental nutrition program WIC in Michigan (Anderson et al., 2001). When coupons were compared to education, coupons had a direct impact on consumption.

The 'Double-Dollars' programs also utilizes a coupon to encourage FV purchases among Supplemental Nutrition Assistance Program users (SNAP). A recent study by Polascek (2018) examined the use of a supermarket double-dollar incentive program. That study found a 53% redemption rate with a 31% increase in fresh FV (Polacsek et al., 2018).

Olsho (2015) studied the impact of the *Health Bucks* program, which targeted low-income New Yorkers by issuing $2 coupons for every $5 spent on FV at FMs (Olsho et al., 2015). In 2011, SNAP-qualified participants had a 93% redemption rate, while non-SNAP low-income had a redemption rate of 70%. In a post intervention survey, 81% of shoppers agreed that the program helped them eat more FV.

The *Seniors Farmers' Market Nutrition Program* provides low-income seniors with $10 vouchers for fresh FV. Kunkel (2003) studied the programs impact when it was introduced in South Carolina (Kunkel, Luccia, & Moore, 2003). Response to an exit survey noted 88.5% they will eat more fresh FV because of the program, but only 16.5% stated they tried FV they never had purchased before. Incentive programs for low-income populations do have a positive impact on FV consumption.

The majority of studies involving FM are centered on low-income populations and the need to increase FV consumption (Abshirini et al., 2018). FV consumption is associated with a lower weight, waist circumference, blood pressure and blood glucose level, but are only been a handful of studies examining the relationship of FV intake with those who shop at FMs.

2.52 Weight/BMI

Jilcott Pitts (2013) conducted an investigation to confirm any association between distance from a supermarket or FM with BMI and systolic blood pressure (Jilcott Pitts et al., 2013). Her findings did not support any differences in BMI, systolic blood pressure and distance from a healthy food source. Jilcott Pitts also examined other associations between shopping at FM with FV intake in the context of weight/BMI. Her 2013 cross-sectional analysis noted women who shop at FM were more likely to consume five or more vegetables per day when compared to women who do not go to FM (Jilcott Pitts et al., 2013). She also noted that shopping at FM has no effect on BMI; however, she when frequency of FM shopping was examined, there was an association between lower BMI and multiple FM shopping trips per week (Jilcott Pitts et al., 2017; Jilcott Pitts et al., 2015).

Singleton (2016) examined association between FV intakes among WIC population in a cross-sectional analysis and found no association with FM shopping and lower BMI (Singleton et al., 2016).

Herman (2008) examined the effects of FV intake and BMI among WIC recipients (Herman, Harrison, Afifi, & Jenks, 2008). Herman's experimental arm received coupons for FV while the control group received coupons for diapers. At the end of the six-month study, there was a significant increase in FV intake; however, BMI for the experimental arm dropped a non-significant .02 kg/m^2.

2.53 Diabetes

Weinstein (2013) tested the impact of educational intervention methods on a low-income, obese, diabetic population (Weinstein, Galindo, Fried, Rucker, & Davis, 2014). The experimental arm received education on FV consumption, meal planning and vouchers for FV at FM. The control arm only received vouchers. After the course of 12 weeks, both groups had a mean reduction in BMI of 0.4 kg/m^2.

Bryce (2017) studied the *Fresh Rx* program's impact on weight (Bryce et al., 2017). Participants in the program were low-income non-pregnant adults with uncontrolled T2DM. Among the 65 participants, weight increased a non-significant 0.7 lbs in this 4-week intervention study. Bryce suggests that the duration of the study may have been too short to affect a significant outcome.

2.54 Blood Glucose

Bryce's (2017) and Weinstein's (2013) studies also examined how a FM based intervention could affect blood glucose measurements (Bryce et al., 2017; Weinstein et al., 2014). Weinstein results after 12 weeks showed the control group had a greater HbA1C decrease (-0.91%) versus the intervention group with FV education (-0.78%). The difference between the two groups was statistically insignificant. Both groups received diabetic education training which may have contributed to the HbA1C decreases in both groups. Bryce study design was interventional and measured pre- and post HbA1C. The results of the study showed a significant -0.71% decrease in 4 weeks. Weinstein's research did not measure pre- post significance.

2.55 Hypertension

Weinstein noted that systolic blood pressure increased 0.6 mmHg and 3 mmHg for the intervention and control arms respectively (Weinstein et al., 2014). Diastolic blood pressure decreased -2 mmHg and -1.6 mmHg respectively. There was no statistical significance between the arms. Bryce (2017) had similar results in his intervention study. Systolic blood pressure increased 135.1 mmHg to 135.8 mmHg while diastolic blood pressure decreased from 79.3 mmHg to 77.6 mmHg (Bryce et al., 2017).

In conclusion, FMs are relying on the results of clinical research to help improve health outcomes of low-income population via increasing FV consumption. Research examining clinical measurements on FM-interventional studies is sparsely located in the literature. Behavioral changes on FV consumption with financial incentives appear to be well represented; however, translating that consumption into measurable health outcomes needs to be added to the literature.

CHAPTER 3: METHODS

Secondary data analysis was conducted using de-identified 2016 data collected by a rural, federally qualified medical clinic located in eastern Kentucky. Study protocol was approved by University of Kentucky's Institutional Review Board.

3.1 Study Setting

The fruit and vegetable (FV) prescription program managed by the medical clinic that took place from May through October 2016 with vouchers being distributed for the data collection span of 26 weeks.

Table 3-1: Three year average weekly prices for selected crops, 2014-2016†

Crop	**Price**	**Crop**	**Price**
Apple (lb.)	$1.41	Asparagus (lb.)	$4.22
Blueberries	$4.26	Broccoli (lb.)	$3.15
Cabbage (each)	$1.67	Carrots (lb.)	$1.49
Corn Sweet (dozen)	$4.45	Cucumber (each)	$0.58
Garlic (each)	$0.57	Leafy Greens (lb.)	$2.48
Lettuce (lb.)	$2.48	Green Pepper (each)	$0.59
Radishes (bunch)	$1.10	Strawberries (qt.)	$4.10
Tomatoes (lb.)	$2.19		

† (Wolff, 2017)

A variety of fruits and vegetables were offered each week that the farmers' market. Fruits ranged from berries, melons, grapes, apples, peaches, pears, plums, and pawpaws. Vegetables ranged from root-based veggies (carrots, turnips, etc.) cruciferous (cabbage, broccoli, etc.), leafy greens (lettuce, spinach, etc.), tubers, nightshades, herbs, onions, garlic, corn, and squashes. Prices for selected crops sold in rural areas tended to be less expensive than urban farmers' markets. See table 3.1 for list of prices on selected products.

3.2 Participants

Enrollment into the fruit and vegetable farmers' market voucher program was restricted to clinic patients. Participants who automatically qualified were pregnant women or patients diagnosed with type-1 diabetes regardless of income. As well, qualifying patients included those diagnosed with T2DM, obesity, and/or HTN and incomes that fell below 100% of the Federal Poverty Guidelines as established by the Department of Health and Human Services.

This study sample included non-pregnant adults 18+ years that were patients of the medical clinic and their household members that agreed to have physical and biochemical measurements taken. "Participants" refers to clinic patients who were enrolled in the voucher program. "Household members" refers to non-patients residing within the participant's house that have access to added FV.

3.3 Measurements

The clinic was responsible for the consent forms and orientation of the participants in the farmers' market voucher program. Participants and household members agreeing to be measured had height, weight, waist circumference, blood pressure and blood glucose levels measured.

Height and weight were recorded using a Health-O-Meter scale (Model 500KL). Waist circumference was measured using flexible measuring tape running the tape parallel with the subject's hips. The average of two measurements was recorded. Blood pressure was measured on a seated subject using an automated sphygmomanometer (Welch Allyn Model 42NoB). Blood pressure measurements were taken twice and the average of the two were recorded. Subjects were asked to fast prior to blood glucose test. Blood glucose was measured using a finger stick tester (Health Pro, model IGM-0028B). Measurements were gathered every 30 days and entered into an excel spreadsheet by clinic employees.

3.4 Intervention

To determine eligibility, patients were screened by a healthcare professional from the medical clinic. Eligible patients were enrolled into the program, which gave them access to free weekly farmers' market vouchers to be spent at the local farmers' market for the duration of the market season. The value of the voucher varied. Patients were given $1 per day and $1 per day for each household member. A family of four would receive $28 per week ($1 per day X 4 people X 7 days = $28). If the household members agree to be measured, the voucher value increased to $2 per day per household member. For a family of four the weekly voucher value would increase to $56 ($2 X 4 people x 7 days = $56).

On the day of the market, participants exchanged the voucher for wooden coins valued $1 and $5 with the market manager. The participant was free to select the booth to purchase their produce. Participants were limited to purchasing produce only rather than products such as meat, eggs or honey.

3.5 Dietary and Behavioral Survey

In October, participants had the option to self-select in an exit survey designed specifically for this population. This was a paper survey administered by clinic staff that also collected and recorded the data in an Excel spreadsheet. The survey was designed to measure subjective changes in participants' self-reported health and behavioral changes that may be attributed to participation in the program. The survey addressed FV consumption, ease of shopping, lifestyle changes, changes in health, diabetes status, diabetes control, and demographic data. Only the participants were asked to complete the surveys. Participant physical and biochemical measurement data and survey data were not linked.

3.6 Statistical Analysis

Biochemical data (height, weight, waist circumference, finger-stick glucose and blood pressure) and demographics (age, gender, use of SNAP) were collected from participants and household members. Survey data was collected from participants only.

The biochemical portion of the study was a quantitative intervention design that initially contained 635 participants. Individuals who were or became pregnant were removed from the data set. Also, any children under the age of 18 at the beginning of the intervention were removed. The remaining data were separated into two principle groups composed of patients (participants actively being treated by the medical clinic) and household members (resident relatives living with participants). Descriptive analyses were determined percentages, means, and standard deviations of participants. The paired sample t-tests were conducted on differences in baseline physical measurements, taken in May, and final measurements taken September-October within and between participants and household members. The t-test was also used to determine associations between change in biochemical measurements and program participation (as measured by voucher redemption), and dollars spent. For the survey, mean, standard deviation, and percentages were used to evaluate participant responses.

CHAPTER 4: RESULTS

There were 784 individuals enrolled in the fruit and vegetable farmers' market voucher program during the 2016 season between June and October. Of these, 149 individuals chose to not to participate, thus resulting in a participation rate of 80.9%. There were 82 pregnant women and 156 people < 18 years excluded from this study (Figure 4.1). Data were analyzed from the remaining 397 subjects. Of these, the majority were clinic patients (77.5%, n = 308) and (22.5%, n = 89) were household members. Among the participants only, 65.14% were female, 53.18% were 55 years of age or older, 63.96% lived alone, and 62.85% were SNAP eligible (see table 1). The most frequent diagnosis was hypertension (43.77%), diabetes (40.4%), and obesity (15.82%). Household members were mostly male (65.88%) 54 years old or younger (68.24%, see table 2).

Figure 4-1: Flow diagram shoing progress of indiiduals participating in the fruit and vegetable farmers' market voucher program.

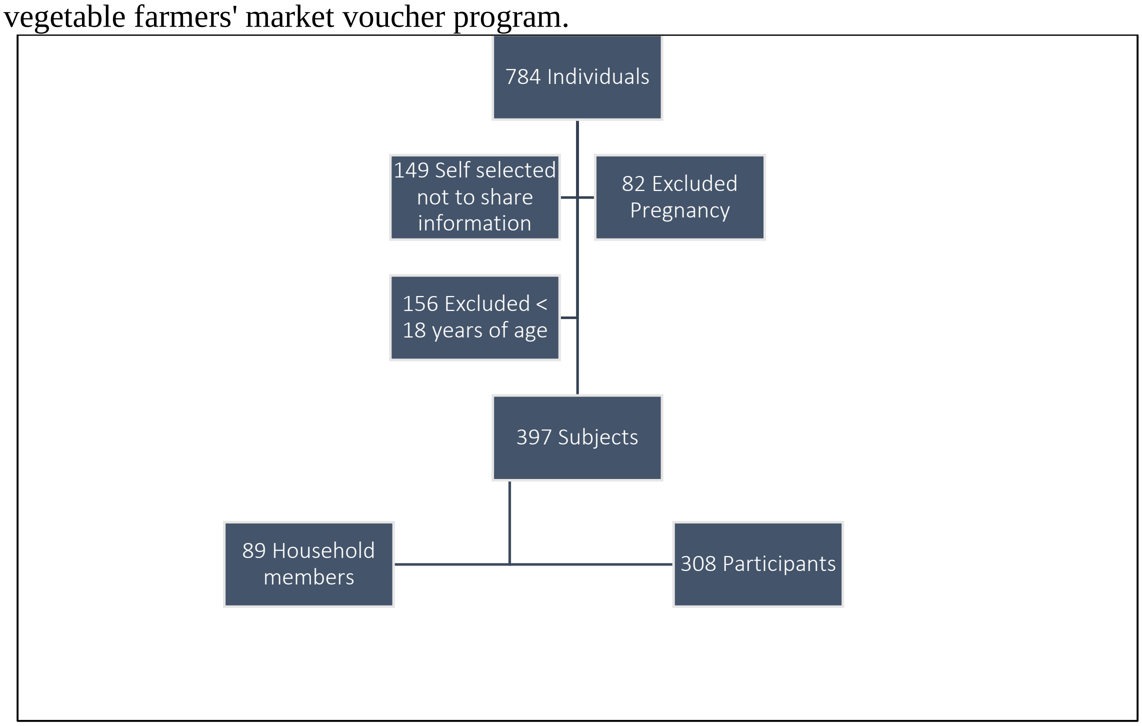

Table 4-1: Demographics of participants in the fruit and vegetable farmers' market voucher program (n=308).

Characteristics	n	%
Female	256	65.15
Male	137	34.86
18-54 years old	184	46.82
55 + years old	209	53.18
Single Household	197	63.96
Household size = 2	63	20.45
Household size = 3	19	6.17
Household size = 4+	29	9.4
SNAP Eligible	247	62.85
Obese	47	15.82
Diabetic	120	40.4
Hypertension	130	43.77
Obese + Diabetic	105	34.57
Obese + Hypertensive	84	27.20

Table 4-2: Demographics of household members in the fruit and vegetable farmers' market voucher program (n=89).

Characteristics	n	%
Female	29	34.12
Male	56	65.88
18-54 years old	58	68.24
55 + years old	27	31.76
Obese and Hypertensive	49	55.30

† Based on initial weight and blood pressure measurements

4.1 Bio-medical Analysis

There were a total of 308 non-pregnant adult participants (medical clinic patients only) with baseline and final physical measurements. The number of participants however, differed with each measurement variable. The results of the t-test measuring pre-intervention and post intervention among this participants showed significant reductions for blood glucose and waist circumference, p=0.0231 and p=0.0014 respectively. Changes in mean for weight, BMI, and blood pressures were non-significant (see table 4.3). Participation ratio and redeemed amount were not associated with weight, BMI, waist circumference, blood pressure and blood glucose (see table 4.4).

Table 4-3: Participant’s weight, body mass index (BMI), waist circumference, systolic blood pressure, diastolic blood pressure and blood glucose before and after participation in the fruit and vegetable farmers’ market voucher program intervention.

Characteristics	**Initial mean (SD)**	**Post mean (SD)**	**p-value**
Weight (lbs,n=202)	211.00 (57.15)	209.93 (58.66)	0.1192
BMI (kg/m^2, n=199)	34.55 (8.83)	34.67 (9.06)	0.9767
Waist Circumference (in, n=196)	46.74 (8.68)	46.48 (8.85)	0.0014
SBP (mm Hg, n=202)	131.88 (17.54)	131.73 (16.06)	0.6992
DBP(mm Hg, n=136)	75.87 (11.11)	73.92 (12.04)	0.204
Blood Glucose (mg/dL, n=178)	161.43 (74.03)	152.51 (68.67)	0.0231

SD – Standard deviation

BMI – Body mass index

SBP – Systolic blood pressure

DBP – Diastolic blood pressure

Participation ratio among the 89 resident household members also differed for each variable: weight (n=58), BMI (n=57), waist circumference (n=57), systolic blood pressure (n=58), diastolic blood pressure (n=46), and blood glucose (n=50). The differences between pre-intervention and post intervention were compared between participants and household members. There was a significant difference in the change in glucose with participants having a greater decrease in blood glucose compared to household members, -11.23 mg/dL (67.41) versus -4.76 mg/dL (35.5), $p<0.001$ (see table 4.5).

Table 4-4: Results of t-test comparing participant's weight, BMI, waist circumference systolic and diastolic blood pressure and blood glucose with participation ratio and redeemed amount (n=308).

Characteristics	**Mean loss or gain (SD)**	**Participation ratio p-value**	**Redeemed amount p-value**
Weight (lbs,n=202)	-0.79 (7.41)	0.3871	0.3126
BMI (kg/m^2, n=199)	0.00520 (2.58)	0.7895	0.6685
Waist Circumference (in, n=196)	-0.618 (2.76)	0.9855	0.8888
Systolic Blood Pressure (mm Hg, n=202)	-0.474 (17.97)	0.3885	0.9584
Diastolic Blood Pressure (mm Hg, n=136)	-1.394 (13.02)	0.1607	0.1867
Blood Glucose (mg/dL, n=178)	-11.231 (67.4)	0.8579	0.4218

SD – Standard deviation

BMI – Body mass index

Table 4-5: Results of t-test, pre-intervention and post intervention between participants (n=308) and household members (n=89).

Characteristics	**Participant mean (SD)**	**Household member mean (SD)**	**p-value**
Weight (lbs)	-0.79 (7.41)	-2.62 (7.55)	0.824
BMI (kg/m^2)	+0.005 (2.58)	-1.04 (2.68)	0.708
Waist Circumference (In)	-0.619 (2.76)	-0.91 (3.08)	0.281
Systolic Blood Pressure (mm Hg)	-0.474 (17.98)	-3.76 (14.60)	0.0647
Diastolic Blood Pressure (mm Hg)	-1.394 (13.08)	-2.52 (11.32)	0.279
Blood Glucose (mg/dL)	-11.23 (67.41)	-4.76 (35.5)	<0.001

SD – Standard deviation

BMI – Body mass index

Table 4-6: Results of t-test pre and post weight, BMI, waist circumference, blood pressure and blood glucose for household members.

Characteristics	Initial mean (SD)	Post mean (SD)	p-value
Weight (lbs)	226.5 (73.36)	212.18(64.83)	0.0108
BMI(kg/m^2)	33.89 (9.16)	31.97 (8.14)	0.9767
Waist Circumference (in)	45.45 (8.51	43.66 (7.69)	0.0014
Systolic Blood Pressure (mm Hg)	132.42(16.03)	127.33 (13.79)	0.6992
Diastolic Blood Pressure (mm Hg)	80.68 (9.89)	76.67 (11.05)	0.204
Blood Glucose (mg/dL)	133.7 (53.07)	127.04 (46.57)	0.0231

Household members had significant reduction in weight, waist circumference, and blood glucose (p=0.0108, p=0.0014 and p=0.0231 respectfully, see table 4.6). There were reductions in BMI, systolic and diastolic blood pressure but they were non-significant.

4.2 Survey Analysis

Exit survey yielded 230 participant-respondents (74.6% response rate) that were mostly white (92.02%), female (72.2%), between the ages of 18-55 (53.04%), and had an annual income below $20,000 (73.08%, see table 4.7).

The survey included questions pertaining to participants FV behaviors such as changes in FV intake and purchasing patterns (table 4.8). Most of the respondents agreed that participation in a fruit and vegetable farmers' market voucher program increased the number of FV consumed 95.58%, the other 4.4% consumed less or had no change. In addition, 56.77% of respondents reported they tried FV they otherwise would not eat. The most write-in responses for new FV were squash (n=9), beans (n=7), kale (n=4), and okra (n=4). The most common purchases were tomatoes (87.0%), green beans (85.7%) and potatoes (85.2%) while beets (10.9%), asparagus (7.4%) and kohlrabi (1.7%) were the least purchased (see table 4.9).

When asked about changes in overall health and well-being, 83.04% stated feeling better while 83.61% of those with clinically-diagnosed diabetes reported that participation in the voucher program made it easier to maintain optimal blood sugar levels. When asked about reductions in medication, 11.11% had a decrease in number of medications prescribed, 2.67% reported decrease in dosage of medication, while only 0.89% had an increase in dosage or number of medications.

Table 4-7: Demographics of participants completing exit survey (n=230).

Characteristics	n	%
Female	148	72.2
Male	57	27.8
Mean age	53.9	
18-55 years of age	122	53.04
55+ years of age	108	46.96
Married	94	45.19
Single	41	19.71
Widowed	31	14.9
Divorced/Separated	41	19.71
Self-report diabetes	113	49.13
White	196	92.02
Non-white	17	7.98
< $20,000	152	73.08
$20,000-$29,999	37	17.79
$30,000-$49,999	15	7.21
$50,000-$69,999	3	1.44
> $70,000	1	0.48
Current tobacco user	51	24.64
Former Tobacco user	19	9.18
Never Tobacco	137	66.18

Table 4-8: Survey response of program participants (n=230).

Have you had changes in your overall health and well-being since starting the program?	Better 83.04%	Worse 0.43%	No Change 16.52%
Did program make it harder or easier to buy fresh fruits and vegetables?	Easier 99.13%	Harder 0.0%	No Change 0.87%
[Diabetic only] did the program make it harder or easier to maintain optimal blood sugar levels?	Easier 83.61%	Harder 1.64%	No Change 6.56%
Did you freeze or can any of the FV you bought through the program?	Yes 69.87%		
How did the number of FV that you ate change as a result of the program?	Ate more 95.58%	Ate less 0.88%	No Change 3.51%
How did the number of fruits and vegetables that your family ate change as a result of the program?	Family ate more 94.74	Family ate less 0.88%	No Change 4.39%
Did you use the program to buy and FV that you/your family usually do not eat?	Yes 56.77%	No 43.23%	
Did the program make it more or less likely that your family members ate more fruits and vegetables?	More likely 96.93%	Less likely 0.44%	No Change 2.63%
Did the program make it easier or harder for your family members to eat more fruits and vegetables?	Easier 97.80%	Harder 0.0%	No Change 2.19%
Do you think the program will change your future shopping behaviors?	Yes-buy more FV 76.65%	Yes-buy less FV 5.29%	No Change 18.06%
Did the program motivate you to decrease tobacco usage?	Yes 3.48%	No 96.52%	
Did the program motivate you to increase exercise?	Yes 32.17%	No 67.83%	
Did the program motivate you to eat a healthier diet?	Yes 90.87%	No 9.13%	
Did the program motivate you to get more sleep?	Yes 8.70%	No 91.90%	
Did the program motivated your family to decrease tobacco usage?	Yes 3.91%	No 96.09%	
Did the program motivated your family to increase exercise?	Yes 29.57%	No 70.43%	
Did the program motivate your family to eat a healthier diet?	Yes 87.83%	No 12.17%	
Did the program motivate your family to get more sleep?	Yes 12.17%	No 87.83%	

Table 4-8 continued.

While participating in the program, did you decrease the amount of money you typically spend in healthcare?	Yes 46.22	No 53.78	
While participating in the program did a healthcare professional (doctor, nurse, etc.) adjust your drug prescription(s)?	Yes, decreased number of drugs prescribed 11.11%	Yes, decreased the dose of drug(s) prescribed 2.67%	Yes, increased the number or dose of drug(s)prescribed 0.89%

Table 4-9: Response to most popular fruits and vegetable purchased using vouchers from program.

Asparagus	7.4%	Onions	61.3%
Beans	17.8%	Potatoes	85.2%
Beets	10.9%	Radish	11.3%
Peppers	67.8%	Spinach	13.9%
Cabbage	72.2%	Squash	57.0%
Cauliflower	47.0%	Tomatoes	87.0%
Carrot	27.4%	Apple	80.4%
Corn	84.4%	Berry	63.5%
Cucumber	81.3%	Grape	58.7%
Green Beans	85.7%	Plum	67.0%
Greens	33.0%	Pear	25.7%
Kohlrabi	1.7%	Melon	77.4%
Okra	16.1%		

CHAPTER 5: DISCUSSION

5.1 Discussion

The results of this study demonstrated that participants of the FV farmers' market voucher program self-reported consuming more FV and a greater variety due to their participation in the program. More than half of the participants reported purchasing FV they normally would not eat and is likely attributed to having discretionary funds to purchase foods (McGuirt et al., 2014).

This is the first study the researcher is aware of examining the relationship between weight, BMI, waist circumference, blood pressure, blood glucose to participation rate and voucher value. The current study found no association between improved health status and participation rate, as measured by voucher redemption rate. Furthermore, no association was observed between voucher value and change in anthropometric and biochemical measurements. A possible explanation for the lack of associations may be attributed to a low voucher amount ($27.71 mean) spread across a household over the span of the study, and/or because of the lack of FV consumption after purchase. The produce may have been preserved, consumed by another person or spoiled before consumption so there was not any therapeutic effect.

Delivering the program as a FV prescription voucher program gives participants the opportunity to make the healthy choice of purchasing FV at a low cost while educating participants of the association between diet and health with FV being the focus. Cost and availability of FV are common barriers reported by rural populations as reasons for low FV consumption (Jilcott Pitts et al., 2015), which were alleviated through this free FV voucher program. As well, FV are rich sources of folate, vitamin A, vitamin C, vitamin K, vitamin E, fiber, magnesium, and potassium which play various roles in the body (Ellie Whitney, 2013). Phytochemicals such as phenols, carotenoids, and flavonols are also found in FV and have been associated with various health benefits including reducing oxidative stress (Giardi, Rea, & Berra, 2010). Finally, FV have a lower caloric-density due to the amount of water and fiber which may displace higher calorie foods via stimulating satiety signals (Rodriguez-Rodriguez et al., 2008; Roe et al., 2012; Rolls et al., 2004).

The effect of the FV voucher program with participant's weight showed a non-significant average decrease of 1.07 lbs. These findings are consistent with other FM interventions (Bryce et al., 2017; Herman et al., 2008; Weinstein et al., 2014). However, randomized clinical studies using FV interventions have shown a significant decrease in weight (Azadbakht et al., 2005; Burke et al., 2007; Nowson et al., 2004). One explanation for this clinical success is they utilized the Dietary Approaches to Stop Hypertension or DASH diet. The delivery of the DASH diet included diet counseling and the DASH diet itself has rigorous dietary restrictions. While the DASH diet emphasizes an increased consumption in FV it also restricts the amount of sodium and dietary fat (Sacks et al., 1995). Currently, the FV voucher program of this study did not include any diet counseling.

The current study is the first, which we are aware of, to examine waist circumference in a FM intervention. Participants lost a significant 0.26 inches of waist circumference. This would suggest that participants reduced intra-abdominal adipose, which is beneficial to decreasing risk of cardiovascular disease (Lopes, Correa-Giannella, Consolim-Colombo, & Egan, 2016). An explanation for FV impact on this reduction comes from the European Prospective Investigation into Cancer and Nutrition study

(EPIC). The EPIC findings suggest as fiber increases, waist circumference decreases (Du et al., 2010).

Participants had a significant 8.92 mg/dL decrease in blood glucose. These findings are consistent with Geidenstam who noted as weight and waist circumference decrease, blood glucose will also decrease (Geidenstam et al., 2016). Weight loss was insignificant; therefore, it appears the waist circumference may have a significant role in controlling blood glucose levels. The concentration of abdominal fat is toxic to surrounding cells which release proinflammatory cytokines which promote insulin resistance (Lopes et al., 2016).

Blood pressure dropped an insignificant 0.15/1.95 mm/Hg. This was consistent with the other studies that showed insignificant decreases (Bryce et al., 2017; Weinstein et al., 2014). The participants' average age was 56.5. Since age is considered a risk factor for hypertension age may be a contributing factor to the insignificant decrease (Pinto, 2007). It is possible over salting food may lessen the potential for any blood pressure lowering benefits (He, Li, & Macgregor, 2013). In addition, participants who fry any FV may be increasing their fat intake, which is associated with increased blood pressure (Gadiraju, Patel, Gaziano, & Djousse, 2015).

This is the first study to examine health improvements of household members residing in the home of individuals participating a FV farmers' market voucher program. The particular voucher program of the current study increased the value of the voucher based on household size. The positive changes in household members' anthropometric and biochemical measurements were impressive. Weight, waist circumference and blood glucose significantly decreased. Since these household members were not patients less data including clinical diagnosis of obesity, hypertension or diabetes was not available. However, the researcher used baseline BMI and blood pressure to categorize household members as being obese and/or hypertensive. Due to finger stick glucose being the only available measurement associated with diabetes, the researcher did not use it as a marker to categorize household members as diabetic. Interestingly, the household members' demographics were opposite the participants in that they were mostly male (65.88%) and younger with the majority (68.2%) in the age range of 18 – 54 years, with a mean age of 45.

Several possible explanations for household members' results include younger age, gender and time of study. This is a younger population that is less likely to have the presentation of chronic diseases or debilitating disabilities therefore; they can be more physically active. This population is mostly male who has more lean muscle tissue. Achten's review on beta-oxidation notes lean body mass, gender, and physical activity contributes towards weight loss (Achten & Jeukendrup, 2004). Lower blood glucose is also associated with physical activity (Mainous, Tanner, Anton, Jo, & Luetke, 2017). These factors are compounded by a summer season with longer days and favorable weather.

Participants may have had a lack of motivation to consume FV, with the possibility of the household members consuming the produce. A study of low-income groups noted there was a cognitive dissonance between eating healthy and consuming five FV per day (Dibsdall, Lambert, Bobbin, & Frewer, 2003). Dibsdall notes low-income individuals may view replacing pleasurable eating with FV as denying oneself. Another finding of

Dibsdall's study reported 70% of low-income groups claim their eating habits to be 'healthy', yet only 18% consumed the recommended five FV per day.

5.2 Limitations and Strengths

The study had limitations with data quality. Researchers were not involved in data collection. Extensive efforts were made to clean data that was keyed incorrectly. There were other steps that could have been taken to make the study more relevant such as conducting a 24-hour recall or a food frequency questionnaire may have helped validate data. Participants were instructed to fast prior to the finger-stick test for blood glucose levels. Lack of compliance may have confounded the results. In hindsight, an HbA1C test would have provided a better measurement regardless of participant compliance. On-site cooking demonstration, recipe cards or other financial incentives may have influenced FV intake. Participants cooking with added salt, fat, and/or sugar may have an impact on results. Statistical strength was strong for participants but was not as strong for the household members. Finally, there were no out of pocket expenses that exceeded the voucher amount. This could help calculate a dollar amount associated with good health.

This was a study with a large sample of a low-income population in a rural setting. Prescription-based interventions are new and give patients more contact with the medical staff, this study adds to those already published. This is the first study to measure health improvements for household members. It provides bio-metric data on how other individuals may benefit from added FV being available in a household.

5.3 Conclusion

The purpose of this study was to measure the impact a farmers' market voucher prescription program, had on health outcomes of participants and household members. The program had a positive effect on blood glucose and waist circumference among the participants. Participants self-reported consuming more FV and 50% added variety of FV to their intake. There were no associations between participation ratio or voucher amount and change in weight, BMI, waist circumference, blood glucose or blood pressure. The household members had significant reduction in weight, waist circumference and blood glucose. However, when comparing decreases in blood glucose between household members and participants, the participants had a statistically significant larger decrease. Future studies may want to consider an educational component addressing healthy eating, cooking and added fat, sugar and salt. Diets low in fat (DASH diet) show significant improvements in weight reduction and improved cardiovascular benefits (Sacks et al., 1995).

APPENDIX: Questionnaire

Thank you for taking the time to fill out this survey. Please circle or mark an "**X**" next to the **best** choice.

1. *Have you had **changes in your overall health and well-being** since starting the program?*

__ Much better __ A little better __ A little worse __ Much worse __ No change

2. *Did the program make it harder or easier to **buy fresh fruits and vegetables**?*

__ A **lot easier**__ A **little easier**__A **little harder** __ A **lot harder** __ No change

3. *Has a doctor ever told you that you have diabetes?*

__ Yes __ No

If **yes**, continue to question **4**
If **no**, skip to question **5**

4. *Did the program make it harder or easier **to maintain optimal blood sugar levels**?*

__ A **lot easier**__ A **little easier**__ A **little harder** __ A **lot harder** __No change

5. *Did you **freeze or can** any of the fruits or vegetables you **bought through the program**?*

__ Yes__ No

6. *Did you use the program to buy any fruits or vegetables that you/your family **usually do not eat**?*

__ Yes __ No
If **yes**, what kind of fruits and vegetables did you try?

____

5. *How did the number of fruits and vegetables that **you ate change** as a result of the program?*

__ Ate a **lot more**__ Ate a **little more**__ Ate a **little less**__ Ate a **lot less**__ No change

6. *How did the number of fruits and vegetables that **your family ate change** as a result of the program?*

__ Ate a **lot more**__ Ate a **little more**__ Ate a **little less**__ Ate a **lot less**__ No change

7. *Did the program make it more or less **likely** that your family members ate more fruits and vegetables?*

__ A **lot more** likely__ A **little more** likely__ A **little less** likely__ A **lot less** likely__ No change

8. *Did the program make it* ***easier or harder*** *for your family members to eat more fruits and vegetables?*

__ A **lot easier**__ A **little easier**__ A **little harder**__ A **lot harder**__ No change

9. *Do you think the program will change your* ***future shopping behaviors****?*

__ **Yes**, I will buy **more** fruits and vegetables after the program

__ **Yes**, I will buy **fewer** fruits and vegetables after the program

__ **No**, there will be **no change** in my shopping behaviors

10. *Did* ***your*** *use of the program motivate* ***you*** *to make any of the following* ***lifestyle changes****? Check all that apply.*

__ Decrease tobacco smoking or use of tobacco products

__ Increase exercise

__ Eat a healthier diet

__ Get more sleep

11. *Did your* ***family's*** *use of the program motivate* ***them*** *to make any of the following* ***lifestyle changes****? Check all that apply.*

__ Decrease tobacco smoking or use of tobacco products

__ Increase exercise

__ Eat a healthier diet

__ Get more sleep

12. Other than fruits and vegetables, what other ***products*** *did you buy with your vouchers this year (even if you only bought it once)?*

__ Meat__ Eggs__ Honey__ Herbs __ Other: ______ Not Applicable

13. In the following table, place an **X** in the box to the right of **any** fruits and vegetables you bought using your vouchers.

Asparagus		Okra	
Beans, dried		Onions OR scallions	
Beets		Potatoes (white OR sweet)	
Bell Peppers		Radishes	

Cabbage OR Brussel sprouts		Spinach	
Cauliflower OR Broccoli		Squash OR Zucchini	
Carrots		Tomatoes	
Corn		Apples	
Cucumbers		Blackberries, blueberries, OR strawberries	
Eggplant		Grapes	
Green Beans		Plums, Peaches OR Nectarines	
Greens (Kale, Turnips, Mustard)		Pears	
Kohlrabi		Watermelon, Cantaloupe, OR honeydew	
OTHER:			

14. *List the* <u>*3*</u> ***fruits*** *that you purchased* ***most often****.*

15. *List the* <u>*3*</u> ***vegetables*** *that you purchased* ***most often****.*

16. *What is* ***one way*** *that the program* ***benefited your family****?*

17. *If you could* ***improve*** *the program for next year,* ***what changes would you make****?*

18. *Would you like* ***nutrition education*** *or* ***specific suggestions*** *of fruits and vegetables to purchase that would* ***help manage health problems, such as diabetes or high blood pressures****?*

__ Yes __ No

What is your Age (years)*:*______________***Sex****:* __ Male __ Female

Race/Ethnicity: __Non-Hispanic White__ Black or African American__ Hispanic or Latino__ Other__ Prefer not to answer

What is your ***total annual household income:*** __ less than $20,000__ $20,000 - $29,999__ $30,000 - $49,999__ $50,000$69,999__ $70,000 or greater

Marital status__Single __ Married __ Widowed __ Divorced or Separated __Other

Tobacco use: __ Yes__ Former tobacco user__ No

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