The Evaluation of Fruit & Vegetable Incentive Programs on Childhood Obesity Prevalence in the Special Supplemental Nutrition Program for Women, Infants and Children

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Dedication

To my mother and brother, for always believing in me; always.

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To my family, you are my foundation, my motivation, my everything in this life; thank you for your unwavering support and encouragement. Thank you to my dear friends for providing light and laughter along this journey, you have been more helpful than you may ever realize. To my mentor, Suzanne, thank you for taking a chance, believing in me, and pushing me to heights I never realized possible. To UVA, thank you for the challenges, opportunities, and guidance around every bend, even if you did turn me navy blue and orange along the way: wa-hoo-wa!

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Abstract

Childhood obesity remains a significant public health crisis. One way to combat obesity is through diet, in particular one rich in fruits and vegetables. The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) has two incentive programs that help increase access to fruits and vegetables for participants, which could help mitigate obesity. Those programs include the Farmers Market Nutrition Program (FMNP) and the Cash Value Voucher (CVV) program.

This research evaluated associations of childhood obesity prevalence with county and state level factors related to farmers markets, food access and the WIC program. Additional associations between state factors and state's participation in the FMNP were investigated. Further analysis explored the effect of the CVV on childhood obesity prevalence in states with and without the FMNP, and barriers and challenges within the FMNP from the lens of program administrators.

Data were extracted from the United States Department of Agriculture Food Environment Atlas, WIC Funding reports and WIC Program Characteristics. Qualitative data collection included a semi-structured guide administered to FMNP stakeholders in participating states. Analysis revealed mixed results across state associations with farmers markets and products sold, with only six states having significant associations. Regression analysis found farmers markets accepting WIC, percent of WIC redemption and number of grocery stores at the county level to be significantly associated with childhood obesity prevalence. At the state level, only participation in the FMNP was significantly associated with childhood obesity prevalence. Exploring state factors associated with participation in the FMNP, only childhood obesity prevalence proved to be a significant correlate. A difference-in-difference analysis showed no

effect of the CVV on childhood obesity prevalence in states with the FMNP compared to states not participating. Finally, analysis from stakeholders revealed six themes of challenges and barriers perceived to be affecting success of the FMNP program: policy limitations, coupon logistics, market factors, competition, farmer challenges, and participant challenges.

In conclusion, this research found mixed results among farmers markets and sales to childhood obesity prevalence in states, no consistent county and state level associations with childhood obesity prevalence, the CVV did not have an effect on childhood obesity prevalence, and the FMNP has significant barriers hindering success of the voucher program. Future research should incorporate longitudinal studies to understand the effects of WIC program's on child obesity prevalence and continue to rigorously evaluate the ability of federal programs to address health outcomes. These findings should be used to promote future work to improve programmatic aspects that may help alleviate childhood obesity prevalence.

Keywords: Childhood Obesity, Farmers Markets, WIC, FMNP and CVV

CHATPER 1: SPECIFIC AIMS

Introduction

Each year, billions of federal dollars are spent to aid in the nutritional health of our nation's youth; however, childhood obesity remains a major public health issue. In 2017, the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), was appropriated nearly $6.5 billion dollars[1] to fulfill its mission of serving low-income mothers and their children by providing aid in the form of food supplements and other nutritional and health services.[2] While WIC's eligibility contains children with nutritional risk factors including overweight and obesity, among WIC participants aged 2-4 years old, 14.5% of these children are obese.[3] Importantly, percent of obesity in WIC participants is significantly higher than the national average of 8.9%.[4] Research demonstrates an adequate consumption of fruits and vegetables is a key component of achieving a healthy lifestyle and preventing obesity.[5,6] To help increase access and affordability of these foods in low-income neighborhoods, federally funded programs such as WIC allow for program benefits to be used at local farmers markets and stores to purchase fruits and vegetables.[7] Specifically, WIC's Farmers Market Nutrition Program (FMNP), and the WIC Cash Value Voucher (CVV) are uniquely positioned to utilize federal funds to help provide additional supplemental assistance to participants to increase purchase and consumption of fresh fruits and vegetables. However, within the research to date, there are still many gaps in our understanding of these programs' ability to help mitigate this nationwide health crisis.

The purpose of this study was to examine the association of fruit and vegetable incentive programs on childhood obesity prevalence, specifically WIC's FMNP and CVV, utilizing data from publicly available data sets: The Food Environment Atlas from the United States

Department of Agriculture and WIC's Participant and Program Characteristics and the WIC website containing program information. Multivariable regression analysis was employed to explore associations between various state factors, childhood obesity, and the FMNP. Logistic regression analysis explored the state factors associated with the presence of the FMNP. The effect of the FMNP and CVV program on childhood obesity prevalence were explored through a difference-in-difference analysis. Finally, a direct content analysis explored state program characteristics, challenges and barriers from the lens of the program directors.

Specific Aims

1. **Describe the association between the county and state-level factors with the prevalence of childhood obesity; and the association between state factors and state participation in the FMNP.**

   To explore these associations, we conducted multivariable, linear, and logistic regressions with data from the USDA Food Atlas and WIC Program.

   a. **Hypothesis 1a.** States with a lower prevalence of childhood obesity will be associated with more farmers markets per 1,000 residents.

   b. **Hypothesis 1b**. States with the FMNP program will be associated with more farmers markets per 1,000 residents.

2. **Determine the effect of the 2009 WIC CVV program on childhood obesity prevalence in states with and without the WIC FMNP and to determine how the effect of the CVV on childhood obesity varies with the level of state FMNP funding.**

   A difference-in-difference analysis was used to determine the effect of the WIC CVV on childhood obesity prevalence in states participating in the FMNP compared to states not

participating. The effect of various FMNP funding levels on childhood obesity prevalence was also explored.

   a. **Hypothesis 2a:** After the implementation of the CVV, states participating in the FMNP will have a significant decrease in childhood obesity prevalence compared to states that did not participate.
   b. **Hypothesis 2b.** After the implementation of the CVV, a higher FMNP budget will significantly affect childhood obesity prevalence compared to states that did not participate.

3. **In states that participate in the WIC FMNP, explore the utilization, barriers and challenges of the program from the lens of the administrators.**

   A comparative qualitative analysis was conducted by administering a six-question survey to 40 stakeholders in FMNP participating states. Results were analyzed using directed content analysis. The data collected was categorized or quantified to help explain the program's redemption rates, county market participation, and barriers to success.

   a. **Hypothesis 3:** In states with lower redemption rates, general themes for barriers will include participant knowledge and farmer engagement.

This study's use of multiple datasets in a novel combination allowed new exploration into factors associated with childhood obesity prevalence. From this study, policy-makers and WIC administrators can gain information on the association among farmers markets, FMNP and CVV with childhood obesity prevalence. An evaluation of these programs, in addition to the qualitative assessment of challenges and barriers, could lead to improved policies and implementations of these and similar programs to help decrease childhood obesity prevalence. Future studies can explore the impact of addressing the challenges and barriers within the FMNP

on coupon redemption, and examine the impact of WIC incentive programs on childhood obesity prevalence within one state through a longitudinal study.

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CHAPTER 2: BACKGROUND AND SIGNIFICANCE

Childhood Obesity

Obesity is a disease that affects persons of all ages, races, ethnicities, and socioeconomic statuses. A national epidemic, obesity is now increasingly affecting our nation's younger generations, with 17% of youth under 19, and 8.9% of children 2-5 years old having a weight status in the obese (BMI $\geq$ age-and-sex specific 95th percentile) range with rising trends.[1] Among children 2 to 5 years of age, 2.1% are classified as having severe obesity (BMI $\geq$120% of the 95th percentile).[2] Childhood obesity rates also vary considerably by race and ethnicity: 21.9% of Hispanics, 19.5% of Non-Hispanic blacks, 14.7% of Non-Hispanic Whites, and 8.9% of Non-Hispanic Asians.[1] Additionally, there are strong correlations between obesity and income, with higher obesity prevalence among lower-income individuals.[3]

The Special Supplemental Nutrition Program for Women, Infants and Children (WIC), is a federal program aimed at addressing the nutritional and health needs of its participants.[4] Being a federal aid program, WIC is positioned to help enhance the nutritional health of some of our countries most vulnerable populations including those from low-income families and minorities. This program of research specifically focused on two programs within WIC aimed at enhancing the nutritional health of its participants, particularly children. Within WIC, children 2-4 years of age suffer from higher prevalence of overweight and obesity when compared to national averages. While WIC's eligibility includes children with nutritional risks (including high weight for height status), similar to national trends, obesity varies by race and ethnicity. Figure 1, accessed from 2016 *Morbidity and Mortality Weekly Report*, shows weight status trends from 2000-2014 of children within WIC by race and ethnicity.[5]

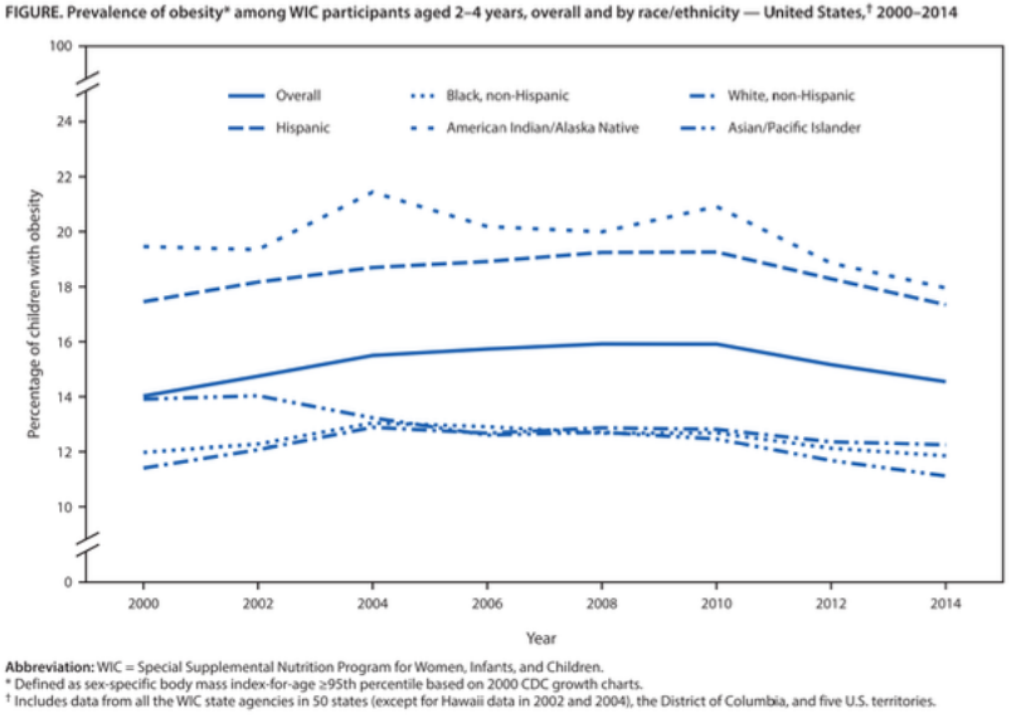

Figure 1. Prevalence of obesity among WIC participants aged 2-4 years, overall and by race/ethnicity – United States, 2000-2014. Adapted from Pan, et al., 2016.[5]

Addressing this disease early in a child's life is critical because obesity can track over the life course and being an obese adult puts one at an increased risk of comorbidities such as hypertension, dyslipidemia, coronary heart disease, and stroke.[6,7] The Cardiovascular Risk in Young Finns Study is a multicenter longitudinal endeavor started in 1980 that tracked nearly 3,600 participants aged 3-18 years old at baseline over a thirty year period. Results from this longitudinal study found that in overweight and obese children, 65% were obese as adults.[8] A ten-year cohort study found that adults with a BMI of 35.0 or more were twenty-times more likely to develop diabetes compared to normal weight adults (relative risk (RR) = 17.0 [95%CI: 14.2-20.5 women]; RR=23.4 [95% CI: 19.4-33.2 men]).[9] The study also concluded that in addition to diabetes, risk for gallstones, hypertension, heart disease and colon cancer increased

with weight in men and women.[9] Finding solutions to this epidemic before it progresses into adulthood, could dramatically alter the quality of and lifespan of a child, in some cases saving a life.

While recent increases in adiposity among children under the age of five is concerning and detrimental to health, it has also increased the attention of researchers to examine early determinants of childhood obesity.[10] Current evidence points to high-calorie diets, low-nutrient diets, decreased or no physical activity, and increased sedentary activities as contributors to this disease.[11] Eating behaviors of a child are also often shaped by the physical and social factors within the home environment, which includes modeling behavior from the caregiver.[12] By continuing to increase the evidence base on childhood obesity, future programs and research studies are well positioned to tackle solutions that could help today's youth become a generation of healthier adults.

Theory on Obesity

The factors attributed to childhood obesity are frequently referred to within the context of the Socio-Ecological Model (SEM), which diagrams layers contributing to health outcomes and prevention. The Dietary Guidelines for Americans (DGA), a report published from the U.S. Department of Health and Human Services and United States Department of Agriculture every five years, is foundational guidance document for policymakers and health professionals working within food and nutrition.[13] As outlined in the DGA, health outcomes applied to the SEM are influenced by food and beverage intake, physical activity, individual factors, settings, sectors and social and cultural norms and values (Figure 2).[13] The DGA also provides information on daily servings and portions necessary to achieve a healthy food-based dietary pattern,[13] which is a key

component for long-term weight maintenance and cardio-metabolic health.[14] An alternative SEM model focused just on child weight status (Figure 3) shows similar layers of influence with common areas being the food environment, which includes access and consumption of fruits and vegetables (FV).[15] This study explored the intersection of three layers of the SEM on childhood obesity prevalence (health outcome)— sectors, settings, and individual factors. Specifically, within those layers, we will explore the (1) WIC program, (2) state and county characteristics, and (3) food access. See Appendix, Figure 1.

Figure 2. A Social-Ecological Model for Food & Physical Activity Decisions. Adapted from U.S. Department of Health and Human Services, 2017.[13]

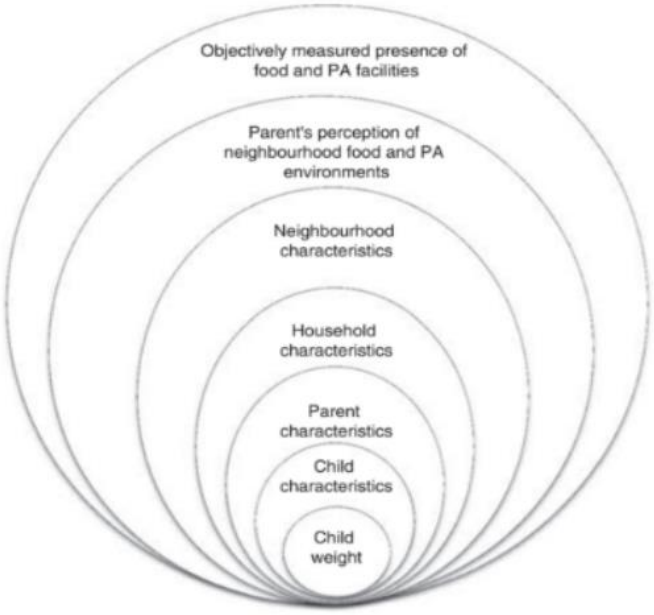

Figure 3. Social-Ecological Model, layers influencing a child's weight status. Adapted from Ohri-Vachaspati, *et al., 2014*.[15]

Fruit and Vegetable Intakes and its Association with Weight Status

National priorities such as Healthy People 2020 recognize the need to address obesity across all ages, with diet being a contributing factor.[16] The SEM informs us that health behavior, such as food consumption behaviors associated with excessive energy intake and weight gain, has many layers of influence from personal, to community, and expanding beyond to policy influence from local to the national level.[15] An example of how federal policies can influence individual choices and ultimately health outcomes are seen within our nutritional aid programs in the United States. Nationwide federal programs such as WIC, and the Supplemental Nutrition Assistance Program (SNAP), utilize federal funds to offer programs that help participants purchase FV at a reduced price from farmers markets (FM) and grocery stores.[17] Understanding that cost was a barrier to these healthy foods, these programs, and others, found ways to ensure citizens were able to consume these necessary dietary items through vouchers, increased access, and additional incentive programs. Despite these national priorities, frameworks, and federal

programs, the population's adherence to recommendations for a healthy diet including FV remains low.[13]

Evidence from a comprehensive review reveals that diets inclusive of fruits and non-starchy vegetables are a necessary component to a healthy lifestyle absent of chronic weight gain.[14] For children, introducing healthy eating habits early is vital to future health, as these behaviors trajectory goes into adulthood.[18] Epidemiologic evidence has supported the use of FV as a means to combat diseases such as cancer, coronary heart disease, and stroke,[19] many of which are comorbidities of obesity. Despite the positive health benefits of FV intake, results indicate that only 13.1% of adults consume the recommended daily amount of fruits and only 8.9% consume daily recommend vegetables.[20] In children, about 40% are consuming recommended fruits, but only 7% consume recommended vegetable servings.[21]

Current research on children and FV consumption explores associations between diets high in FV intake and weight status. A cross-sectional study conducted in Philadelphia, PA, collected data on children (n=36) ages 5 and 6 to assess the relationship between weight status and FV consumption. Results indicated that overweight and obese children consumed significantly fewer FV servings per day than normal-weight children (4.0 +/- 0.5 vs 7.2 +/- 1.1 servings/day; $p = 0.02$).[22] In another cross-sectional analysis of Louisiana children (n=78) aged 2-5, survey results from parents indicated a significant inverse correlation between vegetable intake, an average of 17.59 servings/week, and BMI z-score in children ($\beta = -0.02$, $p=0.0472$).[23] Findings from research on children and FV intake highlight the inverse correlation that supports the potential for these foods to affect weight status. However, a systematic review of 50 different trials on the effectiveness of various interventions on increasing consumption of FV in children under the age of five, found limited strategies for increasing vegetable intake at the individual

level.[24] Thus, more work is warranted to explore other sector influences of increasing intake.

Similar to studies within children, adults also appear to have a significant association between FV consumption and weight status. This is a critical component to explore given the propensity of childhood overweight and obesity into adulthood. A cross-sectional study from 2001-2010 using health screenings from Mei Jau, Taiwan, found adults within the highest quintile of FV servings per day as measured from food frequency questionnaire, had significantly reduced likelihoods of being overweight (OR=.91) or obese (OR=.85).[25] Additionally, a cross-sectional analysis from the 2007 Behavior Risk Factors Surveillance System concluded that the presence of 5+ FV servings/day was significantly associated with BMI status across normal, overweight and obese adults, with overweight and obese individuals consuming significantly less FV servings/day than normal weight adults.[26] Information from these studies support the recommendations from the Dietary Guidelines for Americans on servings of FV needed in our daily diets.

Results from an observational longitudinal study found several significant relationships between FV consumption, weight, and BMI. Participants included Chinese adults (n=4,357) 18-65 years old, who had height, weight and diet-recall measured over five years. Researchers found that when the FV consumption was increased by 100g, men experienced an average weight decrease of 211g ($p<0.001$) and 0.94 kg/m^2 decrease in BMI ($p<0.001$), and while decreases were seen with women, results were not significant.[27] Similarly, an observational cohort study in European adults (n=89,432) found that per 100g intake of FV, participants weight decreased by 14 grams/year (95% CI:-19, -9 g/y).[28] These results lend promising insight into the ability for FV consumption to alter weight status and weight loss.

A suggested approach to increasing healthy foods into a diet is through interventions that change the behaviors that lead to food consumption.[29] As referred to in the layers of the SEM, personal factors contribute to health outcomes. The transtheoretical model is a tool that explains the process in which an individual changes an unhealthy behavior to a healthy one and has noted success in smoking reduction among adults.[30] A Cochrane review on overweight and obese adults found low-quality evidence around FV intake after exploring studies that used the transtheoretical stages of change model as an intervention for weight loss.[30] The quality and amount of evidence were minimal, but studies suggest some positive changes to weight when FV consumption is increased. In particular, one randomized control trial implemented the change model on overweight and obese men and women over a two-year time period.[31] A component of the intervention was to follow national guidelines that stated a need for decreased calories from fat and increased calories from fruits and vegetables.[31] While results were not significant, evidence suggests this diet change does enhance weight loss.[31] Through focused studies within one layer of the SEM model, in this case personal behavior factors, the overall complexity of a disease like obesity is explored and findings can be used in future studies that look across layers.

Role of Farmers Markets

FM and roadside stands offer one venue to purchase fresh produce, in addition to offering economic benefits and support to local farmers.[17] Consumption of FV has been established as a means to a healthier diet and lifestyle, and research indicates FM is an effective means to providing and aiding the increase in consumption of these foods.[32] As of 2017, over 8,687 FM were sited within the USDA's directory across all fifty states.[33] While that roughly equates to

less than one FM per 1,000 capita, recent data indicate that the number has been increasing over time.[17,34]

FM, while a convenient one-stop shop for FV, also have barriers that impact their use among certain populations. Specifically, among low-income populations, reasons for not utilizing FM included misperception of benefit acceptance, high prices, and lack of transportation.[35–37] One study that compared prices of FM to grocery store produce found significant differences ($p<0.05$) in several foods including broccoli, green beans, peaches, and raspberries, with the lower costs occurring at grocery stores.[38] Another study, conducted among North Carolina FM, found that some foods, such as carrots, are substantially more expensive at FM than in supermarkets.[39] Understanding that prices at FM tend to be higher, federal programs that help address barriers, such as cost, are necessary to increasing the purchase and consumption of these healthy foods.

FM availability is also varied across the United States, which plays a significant role in access. One study used data from the Food Atlas to further explore associations among FM across the US. Results utilized data from 2009-2010 across 3,135 counties in the US and found several disparities among FM availability. In particular, only 56.6% of counties in the US had at least one FM.[40] Among non-metro counties, higher median household income was associated with increased odds of having a FM, and both living in poverty and percentage of non-Hispanic Blacks were negatively associated with FM per captia.[40]

Despite the barriers and often higher costs, FM's have the means to greatly enhance FV consumption with results from research supporting the use of incentive programs to achieve increased consumption. Among surveyed produce consumers at stores and markets, produce at FMs was perceived as fresher looking, fresher tasting, a higher-quality and better value than

those at supermarket produce.[41] In New York, a program called Healthy Bucks dispensed $2 coupons directly to shoppers at FM, as well as to SNAP participants on a basis of a $2 coupon for every $5 they spent.[42] Results were collected after the 2011 FM season through surveys in neighborhoods and from SNAP participants. The authors' found that Healthy Bucks were associated with increased awareness of FM, more frequent shopping ($p=0.001$), increased overall spending at FM and increased likely purchases of FV.[42] While more information is necessary to confirm increased consumption, overall results show immense success with an FM incentive program on purchases of healthy foods.

Special Supplemental Nutrition Program for Women, Infants & Children

The WIC program has been providing assistance in the form of nutrition education and supplemental food to women and infants for almost fifty years. WIC helps mothers through the postpartum period, and continues benefits up to the child's fifth birthday.[43] WIC aims to serve low-income mothers who often face an array of health and lifestyle challenges, such as inadequate time to prepare foods in the home, sedentary activity levels, and ailments such as obesity and hypertension.[44] By helping mothers overcome these barriers and ultimately improving their health and well-being, it is hoped that their child(ren) will emulate these behaviors and benefits.

To receive WIC benefits, participants must meet four eligibility requirements: categorical (women, infants, children), residential (must live in the state they apply for benefits), income eligibility (between 100% to 185% federal poverty level), and be at nutritional risk.[45] Once qualified, participants are eligible for one of the seven food packages offered through WIC. Figure 4, shows the various WIC food packages available; of interest to this study, Food Package

IV for children ages 1 through 4 years of age. Participants receive a monthly-food benefit, which then is used to purchase the specified foods from the approved packages at participating WIC stores.[44] Food packages are designed to supplement participants diets by providing foods that are in line with the DGA recommendations.[44]

WIC Food Packages	
Food Package I	▪ *Participants*: Infants birth through five months ▪ *Authorized foods*: Although breastfeeding is the preferred method of nutrition for this group, WIC formula may be provided
Food Package II	▪ *Participants*: Infants six through eleven months ▪ *Authorized foods*: Infant formula, infant fruits and vegetables, infant meat, and infant cereal
Food Package III	▪ *Participants*: Clients with a documented health condition (e.g., premature birth, metabolic disorders, immune system disorders) ▪ *Authorized foods*: Infant formula, WIC-eligible medical foods, infant cereal, infant food fruits and vegetables, milk and milk alternatives, cheese, eggs, canned fish, fruits and vegetables, breakfast cereal, whole wheat bread or grains, juice, legumes, and/or peanut butter
Food Package IV	▪ *Participants*: Children one through four years ▪ *Authorized foods*: Milk, breakfast cereal, juice, fruits and vegetables, whole wheat bread or other whole grains, eggs, and legumes or peanut butter (food substitutes are available due to allergies)
Food Package V	▪ *Participants*: Pregnant and Partially breastfeeding women ▪ *Authorized Foods*: Milk, breakfast cereal, juice, fruits and vegetables, whole wheat bread or other whole grains, eggs, and legumes or peanut butter (food substitutes are available due to allergies)
Food Package VI	▪ *Participants*: Postpartum women ▪ *Authorized Foods*: Milk, breakfast cereal, juice, fruits and vegetables, eggs, and legumes or peanut butter (food substitutes are available due to allergies)
Food Package VII	▪ *Participants*: Fully breastfeeding women up to one year postpartum ▪ *Authorized Foods*: Milk, cheese, breakfast cereal, juice, fruits and vegetables, whole wheat bread or other whole grains, eggs, legumes, peanut butter, and canned fish

Figure 4. WIC Food Packages. Adapted from *Melean, T. 2014.*[45]

The United States Department of Agriculture (USDA) Food and Nutrition Service (FNS) is the federal governing body of WIC. It administers the program to the states which include 90 WIC state agencies that cover all fifty states, the District of Columbia, 34 Indian Tribal

Organizations, agencies in American Samoa, Guam, Commonwealth Islands of the Northern Marianas, Puerto Rico, and the U.S. Virgin Islands.[46] In Fiscal Year (FY) 2017, the WIC program was appropriated $6.5 billion in grant funding, inclusive of the Food Grant and the Nutrition Services and Administration grant.[47] Figure 5, illustrates WIC funding by grant and total funding from FY 2000 to 2017.

Figure 5. WIC Funding Fiscal Year 2000-2017. Adapted from USDA WIC funding documents.

According to WIC's Program Report, as of April 2016, 8,815,72 women, infants, and children were participating in the program.[4] Of participants at that time, 23.3% were infants, 23.4% were women (pregnant or postpartum) and 53.3% were children.[4] However, since 2010, overall participation within the program has been declining.[4] Data collection of race and ethnicity are required of WIC participants by the Office of Management and Budget which show the following breakdown in 2016: 58.6% White, 20.8% Black/African American, 10.3% American Indian/Alaska Native and 4.4% Asian/Native Hawaiian/Other Pacific Islander; 41.8% Hispanic/Latino.[4] Table 1 displays budget allocations and funding per participant (hypothetical figure) in WIC from 2013-2017.

Table 1. WIC Funding & Participants 2013-2017

Fiscal Year	Total WIC Funding	Total WIC Participants	WIC Funding per Participant
2013	$6,820,904,376	8,662,751	$787.38
2014	$6,899,608,031	8,258,413	$835.46
2015	$6,671,213,137	8,023,742	$831.43
2016	$6,588,937,961	7,696,439	$856.10
2017	$6,512,689,161	7,286,161	$893.84

Farmers Market Nutrition Program

In 1992, WIC created the FMNP with the intent of providing fresh foods to program participants as well as expanding the awareness and use of FM.[48,49] The program is a partnership between the states and the federal government whereby states must apply for the additional federal funds, and to date, thirty-nine states and the District of Columbia currently participate in the FMNP.[48] To receive the federal-funds for the program, a state must submit a plan that describes how they plan to operate the program. FMNP funds are then awarded to State agencies, specific agencies varies state to state, who are then responsible for coordinating receipt to eligible WIC participants.[48]

Participating WIC recipients will receive a voucher for a minimum benefit level of $10 up to a maximum of $30, to be used in addition to WIC benefits for the entire harvest season.[50] These coupons are then used to purchase eligible fruits and vegetables from approved farmers, farmers markets and roadside stands. The program aims to support farmers that grow FV, also known as “specialty crops”, which are not currently supported through the Farm Bill.[51] As of FY 2015, there were 1.7 million participants, 17,926 farmers, 3,390 FM, and 2,894 roadside stands, equating to roughly $16.55 million in federal funds appropriated to the program.[50] Table 2 shows the past decade of FMNP funding and number of states participating, information adapted from

FMNP Fiscal Profiles.[48]

Table 2: WIC Farmers Market Nutrition Program 2010-2017

Fiscal Year	2010	2011	2012	2013	2014	2015	2016	2017
FMNP Budget (Millions of Dollars)	$22.089	$23.283	$20.517	$18.723	$19.633	$19.667	$21.043	$22.921
Number of Participating States*	37	37	37	37	39	39	40	40
Budget of Participating States* (Millions of Dollars)	$19.88	$21.07	$18.56	$16.92	$17.78	$17.82	$19.91	$20.43

*Excludes the following tribal nations and territories: Chickasaw Nation (OK), Choctaw Nation (OK), Five Sandoval Indian Pueblos (NM), Guam, Mississippi Band of Choctaw Indians, Osage Tribe (OK), Pueblo of San Felipe (NM), Puerto Rico, Virgin Islands. Information adapted from FMNP Fiscal Profiles.

Studies conducted on the WIC FMNP program support its ability to utilize FM to increase access and consumption of FV to participants. In an Ohio WIC center, participants who had participated in that harvest season, the FMNP program (which FM season ended October 31) significantly increased consumption of vegetables (2.2 ± 1.2, $p<0.040$) compared to non-participants in WIC.[52] Kropf et al. also found that FMNP participants exhibited indicators of a more healthful diet inclusive perceived benefits of consuming more FV.[52] Another study showed FM coupon incentives increase consumption of FV at 1.4 servings per 1000 kcal of consumed food ($p< 0.001$).[53] By helping participants afford FV, the benefits translate to purchases and consumption.

In addition to helping participants with the affordability of FV, the FMNP is also addressing the travel and transportation components. Through program funds that offer incentive coupons to participants, it in turn increases sales, which encourages farmers to come into these low-income neighborhoods.[54] The sales incentives are often a key factor for these farmers to participate.[54] With continued grant support from the FMNP programs, more FM could enter areas of high need and eliminate some of the access and travel barriers seen with FV purchases.

Cash Value Voucher Program

Another incentive program within WIC is the Cash Value Voucher (CVV), fully implemented in 2009 to better align WIC's food benefits with the DGA.[55] Part of this alignment, was to increase consumption of fruits and vegetables for WIC participants as part of the monthly food benefit package that participants already receive and access from WIC stores.[56]In creating this program, the food-package overall had to remain cost-neutral, which meant monthly allotments of other foods were reduced, varying by food package.[56] When the program was first introduced, it provided $6 per month to children and $10 per month to women for the purchase of FV at participating WIC vendors.[57] Realizing this value was not sufficient, in 2014, an effort was made to increase the amounts to $8 for children and $11 for women.[58] Unlike the FMNP, this voucher can be used on canned or frozen FV and is available in all WIC agencies across the nation, with redemption rates around three-quarters of all WIC participants.[57]

However, the most recent review of the WIC food packages discusses the additional considerations, such as cultural food preferences as part of the success of the CVV helping participants achieve a more balanced diet, and how the voucher support is not enough.[56] To help all participants meet their dietary needs, the committee recommended to increase CVV to $12 per child and as high as $35 in fully breastfeeding women to align with the DGA.[56] Discussions also include the possibility of expanding the CVV to juice and canned legumes in an effort to meet cultural dietary needs as well as the overall dietary needs of participants.[56]

The CVV supports purchases of FV, even outside the harvest season and is another mechanism addressing the price barrier to FV consumption. A recent study in Alabama showed that redemption of these vouchers was associated with significantly increased consumption of FV from the 189 participants that regularly used the vouchers (β=0.67, p=0.007) when compared

to the irregular and non-redeemers.[55] A cross-sectional analysis collected data from parents/guardians of children enrolled in WIC to better understand CVV purchases. Results indicated that all participants (n=150) purchased FV for their children in the past month and 98% used the CVV for those purchases.[59] Moreover, 38% of participants cited over-spending the voucher amount as the barrier to the CVV. With the CVV, WIC has created a year-round incentive to help its participants afford FVs from supermarkets and other WIC approved stores.

Stakeholders

At the federal level, WIC is not the only national nutrition program with a stake in decreasing childhood obesity prevalence by providing the means to a healthier diet. In addition to WIC, federal nutrition programs include School Breakfast Program, National School Lunch Program, Summer Food Service Program, At-Risk Afterschool Meals Program, and the Supplemental Nutrition Assistance Program.[60] These programs have varying benefits but all revolve around ensuring our nation's most vulnerable population is able to receive healthy food. This proposal analyzed one of the major federal program's associations with childhood obesity prevalence and program effects, thus opening the path for future similar studies to explore other programs. Table 3 summarizes key components from federal programs that aid nutritional needs.[60]

Table 3 United States Federal Programs for Nutrition Aid

Program	Participants	Fiscal Year 2016 Funding
School Breakfast Program	School children with family incomes under 185 percent of federal poverty level. 14.1 million students in FY 2016.	$4.3 billion
National School Lunch Program	School children with family incomes under 185 percent of federal poverty level. 30.5 million students in FY 2016.	$12.5 billion
Summer Food Service Program	2.8 million students in FY 2016.	$472 million
At-Risk Afterschool Meals Program	Hungry kids during after school hours, during weekends, or breaks throughout the school year. 230 million in FY 2016	--*
Supplemental Nutrition Assistance Program (SNAP)	Families that meet federal poverty eligibility. Average of 45.8 million people in FY 2015.	$70.8 billion
Special Supplemental Nutrition Program for Women, Infants and Children (WIC)	Pregnant and postpartum women, infants and children that meet program eligibility. Nearly 9 million in FY 2016.	$6.35 billion

Adapted from *Feeding Hungry Children: A guide for state policy makers.* *No annual budget available.

Innovation

While the methodology applied in this project is not innovative, the databases were used in a novel fashion. To our knowledge, no studies to date have combined data from these databases to explore the aims of this study. Through this study, results help to form and lead future research aimed at decreasing obesity, both childhood and adult, through federally subsidized programs that aid food purchases. Specifically, this study deepens our understand of the association between farmers' production of FV and childhood obesity prevalence. Additionally, this study explored WIC's FMNP and CVV, as a potential catalyst for addressing childhood obesity prevalence. Finally, it is the first to our knowledge to conduct a formal analysis of the states participating in the FMNP to gather information on barriers and challenges.

Future studies could explore additional federal programs such as the Supplemental Nutrition Assistance Program, which is currently the largest food assistance program in the country, reaching nearly 46 million Americans.[60] Alternatively, results from this study combined with previously known risk factors for childhood obesity could lead to new experimental studies

that aim to explore ways to decrease childhood obesity. At a time when securing federal funds for health-related programs becomes increasingly difficult, studies, such as this one, with results on understanding the programs ability to address a health outcome, are necessary contributions to sound policy decisions.

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CHAPTER 3: METHODS & ANALYSIS

Data sets

USDA Food Environment Atlas: The primary data set for this study was the USDA Food Environment Atlas. The Food Atlas is a publicly available online dataset. The USDA Food Atlas complies information from multiple data sources to create the overall dataset. Information for this study included data collected from: Access to Affordable and Nutritious Food: Updated Estimates of Distances to Supermarkets Using 2010 Data; the U.S. Census Bureau, County Business Patterns; USDA's Food and Nutrition Service, Supplemental Food Programs Division, Program Analysis and Monitoring Branch; the U.S. Census Bureau, Population Estimates; USDA's Agricultural Marketing Service, Marketing Services Division; the Census of Agriculture; and the Centers for Disease Control and Prevention's (CDC) analysis of height and weight data from the Pediatric Nutrition Surveillance System data (PEDNSS) as described in Obesity Prevalence Among Low-Income, Preschool-Aged Children—United States, 1998-2008, CDC, Morbidity and Mortality Weekly Report, July 24, 2009/58(28):769-773.[1]

The Food Atlas contains nearly 300 variables at the county, state, and regional level across categories including food choices, health and well-being and community characteristics. The purpose of the Atlas is to stimulate research in the areas of food choices and diet quality, as well as community data on access to food. The August 2015 and 2017 Atlas data were utilized for this program of research. The study utilized data from all 50 states and 3,143 counties. From this data set, some of the variables of interest included, sales at FMs, FM per 1,000 residents, FM accepting WIC Cash, and obesity prevalence among low-income preschool-aged children. The complete list of variables is detailed in the Appendix, Table 1.

WIC Program Data: The second data set was comprised from the Women, Infant, and Children Participant and Program Characteristics from the Center for Disease Control and Prevention and the WIC Website. The dataset is generated biannually by the Food and Nutrition Services of the USDA by collecting data based on the WIC Minimum Data Set compiled from the states.[2] The data were published in reports available online for public use. From this data set, the main variable of interest was childhood obesity prevalence in participants 2-4 years of age. By accessing past reports, childhood obesity prevalence by state was collected from 2000 to 2014.

Additional information about WIC was gathered from the WIC website that houses archived data. Data included yearly budget reports on the total funding received for each state from the Food Grant and Nutrition Services Administration to create total WIC funding. Funding data were accessed back to fiscal year 2000. Participant data was also available on the WIC website which included number of women, infants and children in each state and territory receiving benefits, biannual reports, starting in the year 2000.

Research Methods

Below is a general overview of the methods for each Aim of the study. Detailed explanations of the methods and analysis can be found in Chapters 4-6.

Aim I

Describe the association between the county and state-level factors with the prevalence of childhood obesity; and the association between state factors and state participation in the FMNP.

Hypothesis 1a. States with a lower prevalence of childhood obesity will be associated with more farmers markets per 1,000 residents.

Hypothesis 1b. States with the FMNP program will be associated with a higher average number of farmers markets per 1,000 residents.

Method

For Aim 1 of the study, the use of multivariable regression analysis allowed for exploration of variables associated with high prevalence of childhood obesity. The first regression was done to test the hypothesis between farmers markets, market sales and childhood obesity prevalence among states as a foundation for further exploration. Following this, a larger exploratory regression analysis looked at county and state level variables that may be associated with childhood obesity from WIC relation or food access. Finally, a logistic regression was used to determine which state variables are associated with a state having the FMNP program, from either food access, farmers markets or health outcome categories. Descriptive statistics (mean, standard deviation, range, etc.) of the states assessed general trends, similarities and differences. Graphical representation was also utilized to express descriptive data. Analysis were run in STATA Version 14.1, with data visualization conducted in QGIS 3.4.4.

Sample Description

The sample included county-level data on FM and products sold at markets in 3,143 counties from 50 states and the District of Columbia. Data for number of FM per county were collected in 2009 and 2013. Childhood obesity prevalence of low-income children 2-4 years old was reported in aggregate at the county level, collected from 2009-2011. The county and state-

level variables used in exploratory analysis spanned farmers market, WIC program and food access from the USDA Food Atlas and WIC data. The FMNP budget and program participation data is available across all states (n=51) from 2000-2017, whereas, missing data in the Food Atlas altered final sample size in analysis. The full list of variables and descriptions are available in the Appendix, Table 1.

Power

Power calculations confirmed sample size was sufficient assuming a type 1 error rate of 5%, a survey design effect of 2 to detect an odds ratio equivalent to a 5-percentage point increase with 80% power.[3]

Descriptive Statistics

For each variable, exploratory and descriptive statistics (e.g. mean, standard deviation, frequency) were determined. These results are displayed in Appendix, Table 1. All analysis were run in STATA Version 14.1. Additional data visualization was conducted using QGIS 3.4.4.

Aim II

Determine the effect of the 2009 WIC CVV program on childhood obesity prevalence in states with and without the WIC FMNP and to determine how the effect of the CVV on childhood obesity varies with the level of state FMNP funding.

Hypothesis 2a: After the implementation of the CVV, states participating in the FMNP will have a significant decrease in childhood obesity prevalence compared to states that did not participate.

Hypothesis 2b. After the implementation of the CVV, a higher FMNP budget will significantly affect childhood obesity prevalence compared to states that did not participate.

Method

For Aim 2a, we used a difference in difference (DD) analysis. DD is often used to evaluate the impact of healthcare policies in observational data[4] when randomization between control and treatment groups is not feasible.[5] The DD analysis compared childhood obesity rates in states with and without the FMNP before and after the nationwide roll out of the CVV program in 2009. DD relies on the identifying assumption that states with and without FMNP had parallel trends in childhood obesity rates prior to the CVV roll out and would have maintained those trends in the absence of the CVV program. For Aim 2b, DD analysis to further explored the effect of FMNP budgets.

Sample Description

The outcome variable was prevalence of WIC enrolled children ages 2-4 years old with BMI-for-age above the 95th percentile of CDC growth charts.[6] The sample included all 50 states and the District of Columbia from 2000-2014. The sample was divided into two groups, states with the FMNP (n=37) and states without the FMNP (n=14). Data on the FMNP budget is a continuous variable from fiscal year 2000-2014.

Analysis

We estimated the DD models with the following formulas:

Equation 1.0:

$$Y_{st} = \alpha_s + \beta_t + \delta(Treat_s * Post_t) + \epsilon_{st}$$

$$Y_{st} = WIC\ childhood\ obesity\ rate\ for\ state\ s\ in\ year\ t$$

$$alpha_s = state\ fixed\ effects$$

$$Beta_t = time\ effects$$

$$Post_t = year\ t\ is\ after\ 2009$$

$$\delta = treatment\ effect$$

Equation 1.1:

$$Y_{st} = \alpha_s + \gamma_t + \beta(W_{st} * P_{st}) + \epsilon_{it}$$

$$Y_{st} = WIC\ childhood\ obesity\ in\ state\ (s), year\ (t)$$

$$alpha_s = state\ fixed\ effects$$

$$gamma_t = time\ effects$$

$$W_{st} = WIC\ FMNP\ in\ pre\ period$$

$$P_{st} = WIC\ FMNP\ funding\ in\ state\ (s), year\ (t)$$

$$\beta = treatment\ effect$$

Aim III

In states that participate in the WIC FMNP, explore the utilization and barriers or challenges of the program from the lens of the administrators. A comparative qualitative analysis was conducted by administering a six-question survey to 40 stakeholders in FMNP participating states.

Hypothesis 3: In states with lower redemption rates, themes for barriers will include participant knowledge and farmer engagement.

Method

For Aim 3, a descriptive qualitative design was the guiding methodology.[7] A semi-structured guide was constructed and consisted of the following six-questions:

i. How many counties in your state participate in the FMNP?
ii. Have the same counties always participated in the program?
iii. What factors lead to the selection of these counties for participation?
iv. Are FMNP benefits offered to residents on the WIC waiting list?
v. What is the redemption rate of the FMNP coupons?
vi. What, if any, are some of the challenges/barriers to implementation of this program?

The questions were sent via email and also included a brief summary of the larger dissertation work. Stakeholders were encouraged to reply via email but a phone call was also an option. No additional information was requested from the sample. No phone conversations were recorded, and a readback was used to ensure correct information was collected.

Sample Description

A purposeful sample was used consisting of program directors of WIC FMNP's from each of the participating states, identified on the program's website.[8] The website was accessed in November of 2018, at which time 39 states and the District of Columbia were participating in the FMNP and had corresponding program directors listed with contact information. All 40 directors replied to the request for information; email only (n=32), email and phone (n=7), and

phone only (n=4). The email that was sent to the stakeholders is available in Appendix, Figure 3.

Analysis

A comparative qualitative analysis was conducted by administering a six-question survey to 40 stakeholders in FMNP participating states. Data collected were categorized and quantified to help explain the program's redemption rates, county market participation, and barriers to success. Data analysis was divided into qualitative and quantitative responses. The first question was converted into a percentage of counties in the state participating. The second question was a binary yes, no response. Six categories were made for the third question, and many states had responses that fell into more than one category. Categories included; number or proximity of the farmers in the county, WIC population or recipient participation, county or WIC agency interest, funding, farmer interest or past participation, and other. Others included existing partnerships, convenience, staffing, and county poverty. The fourth question would have been a binary yes no but due to misinterpretation of the question, results were voided. The fifth question was taken as the percentage given by the stakeholder, and when a range was given the average was used for this analysis. The final question was line-by-line coded, resulting in 50 line-codes, with results analyzed using directed content analysis.[9] From these, 18 categories were formed and six final themes were deduced. Coding was double verified by another member of the research committee. Analysis are further explained in Chapter 6.

This work received approval from the University of Virginia's Institutional Review Board Project #2018-0340-00.

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CHAPTER 4: ASSOCIATIONS BETWEEN CHILDHOOD OBESITY PREVALENCE, FARMERS MARKETS AND THE WIC PROGRAM

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Abstract

Introduction: Our nation continues to face rising obesity rates and low consumption of healthy foods. The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) has programs which help increase access and intake of healthy foods, mainly fresh fruits and vegetables. This paper will explore childhood obesity prevalence across the United States (U.S.) and its association with the WIC program, farmers markets, types of sales, and food access to gain a better understanding of factors that may be related to a child's weight status.

Methods: Data for the analysis is from the U.S. Department of Agriculture Economic Research Food Environment Atlas and WIC program data. Multivariable linear regression was used to explore state specific associations among number farmers markets and products sold with childhood obesity prevalence. Univariable linear regression was used to assess county and state level associations, followed with step-wise regression controlling for race and urbanicity at the county-level.

Results: Six states out of 44 had a significant relationship between childhood obesity prevalence and the number of farmers markets or types of sales in the markets after controlling for covariates. South Dakota exhibited childhood obesity prevalence inversely associated with the number of farmers markets per 1,000 residents while Pennsylvania and Washington showed the opposite relationship. Examination of the relationship by types of products sold, revealed that California had a positive association (increased prevalence) with animal products sold at farmers markets; Oregon had a positive association with all products sold; and Tennessee had an inverse association (decreased prevalence) with all products sold at a farmer's market (fruits and vegetables, animal products, and other). Analysis identified seven county-level factors and nine state-level factors associated with childhood obesity prevalence. In the step-wise analysis

significant county-level variables included farmers markets accepting WIC, percent of WIC redemption, and number of grocery stores; at the state level, only participation in the FMNP remained significantly associated with childhood obesity prevalence.

Conclusion: Overall, state specific analysis revealed results that were not consistent, and when controlling for covariates many associations were attenuated and no longer significant. Results from the county and state level offer areas of further exploration. Future studies are necessary to understand the relationship between WIC programs that engage farmers markets and incentive programs targeted at fruit and vegetable purchases, with weight status in children.

Introduction

Obesity remains a major health problem affecting children around the globe. Specifically, in the United States as of 2016, 18.5% of youth 2-19 years are obese and 13.9% of 2-5 year-olds are obese.[1] As obesity rates among Americans continue to rise, the time has never been more pressing for research and policy solutions to help address this preventable disease, given the severe consequences that often accompany this condition. Obesity is known to increase the risk of significant comorbidities, such as hypertension, dyslipidemia, coronary heart disease, and stroke, later in life.[2,3] In children, unhealthy weight status becomes a more serious issue as research shows children with obesity are more likely to remain obese, carrying with them the increased risk of all comorbidities of obesity.[4] A longitudinal cardiovascular risk study found that 65% of children with overweight and obese continued to be obese in adulthood.[5] Furthermore, current data indicates, if the course of action does not change, 59% of today's 2-year-old children have obesity by their 35th birthday.[6] Identifying and addressing obesity in childhood could reduce the risk of cardiac comorbidities and mortality in adulthood,[7] providing children the chance to live a healthier life.

Part of achieving a healthy lifestyle and preventing obesity is through adequate consumption of fruits and vegetables (FV),[8,9] however, data from the National Health Nutrition Examination survey (NHANES) indicate that Americans are not consuming recommended amounts.[8] Introducing these healthy eating habits early in life is vital to later health, as these behaviors are likely to continue through adolescence and into adulthood.[7] Additionally, evidence from cross-sectional research indicates an inverse correlation between vegetable intake and BMI (body mass index) z-score (the relative weight adjusted for age and sex) in children.[10] Studies also show that normal-weight children consume more FV servings than overweight and obese

children.[11] Despite the positive health benefits of FV intake, results indicate that only 40% and 7% of children are consuming recommended fruit and vegetable servings, respectively.[12]

The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) is a federal program that for almost fifty years has addressed some of the barriers to the consumption of healthy foods by providing incentives and nutritional education to its participants.[13] In addition to the food packages aligned with the national dietary guidelines,[14] WIC has two incentive programs that target FV consumption. The Farmers Market Nutrition Program (FMNP) aims to help beneficiaries eat healthier foods by addressing access and price barriers to farmers markets (FM) through coupons during the harvest season for states that chose to participate.[15,16] The Cash Value Voucher (CVV) program, unlike the FMNP, is available in all fifty states and offers monthly coupons for purchases of FV at participating WIC vendors.[17]

Healthy diets continue to show promise with healthy weight status and serve as a critical access point to addressing the obesity epidemic; as long as families are able to access these foods. One avenue to increase consumption of these healthier foods is through access and use of FM. The number of farmers markets continues to grow from year to year[18] and research has shown an association between these markets and FV consumption.[19] With programs like those available within WIC, barriers such as price to these healthier foods are being addressed.

This study was the first step in our understanding of the impact of WIC programs on children's access to FV and health outcomes, particularly obesity. The purpose of this paper is to explore the childhood obesity prevalence across the U.S. and its association with the WIC program, FM and types of sales, and food access. Through regression analysis we will contribute foundational knowledge to future studies on the WIC incentive programs and childhood obesity prevalence.

Methods

Data were extracted from the publicly available United States Department of Agriculture (USDA) Food Environment Atlas which contains information on health outcomes, food resources (e.g. access to stores, sales of fresh produce at stores), federal food assistance programs and farming statistics (e.g. number of farmers markets per residents, sales at farmers markets), as well as information from the US Census Bureau such as race, ethnicity, income and urbanicity (i.e. whether a county was classified as metro or non-metro).[20] Data in the Food Atlas was collected from the regional, state, and county-level with the time of collection varying across categories. We also concatenated the USDA Atlas data with information from the WIC Participant and Program Characteristic dataset. The USDA Food and Nutrition Services collects participant characteristics based on the WIC Minimum Data Set compiled from the states, biannually, from which we extrapolated enrollment numbers.[21] Additional data regarding funding allocations for WIC and the FMNP were retrieved from the USDA's webpage which publicly reports these amounts.[15] The full list of variables can be seen in Supplemental Table S1. This study was ruled exempt by the University of Virginia's Institutional Review Board.

Statistical Analysis

To determine association between FM (number and types of sales) and childhood obesity prevalence in individual states, multivariable linear regression analyses were conducted. The dependent variable in this analysis was childhood obesity prevalence of preschoolers ages 2-4 years old living in households with income up to 200 percent of the poverty threshold based on family size in 2009-2011. The independent variables included number of FM in a country per

1,000 residents from 2009 and the number of FM in the county that report selling fruits and vegetables; animal, and other products (e.g. baked goods, crafts, flowers, herbs, honey, jams, maple syrup, nursery plants, nuts, prepared foods, soap, trees and/or wine) all in 2013. The analysis included 44 states, due to childhood obesity missing from Alaska, District of Columbia, Delaware, Maine, Oklahoma, South Carolina and Wyoming. In the regression analysis, percent of the population that self-reported as African American or Hispanic race, and whether the county was considered metro or nonmetro, urbanicity, were additional controls.[22]

To determine county and state level associations, twenty-seven independent variables were chosen based on their relation to WIC or food access, see Appendix B, Table 1. Univariable regression analysis were a first step to explore associations and resulted in the identification of significant associations at a p-value of $p \leq 0.05$. Forward and backward stepwise regression analyses were performed using an inclusion and exclusion p-value of ≤ 0.05, to determine the best model Akaike information criteria, or model quality. A pairwise correlation matrix was used to ensure no variables were significantly correlated with one another, determined to be a correlation value of > 0.60.[23] Final regression analysis included percent Hispanic, percent African American, and urbanicity, based on previous literature.[22] At the state level, urbanicity was not used due to it being a county variable not replicable at the state level, and neither analysis controlled for income due to the outcome variable being low-income children.

All analyses were conducted in STATA Version 14.1. Regressions were reported significant for a p-value ≤ 0.05 and when reported, confidence intervals are at 95%.

Results

Farmers Markets, Products Sold & Childhood Obesity

Using the USDA data, we explored the relationship between childhood obesity prevalence and number of FM per 1,000 residents. Given seven states were missing childhood obesity prevalence data, only 44 states across 2,714 counties were analyzed. The mean prevalence of children with obesity was 14% (SD = -3.50) from 2,714 counties and the mean number of FM per 1,000 residents was 0.04 (SD = 0.07). The average percent of FM selling the various types of products were 50.5% (SD = 40.9) for fruits and vegetables, 46.9% (SD = 40.59) for animal products, and 50.6% (SD = 40.8) for other products (n= 2,181 counties).

In Table 1 we express the change in childhood obesity prevalence for every unit increase in FM per 1,000 residents (for example, a one unit increase is 0.04 to 1.04 FM per 1,000 residents). The prevalence of children with obesity was significantly inversely related to the number of FM per 1,000 residents in five states in the unadjusted models; California (CA), Connecticut, Rhode Island, South Dakota, and Vermont ($p<0.05$). However, in Pennsylvania (PA), the reverse association was seen in the unadjusted model ($\beta = 29.8$, SD = 14.4, p=0.04). After controlling for race, ethnicity, and urbanicity, only PA still held a significant relationship ($\beta = 33.1$, SD = 15.0, p=0.03). After adjusting for covariates, a significant association was seen in Washington ($\beta = 43.5$, SD=21.6, p=0.05).

Exploring the association with types of food sold at markets (fruits, vegetables, animal products, or others), shown in Table 2, we found only two states where the percent of childhood obesity prevalence significantly changed with an increase in the percent of farmers markets selling these products. In the unadjusted model for Tennessee (TN), a one-unit increase in markets selling fruits and vegetables was significantly associated with a decrease in childhood obesity prevalence ($\beta = -0.03$ SD = 0.01, p=0.01). After adjustments, only TN had a significant inverse association ($\beta = -0.04\%$ SD = 0.01, p=0.00) and Oregon (OR) revealed a positive

association (β = 0.04 SD = 0.01, p=0.01).

In the adjusted analysis for CA and OR, an increase in the number of FM selling animal products was significantly associated with an increase in children with obesity (CA: β = 0.04 SD = 0.01, OR: β = 0.05 SD = 0.01, p<0.05) while TN exhibited an inverse relationship (β = 0.04 SD = 0.01, p<0.01). Other products sold at FM included baked goods, crafts, flowers, herbs, honey, jams, maple syrup, nursery plants, nuts, prepared foods, soap, trees and/or wine. OR and TN both had significant associations in the adjusted model (OR: β = 0.04, SD = 0.01, p=0.01) (TN: β = -0.04, SD = 0.01, p=0.01).

County Level Associations

In total, nineteen independent county-level variables were selected from the USDA Food Atlas for analysis. Supplemental Table S1, has the complete list of the selected variables. Univariate regression analysis identified nine statistically significant associations ($p \leq 0.05$), all of which were associated with an increase in childhood obesity prevalence. Variables included, number of WIC authorized stores per 1,000 residents, percent of WIC redemption per capita, percent of population that was WIC participants, farmers markets accepting WIC vouchers, percent of farmers markets accepting WIC vouchers, number of farmers markets accepting fruits and vegetables, number of grocery stores, and grocery stores per 1,000 residents. The complete list of significant variables can be seen in Table 3 and the complete list of all univariate analysis is shown in Supplemental Table S2.

Step-wise regression, forward and backward identified three variables significantly associated with childhood obesity prevalence. Childhood obesity prevalence of low income 2-4 year olds increased for every unit increase in number of farmers markets accepting WIC (β=0.07,

p=0.001), percent of WIC redemption per capita (β=0.06, p=0.000), and the number of grocery stores per thousand residents (β=2.00, p=0.002). These three variables explained 4.5% of the association with childhood obesity prevalence, and when covariates were added, adjusted R-square increased to 5.5%. All three variables remained significant and positively associated with childhood obesity prevalence, Table 4.

State Level Associations

Using the USDA data, we explored the relationship between childhood obesity prevalence and twenty-two state-level variables including data on WIC participation, FMNP, WIC program budgets, number of farmers market, and food access (Supplemental Table S1). From the full list, the univariate analysis identified six variables significantly associated ($p \leq 0.05$) with childhood obesity prevalence. Each of the factors were positively associated and showed childhood obesity prevalence increased for every unit increase in farmers markets, farmers markets selling fruits and vegetables, farmers markets accepting the WIC Cash Value Voucher, farmers markets accepting WIC coupons, participation in the FMNP, and the number of WIC stores in a state. These results can be seen in Table 5, with the full univariate analysis results in Supplemental Table S3.

Step-wise modeling, forward and backward, identified state participation in the FMNP and number of farmers markets that sell fruits and vegetables as significant variables associated with childhood obesity prevalence at a relaxed p-value of $p<0.10$ and only FMNP at $p<0.05$. States that participated in the FMNP were associated with a 1.78 higher childhood obesity prevalence. Adjusted for race, the presence of the FMNP was still significantly associated with an increase in childhood obesity prevalence (β=1.57, p=0.01). Results are available in Table 6.

Discussion

As childhood obesity continues to affect our nation's youth, the need for directed solutions becomes imperative for the future health of children and our nation. This study used public data to first explore state relations between number of FM and products sold with childhood obesity prevalence of low-income 2-4 year olds. From there, our analysis went on to explore county and state level variables related to food access and the WIC program, again with childhood obesity prevalence of low-income 2-4 year olds.

The state analysis of the associations between the number of FM and childhood obesity prevalence showed few significant relations. Only one state showed a significant inverse relationship between the number of FM per 1,000 residents and childhood obesity prevalence (South Dakota), leaving 43 states with no significant inverse association. There is a dearth of research on similar findings among children; however, studies do exist among adults that can be compared to these results. Using data from the Food Atlas, Jilcott et al. (2011) examined the associations of FM on adult obesity prevalence and found that in non-metro counties there was a 0.07% decrease in obesity prevalence with an increase of one additional standard deviation for FM per 1,000 residents.[24]

Our analysis exploring the relationship between what was sold at FM and childhood obesity prevalence did not reveal consistent findings, and overall magnitude of associations small. Previous research has shown that FV consumption is associated with a decrease in the prevalence of childhood obesity,[10,11,25] whereas diets high in red meat are associated with higher BMI.[26] These observations would lead us to think an inverse association between obesity and the number of FM with FV sales and a positive association with the number of markets selling animal products. Our data showed that only in California and Oregon was there a significant

positive relationship between obesity prevalence and markets selling animal products, whereas only Tennessee revealed a decrease in obesity prevalence with more markets selling FV. In Tennessee and Oregon, significant associations between childhood obesity prevalence and farmers market sales in each category were observed, warranting further exploration as to why this is occurring in these two states. Of note, each product was analyzed separately and did not adjust for the other type of product sold since we were interested in the contribution of each separately on our outcome of interest.

Incorporating lessons from the Socioecological Model (SEM), other community factors are likely playing a role in the associations between this study's explored factors and childhood obesity prevalence. The SEM details four layers considered to contribute to health outcomes: individual, setting, sector, and social/culture norms and values.[27] The setting layer, where community assets such as a FM fit, is a critical point of consideration for this study. If the volume of FM is enough to show an association with obesity prevalence, state officials may consider supporting the presence of more markets. However, given that so few states showed an association between the number of markets and childhood obesity prevalence, and on average there are less than 1 farmers market per 1,000 residents, it is possible other community factors, such as recreation centers and fast food restaurants, are key influences. From this analysis of the USDA Food Atlas, simple differences were seen in average number of farmers markets per 1,000 residents, just 0.04, compared to grocery stores at 0.20, and fast food restaurants at 0.72 per 1,000 residents. Factoring in that farmers markets are typically only open for sales once a week, the availability to purchase fruits and vegetables is much less when compared to fast food. Previous research has shown associations between access to healthy food stores and lower BMI,[28] as well as increases in adult obesity prevalence associated with more fast food

restaurants.[29]

All county-level associations found in this study were positive, indicating increases in childhood obesity prevalence with more farmers markets accepting WIC, WIC redemption, and the number of grocery stores. Part of WIC's eligibility is nutritional risk, under which a high weight-for-height status is an eligibility factor, thus higher weight status in and among WIC participants may be expected. For instance, the average childhood obesity prevalence among WIC children in 2014 was 14.5%,[30] compared to 8.9% reported as the national average in the same year.[31] The positive association in grocery stores is surprising given recent literature around WIC purchases at grocery stores. A study among WIC participants shopping at grocery stores in New England, found increases of frozen vegetables (27.8%), fresh vegetables (17.5%) and fresh fruit (28,6%), after 2009 WIC policy changes.[32] Further research is needed to explore the consumption of fruits and vegetables and WIC participant weight status.

State level analysis found a significant association only between obesity prevalence of low income 2-4 year olds and a state's participation in the FMNP. Because WIC already has higher obesity levels, this could be a factor in states participating in the program in an attempt to address this health outcome. The FMNP partnership aims at increasing access of fresh FV to WIC participants, which in turn hopefully increases consumption; a component of achieving a healthier weight status.[10,11] Research conducted in a Georgia WIC center, found median FV intake was higher in children whose parent used the FMNP coupon, when compared to those that did not.[33] Additional research supports incentive and educational programs targeted at increasing use of farmers markets to help with increased purchases of FV.[34,35] Future research on the FMNP should investigate purchases at markets and consumption in children to better understand program impact on childhood obesity.

There are several limitations of this study which need to be considered. First and foremost, all of the analyses were cross-sectional, and thus, we cannot infer causality. Second, due to the use of publicly available data, years certain data were collected were not always the same or the most ideal. Specifically, the data collection of products sold at the farmer's market comes after the childhood obesity prevalence data. Our ability to capture county-specific data on obesity prevalence for low-income children was hampered by the discontinuation of the Pediatric Nutrition Surveillance Survey data at CDC, our source of 2-4 year old obesity prevalence. Third, the use of urbanicity, which controlled for counties that were metro or non-metro, was not defined by the researcher. Due to several ways to classify urban and rural (metro and non-metro), some may disagree with certain counties classification from this method.[24,36] Finally, we cannot rule out that our findings are due to chance, given the number of analyses conducted and relatively low number of significant associations seen.

Conclusion

From these analysis, only Tennessee showed significant associations between number of farmers markets and markets selling fruits and vegetables with decreasing childhood obesity prevalence. Six states in total, showed small yet significant associations between number of markets and products sold with obesity prevalence. From county analysis, number of farmers markets accepting WIC, percent of WIC redemption and number of grocery stores were associated with increases in childhood obesity prevalence of low-income 2-4 year olds; and at the state level, a state's participation in the FMNP was associated with higher prevalence of childhood obesity within low-income 2-4 year olds.

This study adds to the literature on childhood obesity prevalence and incorporates

components from a national nutrition program. Furthermore, this study identifies specific states with associations between farmers markets (and products sold) and childhood obesity prevalence and places them in the context of WIC FMNP, a means to increase FV access. Specifically, WIC's FMNP utilizes farmers markets to increase the consumption of fresh produce for its participants, which could ultimately improve diet and health outcomes. Understanding factors that contribute to state's participation and WIC participants use of the program would be a next step to help improve diet in our nation's youth, ultimately improving weight status and health outcomes.

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Tables

Table 1
Significant Associations Between Childhood Obesity Prevalence and Farmers Markets in Adjusted and Unadjusted Models

State	Crude Model	Standard Error	P-Values	Adjusted Model*	Standard Error	P-Values
California	-17.52	7.83	0.03	-1.47	9.21	0.87
Connecticut	-104.38	41.94	0.05	-78.99	50.94	0.22
Pennsylvania	***29.83***	***14.38***	***0.04***	***33.14***	***14.99***	***0.03***
Rhode Island	-79.04	17.04	0.02	-73.21	10.43	0.09
South Dakota	***-32.45***	***15.79***	***0.05***	***-34.38***	***16.51***	***0.04***
Vermont	-21.08	8.31	0.03	-13.42	13.05	0.33
Washington	40.85	23.20	0.09	*43.49*	*21.60*	*0.05*

*Adjusted for Census data at the county level of percent Black, percent Hispanic, median household income and urbanicity defined as a counties designation of rural or urban. Childhood obesity prevalence was from low income 2-4 year-olds from 2009-2011 aggregate data from the USDA Food Atlas. Farmers' markets were per 1,000 residents in the county. Forty-four states were included this analysis, the following were omitted due to missing childhood obesity data: Alaska, Delaware, DC, Maine, Ohio, South Carolina and Wyoming.

Table 2
Significant Associations Between Childhood Obesity Prevalence and Number of Farmers Markets by Type of Sales

State	Crude Model	Standard Error	P-value	Adjusted Model*	Standard Error	P-value
Farmer's Market/1,000 Residents Selling Fruits & Vegetables						
Oregon	0.03	0.02	0.06	0.04	0.01	0.01
Tennessee	-0.03	0.01	0.01	-0.04	0.01	0.00
Farmer's Market/1,000 Residents Selling Animal Products						
California	0.03	0.01	0.03	0.04	0.01	0.00
Kentucky	-0.02	0.01	0.03	-0.02	0.01	0.07
Louisiana	0.01	0.01	0.03	0.01	0.01	0.35
Oregon	0.03	0.02	0.05	0.05	0.01	0.00
Tennessee	-0.03	0.01	0.05	-0.04	0.01	0.01
Farmer's Market/1,000 Residents Selling Other Products						
Oregon	0.03	0.02	0.06	0.04	0.01	0.01
Tennessee	-0.03	0.01	0.02	-0.04	0.01	0.01
Texas	0.01	0.01	0.03	0.01	0.01	0.13

*****Adjusted for Census data at the country level of percent Black, percent Hispanic, median household income and urbanicity defined as a counties designation of rural or urban. Childhood obesity prevalence was from low income 2-4 year-olds from 2009-2011 aggregate data from the USDA Food Atlas. Forty-four states were included this analysis, the following were omitted due to missing childhood obesity data: Alaska, Delaware, DC, Maine, Ohio, South Carolina and Wyoming.

Table 3

Significant Univariable Analysis of County-Level Variables on Childhood Obesity Prevalence

Variable	Sample Size	Coefficient (Standard error)	P-Value	95% Confidence Interval
WIC Stores PTH	2,714	0.99 (0.34)	0.003	[0.33 – 1.65]
PCT WIC REDEMPTION	1,921	0.06 (0.01)	0.000	[0.05 - 0.08]
PCT WIC	2,714	0.26 (0.09)	0.004	[0.08 - 0.43]
FM WIC	1,976	0.08 (0.03)	0.003	[0.03 - 0.13]
PCT FM WIC	1,976	0.01 (0.00)	0.010	[0.00 - 0.01]
FM WIC CVV	1,976	0.11 (0.05)	0.013	[0.02 - 0.21]
FM FV	1,976	0.04 (0.02)	0.040	[0.00 - 0.08]
GROC	2,714	0.00 (0.00)	0.013	[0.00 - 0.00]
GROC PTH	2,714	1.15 (0.40)	0.004	[0.36 - 1.95]

Results from the univariate regression analysis, associations to childhood obesity prevalence of low-income 2-4 year olds 2009-2011. PTH = per one-thousand. PCT = percent. FM = farmers markets. CVV = Cash Value Voucher. FV = fruits and vegetables. GROC = grocery store.

Table 4
Associations of County Level Variables & Childhood Obesity Prevalence

Variable	Coefficient	Standard error	t	P-Value	95% Confidence Interval
FM WIC	0.07	0.03	2.65	0.008	0.04 - 0.08
PCT WIC REDEMPTION	0.06	0.01	6.42	0.000	0.02 - 0.12
GROC	2.22	0.69	3.22	0.001	0.87 - 3.58
METRO	0.10	0.18	0.52	0.601	-0.26 – 0.46
PCT_NHBLACK	-0.02	0.01	-3.18	0.002	-0.04 - -0.01
PCT HISP10	0.02	0.01	2.05	0.040	0.00 – 0.03
cons	12.09	0.28	42.77	0.000	11.54 – 12.64

Adj R-squared = 0.0549 Final regression analysis, associations to childhood obesity prevalence of low-income 2-4 year olds 2009-2011. FM = farmers markets. PCT = percent. GROC = grocery store. METRO = urbanicity. NHBLACK = Non-Hispanic African American. HISP = Hispanic. Sample size = 1,582.

Table 5

Significant Univariable Analysis of State Level Variables & Childhood Obesity Prevalence

Variable	Coefficient (Std Error)	P-Value	95% Confidence Interval
FMNP	1.78 (0.59)	0.004	[0.59 - 2.96]
FM	0.01 (0.00)	0.032	[0.00 - 0.01]
FM FV	0.01 (0.00)	0.027	[0.00 - 0.02]
FM WIC CVV	0.02 (0.01)	0.040	[0.00 - 0.03]
FM WIC	0.01 (0.00)	0.031	[0.00 - 0.00]
WIC STORES	0.00 (0.00)	0.045	[0.00 - 0.00]

Sample size = 44 states. Univariate regressions state variables and association with childhood obesity prevalence among low-income 2-4 year olds, 2009-2011, aggregated to state level prevalence. FMNP = Farmers Market Nutrition Program. FM = farmers markets. FV = fruits and vegetables. CVV = Cash Value Voucher. Data from the 2015 USDA Food Atlas.

Table 6

Association of State Factors and Childhood Obesity Prevalence

Variable	Coefficient	Standard error	t	P-Value	95% Confidence Interval
FMNP	1.57	0.62	2.53	0.02	[0.31-2.82]
PCT_His11	-0.02	0.03	-0.64	0.53	[-0.07-0.34]
PCT_Black11	0.03	0.03	1.12	0.27	[-0.03-0.09]
Cons	12.28	0.61	20.21	0.00	[11.06-13.51]

Results from the multivariable logistic regression analysis, associations to childhood obesity prevalence of low-income 2-4 year olds 2009-2011. FMNP = Farmers Market Nutrition Program. FM PCT_BLACK = Non-Hispanic African American. HISP = Hispanic.

Supplemental Tables

Table S1 : Variable List

VARIABLE NAME	DESCRIPTION	YEAR	COUNTY/STATE	LEVEL
WIC STORES	Number of WIC stores	2008	County & State	WIC
WIC STORES PTH	Number of WIC stores per 1,000 residents	2008	County	WIC
PCT WIC REDEMPTION	Percent of WIC redemption per capita	2008	County	WIC
PCT WIC	Percent of Population enrolled in WIC	2009	County	WIC
PCT FM FV	Percent of FM selling FV	2013	County	Food Access
PCT FM ANIMAL PRODUCTS	Percent of FM selling animal products	2013	County	Food Access
PCT FM OTHER	Percent of FM selling other products	2013	County	Food Access
FM	Number of FM	2009	County & State	Food Access
FM PTH	Number of FM per 1,000 residents	2009	County & State	Food Access
FM WIC	FM accepting WIC vouchers	2013	County & State	WIC
PCT FM WIC	Percent of FM accepting WIC vouchers	2013	County & State	WIC
FM WIC CVV	FM accepting WIC CVV	2013	County & State	WIC
PCT FM WIC CVV	Percent of FM accepting WIC CVV	2013	County & State	WIC
FM FV	Number of FM selling FV	2013	County & State	Food Access
PCT FM FV	Percent of FM selling FV	2013	County & State	Food Access
LOW ACCESS	Number of children with low access to stores	2010	County & State	Food Access
GROC	Number of grocery stores	2007	County & State	Food Access
GROC PTH	Number of grocery stores per 1,000 residents	2007	County & State	Food Access
SUPER	Number of supercenters	2007	County & State	Food Access
SUPER PTH	Number of supercenters per 1,000 residents	2007	County & State	Food Access
FFR	Number of fast food restaurants	2007	County & State	Food Access
FFR PTH	Number of FFR per 1,000 residents	2007	County & State	Food Access
WIC POP	Number of WIC Participants in State	2010	State	WIC
PCT WIC CHILD	Percent of Children in WIC	2010	State	WIC
WIC BUDGET	WIC Budget	2010	State	WIC
FMNP	Participation in FMNP	2010	State	WIC
FMNP BUDGET	FMNP Budget	2010	State	WIC

PTH = per one-thousand. FM = farmers markets. PCT = percent. CVV = Cash Value Voucher. FV = fruits and vegetables. GROC = grocery store. FFR = fast food restaurant. FMNP = Farmers Market Nutrition Program.

Table S2:

Univariable Regression Analysis of Childhood Obesity & County Variables

Variable Code	Variable	N	Coefficient	Standard Error	P-Value	Lower CI	Upper CI
WICS08	WIC authorized stores 2008	2714	0.002	0.001	0.106	0.000	0.004
WICSPTH08	WIC authorized stores per 1,000 population in 2008	2714	0.988	0.338	**0.003**	0.325	1.650
PC_WIC_REDEMP08	Percent of WIC redemption per capita, 2008	1921	0.062	0.007	**0.000**	0.048	0.076
PCT_WIC09	WIC participants, % of population 2009	2714	0.256	0.088	**0.004**	0.083	0.428
FMRKT09	Number of Farmers Markets 2009	2713	0.021	0.016	0.178	-0.010	0.053
FMRKTPTH09	Farmers Markets per 1,000 residents 2009	2713	-1.427	1.187	0.229	-3.753	0.900
FMRKT_WIC13	FM accepting WIC voucher 2013	1976	0.076	0.025	**0.003**	0.026	0.125
PCT_FMRKT_WIC13	Percent of FM accepting WIC vouchers 2013	1976	0.006	0.002	**0.014**	0.001	0.010
FMRKT_WICCASH13	FM accepting WIC Cash Value Voucher 2013	1976	0.114	0.046	**0.013**	0.024	0.205
PCT_FMRKT_WICCASH13	Percent of FM accepting WIC Cash Value Voucher 2013	1976	0.005	0.003	0.124	-0.001	0.011
FMRKT_FRVEG13	Number of Farmers Markets selling fruits & vegetables 2013	1976	0.039	0.019	**0.040**	0.002	0.076
PCT_FRMKT_FRVEG13	Percent of FM selling fruits and vegetables 2013	1976	0.002	0.002	0.201	-0.001	0.006
LACCESS_CHILD10	Children with low access to store	2714	0.000	0.000	0.626	0.000	0.000
GROC07	Grocery stores in 2007	2714	0.002	0.001	**0.013**	0.000	0.004
GROCPTH07	Grocery stores per 1,000 residents	2714	1.154	0.404	**0.004**	0.362	1.946
SUPERC07	Supercenters in 2007	2714	-0.004	0.024	0.871	-0.051	0.043
SUPERCPTH07	Supercenters per 1,000 residents	2714	5.876	3.920	0.134	-1.811	13.563
FFRPTH07	Fast food restaurants per 1,000 residents	2,714	-0.398	0.259	0.125	-0.906	0.110
FFR07	Fast food restaurants 2007	2,714	0.000	0.000	0.071	0.000	0.001

PTH = per one-thousand. FM = farmers market. PCT = percent. FRVE = fruits and vegetables. GROC = grocery store. SUPERC= Supercenter. FFR = fast food restaurant. FMNP = Farmers Market Nutrition Program. CI = 95% Confidence Interval.

Table S3:

Univariable Regression Analysis of Childhood Obesity & State Variables

Variable Code	Variable	N	Coefficient	Standard Error	p_value	Lower CI	Upper CI
WIC_ALL10	WIC population 2010	44	0.000	0.000	0.123	0.000	3.39E-06
PCT_CHD_WIC10	Percent Children in WIC 2010	44	-5.147	4.723	0.282	-14.679	4.385
WICFY2010	WIC Budget FY2010	44	0.000	0.000	0.107	0.000	5.07E-09
FMNP2010	FMNP Program	44	1.777	0.588	0.004	0.591	2.96E+00
FMNP_FY10	FMNP Budget FY2010	44	0.000	0.000	0.064	0.000	1.50E-06
FMRKT09_ST	Number of Farmers Markets	44	0.006	0.003	0.032	0.001	0.011
FMRKTPTH2009	FM PTH 2009	44	-9.176	13.487	0.500	-36.394	18.042
FMRKT_FV13	Number of FM selling FV	44	0.008	0.003	0.027	0.001	1.47E-02
FMRKT_WICCASH13_ST	Farmers Markets Accepting WIC CVV	44	0.017	0.008	0.040	0.001	3.24E-02
FMRKT_WIC13_ST	Farmers Markets accepting WIC voucher	44	0.01	0.00	0.031	0.00	1.65E-02
PCT_FMRKT_FV13	Percent of FM selling FV	44	0.023	0.019	0.222	-0.014	6.04E-02
PCT_FMRKT_WICCASH13_ST	Percent of FM accepting WIC CVV	44	0.038	0.023	0.108	-0.009	8.44E-02
PCT_FRMKT_WIC13_ST	Percent of FM accepting WIC voucher	44	0.027	0.014	0.056	-0.001	5.54E-02
LA_CHILD10_ST	Children with low access to stores	44	0.000	0.000	0.150	0.000	2.97E-06
WICS08_ST	Number of WIC stores 2008	44	0.001	0.000	0.045	0.000	1.10E-03
GROS07_ST	Number of grocery stores	44	0.000	0.000	0.054	0.000	6.44E-04
GROSPTH2007	Grocery stores PTH 2007	44	8.359	4.954	0.099	-1.639	18.357
SUPERCO07_ST	Number of supercenters	44	0.005	0.005	0.253	-0.004	1.47E-02
SUPERCOPTH2007	Supercenters PTH 07	44	-32.976	51.088	0.522	-136.076	70.124
FFR07	Number of fast food restaurants	44	0.000	0.000	0.086	0.000	0.000
FFRPTH07	Fast food restaurants PTH	44	-4.544	3.504	0.202	-11.62	2.527

PTH = per one-thousand residents. FM = farmers market. PCT = percent. FRVE = fruits and vegetables. GROC = grocery store. SUPERCO= Supercenter. FFR = fast food restaurant. FMNP = Farmers Market Nutrition Program. CI = 95% Confidence Interval.

CHAPTER 5: STATE PARTICIPATION IN THE WIC FAMERS MARKET NUTRITION PROGRAM AND THE EFFECT OF THE CASH VALUE VOUCHER ON CHILDHOOD OBESITY PREVALENCE

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Manuscript 2

Abstract

Introduction: The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) offers two incentive programs to aid in the purchase of fruits and vegetables among participants; Farmers Market Nutrition Program (FMNP) and the Cash Value Voucher (CVV). This study explores factors associated with a state's participation in the FMNP, and if the passage of the CVV had an effect on childhood obesity rates in states with and without the FMNP.

Methods: Data came from the U.S. Department of Agriculture Economic Research Service's Food Environment Atlas and WIC program data. Logistic regression analysis explored state variables association to participation in the FMNP. A difference-in-difference analysis was used to determine the effect of the CVV on childhood obesity prevalence of WIC children ages 2-4 years old in states with and without the FMNP.

Results: We found seven state factors associated with participation in the FMNP; number of farmers markets, number of children with low access to stores, number of individuals living with low income and low access to stores, number of grocery stores, number of supercenters, number of fast-food restaurants, and childhood obesity prevalence. Only childhood obesity prevalence (β=0.71, p=0.04) remained significant in the adjusted models. Implementation of the CVV had no significant effect on childhood obesity prevalence in states with the FMNP (β=0.04, p=0.95).

Conclusion: More research is needed to explore the relationship on state's participation in the FMNP. Future studies are also needed to understand if these programs are changing diets in WIC children and ultimately effecting weight status.

Keywords: Childhood obesity, WIC, FMNP, CVV

Introduction

The Special Supplemental Nutrition Program for Women, Infants and Children (WIC) provides nutritional assistance to an average of seven million participants per month who meet income, residency, and nutritional risk eligibility criteria.[1] Participants receive one of seven food packages determined by nutritional needs and age, all of which are consistent with Food and Drug Administration (FDA) standards.[2] Packages for infants consist of baby food and formula, and foods such as juices, milk, fruits and vegetables, whole wheat bread and legumes for women and children.[3]

There are two specific programs that target increases in the consumption of fruits and vegetables for WIC participants. In 1992, the Farmers Market Nutrition Program (FMNP) was created with the intent of providing fresh food to program participants as well as expanding the awareness and use of farmers markets.[4,5] States are not required to participate in this program, though 39 states and the District of Columbia currently do by offering a voucher to participants at a minimum benefit level of $10 and a maximum of $30 for fresh fruit and vegetable purchases at participating farmers markets during the harvest season,[6] which on average runs between May and October. In 2009, the Cash Value Voucher (CVV) program was implemented and provides a coupon worth $11 for women and $8 for children, per month, to help offset the costs of fruits and vegetables.[3] The CVV can be used at all WIC participating stores and does not exclusively pertain to farmers markets.

Aiding these participants, particularly children, with a means to achieving a healthy diet is a critical component in promoting healthier futures for some of our nation's most vulnerable citizens. Among children ages 2-4 years old enrolled in WIC as of 2014, 14.5% had a weight-for-height status classified as obese.[7] Diets that include an adequate consumption of fruits and

vegetables are a key component of achieving a healthy lifestyle and preventing obesity.[8,9] Introducing these healthy eating habits in childhood is also vital to future health, as these behaviors tract through adolescence and into adulthood.[10] Recent trends of childhood obesity within WIC are reported to be decreasing,[11] which seems appropriate given WIC's food packages as a driving force behind a healthy diet for program participants. However, the FMNP is not available in all states and it's unclear as to how or which states decide to participate. Furthermore, the effect of the FMNP on childhood obesity has yet to be studied.

This work aims to explore factors from available public data that may be associated with a state's participation in the FMNP, and if the implementation of the CVV had an effect on childhood obesity prevalence in states participating in the FMNP. Unlike the FMNP, the CVV had to be implemented in all states when it was passed into law. It was hypothesized that in states already participating in the FMNP, the additional benefit of the CVV to WIC participants for the purchase of fruits and vegetables would decrease childhood obesity prevalence compared to states that did not participate in the FMNP.

Methods

Data came from the United States Depart of Agriculture's (USDA) 2015 Food Environment Atlas (Food Atlas),[12] US Census data,[13] WIC Program Data,[14] and WIC childhood obesity records reported in the 2016 Morbidity and Mortality Weekly Report.[7] The Food Atlas is published biannually and contains over 300 variables collected from the local, state, and regional level on topics including health, food access, agriculture, public assistance, and socioeconomics.[12] Population data were pulled from the United States Census Bureau to create population weighted variables at the state level. WIC's website was accessed during the Fall of

2018 to abstract FMNP program data and childhood obesity prevalence. This study was exempted by the University of Virginia's Institutional Review Board.

Variables

Independent variables fell into three categories; farmers markets, food access, and health outcomes. Table S1 in Supplemental Tables describes all independent variables considered in the univariate analysis of factors associated with state participation in the FMNP. All data were extracted from the Food Atlas. When only county-level variables were reported in the Food Atlas, the research team aggregated counts to the state level and used same year census population data to create per 1,000 resident variables.

Farmers market specific data included the number of markets in a state, number of markets per 1,000 residents, number and percent of farmers markets selling fruits and vegetables, compiled from Agriculture Census data and USDA's Agricultural Marketing Service, Marketing Services Division.[12] Food access data included the number of grocery stores, supermarkets and fast-food restaurants in the state and per 1,000 residents, collected in 2012 from US Census Burau, County Business Partners.[12] The final two access variables included low income individuals with low access to stores, and children with low access to stores. Low access was defined as living more than one mile from a supermarket/grocery store in an urban area, and more than 10 miles in rural areas, with data collected from the *Access to Affordable and Nutrition Food* report.[12] All of these data were compiled within the Food Atlas.

For health outcomes, we used obesity prevalence among low-income preschool children ages 2-4 years old aggregate data from 2009-2011 collected from the Pediatric Nutrition Surveillance System (PedNSS) data. Due to missing childhood obesity data in 7 states (Alaska,

Delaware, DC, Maine, Ohio, South Carolina, and Wyoming), the final sample size was 44 for the univariate analysis. The PedNSS stopped collecting data in 2011. The only other publicly available obesity prevalence data in children under the age of 5 is from WIC data, which the research team felt would be inappropriate given criteria for WIC eligibility includes weight status. Adult obesity data was reported at the state-level from the Behavioral Risk Factor Surveillance Survey.[12,15]

The dependent variable was participation in the FMNP in the year 2014, at which time 12 states did not participate. For this analysis, states include all fifty and the District of Columbia, excluding tribal territories due to no accompanying obesity or Atlas data. The FMNP data was extracted from WIC's website that contained available data on the program dating back to 2004.[4]

Statistical Analysis

Logistic regression was used to explore factors associated with a state participating in the FMNP. Significant variables ($p \leq 0.05$) identified from the univariate analysis were run through stepwise logistic regression analysis. Using a relaxed p-value of $p \leq 0.10$, forward and backward stepwise regression analysis identified three significant variables. Each of the significant variables was included in a correlation table to determine relations between independent variables. The correlation between the variables identified in the stepwise was referenced for the final selection of variables.[16] Two of the original independent variables were further placed into a multivariable logistic regression while also controlling for race.

To determine the effect of the CVV implementation on childhood obesity prevalence, a difference–in–difference (DD) analysis was performed using panel data. DD is often used to evaluate the impact of healthcare policies in observational data[17] when randomization between

control and treatment groups is not feasible.[18] The key requirements with DD analysis are to have data with similar trends before and after the exposure event, a change in one group after exposure, and measures of the outcome variable either over time or similar time points before and after.

The dependent variable of interest for the DD analysis was childhood obesity prevalence collected from WIC program data. Only Hawaii had missing childhood obesity data in 2004. All other states had a childhood obesity prevalence percentage reported in 2004, 2008, 2010, 2012 and 2014.[7] States were divided based on their participation status in the FMNP as of 2004. The year 2004 was the earliest available FMNP data to determine state participation. Since the Cash Value Voucher program was passed into law in 2009 in all 50 states and DC, 2004 and 2008 data were considered pre-exposure and 2010-2014 data were post-exposure. All analyses were conducted in STATA Version 14.1.

Results

In 2014, 39 states participated in the FMNP. As of 2013, the number of farmers markets in a state ranged from 28-760, with an average of 160 farmers markets per state. Among these farmers markets, on average 85 markets per state sold fruits and vegetables, with the range being 12-372 across states. The average childhood obesity prevalence of 2-4-years old (2009-2011 aggregate) was 13.62% and adult obesity prevalence (2013) was 28.6%.

Univariate logistic regression analysis identified seven variables, across all three categories, from the original fourteen independent variables significantly associated with the presence of the FMNP in a state ($p \leq 0.05$), Table 1. Those variables included number of farmers markets, number of children with low access to stores, number of individuals living with low

income and low access to stores, number of grocery stores in state, number of supercenters in state, number of fast-food restaurants in the state, and childhood obesity prevalence. Forward stepwise regression with a relaxed p-value ($p \leq 0.10$) identified childhood obesity prevalence ($\beta=0.76$, $p=0.02$) and low income and low access to stores ($\beta=6.6e\text{-}06$, $p=0.04$) as associated with program presence in the state. Backward stepwise regression also identified childhood obesity prevalence ($\beta=0.64$, $p=0.03$) as well as number of grocery stores per state ($\beta=0.003$, $p=0.07$). Correlation results indicated an association ($\beta=0.57$ $p \leq 0.05$) between low income, low access and grocery stores in a state. Childhood obesity prevalence and grocery stores were moved to the final logistic regression analysis, and after controlling for race, only childhood obesity prevalence ($\beta=0.71$, $p=0.04$) remained significantly associated with state presence of the FMNP, Table 2.

CVV Effect on WIC Childhood Obesity

In 2004, 37 states participated in the FMNP, with an average WIC childhood obesity prevalence of 15.4%, compared to 13.5% for the 13 states that did not participate. Figure 1 illustrates the trends of childhood obesity prevalence in WIC for states that participated in the FMNP compared to those that did not from 2004-2014. From these parallel trends, we observe some change in obesity prevalence after 2009 when the CVV program was implemented, but the difference-in-difference analysis estimates if the difference was significant. The DD analysis results indicate that after the passage of the CVV program, states with the FMNP had a small insignificant increase ($B=0.04$, $p=0.95$) in obesity prevalence compared to states without the program. In addition, over the time period of 2004-2014, on average, childhood obesity prevalence in WIC decreased by 0.36 which was non-significant ($p=0.54$). Overall, the analysis

indicates that implementation of the CVV did not have an effect on childhood obesity prevalence in states with the FMNP compared to states without the program (refer to Table 3).

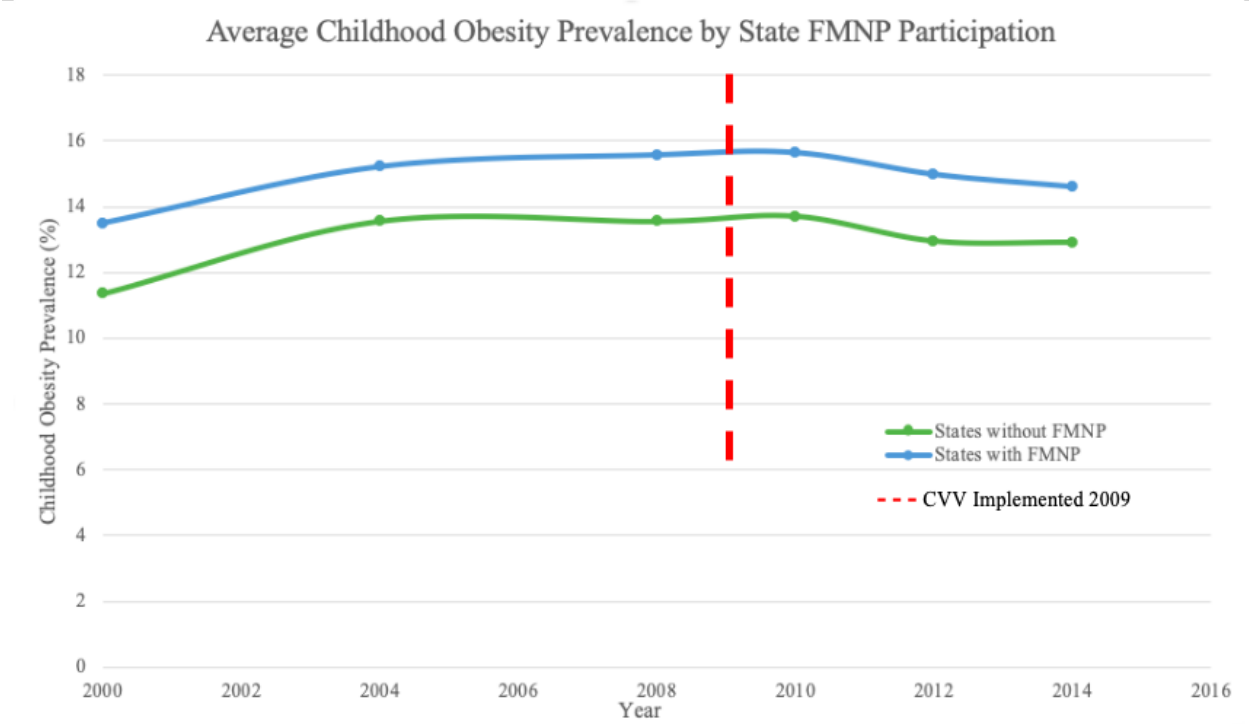

Figure 1. Data was accessed from WIC childhood obesity records reported in 2016 Morbidity and Mortality Weekly Report, *Pan, Freedman, Sharma, et al. 2016.*[7]

Discussion

Overall, this study identified seven factors associated with a state's participation in the FMNP. However, the final analysis identified only childhood obesity prevalence as significantly associated with a state's participation in the FMNP. The hypothesis stated after the implementation of the CVV, states participating in the FMNP would have a significant decrease in childhood obesity prevalence compared to states that did not participate, this was rejected.

Our analysis used publicly available data to explore associations of state factors on presence of the FMNP, and the effect of the CVV on childhood obesity prevalence for 2-4 year olds. Unfortunately, child obesity prevalence data for those under 5 has become less accessible since 2011 when the PedNSS was discontinued, and childhood obesity at the county level was no

longer reported in the Food Atlas. Currently, the WIC program is the sole source of childhood weight status for this age group but is reported only at the state level as compared to county-level data from the PedNSS. Moreover, part of the eligibility criteria for WIC includes a high weight-for-height as a risk. Therefore, it is not surprising that in 2014 WIC obesity prevalence of children under 5 was 5.6 percentage points higher than the national average.[7,19] Our ability to understand the impact of programs like the FMNP and CVV on preventing childhood obesity, and state's decisions on nutritional legislation would be enhanced by having longitudinal data on WIC children and state data on childhood weight status, since not every child is enrolled in WIC.

This study used logistic regression to identify factors associated with a state participating in the FMNP, however few were found to be significant. Publicly available variables were chosen for the analysis if they fell into one of three categories the research team a-priori determined as applicable to the FMNP; farmers markets, food access, and health outcomes. In addition to these state factors that may influence the uptake of the FMNP, incorporating aspects from policy theory may offer additional insights.

Theories on the policy process and connections between research and policy decisions are an area of science that is not often tied to one specific cause and effect.[20] John Kingdon refers to a "window of opportunity" where the process comes downs to three streams affecting agenda-setting in policy formation.[20] Richard Hofferbert created a model with government decision or policy output as the dependent variable and names history, socioeconomics, political behavior, government and behavior among the components affecting the outcome.[20] This study explored factors related to the FMNP, such as farmers markets, food access and health outcomes, all which are related to the purpose of the FMNP. Future studies should combine factors from policy theory and program specifics to try and untangle what seems like a "perfect storm" of factors leading to

a state's participation in the FMNP. Identifying these factors could be useful in future policy adoption and program feedback. For example, if childhood obesity prevalence is a driver in participation, more work is needed to determine the program's effect on eating habits, specifically fruits and vegetable, to then inform policy makers if the program is successful or may need adjustments.

The implementation of the CVV, an additional fruit and vegetable incentive for WIC participants, did not have a significant effect on childhood obesity prevalence in states with the FMNP program compared to those not participating. However, in addition to data on low-income childhood obesity prevalence, more time may be needed to fully assess this effect. In 2007, WIC realigned its food packages with the Dietary Guidelines for Americans and added fruits and vegetables to their packages.[2] At that time, the final rule stated all WIC centers would incorporate the vouchers by August,[21] then moved to October of 2009,[22] with a final provision stating children vouchers had until 2014.[23] Due to implementation variation, the full impact may not be reflected in our analysis.

Unlike the FMNP, the CVV allows vouchers for fruits and vegetables on a monthly basis compared to just during the harvest season. Similarly, both programs only provide a limited dollar amount to purchase fruits and vegetables; the FMNP up to $30 for the entire season, and the CVV $8 monthly for children. Research tells us that the price of fruits and vegetables, particularly at farmers markets, are a major barrier to the purchase of these healthy foods,[24–27] and that incentive vouchers are useful in addressing this challenge but a higher dollar amount may be needed than what is currently being provided. WIC has already increased their CVV amount once, realizing the value was too small to benefit participants.[28] The frequency and amount of the FMNP voucher is another area of consideration, as studies have shown additional

cash incentives on a weekly basis increase purchases[29] and can decrease the body-mass-index of recipients.[30]

Limitations

There are several limitations of this study which should be considered when interpreting the results. First, causality cannot be inferred as all regression analyses were from cross-sectional data. Second, due to the use of publicly available data, years certain variables were collected were not consistent. Our ability to capture specific data on obesity prevalence for low-income children was hampered by the discontinuation of the PEDNSS data at CDC and lack of reporting for missing states. Third, in DD there was the potential for spill-over effect, which means that after the policy is implemented, the control/unexposed group could be getting benefits despite not being directly targeted[17] and could affect results. In the case of the FMNP, it is unlikely that spillover occurred with regards to coupon use, but the proximity or location of farmers markets to non-participating states on borders could contribute to spill over. Last, was the time states were given time to roll out the CVV program. While the law states benefits were required by October of 2009, as mentioned earlier, it is unclear exactly when each WIC center rolled out the benefits.

Conclusion

In closing, we found seven state factors associated with participation in the FMNP, but only childhood obesity prevalence remained significant after controls were added. The implementation of the CVV which offers $8 monthly for the purchase of fruits and vegetables had no effect on childhood obesity prevalence in states with the FMNP compared to states

without the program. Research shows that diets plentiful in fruits and vegetables have been associated with healthier weight statuses in children.[31–34] However, WIC's two incentive programs that increase ability to purchase fruits and vegetables, do not appear to be having the same health outcomes on children. Future studies are necessary to understand if these programs are changing diets in the children and ultimately effecting weight status. To ensure a healthier future for our nation, we must start with youth and the programs available to aid their current nutrition and future health.

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Tables

Table 1:

State Factors Significantly Associated with the Farmers Markets Nutrition Program

Variable	*Sample Size*	*Odds Ratio*	*Coefficient*	*Standard Error*	*P>|z|*	*Lower CI*	*Upper CI*
Farmers Market in 2013	51	1.01	0.01	0.01	0.03	0.00	0.03
Children Low Access to Stores 2010	51	1.00	0.00	0.00	0.03	0.00	0.00
Grocery Stores in State 2012	51	1.00	0.00	0.00	0.02	0.00	0.01
Supercenters in State 2012	51	1.01	0.01	0.01	0.05	0.00	0.03
Low Income Low Access to Stores 2010	51	1.00	0.00	0.00	0.04	0.00	0.00
Childhood Obesity Prevalence	44	2.19	0.78	0.29	0.01	0.19	1.38
Fast food Restaurants in State 2012	51	1.00	0.00	0.00	0.03	0.000	0.00

Table 1 displays the results from the univariate logistic regressions between state variables and a state's participation in the Farmers Markets Nutrition Program (FMNP). State participation in the FMNP was recorded at the year 2014, with all independent variables collected before from the USDA Food Atlas. Significant univariate variables were reported when $p \leq 0.05$. CI = Confidence Interval at 95%.

Table 2:

Association Between State Factors and Participation in the FMNP

	Coefficient	*Standard Error*	*p-value*	*95% CI Lower*	*95% CI Upper*
Childhood Obesity Prevalence	0.713	0.354	0.044	0.019	1.407
Grocery Stores	0.002	0.001	0.140	-0.001	0.005
Hispanic	0.044	0.047	0.344	-0.047	0.135
African American	0.051	0.076	0.500	-0.098	0.200
Cons	-10.58	4.912	0.031	-20.207	-0.953

Table 2: The multivariate logistic regression of state factors and a state's participation in the FMNP. Variables were pulled from the step-wise regression that identified childhood obesity prevalence and number of grocery stores in the state as significantly associated. Hispanic and African American are reported as percent of population from census data.[13] Sample size (n=44), excludes 7 states due to missing childhood obesity data. Pseudo r-squared = 44.08%.

Table 3:

Difference in Difference Estimates of Cash Value Voucher Effect on WIC Childhood Obesity Prevalence

Number of observations = 254
F(3, 250) = 10.68
Prob > F = 0.0000
R-squared = 0.1332
Root MSE = 2.1738

	Coefficient	**Standard Error**	**t**	**P>|t|**	**95% Confidence Interval Upper**
Childhood Obesity Prevalence Rate	-0.36	0.58	-0.61	0.54	(-1.50 – 0.79)
Childhood Obesity Prevalence Between Groups	1.84	0.48	3.84	0.00	(0.90 – 2.78)
CVV Effect	0.04	0.66	0.07	0.95	(-1.26 – 1.34)
Cons	13.55	0.41	33.39	0.00	(12.75 -14.35)

Table 3 is the results from the difference-in-difference analysis to determine the effect of the Cash Value Voucher on states with and without the Farmers Market Nutrition Program.

Supplemental Tables

Table S1: Independent Variables for Analysis

VARIABLE NAME	YEAR	DEFINITION	CATEGORY
1. FM	2013	Number of FM in a state	Farmers Market
2. FM PTH	2013	Number of FM per 1,000 residents	Farmers Market
3. FM SELLING FV	2013	Number of FM in state selling FV	Farmers Market
4. PERCENT OF FM SELLING FV	2013	Percent of FM in state selling FV	Farmers Market
5. GROCERY STORES	2012	Number of grocery stores in the state	Food Access
6. GROCERY STORES PTH	2012	Grocery stores per 1,000 residents	Food Access
7. SUPERCENTERS	2012	Number of supercenters in the state	Food Access
8. SUPERCENTERS PTH	2012	Supercenters per 1,000 residents	Food Access
9. FAST FOOD RESTAURANTS	2012	Number of fast food restaurants in state	Food Access
10. FAST FOOD RESTAURANTS PTH	2012	Fast food restaurants per 1,000 residents	Food Access
11. CHILDREN LOW ACCESS TO STORES	2010	Number of children <18yrs age living >1mile in urban areas to supermarket/grocery store/supercenter; >10miles in rural areas	Food Access
12. LOW INCOME LOW ACCESS TO STORES	2010	Number of low income living >1mile in urban areas to supermarket/grocery store/supercenter; >10miles in rural areas	Food Access
13. ADULT OBESITY PREVALENCE^	2013	Percent of adults in state with BMI $\geq$30kg/m^2	Health Outcome
14. CHILD OBESITY PREVALENCE	2009-2011	Percent of children in state with BMI-for-age > 95th percentile based on CDC 2000 growth chart	Health Outcome

Key: FM = farmers market. FV = fruits and vegetables. PTH = per 1,000 residents. BMI = body mass index.

Table S2: Univariable Logistic Regression Analysis of State Variables and Participation in the Farmers Market Nutrition Program in 2014

Logistic Regressions	N	Odds Ratio	Coef	Std Error	Z	P>|z|	Lower_CI	Upper_CI	Pseudo R2	Log Likelihood	LR Chi2	Prob> chi2
Farmers Markets	51	1.013	0.013	0.006	2.14	**0.033**	0.001	0.026	0.141	-23.91	7.82	0.01
Farmers Markets per 1,000 Residents	51	0.000	-12.001	12.229	-0.98	0.326	-36.576	12.575	0.02	-27.35	0.95	0.33
Farmers Markets Selling Fruits and Vegetables	51	1.015	0.015	0.009	1.73	0.083	-0.002	0.033	0.08	-25.50	4.65	0.03
Percent of Farmers Markets Selling Fruits and Vegetables	51	0.994	-0.006	0.022	-0.28	0.776	-0.052	0.039	0.00	-27.78	0.08	0.78
Children with Low Access to Stores	51	1.000	0.000	0.000	2.15	**0.032**	0.000	0.000	0.14	-23.94	7.77	0.01
Grocery Stores	51	1.002	0.002	0.001	2.28	**0.023**	0.000	0.005	0.21	-21.88	11.88	0.00
Grocery Stores per 1,000 residents	51	130392	14.081	8.870	1.59	0.112	-3.744	31.906	0.06	-26.06	3.53	0.06
Super Centers	51	1.013	0.013	0.007	1.98	**0.047**	0.000	0.026	0.10	-24.94	5.78	0.02
Super Centers per 1,000 residents	51	0.000	-75.422	48.527	-1.55	0.120	-172.941	22.097	0.05	-26.47	2.71	0.10
Low Income Individuals and Low Access to Stores	51	1.000	0.000	0.000	2.03	**0.042**	0.000	0.000	0.12	-24.43	6.78	0.01
Adult Obesity Prevalence	51	1.127	0.120	0.113	1.19	0.232	-0.077	0.316	0.03	-27.09	1.48	0.22
Childhood Obesity Prevalence	44	2.191	0.784	0.293	2.68	**0.007**	0.193	1.376	0.25	-17.82	11.53	0.00
Fast Food Restaurants	51	1.000	0.000	0.000	2.14	**0.033**	0.000	0.001	0.16	-23.45	8.76	0.00
Fast Food Restaurants per 1,000 Residents	51	0.602	-0.507	2.973	-0.17	0.865	-6.482	5.468	0.00	-27.81	0.03	0.87

CHAPTER 6: AN INSIDER'S VIEW TO THE CHALLENGES AND BARRIERS OF THE WIC FARMERS' MARKET NUTRITION PROGRAM

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Manuscript 3

Abstract

Background: Created over 25-years ago, the Farmers Market Nutrition Program (FMNP) has had varied participation and a dearth of research connecting it with health outcomes, in particular, childhood obesity. A subprogram within the Special Supplement Nutrition Program for Women Infants and Children (WIC), the FMNP is currently available in 39 states and DC.

Purpose: The purpose of this study was to explore state variation, challenges and barriers within those participating in the FMNP through the lens of state stakeholders.

Design & Methods: A descriptive qualitative design was employed with a purposeful sample to select stakeholders within the FMNP among the 39 states and DC.

Results: All 40 participating states (including DC) responded to the request for information. On average, states had 63% of their counties participating in the FMNP. Reasons for selection of participating counties included the number or proximity of the farmers in the county, WIC population or participation, county or WIC agency interest, program funding, farmer interest or past participation. The average redemption rate of the program coupons was 55%. Six themes emerged as the barriers and challenges to the program; policy limitations, coupon logistics, market factors, competition, farmer challenges, and participant challenges.

Conclusion: Despite varying program participation and redemption rates, many states face similar challenges and barriers with the FMNP. The program has the potential to enhance the diets of WIC participants while simultaneously supporting our country's farmers; however, many challenges stemming from program logistics need to be addressed to pave the way for the program's success.

Keywords: Qualitative analysis, WIC, FMNP, barriers and challenges

Introduction

Federally mandated programs have been addressing the health concerns of women and children for nearly 100-years. In 1921, the Sheppard Towner Act was the first federal legislation aimed directly at aiding women and children; specifically helping to decrease maternal and infant mortality.[1] Today, the Special Supplemental Nutrition Program for Women Infants and Children (WIC), passed into law in 1975, is a federal program that supports pregnant women, infants and young children (up to the age of 5) across all fifty states who due to poor or inadequate health care and nutrition, are at an increased risk to their physical and mental wellbeing.[2,3] As of 2016, WIC served 8.8 million people, of which 23.4% were women, 23.3% were infants (under 12 months) and 53.3% were children aged 1-4 years.[4]

One-hundred years ago, federal legislation was addressing mortality, malnutrition and food insecurity, whereas today, a health concern of our country is related to obesity. Obesity prevalence of 2-4 years old enrolled in WIC varies from 20.0% in Virginia to 8.2% in Utah, with the national average at 14.5% as of 2014.[5] As new health concerns arise, federal programs adapt over the years to try and keep pace with changes. One example within WIC, is the addition of incentive programs to aid in increased consumption of healthier foods, a proven means to achieving a healthy weight status,[6–8] ultimately targeted at decreasing obesity.

In 1992, WIC created the Farmers Market Nutrition Program (FMNP) with the intent of providing fresh foods to program participants, as well as expanding the awareness and use of farmer's markets.[4,9,10] The program is a partnership between the states and the federal government whereby states must apply for the federal funds and match administrative funds,[11] with current participation including 39 states and the District of Columbia (DC).[10] The program helps provide these foods by offering vouchers to participants for the harvest season,[10] usually

between May and October. Studies conducted among WIC participants within the FMNP show the program's success in increasing fruit and vegetable consumption.[12,13] The FMNP's ability to enhance diet quality among participants is a key component to achieving a healthier weight status; a current health concern for many WIC children.

However, the current statute does not mandate that every state's WIC program participate in this nutritional incentive program, and publicly available budget data shows year to year variation of state participation, varying coupon amounts and number of participants.[10,14] States also vary on the value of the voucher, with a minimum benefit level of $10 and maximum of $30, as well as the number of participating recipients, farmers, and markets engaged across the state.[10] Beyond these implementation differences, further evidence does not exist on why such variation may be occurring or what other factors may be hindering the programs ability to increase participants and benefit usage. Research on state policies in schools shows significant associations between strong policies and lower BMI z-scores in children, with strong policies characterized as those with a required implementation plan or strategy.[15] In order to evaluate the strength of policies, in particular the FMNP, more research on the program implementation and processes is necessary.

This study is part of a larger body of work to explore associations between fruit and vegetable incentive programs within WIC and childhood obesity prevalence. The purpose of this study was to explore state variation, challenges and barriers within those participating in the FMNP through the lens of stakeholders, specifically program Directors. Through a better understanding of the FMNP across participating states, policymakers can gain useful insights for policy improvements and future research can explore the effect of the program on health outcomes.

Methods

A descriptive qualitative design[16] was employed with a purposeful sample to select stakeholders within the FMNP among states that participated in the program. Eleven states were excluded due to non-participation. Forty stakeholders across 39 states and the District of Columbia were sent an email (N=40) with six questions and given the option to reply via email or discuss over the phone. Specific questions are listed in Table 1. Stakeholders were defined as FMNP Program Directors, identified on the WIC FMNP website in October of 2018. This study was ruled exempt by the University of Virginia Institutional Review Board.

TABLE 1: Interview Questions

1. How many counties in your state participate in the FMNP?
2. Have the same counties always participated in the program?
3. What factors lead to the selection of these counties for participation?
4. Are FMNP benefits offered to residents on the WIC waiting list?
5. What is the redemption rate of the FMNP coupons?
6. What, if any, are some of the challenges/barriers to implementation of this program?

Analysis

The email message prefaced the dissertation work which was a part of this project and explained that the purpose was to seek additional clarification on the implementation and administrators perceived challenges and barriers to the program. The majority of responses came via email (N=32), seven responded with phone and email, and four responses came from phone conversations. No additional information was collected from stakeholders. Conversations over

the phone were not recorded, and a closed-loop read-back communication was used to ensure the correct information was heard.

Qualitative methods were carried out using direct content analysis.[17] Four of the questions were quantified, one was divided into categories and the sixth coded. The sixth question on barriers and challenges was line-by-line coded and double verified by a second researcher. Codes were grouped together by the origin of reason, for example, if the code was related to the state's participant in the program, they were further clustered together. Using this technique, 50 line codes were condensed into 18 categories and finally into six themes. The final themes were researched through the consensus of the research team. Trustworthiness and rigor were ensured through the completion of an audit trail and through making decisions transparent with the research team during the process. Data visualization was conducted in QGIS 3.4.4.

Results

Question 1: How many counties in your state participate in the FMNP?

Wide variation was seen across states in regard to the number of counties that participate in the program. Responses spanned from 1% of counties (Nebraska) to 100%, which was true for 14 states. Several states offered clarification to this question, most specifically that participation in their state was not by county but defined otherwise. For the purpose of this study, all variations were treated as if they were counties, and exceptions are noted in Figure 1.

Question 2: Have the same counties always participated in the program?

In 17 states, the same counties have always participated in the FMNP, or to the best knowledge of the director. Twenty-three states reported variation in the specific counties that participated. The reason for variation included addition and subtraction of participating counties over the years, with specifics addressed in the subsequent question.

Question 3: What factors lead to the selection of these counties for participation?

Reasons for county participation were sorted into six categories: number or proximity (to WIC centers) of the farmers in the county, WIC population or recipient participation, county or WIC agency interest, funding, farmer interest or participation, and other. Others included existing partnerships, convenience, staffing, and county poverty. Twenty-nine states and DC answered this question, 20 referencing more than one reason for which areas within their state took part in the FMNP. The number or proximity of farmers markets in the county was the highest referenced reason for the selection of participating counties (33%), followed by county/agency interest (21%). Results are displayed in Figure 2.

Question 4: Are FMNP benefits offered to residents on the WIC waiting list?

In the FMNP statue, a state can elect to give coupons to residents that may be on the waitlist for WIC.[11] To the knowledge of the research team, no state had a waiting list, thus this question created confusion among many responders, most only answering the state did not have a waitlist. This question was thrown out of the analysis due to a lack of clarity and specificity from the researchers.

Question 5: What is the redemption rate of the FMNP coupons?

Redemption of coupons varied from 27% (Delaware and Virginia) to 94% (Georgia), while no value was reported from New York. On average, coupon redemption was 55% among the 39 states that responded. Georgia was the only state to specifically state they did not over-issue checks to achieve reported redemption rates. Over-issuing checks were described as double or triple printing and distribution of redeemable vouchers resulting in over issuing to reach the desired redemption. Coupon redemption appeared to have some clustering on the East Coast near Maryland and Pennsylvania, but visualization of redemption (Figure 3) did not uncover any other themes.

Question 6: *What, if any, are some of the challenges/barriers to implementation of this program?*

Barriers and challenges to FMNP implementation were reported by 36 of the 39 participating stakeholders. Through the content analysis, six overarching categories of challenges emerged. Areas included: policy limitations, coupon logistics, market factors, competition, farmer challenges, participant challenges. Figure 4 is a diagram map of the coding tree and Table 2 shows reported barriers/challenges by state.

Policy Limitations

Policy limitations included any challenge or barrier that was rooted in the FMNP policy or program logistics. The main challenge within this grouping was funding; in particular lack of funding. Funding challenges included difficulties of securing match funds from the state, as well as the limited funds available to aid in implementing the program. Funding was often referenced

as a precursory barrier to administrative demands. Due to a lack of administrative funds, many states had one person responsible for all the administrative responsibilities of the program, often causing a strain to the sole person responsible. Specific to FMNP program logistics, several states mentioned the mountain of program rules and regulations as a barrier to attracting farmers to participate.

Coupon Logistics

Coupon logistics was broken into two subcategories; feasibility and distribution. Many stakeholders commented on the challenges of having the FMNP still operate with paper checks; old technology compared to the Electronic Benefit Transaction cards that WIC recipients are familiar with. Additional feasibility problems were referenced in the processes of how the coupons can and cannot be combined with other benefits or transactions. Distribution was also cited as a problem when sending of coupons did not come from a centralized source, but instead was left to individual centers across the state.

Market Factors

The majority of barriers and challenges listed by stakeholders were in regards to the markets themselves. Accessibility of the markets was the most referenced reason among stakeholders for lack of program success, and thus a major challenge for them to overcome. In addition to physical accessibility, the time, transportation, weather and familiarity of the markets was also a challenge.

Competition

Only two states referenced outside challengers as a barrier to the FMNP. Stakeholders believed that programs within WIC may be detracting from the use of farmers markets because they create ease of buying fruits and vegetables with electronic benefits at stores. In particular, the Cash Value Voucher program promotes the purchase of fruits and vegetables but eliminates the challenge of going to the farmers market.

Farmer Challenges

In order for the program to operate, farmers must sign-up to become participating vendors which presented challenges previously mentioned under policy limitations. Similarly, stakeholders referenced the sheer number of interested farmers and lack of engagement as a common barrier. In particular, finding new farmers was referenced as a challenge to expanding the program. Specific reasons for low farmer interest were not explored.

Participant Challenges

The second most referenced challenge in the implementation of the FMNP was the WIC participants. As seen in early data on the percentage of coupons redeemed, participant engagement in terms of redeeming coupons varies considerably state to state. In addition, several stakeholders mentioned nutritional education and program awareness as a barrier to the redemption of the coupons. Other challenges included language barriers, participant comfort with using markets and overall understanding of the program and how it could be of benefit to the participants.

Discussion

This study illustrates the breadth of differences and challenges that exists in and among the states that participate in the FMNP. In particular, this work demonstrates the varying degree of success, coupon redemption, participation, and the number of counties, that exists within the program across the nation. Furthermore, actionable items can be drawn from the barriers and challenges presented by the stakeholders to ultimately improve the FMNP's potential benefit to the WIC participants and farmers.

The percent of participating counties varied considerably from 1 to 100%. Interestingly, each county in a state does not always have its own designated WIC center, as many states have WIC centers serving more than one county. Further complicating counties' participation could be the varying responsibilities of implementing the program that was anecdotally observed while collecting information. For example, some stakeholders were within the state's health department others within the agricultural division and solely responsible for farmers and coupon distribution and thus not associated with WIC. Other states divided responsibilities to the WIC centers, who were responsible for a varied number of counties and participants. Further understanding of these state differences, could lend a better explanation to the varying degree of county participation.

Market factors were the highest referenced perceived barrier within the FMNP, followed by participant challenges. Within markets, specifics included the market hours of operation, transportation to these markets, visibility in terms of location and weather conditions which influenced shopper's attendance. Challenges from the participants encompassed familiarity with the program, nutritional education, language barriers and lack of engagement. These challenges are consistent with the literature, where studies found particularly among low-income

individuals, barriers to use of farmers markets included misperception of benefit acceptance, high prices, lack of nutritional education around the available foods, and lack of transportation.[18–20] Part of WIC's mission is providing nutritional education to its participants,[4] which may call for a deeper look into the educational programing. Innovation around nutritional education, for example having education booths on site at the farmers market that was trialed in Alabama,[21] could also enhance FMNP participation. Research conducted in Pittsburg, Pennsylvania WIC office, suggests that mobile markets may be a possible avenue to help with transportation barriers.[22] State innovation coupled with research evaluations are critical next steps to addressing these barriers.

Additional justification for the selection of counties that participated was the number of interested farmers and the proximity of farmers market to WIC serving areas. In some states, farmers markets were held in WIC center parking lots, a dual benefit to the participant and the farmer. As the number of farmer's markets in the US continues to grow each year,[23] this barrier may be overcome through programs such as the FMNP that also support farmers by bringing them additional business. However, at the current state, the number of farmer's markets relative to population and compared to grocery stores is low, and averages 0.03 farmer's markets per 1,000 residents as of 2009.[23] Farmers challenges were also a theme in overall challenges to the program. Evidence from interviews with farmers in the Special Nutation Assistance Program markets highlights burdens in payment processing, limited administrative information, and limited support as barriers to their participation.[24] Given the necessity of farmers to the program, ways to simplify this administrative process to increase farmer engagement would seem paramount.

Further exploration into coupon redemption across states may lend best practices to be learned from those states with higher rates. Many states mentioned they over-issued coupons to achieve their current rates. While over-issuing may help reach more participants, other states reference partnerships with local governments and non-profits as their means to higher coupon redemption. New York has shown great success by partnering with other state programs that encourage participation in the FMNP and purchase of fruits and vegetables at farmers markets.[20] Research has also identified key areas that could improve coupon redemption such as providing more coupons and educational material, collaborating with local agencies, and hiring an FMNP manager to focus only on this program.[25]

Another area of improvement that could improve the impact of the program is through the modernization of the coupons. While WIC has made substantial advances over the years to bring EBT to its participants, creating both ease of the participant and streamlining information for WIC, it is surprising that the FMNP coupons remain as a method of the past. Several states referred to the challenges of managing printed coupon booklets, whereas other WIC benefits, including the new Cash Value Voucher program, are all electronically managed.

Funding presented challenges across many sectors within the program, from administrative support funds for more staffing, securing match funds for the program, and the amount of money the coupons contain for produce purchases. In FY2018, the FMNP was appropriated $18.548 million in federal funds and served about 1.7 million or 19% of WIC participants.[10] From this work, it is known that not all funds get utilized every year and thus original program intent of benefiting farmers and WIC participants is less than optimal. As this country continues to battle staggering healthcare costs, unused federal funds to support health should not be ignored, but focus turned to help ensure the reach of these programs is optimized.

Health policies have been influential in improving health outcomes, in particular in addressing the health of children through legislation that focuses on healthy eating.[26,27] These policies are also noted to save more than they cost to implement while improving diet quality and potentially decreasing obesity prevalence.[26,28]

As research continues to explore farmers markets and health outcomes, and policy adapts to increase access to these foods for all, rigorous evaluations should be conducted for policymakers. At current operation from a budget standpoint, an average redemption of coupons at 55% would mean roughly $9 million dollars in federal funds are going unused each year. Evidence from this study should be used in future work to find solutions to barriers such as farmer engagement, or administrative burdens that seem most pressing to the success of the program. The policy barriers related to administrative budgets, accompanying administrative workload and coupon type are additional areas of needed attention concluded from this study. Ultimately, policy changes at the local, state and federal level could help streamline the program, address barriers to success, and ultimately improve redemption rate[22] that benefits both the consumer and the farmer.

From this study, we learned that a significant portion of the federal dollars allocated to this program go unused as barriers and challenges identified prevent a high coupon redemption rate within the WIC FMNP. In contrast, the farmers market nutrition programs within the senior citizen program appears to function better. The Farmers Market Coalition references coupon redemption as high as 85% within senior communities.[29] A survey analysis among seniors participating in the South Carolina program indicated that 89% of respondents reported an intent to eat more fruits and vegetables because of this program.[30] In 2001, the Seattle Senior Farmers Market Nutrition Pilot Program delivered bi-weekly produce to homebound seniors and after the

intervention period found that produce recipients reported consuming 1.04 more daily servings of fruits and vegetables.[31] Participants that received the food baskets increased consumption of 5 or more fruits and vegetables per day by 17% at the end of the study, and the mean difference in consumption compared to the control group was 1.31 ($p < 0.001$).[31] From studies such as these, it is clear the program has the ability to be successful in terms of a high redemption rate and increasing fruit and vegetable consumption. However, if current barriers and challenges within the WIC FMNP are not addressed, it is fair to say that tax payer dollars may need to be allocated differently within WIC to ensure use of funds are reaching and aiding beneficiaries. Moreover, given that transportation was a key barrier within the WIC FMNP, future studies may look at a deliver program similar to the one conducted among seniors.

Strengths and Limitations

The semi-structured interview left interpretation and extent of response to the stakeholder. This method created variation between length of responses as well as detail provided. A strength of this study was the responses were collected from 100% of the states participating in the FMNP.

Conclusion

This study brings forward key differences in the states participating in the FMNP while revealing key barriers to its success from those working on the frontline. The average coupon redemption was 55%, and key barriers included, external farmer market factors, participant challenges, and policy challenges. This work contributes to the small body of literature on the FMNP, and corroborates the need for sharing best practices and barriers among participating

states to create a stronger future for the program.[21] The FMNP has the potential to increase access to healthy food for our nation's most vulnerable population while simultaneously supporting our nation's farmers. It is time attention be given, policies reworked to ensure regulatory barriers are not impeding program success, and more research efforts focusing on how these programs and best practices may be improving health outcomes, or not.

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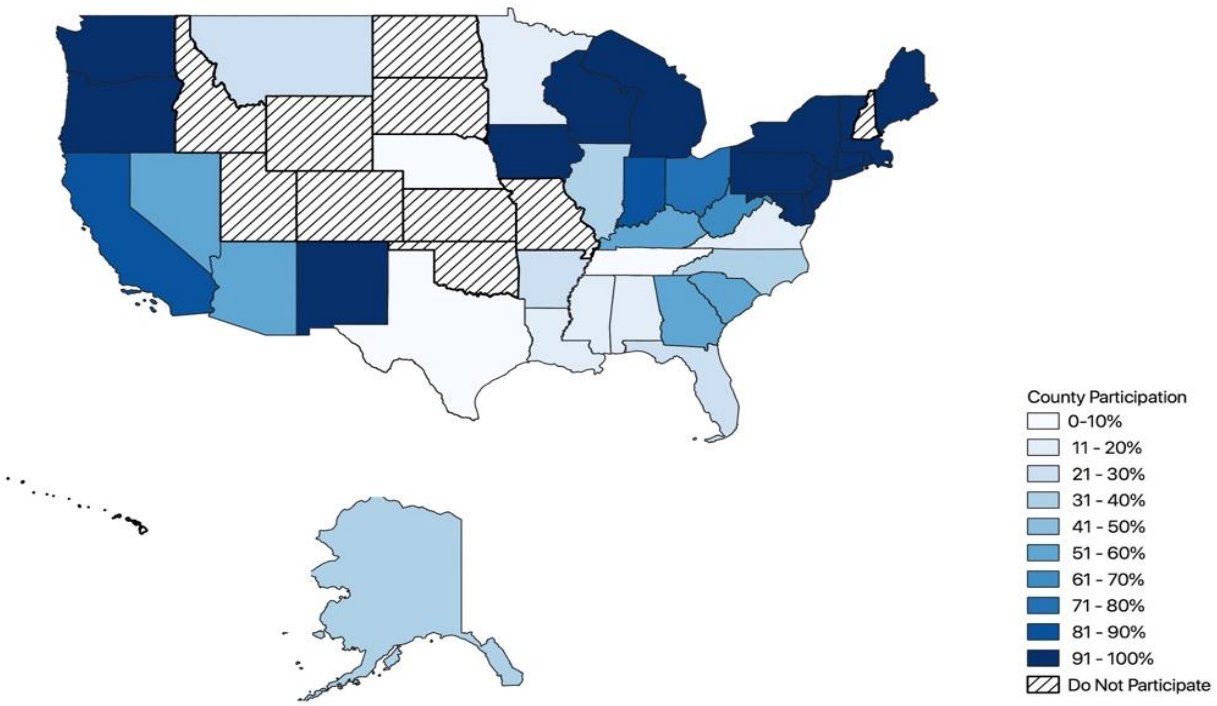
Tables & Figures

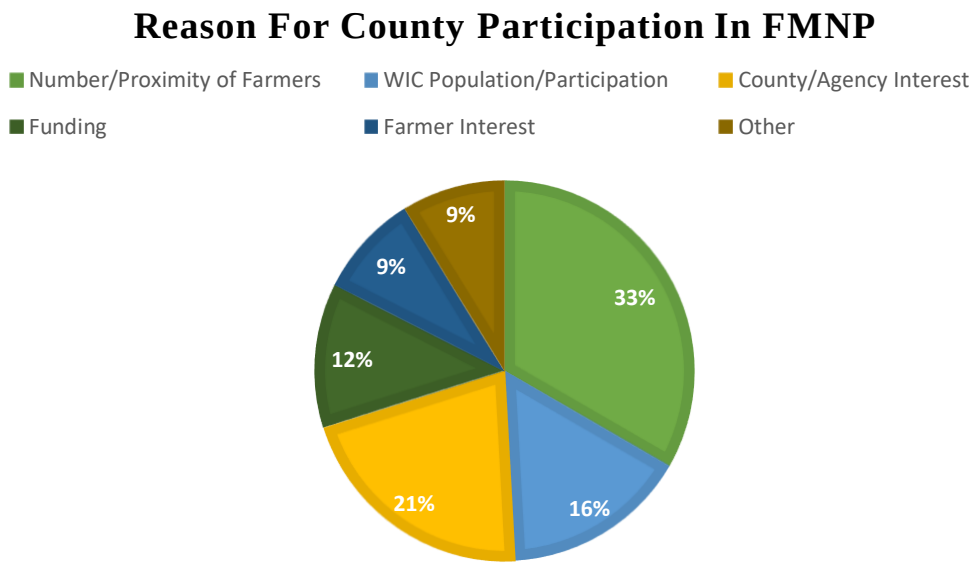
Figure 1

Percent of Counties that Participate in the WIC FMNP



Footnote: Alaska is divided into city boroughs, boroughs and census areas, which were all treated equally for the purposes of this question. DC is not a county and participates in Maryland counties. Maryland has counties plus the city of Baltimore. Washington also reported dual participation in Idaho. Louisiana is defined by parishes and Minnesota includes tribal nations.

Figure 2



Footnote: Other = existing partnerships, convenience, staffing, and county poverty.

Figure 3

United States' Redemption of FMNP Coupons

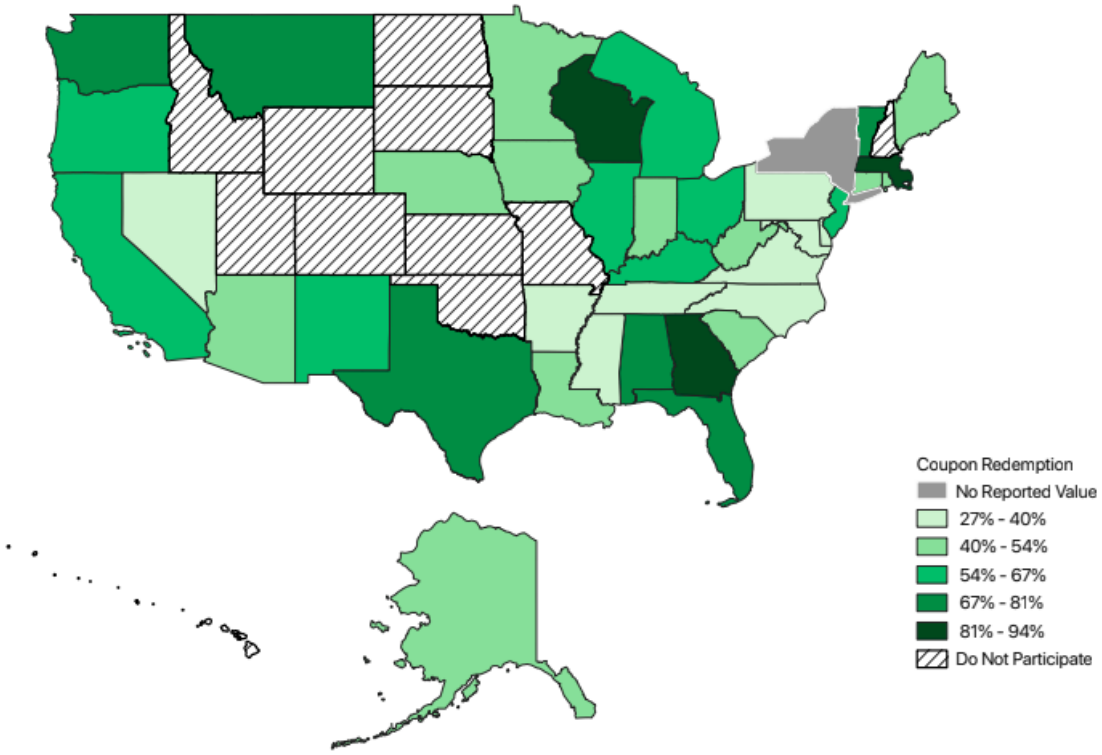


Figure 4

Coding Tree for Challenges and Barriers within the FMNP

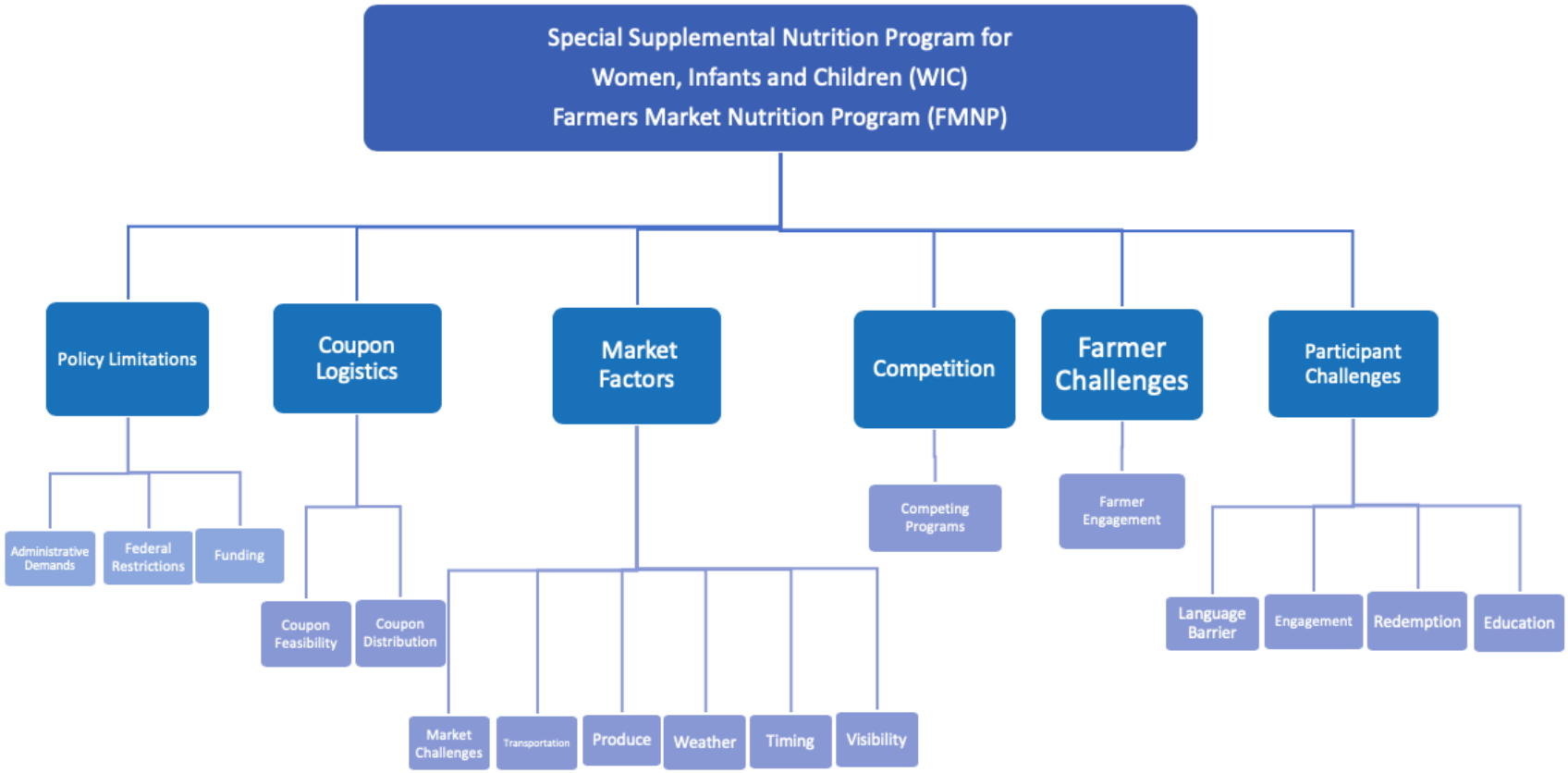


Table 2:

State Specific Themes of Challenges and Barriers to FMNP

	Policy Limitations	*Coupon Logistics*	*Market Factors*	*Competition*	*Farmer Challenges*	*Participant Challenges*
Alabama			XX			X
Alaska	X	X			X	
Arizona	XXX	X	X			X
Arkansas			XXX			X
California	XX					
Connecticut	XXX					XXX
District of Columbia	XX		XX			X
Delaware	X	X				
Florida			X			X
Georgia						
Illinois	X		X		X	
Indiana			XX		X	X
Iowa		X		X		X
Kentucky		X				
Louisiana	X					X
Maine	X					
Maryland		X	XX			
Massachusetts	X					
Michigan			XX			
Minnesota			XX			X
Mississippi		X	X			XX
Montana			XXX			X
Nebraska	XX					
Nevada			XXX			X
New Jersey						X
New Mexico						X
New York						
North Carolina			XXX			XX
Ohio	X				X	X
Oregon		X	XX			X
Pennsylvania			X			X
Rhode Island			X			
South Carolina	X		XX		X	X
Tennessee	X			X		
Texas		X	X			X

Vermont			XX			XX
Virginia			XXX			X
Washington	X					
West Virginia	X		XX			XXX
Wisconsin						
Totals	***23***	***9***	***42***	***2***	***5***	***31***

Each "x" indicates a response from the state that corresponded to that theme.

CHAPTER 7: SYNTHESIS & IMPACT WITHIN NURSING

The purpose of this research was to explore associations between childhood obesity prevalence and incentive fruit and vegetable programs within the Special Supplemental Nutrition Program for Women, Infants and Children (WIC). Those programs included the Farmers Markets Nutrition Program (FMNP) and the Cash Value Voucher (CVV), both which serve as a means to increase access to fruits and vegetables for WIC participants. Given a diet plentiful in fruits and vegetables can have an inverse association to weight status,[1,2] these incentive programs are well positioned to aid in addressing a national health crisis; obesity. This work focused on low-income children under the age of five and a federal program's potential to improve their health status.

Specific aims of this program of research included: (1) discovering county and state level factors within farmers markets, food access and the WIC program that were associated with obesity prevalence of 2-4 year old children from low-income families, and state factors associated with participation in the FMNP, (2) determining the effect of the 2009 implementations of the CVV program on obesity prevalence of WIC children 2-4 years old living in states with and without the FMNP, and (3) exploring the barriers, challenges, and variability among the FMNP from the lens of state stakeholders/program directors.

Overview of Findings

Results from Aim 1

Beginning with the association of childhood obesity prevalence and farmers markets, analysis revealed mixed results across states and types of products sold at the markets. In Pennsylvania and Washington, an increase in number of famers markets was associated with an increase in childhood obesity prevalence. Whereas in South Dakota, as the number of markets

increased, childhood obesity prevalence decreased. Further looking at types of products sold at farmers markets, only Tennessee had a significant association between fruits and vegetables and decreasing childhood obesity prevalence, whereas Oregon showed the opposite, an increased obesity prevalence with farmer's markets selling fruits and vegetables. As the number of markets that sold meat increased, California and Oregon showed significant associations with increasing childhood obesity prevalence, and in Tennessee, obesity prevalence decreased. Last, among other products sold, Tennessee had a significant association with decreasing childhood obesity prevalence while in Oregon more markets selling other products were associated with increased childhood obesity prevalence. Although not much can be assembled from these mixed results, some are consistent with hypothesis and others are counter intuitive. However, it is clear that the overall number of farmers markets is very low in our country compared to other food outlets. The average number of farmers markets per 1,000 residents was just 0.04, compared to grocery stores at 0.20, and fast food restaurants at 0.72 per 1,000 residents. This limited access to healthy food outlets hinders the potential for healthy diets, plentiful of fruits and vegetables, in the population.

After exploring associations between farmers markets and products sold, variable exploration expanded to include WIC program factors and additional county and state level factors. From the step-wise linear regression analysis, it was identified that farmers markets accepting WIC, percent of WIC redemption and number of grocery stores, at the county-level, were significantly associated with an increase in childhood obesity prevalence. State analysis showed a significant association between childhood obesity prevalence and a state's participation in the FMNP. Final exploration within Aim 1, assessed state factors associations with a state's participation in the FMNP. Results indicated that childhood obesity prevalence among low-

income 2-4 year-olds and the number of grocery stores in a state were associated with a state's participation in the FMNP, but only obesity prevalence remained significant in final model.

Overall, the results from Aim 1 suggest small and varied associations between farmers markets, products sold, WIC involvement and food access (particularly grocery stores) with an increased obesity prevalence of 2-4 year-old low-income children. The findings are counter intuitive, but could be in part due to the limitations of cross-sectional data only capturing a piece of time. The linear regression and logistic regression analysis both identified associations between childhood obesity prevalence, the FMNP and the number of grocery stores in a state. From previous research, it is known that the types of food one has access to and low-income are risk factors for increased obesity prevalence.[3,4] However, previous research has also shown the potential of healthy diets to improve weight status.[5,6] WIC is a federal program aimed at improving diet and health, and in this study factors were identified that warrant further exploration into understanding how WIC can improve weight status through diet.

Results from Aim 2

The FMNP has been a WIC incentive program since 1992, aimed at increasing access to fresh fruits and vegetables to some of our nation's most vulnerable citizens, as well as helping our nation's farmers.[7] While WIC is available in every state, FMNP participation has varied over the years, and even today not all states participate.[7] In 2009, the USDA Food and Nutrition Service called for the CVV program to be implemented in all WIC centers.[8] This study determined there was no effect of the 2009 CVV implementation on childhood obesity prevalence in states with the FMNP compared to those without. However, a decreasing trend in obesity prevalence over time, and difference in prevalence between states that participated and

did not participate in the FMNP was revealed. We also explored the potential of the FMNP budget as a cofactor but the resulted were unchanged.

A recent study attributes decreasing childhood obesity trends within WIC to these 2009 food package changes, stating they were increasing at a rate of 0.23 percentage points annually, then began decreasing by 0.34 percentage points.[9] While this study also finds a decreasing obesity trend within WIC, albeit not significant, limitations in available longitudinal data do not allow for causal conclusions. Data included obesity prevalence within WIC from 2000-2014 at the state level, thus only providing a snap-shot of children within WIC during that year and not overall trends of the same children. However, these results indicate there is some association between these programs and obesity prevalence that warrants more rigorous research approaches.

Results from Aim 3

For Aim 3, the goal was to gain an in-depth understanding of the inner workings of the FMNP, including barriers and challenges from the lens of stakeholders; program directors. Analysis agreed with the literature that coupon redemption varied from state to state.[10] Additionally, results showed that states vary considerably in how many counties are able to offer the program to WIC participants, but reasons for availability of counties included: funding, county interest, WIC participation, farmer interest, and access to farmers.

Challenges and barriers from the lens of interview stakeholders revealed six overarching area themes contributing to the success of the program. Not surprisingly, market factors were the most referenced barrier to FMNP success, including reasons such as transportation to markets, produce knowledge, weather, and timing of markets. From previous studies on the use of farmers markets, these challenges come as no surprise.[11,12] The second most referenced reasons were

within the participants themselves, challenges such as lack of engagement, low coupon use, and education around the program. Finally, the third highest area of challenges were barriers created from the policy itself, including a low budget, administrative burdens and federal restrictions (i.e. paperwork requirements, processing). Additional areas included coupon logistics, program competition, and farmer challenges all effecting states perceived success of implementing the FMNP.

While other studies have looked at various components of the FMNP or barriers to using coupons at markets,[13,14] this study collated responses from all participating states for a nationwide look into the WIC FMNP. This in-depth analysis from key FMNP stakeholders opens up a breadth of information for policymakers and program administrators to consider. Importantly, policymakers and administrators must also ask themselves if this program is achieving the goals that were intended, or are tax dollars being wasted? Coupled with further in-depth analysis, these results are a starting point in conversations that need to ask if this incentive program is the best use of federal funds to increase fruit and vegetable consumption for WIC participants.

Strengths and Limitations

As with all studies, there are limitations to this work including, sample size, use of public data, and assumptions within DD analysis. First, WIC childhood obesity prevalence is only available at the state level and publicly available county-level obesity data was missing in seven states. Both of these contribute to sample size and power restrictions. Additionally, as mentioned before, the main dependent variable of childhood obesity prevalence of 2-4 year-olds from low-income families is from 2009-2011; which is the only publicly available county-level

child obesity data, despite being several years old. When the PedNSS was discontinued in 2011, WIC took over capturing and reporting childhood obesity data of children under 5 years of age.

The next limitation comes from the use of public datasets which contain cross-sectional data. The dataset is a snapshot of variables at a specific time point; thus, no causation can be determined. The second limitation of using public data sets is the research is confined to the variables collected. The use of publicly available data sets and secondary data analysis requires the researcher to ask questions that can be answered with the variables present in the dataset, often limiting the scope. A third limitation is the time period which the data is collected, and in particular, within the Food Atlas the years of data collection do not match across variables. This difference in time of data collected could induce error into analysis.[15] A fourth limitation of these public data sets is that they are often not generalizable to the broader population, specifically childhood obesity which was only measured from low-income families.

Limitations also existed within the DD analysis. One limitation is the potential for spill-over effects,[16] in particular, for people living on the border of a state with and without the FMNP. The state with the program may be increasing access to FV for someone in a state without the program thus affecting weight status, a spill-over effect that would not be controlled for in the data analysis. Last, DD analysis often has some ambiguity in how comparison groups arise.[17] For this study, start year of 2004 as the deciding year for states enrolled or not in the FMNP when in actuality there was variability over the years.

Despite the limitations explained, this study offers several unique strengths that add to the body of literature on childhood obesity prevalence and WIC incentive programs. To our knowledge, this is the first study to concatenate several public data sets to explore childhood obesity prevalence in children under the age of five. Second, our analysis of the FMNP is the

first to explore all participating states from a research methods background, qualitative content analysis. From this study, results may help to form and lead future research aimed at decreasing obesity, both childhood and adult, through federally subsidized programs that aid in food purchases. Specifically, this study will show how, through a combination of existing data, we can further understand the association between farmers production of FV and childhood obesity prevalence. In closing, this study presses on the importance of reliable, timely, and thorough publicly available data for research and health outcome advances.

Future Studies

Future studies should address four areas; timely assessment of the associations between farmers markets and childhood obesity within one state, longitudinal studies to determine WIC program effects on childhood obesity, similar studies in other federal programs, and studies aimed at improving the barriers in the FMNP. This program of research found several small significant associations between farmers markets and childhood obesity prevalence. Mentioned throughout this work, a lack of current, publicly available county-level childhood obesity data is prohibiting timely research on these associations. Another avenue a future study could focus is within one state, working with the state departments for data access at the county level. Exploring the variation in farmers markets across counties and associations with childhood obesity prevalence over several years, may lend more insight to understanding the role of farmers markets in addressing the obesity epidemic.

From timely and robust childhood obesity data, additional studies can examine the effects of the WIC incentive programs on childhood obesity prevalence. Within the current available data, only cross-sectional associations can be drawn, thus a next step would be a longitudinal

study of WIC children to explore how being in the WIC program may affect diet and weight status. Since it is known that diet habits and obesity both track through adulthood, a longitudinal study would be vital in determining if introduction of fruits and vegetables continues as a dietary habit into adulthood, also capturing effect on weight status.

WIC is one of several national nutrition programs aimed at helping citizens eat a healthier diet, and next steps of research should expand into these programs. Future studies could look at the nutritional impact of several federal programs as a child goes from infant to school years, in a longitudinal study. The Special Nutrition Assistance Program is another federal program aimed at helping low-income children, and their families, which could serve as a next program to investigate. Finally, research indicates the FMNP has been successful in increasing fruit and vegetable intake among senior citizens when produce was delivered,[18] which lends way to sharing of best practices. Overall, the incorporation of additional federal nutrition programs would be a critical next research step in studying childhood obesity.

Finally, future studies should focus on exploring specific actionable items for policymakers to help improve the WIC FMNP. Decades ago when these programs were first rolled out, the data recording methods and technology were not what they are today. From technology advances, best practices from research, and gaps identified from research, federal programs may finally be able to complete a feedback loop on a program. For example, from the information gained in our qualitative analysis we found markets factors as the main barrier to FMNP success. In PA, a pilot study on a mobile farmer market was found to increase vegetable intake by 20% in one neighborhood.[19] Future work should incorporate research-based evidence on how to address market barriers, and place them in the context of the FMNP.

Overall, the next steps in childhood obesity research need timely data. From this, formal

evaluations of federal programs can be conducted and future work can bring in evidence-based methods to address challenges and barriers. It is through this continues feedback loop that we may be able to mitigate childhood obesity prevalence through our federal aid programs.

Nursing & Policy Significance

Nurses are uniquely positioned to help address the childhood obesity crisis through caregiving, patient-centered research and action within health policy. As care-providers, nurses are at the bedside or in the exam room to have the necessary conversations with patients and parents regarding obesity and nutritional health. Specifically, nurses working within WIC centers are on the front lines with this population and their families to have conversations related to diet. As nurse researchers and through studies like this one, we bring our patient-centered thinking to the world of discovery; never losing sight of the person during our studies. Last, part of nursing's role is driving health policy change through active participation in forming, implementing, and evaluating policy that affects our patients' health outcomes.[20]

The Institute of Medicine recognized and called on the importance of health care providers to help prevent, educate, diagnose, and treat obesity across all ages.[21] Nurses are equally involved with the policies that address childhood obesity; whether through research, advocacy, or implementing new policies, making the nurse a central component in driving change. Nurses will continue to aid in this process through policy evaluations and suggestions, such as these, in addition being change advocates for our patients and within healthcare settings to show these policies have the potential to address childhood obesity.

While the nursing profession continues to address major health issues through patient-centered research, this study also leans on the need for formal policy evaluations to ensure

legislation is meeting the needs of the nation. This program of research disaggregated a large national program to offer a new look at factors that could be associated with program success and barriers. Additionally, through meticulous research methods, participating states revealed six areas for program improvements that could help with FMNP success. Studies like this one, and ones that specifically measure program participants, are critical to program evaluations. To help policymakers and government officials who crafts laws with potential health outcome impact, a vast body of rigorous evaluations are needed to enhance the evidence base.[22]

Health is a core component of well-being and self-needs. Today, many of our nation's children are battling a health crisis; obesity. Obesity is a preventable disease that when afflicting persons of youth, is also likely to become a life-long disease. Our great nation has battled many diseases throughout history, and with the help of federal funds, research, and medical advances, we continue to pave a healthier future for citizens. However, a portion of our nation's youth still battle obesity, despite advances, thus more research and efforts are necessary to decrease prevalence of this preventable disease. This program of research explored only a portion of the childhood obesity dilemma, as it focused on fruit and vegetable incentive programs within the Special Supplemental Nutrition Program for Women, Infants and Children as part of the program's ability to decrease obesity prevalence. Through exploring county and state level variables related to farmers markets, food access and the WIC program, this study has identified associations with childhood obesity. Through additional analysis and stakeholder interviews, the effect, challenges and barriers of WIC's incentive programs were uncovered. Ultimately, these findings can help guide policymakers decisions and promote future work to alleviate childhood obesity prevalence from our nation's youth.

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EPILOGUE

One-thousand seventy-two days; my PhD journey. An unparalleled experience of working as a registered nurse for five years. Taking a chance that revealed a passion and two years of work in health policy and government affairs. Together, giving the meaning and substance behind the drive for pursing a doctoral degree. And now to add my third hat; a registered nurse, a healthcare advocate and a scholar in nursing research. From here, it is all history in the making for a healthier tomorrow for all.

-Leeza Mariella Constantoulakis, PhD, RN

APPENDIX

Figure 1: Socio-Ecological Model Reference Model

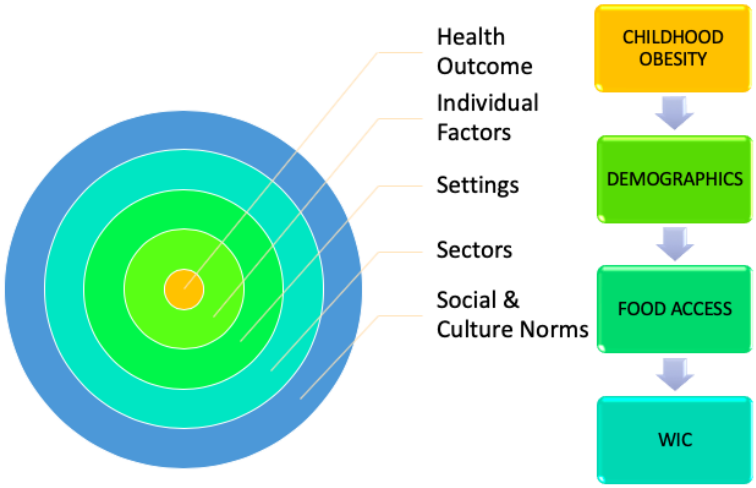

Figure 2: Map of Farmers Markets per State 2009 & 2013

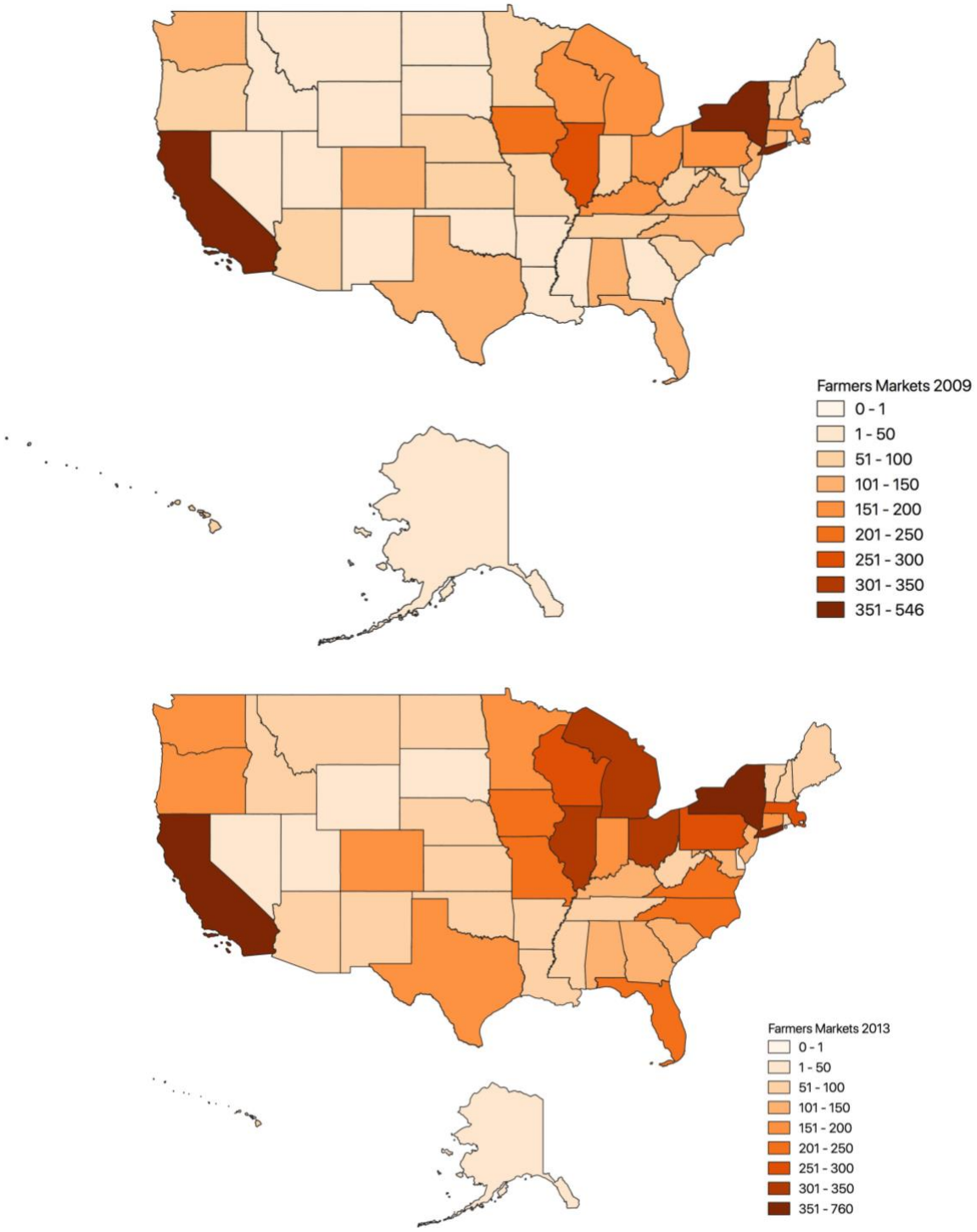

Figure 3: Email to FMNP Stakeholders

Dear **[Director's Name],**

My name is Leeza Constantoulakis, a PhD candidate at the University of Virginia. My thesis is exploring the relationship between childhood obesity prevalence and farmer's markets, specifically looking within WIC and the Farmer's Market Nutrition Program. To this point, I have run secondary data analysis using publicly available data. This has led to a few additional questions in an effort to better understand this possible relationship.

I am contacting you today in regards to the below follow-up questions on the WIC FMNP in **[STATE].** Would you, or another of your staff members, be available to take a few moments via email or phone to discuss the following questions:

1. How many counties in your state participate in the FMNP?
2. Have the same counties always participated in the program?
3. What factors lead to the selection of these counties for participation?
4. Are FMNP benefits offered to residents on the WIC waiting list?
5. What is the redemption rate of the FMNP coupons?
6. What, if any, are some of the challenges/barriers to implementation of this program?

Thank you so much for your time and consideration. If there is someone else who I should contact regarding these questions, could you please let me know. Thank you!

Best Regards,
Leeza

Table 1: Variable Table

Variable Code	Variable Name	Description	Variable Source	Year	Level	Observation	Mean	Standard Dev
PCT_OBESE_CHILD08	Obesity Prevalence 2-4yr olds 08	Obesity prevalence of low-income children 2-4 years age from households with income up to 200 percent of poverty threshold for a family of four	USDA 2015 Food Atlas	2006-2008 aggregate data	county	2,691	14.19	3.72
PCT_OBESE_CHILD11	Obesity Prevalence 2-4yr olds 11	Obesity prevalence of low-income children 2-4 years age from households with income up to 200 percent of poverty threshold for a family of four	USDA 2015 Food Atlas	2009-2011 aggregate data	county	2,714	13.98	3.5
WICS08	WIC authorized stores 2008	The number of stores in a county that are authorized to accept WIC Program	USDA 2015 Food Atlas	2008	county	3,143	14.37	49.86
WICS12	WIC authorized stores 2012	The number of stores in a county that are authorized to accept WIC Program	USDA 2015 Food Atlas	2012	county	3,143	15.11	55.83
WICSPTH08	WIC authorized stores per 1,000 population	The number of stores in a county that are authorized to accept WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) benefits per 1,000 population. Using Census Population estimates	USDA 2015 Food Atlas	2008	county	3,143	0.26	0.26
WICSPTH12	WIC authorized stores per 1,000 residents 2012	The number of stores in a county that are authorized to accept WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) benefits per 1,000 population. Using Census Population estimates	USDA 2015 Food Atlas	2012	county	3,143	0.23	0.21
REDEMP_WICS08	WIC redemptions/WIC-authorized stores, 2008	The total dollar amount of WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) benefits redeemed through WIC-authorized stores in a county divided by the number of WIC-authorized stores.	USDA 2015 Food Atlas	2008	county	2,079	116,673	67,491.67
REDEMP_WICS12	WIC redemptions/WIC-authorized stores, 2012	The total dollar amount of WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) benefits redeemed through WIC-authorized stores in a county divided by the number of WIC-authorized stores.	USDA 2015 Food Atlas	2012	county	2,004	110,173.60	62,915.26
PC_WIC_REDEMP08	Percent of WIC redemption per capita, 2008	The total dollar amount of WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) benefits redeemed through WIC-authorized stores in a county divided by the total county population.	USDA 2015 Food Atlas	2008	county	2,079	$21.38	$10.57

PC_WIC_REDEMP12	WIC redemption per capita, 2012	The total dollar amount of WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) benefits redeemed through WIC-authorized stores in a county divided by the total county population.	USDA 2015 Food Atlas	2012	county	2,004	$19.15	$9.88
PCT_WIC09	WIC participants, % of population 2009	The monthly average percentage of the population who received at least one WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) food instrument or food during the report month or were breastfed by a participating mother. Participation data are 12-month averages.	USDA 2015 Food Atlas	2009	State	3,143	2.96%	0.75%
PCT_WIC14	WIC participation % of population 2014	The monthly average percentage of the population who received at least one WIC Program (Special Supplemental Nutrition Program for Women, Infants, and Children) food instrument or food during the report month or were breastfed by a participating mother. Participation data are 12-month averages.	USDA 2015 Food Atlas	2014	State	3,143	2.44%	0.47%
FMRKT09	Farmers Markets 2009	Number of farmers' markets in the county.	USDA 2015 Food Atlas	2009	County	3,141	1.67	4
FMRKT13	Farmers Markets 2013	Number of farmers' markets in the county.	USDA 2015 Food Atlas	2013	County	3,142	2.6	5.68
FMRKTPTH09	Farmers Markets per 1,000 residents 2009	Number of farmers' markets in the county per 1,000 county residents.	USDA 2015 Food Atlas	2009	County	3,137	0.04	0.07
FMRKTPTH13	Farmers Markets per 1,000 residents 2013	Number of farmers' markets in the county per 1,000 county residents. For 2013 farmers' markets/1,000 pop calculation, 2012 population estimates for counties were used in the denominator due to 2013 county population data unavailability.	USDA 2015 Food Atlas	2013	County	3,138	0.05	0.09
FMRKT_WIC13	FM accepting WIC voucher 2013	Number of farmers' markets in the county that accept WIC vouchers.	USDA 2015 Food Atlas	2013	County	2,181	1.03	2.9
PCT_FMRKT_WIC13	Percent of FM accepting WIC voucher 2013	Percent of all farmers' markets in the county that accept WIC vouchers.	USDA 2015 Food Atlas	2013	County	2,181	19.70%	32.29%
FMRKT_WICCASH13	FM accepting WIC Cash Value Voucher 2013	Number of farmers' markets in the county that accept WIC Cash Value vouchers.	USDA 2015 Food Atlas	2013	County	2,181	0.5	1.62
PCT_FMRKT_WICCASH13	Percent of FM accepting WIC CVV 2013	Percent of all farmers' markets in the county that accept WIC Cash Value vouchers.	USDA 2015 Food Atlas	2013	County	2,181	9.79%	23.49%
FMRKT_FRVEG13	FM selling FV 2013	Number of farmers' markets in the county that sell fresh fruits and/or vegetables (does not include herbs).	USDA 2015 Food Atlas	2013	County	2,181	1.98	3.89

PCT_FRMKT_FRVEG13	Percent of FM selling FV 2013	Percentage of all farmers' markets in the county that sell fresh fruits and/or vegetables (does not include herbs).	USDA 2015 Food Atlas	2013	County	2,181	50.52%	40.93%
LACCESS_CHILD10	Children low access to stores 2010	Number of children (age <18) in a county living more than 1 mile from a supermarket, supercenter or large grocery store if in an urban area, or more than 10 miles from a supermarket or large grocery store if in a rural area.	USDA 2015 Food Atlas	2010	County	3,143	4,959.22	13,169.30
GROC07	Number of grocery stores 2007	The number of supermarkets and grocery stores in the county. Grocery stores (defined by North American Industry Classification System (NAICS) code 445110) include establishments generally known as supermarkets and smaller grocery stores primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry. Included in this industry are delicatessen-type establishments primarily engaged in retailing a general line of food. Convenience stores, with or without gasoline sales, are excluded. Large general merchandise stores that also retail food, such as supercenters and warehouse club stores, are excluded.	USDA 2015 Food Atlas	2007	County	3,143	20.4	76.75
GROC12	Number of grocery stores 2012	The number of supermarkets and grocery stores in the county. Grocery stores (defined by North American Industry Classification System (NAICS) code 445110) include establishments generally known as supermarkets and smaller grocery stores primarily engaged in retailing a general line of food, such as canned and frozen foods; fresh fruits and vegetables; and fresh and prepared meats, fish, and poultry. Included in this industry are delicatessen-type establishments primarily engaged in retailing a general line of food. Convenience stores, with or without gasoline sales, are excluded. Large general merchandise stores that also retail food, such as supercenters and warehouse club stores, are excluded.	USDA 2015 Food Atlas	2012	County	3,143	21.01	89.09
GROCPTH07	Grocery stores per 1,000 residents 2007	The number of supermarkets and grocery stores in the county per 1,000 county residents.	USDA 2015 Food Atlas	2007	County	3,143	0.29	0.24

GROCPTH12	Grocery stores per 1,000 residents 2012	The number of supermarkets and grocery stores in the county per 1,000 county residents.	USDA 2015 Food Atlas	2012	County	3,143	0.26	0.22
SUPERC07	Supercenters and club stores 2007	The number of supercenters and warehouse club stores in the county.	USDA 2015 Food Atlas	2007	County	3,143	1.04	2.64
SUPERC12	Supercenters and club stores 2012	The number of supercenters and warehouse club stores in the county.	USDA 2015 Food Atlas	2012	County	3,143	1.64	3.9
SUPERCPTH07	Supercenters and club stores per 1,000 residents 2007	The number of supercenters and warehouse club stores in the county per 1,000 county residents.	USDA 2015 Food Atlas	2007	County	3,143	0.01	0.02
SUPERCPTH12	Supercenters and club stores per 1,000 residents 2012	The number of supercenters and warehouse club stores in the county per 1,000 county residents.	USDA 2015 Food Atlas	2012	County	3,143	0.02	0.02
PCT_NHWHITE10	% White, 2010	Percentage of county resident population that is non-Hispanic White from Census Data	USDA 2015 Food Atlas	2010	County	3,143	78.29	19.89
PCT_NHBLACK10	% Black, 2010	Percentage of county resident population that is non-Hispanic Black or African American from 2010 Census Data	USDA 2015 Food Atlas	2010	County	3,143	8.75	14.42
PCT_HISP10	% Hispanic, 2010	Percentage of county resident population that is of Hispanic origin from 2010 Census Data	USDA 2015 Food Atlas	2010	County	3,143	8.28	13.19
PCT_NHASIAN10	% Asian, 2010	Percentage of county resident population that is Asian from 2010 Census Data	USDA 2015 Food Atlas	2010	County	3,143	1.13	2.47
PCT_NHNA10	% American Indian or Alaska Native, 2010	Percentage of county resident population that is American Indian or Alaskan Native from Census Data 2010	USDA 2015 Food Atlas	2010	County	3,143	1.87	7.6
PCT_NHPI10	% Hawaiian or Pacific Islander, 2010	Percentage of county resident population that is Hawaiian or Pacific Islander from 2010 Census Data	USDA 2015 Food Atlas	2010	County	3,143	0.08	0.95
MEDHHINC10	Median household income, 2010	Median income by household: income level that divides county households in half, one half with income above the median and the other half with income below the median; includes income of all household members 15 years old or older.	USDA 2015 Food Atlas	2010	County	3,142	43144.87	10742.29
CHILDPOVRATE10	Child poverty rate, 2010	Percentage of county residents under age 18 living in households with income below the poverty threshold.	USDA 2015 Food Atlas	2010	County	3,142	24.17	9.06

METRO13	Metro/nonmetro counties, 2010	Classification of counties by metro or nonmetro definition, where 1=metro county; 0=nonmetro county; metro areas include all counties containing one or more urbanized areas: high-density urban areas containing 50,000 people or more; metro areas also include outlying counties that are economically tied to the central counties, as measured by the share of workers commuting on a daily basis to the central counties. Nonmetro counties are outside the boundaries of metro areas and have no cities with 50,000 residents or more.	USDA 2015 Food Atlas	2010	County	3,143	0.371301	0.48323
FFR07	Fast Food Restaurants 2007	Number of fast-food restaurants in a county	USDA 2015 Food Atlas	2007	County	3,138	67.25	228.58
FFR12	Fast Food Restaurants 2012	Number of fast-food restaurants in a county	USDA 2015 Food Atlas	2012	County	3,143	71.55	249.19
FFRPTH07	Fast Food Restaurants per 1,000 residents	Number of fast-food restaurants in a county per 1,000 residents	USDA 2015 Food Atlas	2007	County	3,138	0.59	0.32
FFRPTH12	Fast Food Restaurants per 1,000 residents	Number of fast-food restaurants in a county per 1,000 residents	USDA 2015 Food Atlas	2012	County	3,143	0.58	0.3
STATE								
WICCHD10	WIC Participation Children 2-4yrs old 2010	Number of Children enrolled in WIC 2010	2016, Pan et al. Trends in Obesity Among Participants Aged 2–4 Years in the Special Supplemental Nutrition Program for Women, Infants, and Children — US, 2000–2014		State	51	63,255.37	95,584.19

PCT_OBESE_WICCHILD10	Obesity Prevalence 2-4yr olds in WIC	State obesity prevalence of WIC children	2016, Pan et al. Trends in Obesity Among Participants Aged 2–4 Years in the Special Supplemental Nutrition Program for Women, Infants, and Children — US, 2000–2014	2010	State	51	15.11	2.33
WIC_ALL10	WIC Participation 2010	Number of participants aggregated from 2010 Ethnicity Report April 2010	WIC Website	2010	State	51	187,502.10	277,031.90
PCT_CHD_WIC10	Percent of WIC Participants, Children 2010	Divide number of children enrolled in WIC by total participants by state	Created	2010	State	51	0.34	0.06
WICFY2010	WIC Funding Fiscal Year 2010	FY 2010 Federal Funds for WIC by state	WIC Website	2010	State	51	1.31E+08	1.89E+08
WICFY2013	WIC Funding Fiscal Year 2013	FY 2013 Federal Funds for WIC by state	WIC Website	2013	State	51	1.27E+08	1.88E+08
WICFY2014	WIC Funding Fiscal Year 2014	FY 2014 Federal Funds for WIC by state	WIC Website	2014	State	51	1.23E+08	1.79E+.08
FMNP2010	Participated in FMNP 2010	Binary variable to indicated a state's participation in the FMNP	Created	2010	State	51	*14 no*	*37 yes*
FMNP2014	Participated in FMNP 2014	Binary variable to indicated a state's participation in the FMNP	Created	2014	State	51	*12 no*	*39 yes*
FMNP_FY10	FMNP Funding 2010	FY 2010 FMNP funds from federal government to participating states	WIC Website	2010	State	51	3.90E+05	6.70E+05
FMNP_FY14	FMNP Funding 2014	FY 2014 FMNP funds from federal government to participating states	WIC Website	2014	State	51	347096	584284
FMRKT09_ST	Number of Farmers Markets 2009	Collated county level data on farmers markets from USDA 2015 Food Atlas to determined number of farmers markets in a state	Created	2009	State	51	102.75	97.41
CHOB_USDA08	Low Income 2-4yr old Child Obesity 2006-2008	Average of county level childhood obesity prevalence of 2-4-year olds from low income 2006-2008	USDA 2015 Food Atlas / Created	2006-2008 aggregate data	State	45	13.94	1.75
CHOB_USDA11	Low Income 2-4yr old Child Obesity 2009-2011	Average of county level childhood obesity prevalence of 2-4-year olds from low income 2009-2011	USDA 2015 Food Atlas / Created	2009-2011 aggregate data	State	44	13.63	1.84

FMRKT_WIC13_ST	Number of FM accepting WIC 2013	Added number of WIC accepting FM per county reported in USDA 2015 Food Atlas for state level	Created	2013	State	51	44	65.16
FMRKT13_ST	Number of FM 2013	Added number of FM per county from USDA Food Atlas 2015 to create state level variable	Created	2013	State	51	160	139
PCT_FRMKT_WIC13_ST	Percent of FM accepting WIC 2013	Created by dividing two state count variables	Created	2013	State	51	23.54	20.33
FMRKT_WICCASH13_ST	FM accepting WIC Cash 2013	Added number of FM accepting WIC CVV in each county from 2015 Food Atlas to create state variable	Created	2013	State	51	21	32
PCT_FMRKT_WICCASH13_ST	Percent of Farmers markets accepting WIC Cash VV	Created by dividing two state count variables	Created	2013	State	51	12.38	12.82
FMRKT_FV13	FM selling FV 2013	Added number of farmers markets selling FV per county reported in 2015 Food Atlas to create state data	Created	2013	State	51	85	76
PCT_FMRKT_FV13	Percent of FM selling FV	Divided FM selling FV by total number of FM in state	Created	2013	State	51	53.02	14.89
LA_CHILD10_ST	Children low access to stores 2010	Collated county data from 2015 Food Atlas to report total number of children in state with low access to stores	Created	2010	State	51	305,624	315,325
WICS08_ST	WIC authorized stores in 2008	Added number of WIC authorized stores per county from USDA 201 Food Atlas to created variable at the state level	Created	2008	State	51	885.69	969.47
WICS12_ST	WIC authorized stores in 2012	Added number of WIC authorized stores per county from USDA 201 Food Atlas to created variable at the state level	Created	2012	State	51	931.14	1104.14
GROS07_ST	Number of Grocery stores 2007	Collated county counts of grocery stores from 2015 Food Atlas to create state data	Created	2007	State	51	1,257	1,610
GROS12_ST	Number of Grocery stores 2012	Collated county counts of grocery stores from 2015 Food Atlas to create state data	Created	2012	State	51	1,295	1,812
SUPERCO07_ST	Number of Supercenters and club stores 2007	Collated counts on supercenters per county from 2015 Food Atlas to create state data	Created	2007	State	51	64.25	58.99
SUPERCO12_ST	Number of Supercenters and club stores 2012	Collated counts on supercenters per county from 2015 Food Atlas to create state data	Created	2012	State	51	101.25	91.41
FFR07	Fast food restaurants 2007	collated counts on FFR per county from 2015 food atlas	Created	2007	State	51	4118.392	4626
FFRPTH07	FFR per thousand 2007	Using 2007 census population data, divided	Created	2007	State	51	0.711	0.109
FFR12	Fast-food restaurants 2012	collated counts on FFR per county from 2015 food atlas	Created	2012	State	51	4409.078	5071
FFRPTH12	FFR per thousand 2012	Using 2012 census population data, divided	Created	2012	State	51	0.717	0.107

POP2010	Census Population 2010	Population estimates from 2010 Census data	Census	2010	State	51	6,065,217	6838212
POP2011	Census Population 2011	Population estimates from 2011 Census data	Census	2011	State	51	6,109,412	6903599
POP2012	Census Population 2012	Population estimates from 2012 Census data	Census	2012	state	51	6,154,100	6969845
POP2013	Census Population 2013	Population estimates from 2013 Census data	Census	2013	State	51	6,197,210	7032457
POP_PTH_2013	Census Pop 2013/1000	Census Pop 2013/1000	Created	2013	State	51	6,197	7032
FMRK_PTH_2013	Farmers Market/1000	Number of FM in 2013, divided by population PTH	Created	2013	State	51	0.04	0.03
FRMKT_FV_PTH13	FV Farmer Market/1000	Number of FM FV in 2013, divided by population PTH	Created	2013	State	51	0.02	0.02
GROS_PTH12	Grocery Stores/1000	Grocery Stores, divided by population PTH	Created	2012	State	51	0.2	0.07
SUPERCO_PTH12	Super Centers/1000	Number of supercenters, divided by population PTH	Created	2012	State	51	0.02	0.01
LACCESS_LOWI10	Low income, low access to store	Collated counts on county variable from 2015 Food Atlas	Created	2010	State	51	337,842	388.891
PCT_ObAdult_2013	Percent of Obese adults 2013	Average Obesity Rate 2013 from State of Obesity	State of Obesity Website	2012	State	51	29.44	3.94
PCT_Pov_11	Percent people in poverty 2011	Two-year average of people living in poverty 2010-2011	Census	2010-2011	State	51	14.27	3.21
Hispanic13	Number of Hispanics	Number of Hispanics as of July 1 2013	Census	2013	State	51	1061632	2523384
PCT_HIS13	Percent Hispanic	Number of Hispanics divided by population as of July 1 2013	Created	2013	State	51	11.19	10.07
NH Black13	Non-Hispanic black as of July 1 2013	Number of non-Hispanic black as of July 1 2013	Census	2013	State	51	817545	984940
PCT_BLK13	Percent NH Black	Divide number of blacks by population estimate for July 1 2013	Created	2013	State	51	11.60	10.97
PCT_His11	Percent Hispanic	From Census took population identified as Hispanic and divided it by total population	Created	2011	State	51	10.82	9.97
PCT_Blk11	Percent African American	From Census took population identified as African American and divided it by total population	Created	2011	State	51	11.45	11.12
PCT_HIS10	Percent Hispanic	From Census took population identified as Hispanic and divided it by total population	Created	2010	State	51	10.62	9.91
PCT_BLK10	Percent African American	From Census took population identified as African American and divided it by total population	Created	2010	State	51	11.49	11.06

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