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FOOD ASSISTANCE PROGRAMS IN THE US AND THEIR IMPACT ON
CHILDHOOD OBESITY

BY

JANNATUL KAWSAR

A thesis submitted in partial fulfillment of the requirement for the degree

Master of Science

Major in Economics

South Dakota State University

2019

FOOD ASSISTANCE PROGRAMS IN THE US AND THEIR IMPACT ON
CHILDHOOD OBESITY

JANNATUL KAWSAR

This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Andrea Leschewski, Ph.D.
Thesis Advisor

Date

Eluned Jones, Ph.D.
Head, Department of Economics

Date

Dean, Graduate School

Date

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ABSTRACT

FOOD ASSISTANCE PROGRAMS IN THE US AND THEIR IMPACT ON
CHILDHOOD OBESITY

JANNATUL KAWSAR

2019

Numerous food assistance programs (FAP) aim to ensure food security among low-income American households. However, the literature suggests that participation in food assistance programs may be associated with the US childhood obesity epidemic. The goal of this study is to analyze the association between the number of major food assistance programs children participate in and childhood obesity. The major food assistance programs considered are the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Food Program for Women, Infants, and Children (WIC), the National School Lunch Program (NSLP), and the School Breakfast Programs (SBP). This is the first study to consider the relationship between childhood obesity and participation in four key food assistance programs in the United States. National Household Food Acquisition and Purchase Survey (FoodAPS) data are analyzed using both mean comparison tests and probit regression analysis. We find an inverse association between the number of food assistance programs a child participates in and childhood obesity. Outcomes from this study can help improve policies aimed at supporting the well-being of low-income children. Overall results suggest that policymakers should prioritize enrolling children in all the food assistance programs for which they are eligible in order to have the greatest impact on childhood obesity.

CHAPTER ONE: INTRODUCTION

Traditionally, obesity is a weight status where a person's weight is well above normal. This study uses the Body Mass Index (BMI) to define obesity. According to the National Institute of Health (NIH), BMI is the ratio of a person's weight in kilograms and the square of his/her height in meters (kg/m^2) (NIH, 2010). BMI plays an important role in defining an individual's weight status as underweight, normal weight, overweight or obese. A BMI of less than 18.5 is considered underweight, a BMI of 18.5 to 24.9 is normal weight, a BMI of 25 to 29.9 is overweight and a BMI of 30 or more is considered obese (CDC, 2019).

Obesity is a global health issue, especially for high-income countries (James, 2008). According to Anene et al. (2014) in the last fifty years, the prevalence of obesity has nearly doubled among the population of the United States. The obesity epidemic has become so commonplace that it is now treated as a cultural norm in American society (Anene, Rafferty, Richards, & Fagan, 2014). Recent statistics show that one-third of the population in the United States is obese, while another third is overweight (Levine, 2011). The medical care expenses of obesity also indicate the severity of the problem. In 2008, the estimated cost of medical care spending attributed to obesity was \$147 billion (Finkelstein, Trogon, Cohen, & Dietz, 2009). By 2011, spending increased to \$168 billion, comprising 16.5% of all medical care costs (Cawley & Meyerhoefer, 2012).

It is no surprise that among public health concerns, obesity is one of the key issues for both the child and adolescent populations in the United States (Cantor, 2017). Since 1970, the prevalence of childhood obesity in the United States has risen by 300%

(Taveras, Rifas-Shiman, Oken, Gunderson, & Gillman, 2008). Among the adolescent age group of 12–19 year old, the prevalence of obesity has increased from 6.1% in 1971–1974 to 17.4% in 2003–2004 (Ogden et al., 2006). According to 2011-2012 data, roughly 17% of children aged 2–19 years were obese (Ogden, Carroll, Kit, & Flegal, 2014).

Obesity is associated with many serious problems involving the physical, social, academic, and mental growth of children. Health problems such as stroke, hypertension, diabetes mellitus, sleep disorder, heart disease, and fatty liver disease (non-alcoholic) have a direct correlation with obesity (Aviva Must, 1999; Ogden, Yanovski, Carroll, & Flegal, 2007). Some research also attributes social stigmatization and discrimination to obesity (Carr & Friedman, 2016). Studies show that school performance is also related to the weight status of students (M. P. D. Story, Kaphingst, & French, 2006). Further, obesity can seriously hamper children's behavior. One study found that obese children required special education and corrective classes two times more often than non-obese children (Schwimmer, 2003).

The reason for the increasing prevalence of obesity among children is quite complex and researchers around the world still find it difficult to draw a conclusion. However, many studies suggest that obesity among children is the outcome of multiple factors including genetics, physical activity, social environment, and learned habits. The environmental factors originate from cultural influences and socioeconomic status, while learned habits are mainly caused by a lack of exercise, an unhealthy diet or overeating (Anene et al., 2014). In comparison, research indicates that hormones and genetics cause less than 10% of all cases of obesity (Xu & Xue, 2016).

Research indicates that in the United States, vulnerability to obesity is positively associated with poverty. This correlation is not surprising as low-income families are the key participants in food assistance programs. One of the primary objectives of all food assistance programs is increasing the availability of food among low-income families. However, additional food resources can sometimes result in an imbalance of caloric needs, resulting in increased rates of overweight and obesity (Kennedy & Guthrie, 2016). It is now a challenge for policymakers to eliminate food insecurity, while at the same time inspiring participants to lead a healthy lifestyle.

For this study, four major food assistance programs, the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Food Program for Women, Infants, and Children (WIC), the National School Lunch Program (NSLP), and the School Breakfast Programs (SBP), are considered. According to the USDA, more than 40 million low-income Americans households were aided by SNAP in the year 2017, while 7.2 million individuals per month benefited from WIC in the same year (USDA, 2018d). Further, NSLP and SBP helped more than 30 million children nationwide, which is almost half of all children in the US (Obesity, 2018). These numbers indicate that these four programs are a key component of US children's food environments.

Several studies analyze food assistance program participation's relationship with childhood obesity. Research suggests that participation in these programs has direct and indirect influences on childhood obesity. Leung et al. (2013), Schmeiser et al. (2012), Anene et al. (2014), Fan et al. (2014), Daepf et al. (2019), Ver Ploeg et al. (2007), Edmunds et al. (2006), Mirtcheva, Donka M. et al. (2013), Millimet et al. (2010) focused on the association between participation in individual food assistance programs and

childhood obesity. Only two studies by Roy, Manan et al. (2012) and Millimet et al. (2010) considered the relationship between childhood obesity and participation in multiple programs. The relationship found in these studies seems to vary based on the number of programs a child participates in, but findings are not consistent. Overall findings suggest that participation in multiple food assistance programs reduces childhood obesity, while participation in individual food assistance programs is positively associated with childhood obesity.

The objective of this study is to analyze the association between the number of major food assistance programs children participate in and childhood obesity. Participation in SNAP, WIC, and School Meal Programs (NSLP & SBP) is considered. This is the first study to consider the relationship between childhood obesity and participation in four major food assistance programs in the United States. In this study, we find an inverse association between the number of food assistance programs a child participates in and childhood obesity while controlling for socio-demographic factors.

CHAPTER TWO: LITERATURE REVIEW

In the literature review section, we provide information about the factors that can affect childhood obesity and the four main food assistance programs: SNAP, WIC, NSLP, and SBP. Finally, we summarize the existing literature on the relationship between participation in each program and childhood obesity.

2.1. Causes of childhood obesity: sociodemographic characteristics

Sociodemographic factors – income, race/ethnicity, gender, region of the U.S., parents educational and marital status, food environment and urban/rural are discussed below with respect to the prevalence of childhood obesity.

2.1.1 Income

Many studies show that family income has a significant impact on child health. For example, the obesity rate for children whose family income is below the poverty threshold is 83% higher than that of their wealthier counterparts (Singh, Kogan, Van Dyck, & Siahpush, 2008). In another study, results suggest that income reduces the prevalence of obesity among non-Hispanic white children and teenagers (Ogden, 2010).

2.1.2 Race/ethnicity

Different ethnic groups have their own way of life and food habits. Statistical analyses show that race/ethnicity has a significant impact on childhood obesity. Compared to non-Hispanic white children, the obesity rate is 34% and 80% higher respectively for Hispanic and non-Hispanic black children (Singh et al., 2008). Similarly, another study found that the prevalence of being overweight was higher among non-

Hispanic black youth and Hispanic youth compared with non-Hispanic white youth. In the case of non-Hispanic Asian youth, the prevalence of obesity is lower than for both non-Hispanic white and non-Hispanic black youth (Ogden et al., 2014).

2.1.3 Gender

The relationship between gender and obesity is unclear. In one study, the rate of obesity is higher among boys (18.1%) than among girls (11.5%) (Singh et al., 2008). Another study from 2011-2012 reported no difference between boys and girls in terms of obesity (Ogden et al., 2014). Further, it has been observed that for a wide range of racial/ethnic groups from 2005 to 2010, the obesity rate is higher among girls than among boys (Weedn, Hale, Thompson, & Darden, 2014).

2.1.4 Region

The Southeastern region of the US experiences a higher rate of obesity than in other regions. The prevalence of obesity also varies depending on the state. For example, a 2005 study shows that four states including Hawaii, Connecticut, Vermont, and Colorado had an obesity rate below 20%, while 17 other states had an obesity rate of more than 25%. The study also showed that among these 17 states, Louisiana, Mississippi, and West Virginia had an obesity rate of more than 30% (Wang & Beydoun, 2007).

2.1.5 Parents education and marital status

Parents education and marital status also play a significant role in child health. Children with parents without a high school diploma had a greater chance of being obese

than those with a college education (Singh et al., 2008). In addition, the prevalence of obesity among boys and girls was lower if the head of the household had a college degree or higher (Ogden, 2010).

Besides the parent's educational attainment, marital status also affects the prevalence of obesity among children. According to Singh et al. (2008), children with single parents have a higher obesity rate (Singh et al., 2008). Further, Gable et al. (2000) reported children with married parents are less vulnerable to obesity compared to those with never-married parents (Gable & Lutz, 2000).

2.1.6 Food environment

The physical and social settings that affect what we eat are known as the food environment. Selecting healthy or unhealthy foods depends on the food environment. The increased rate of obesity in the United States has a proportional relationship with consuming unhealthy food (Anene et al., 2014). The frequency of obesity among low-income kindergarten children is negatively related to the density of full-service restaurants near their home, while the density of both convenience and grocery stores are positively associated with the prevalence of obesity. The negative relationship is also found for WIC-authorized stores, superstores, and warehouse clubs (Salois, 2012). In New York, the Bronx and Richmond county, researchers further find that the presence of SNAP-authorized stores increases the rate of obesity among students (Cantor, 2017).

2.1.7 Urban/Rural

Food habits, lifestyles, and food availability are significantly different in rural and urban areas. Research suggests that the occurrence of obesity among rural children is

higher than among urban children (Jihong Liu, 2008). In a 2015 study of 74,168 children, the rate of obesity was 26% higher among children in rural versus urban areas (Johnson Iii & Johnson, 2015).

2.2 Impact of food assistance program participation on childhood obesity

The main objective of food assistance programs (FAP) in the United States is to advance the nutritional quality of diets and meet the energy needs of children, especially from low-income households (Frisvold, 2015). However, research finds that additional food resources can sometimes result in an imbalance of caloric needs, resulting in increased rates of obesity (Kennedy & Guthrie, 2016). Obesity is increasing at an alarming rate and impacting a large share of the U.S. population (Ver Ploeg, Mancino, & Lin, 2007). As the relationship between FAP and obesity is a complex problem, the following sections describe the major US FAP and their link with childhood obesity.

2.3 Introduction to SNAP

Initiated by the U.S. Department of Agriculture (USDA), the Supplemental Nutrition Assistance Program (SNAP), previously known as the Food Stamp Program, is the largest food assistance program in the US. The key objectives of this program are increased food security, decreased hunger, a nutritious diet, and nutrition schooling for low-income Americans (USDA, 2018a). Approximately 25% of children in the US receive assistance from this program (Cantor, 2017).

In the period of the Great Depression, SNAP started as a temporary relief program. In 1964 under President Lyndon Johnson, it was made a permanent program. During the first year of the program, the budget was approximately \$75 million. By the

fiscal year 2017, it had developed into a \$70 billion program. In 2017, SNAP aided more than 40 million low-income Americans in a representative month to afford a nutritionally acceptable diet (USDA, 2018a). According to the USDA, to be eligible for SNAP, a household's gross monthly income should be lower than 130% of the Federal Poverty Line, which for example, in the year of 2018 was \$2,213 a month for three-members family (USDA, 2018a).

Key participants of SNAP include working families with low-income, low-income elderly, and the disabled. Among SNAP participants, approximately 70% are households that have children, households with seniors, or individuals with disabilities. In total, 83% of all SNAP benefits are awarded to these groups of individuals (America, 2013). One of the great features of SNAP is nutrition schooling known as SNAP-Ed. According to USDA, SNAP-Ed mainly focuses on helping SNAP participants live healthier lives by providing evidence-based information. SNAP-Ed educates people to manage best the nutrition obtained from SNAP benefits (USDA, 2018a).

2.4 The link between childhood obesity and participation in SNAP

Research shows different associations between childhood obesity and SNAP participation. Leung et al. (2013) found a negative correlation between SNAP and childhood obesity (Leung et al., 2013). Schmeiser et al. (2012) reported reduced obesity for both boys and girls aged between 5 to 11 years that participated in SNAP (Schmeiser, 2012) while Anene et al. (2014) reported a strong positive correlation between SNAP and childhood obesity (Anene et al., 2014). On the other hand, Fan et al. (2014) reported that

a higher prevalence of obesity and SNAP is not correlated among children from low-income families (Fan & Jin, 2014).

2.5 Introduction to WIC

Under the authority of the United States Department of Agriculture (USDA), the Special Supplemental Food Program for Women, Infants, and Children (WIC), a public health nutrition program was established as an experimental program in 1972 and became a permanent program in 1974. Through the House Appropriations Committee and the U.S. Senate, WIC is funded yearly and is not an entitlement. WIC assists low-income women who are in the pregnancy phase (breastfeeding, and non-breastfeeding postpartum), infants, and children under age 5 who are in nutritional danger by providing supplemental foods, health care, and nutrition schooling (USDA, 2019b).

The key goal of this program is to provide healthy foods to low-income families during a critical stage of life. The food comes through the WIC package prescribed based on healthy diets both for the women and children. This prescribed food is known as a WIC food package (Koleilat, Whaley, Esguerra, & Sekhobo, 2017).

The general targeted population of WIC is low-income households where gross monthly income is below 185% of the Federal Poverty Line. In three cases, women get served by this program: pregnant women, breastfeeding women, and non-breast-feeding postpartum women. Infants are served until their first birthday, while children are supported up to their 5th birthday (USDA, 2019b).

The number of women, infants, and children receiving WIC benefits has increased from 88,000 to 7.7 million from 1974 to 2016. In 2017, WIC benefits recipients

each month reached roughly 7.3 million (children: 3.76 million; infants: 1.79 million; women: 1.74 million) while the period between January to May of 2018, over 7 million per month on average participated in WIC. This indicates that children are the primary recipients of WIC (USDA, 2018c). In total, over 50% of all infants born in the United States, and 25% of the nation's children below five years of age are served by WIC (Oliveira & Frazão, 2015).

2.6 The link between WIC and childhood obesity

The main objective of WIC is to provide support during critical periods of growth and development by preventing adverse health outcomes. However, research has shown that there is a correlation between the prevalence of obesity and WIC participation. Many studies have analyzed the association between childhood obesity and WIC. Prior to 2009, the frequency of obesity among 2 to 4-year-old WIC children was growing by 23% per year. After 2009, this rate started to decrease. One study attributed this decreasing trend to the 2009 WIC food package changes (Daepf, Gortmaker, Wang, Long, & Kenney, 2019). Ver Ploeg et al. (2007) reported that WIC children are not in danger of being overweight or having a higher BMI compared to nonparticipant children (Ver Ploeg et al., 2007). In another study done in New York state, estimates show the prevalence of obesity remains higher among WIC participants than nonparticipants (Edmunds et al., 2006).

2.7 Introduction to NSLP

Among the food and nutrition assistance programs, the National School Lunch Program (NSLP) is ranked second in terms of participation nationally. Started in 1946 as

an intervention and prevention program signed by President Harry Truman, the National School Lunch Program (NSLP) is a federally funded meal program. The program functions both in public and nonprofit private schools, as well as in residential childcare institutions (USDA, 2019b). The program aims to secure healthy growth of school-going children from low-income families by providing nutritionally sound, free or low-cost lunches each school day (Hernandez, Francis, & Doyle, 2011).

In the first year of the NSLP, approximately 7.1 million children participated. This number increased steadily to 30.4 million in 2016. Approximately 100,000 public and nonprofit private schools benefited from NSLP in the year of 2018. In the same year, 29.7 million children were served every day by NSLP at the cost of \$13.8 billion. The criterion to be eligible for this program is straightforward. Children with income below 130% of the Federal Poverty Line qualify for a free school meal and the children with income below 185% of the Federal Poverty Line qualify for a reduced school meal (USDA, 2019b).

2.8 The link between NSLP and childhood obesity

One of the key concerns raised for the National School Lunch Program (NSLP) is whether it provides high-calorie lunches to a large number of (31 million) school-going children resulting in obesity among nearly 17% of program participants (Peckham & Kropp, 2012). A similar association was reported by Mirtcheva, Donka M. et al. (2013), who studied whether the bodyweight of 1–12 graders in public schools was influenced by the NSLP. They found that NSLP participation was associated with a 3.4-point increase in BMI. They further analyzed the data with respect to gender, finding that participation in NSLP influences obesity among girls, but not among boys (Mirtcheva & Powell,

2013). In contrast, Millimet et al. (2010) found no association between NSLP participation and long-run measures of child body weight (Millimet, Tchernis, & Husain, 2010).

2.9 Introduction to SBP

Under the Child Nutrition Act of 1966, the School Breakfast Program (SBP) was founded as an experimental project and was made permanent in 1975. Educational institutions, including public and nonprofit private schools, as well as residential child care institutions, are assisted federally under SBP. Children from low-income families are eligible for this program. Children with income below 130% of the Federal Poverty Line qualify for a free school meal and children with income below 185% of the Federal Poverty Line qualify for a reduced school meal (USDA, 2019d).

SBP participation has grown slowly, but progressively over the years. In 1970, only half a million children were served under this program, while in 1995 it reached to 6.3 million children. On a daily basis, an average of 7.8 million children participated in the financial year of 2001, while in 2002 it grew up to 8.2 million. The student participation number in SBP was 14.69 million per day in the year of 2018 and for the same year, the total expenditure for the program alone was \$4.4 billion. Statistics also indicate that spending in the year of 2018 increased by 3% over the previous year (USDA, 2019d).

2.10 The link between SBP and childhood obesity

Millimet et al. (2013) analyzed the relationship between SBP participation and children's weight. Results show a positive but statistically insignificant association. In some cases, negative and occasionally significant causal effects have also been found depending on the change in the condition of the estimator (Millimet & Tchernis, 2013). In another report, while considering a long-run measure of children's weight, outcome, and participation in both SBP and NSLP are positively associated with a child's weight (Millimet et al., 2010).

2.11 The link between multiple food assistance program participation and childhood obesity

Many low-income households participate in multiple food assistance programs. Each of these programs has its own goals and objectives. A handful of studies have been conducted to evaluate the interactive differences across participants and non-participants of multiple food assistance programs. Roy et al. (2012) reported that participating in multiple food assistance programs had a different impact on body weight compared to children participating in one program. For children participating in just NSLP, the association between NSLP and childhood obesity was positive. Among children participating in just SNAP, the association between SNAP and childhood obesity was positive. For children participating in NSLP and SBP, the relationship between both programs and childhood obesity was positive. Further, they found that participation in all three programs had a negative relationship with childhood obesity (Roy, Millimet, & Tchernis, 2012). Evaluating the combined effect of participation in SBP and NSLP,

Millimet et al. (2010) concluded that, in the third grade, there is no association between NSLP participation and child body weight, while there is a solid, positive association with SBP participation (Millimet et al., 2010).

2.12 Study gaps

As discussed in the literature review, many studies have analyzed the individual association between major food assistance program (SNAP, WIC, NSLP, and SBP) participation and childhood obesity. However, only two studies have focused on the association between multiple food assistance program participation and childhood obesity. This study focuses on four main food assistance programs in the US. The objective of this study is to analyze the association between the number of major food assistance programs households participate in and childhood obesity. Participation in SNAP, WIC, and School Meal Programs (NSLP & SBP) is considered.

CHAPTER THREE: CONCEPTUAL FRAMEWORK

Obesity originates from numerous sources. According to Townsend et al. (2001) sociodemographic variables such as age, household size, race, income, region, education status, marital status, and government food assistance program participation all have a relationship with obesity (Townsend et al. 2001). The main objective of food assistance programs (FAP) in the United States is to advance the nutritional quality of diets and meet the energy needs of children, especially from low-income households (Frisvold, 2015).

In general, all food assistance programs have their own eligibility criteria and structure. The impact of these different programs is mixed, with studies finding both a positive and inverse relationship between food assistance program participation and childhood obesity. Different studies show that obesity reduction mostly depends on the ability to purchase nutritious food, as well as receiving nutrition education. Schmeiser et al. (2012) reported that increasing a family's food budget improves their nutritional intake in that they purchase more fruits and vegetables (Schmeiser et al. 2012). Food assistance program was also shown to improve households' nutrition intake by impacting the eating manner such as eating at home rather than at restaurants. According to Ayala et al. (2008), the risk of obesity greatly depends on Away-from-home food consumption. Compared to homemade foods, Away-from-home foods have a lower amount of fiber, iron calcium but a higher amount of sodium. Research further indicates that foods eaten outside are usually contained a low amount of nutrition but larger in portion size (Ayala et al., 2008). Among the FAP participant, Bes-Rastrollo et al. (2010) concluded that, a participant who ate more frequently outside consumed more soft drinks, meat, fast food,

juice, and processed food while the amount of intake vegetable, fruit are less (Bastrullo et al., 2010).

In analyzing the Supplemental Nutrition Assistance Program-Education (SNAP-Ed), Koszewski et al. (2011) reported that nutrition education programs have a positive effect on behavioral change, such as making healthy food choices (Koszewski, Sehi, Behrends, & Tuttle, 2011). Among federal food assistance programs, WIC is regarded as one of the most prescriptive and targeted programs. Imposing some restrictions such as milk purchases restricted to lower-fat milk and including fruits, vegetables, and whole grains in the WIC food package, WIC improved eating according to the Dietary Guidelines for Americans (Whaley, Ritchie, Spector, & Gomez, 2012). Meals served in both NSLP and SBP must have to follow the nutrition standards established in the Dietary Guidelines for Americans to get the federal subsidies (M. Story, Nanney, & Schwartz, 2009). As the FAPs help program participants to improve the nutritional quality of their food choices, it is logical that participation in the programs should have some positive impact on reducing obesity.

However, research also finds that additional food resources from food assistance programs can sometimes result in an imbalance of caloric needs, resulting in increased rates of obesity (Kennedy & Guthrie, 2016). Anene et al. (2014) reported a strong positive correlation between SNAP and childhood obesity. The Food and Nutrition Act of 2008 permits SNAP participants to buy food items such as ice cream, cookies, soda, candy, and bakery cakes. Those food items are regarded as unhealthy and spending SNAP benefits on these unhealthy foods decreases the nutritional quality of participants' diets and could lead to a higher likelihood of being obese (Anene et al., 2014). Thus,

there is a possibility that FAP participation may have a positive relationship with childhood obesity.

From the above discussion, it is likely that FAPs impact the prevalence of obesity both positively and negatively (showed in figure 3.1: the conceptual model of this study). Which impact, positive or negative, is greater in magnitude is unclear. Thus, this analysis aims to analyze the association between participation in multiple food assistance programs and childhood obesity.

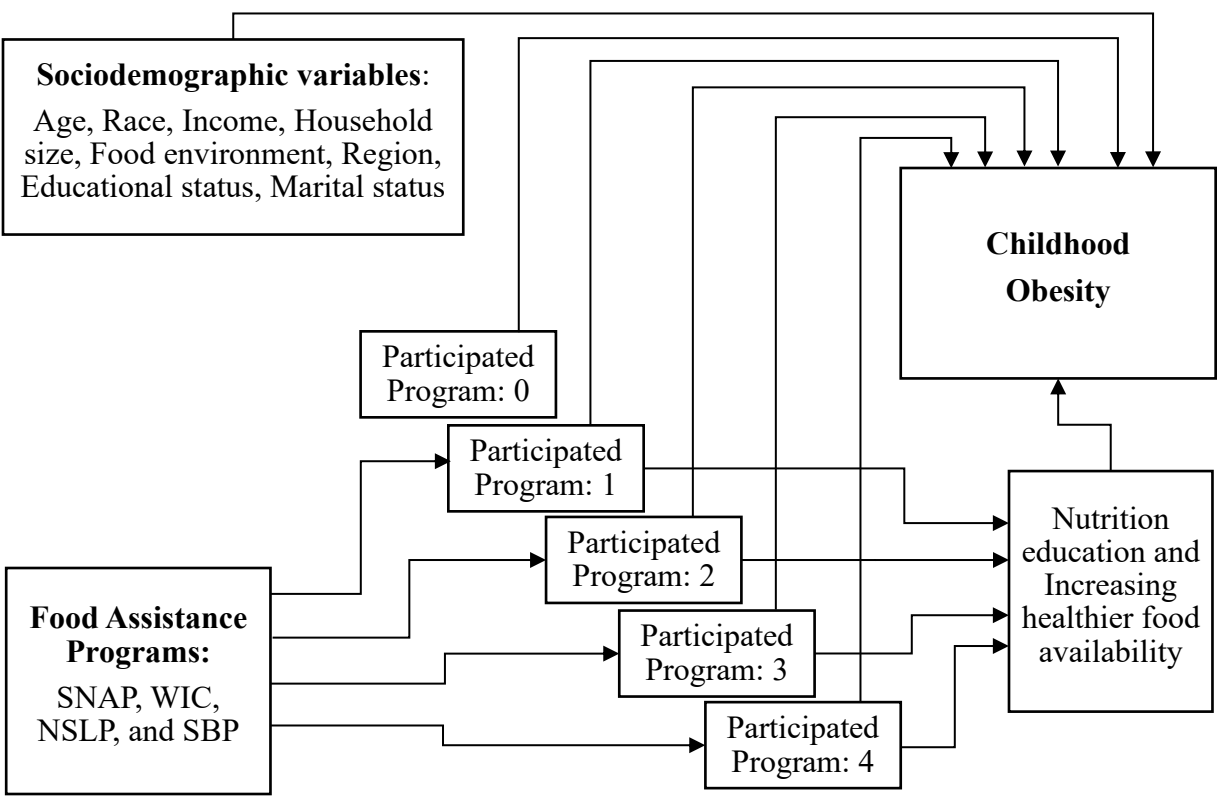


Figure 3.1: Conceptual framework

CHAPTER FOUR: DATA ANALYSIS

The objective of this study is to analyze the association between the number of major food assistance programs households participate in and childhood obesity. Participation in SNAP, WIC, and school meal programs (NSLP & SBP) is considered.

4.1 The National Household Food Acquisition and Purchase Survey (FoodAPS)

This study uses data from a nationally representative survey of American households known as the National Household Food Acquisition and Purchase Survey (FoodAPS), administered by the U.S. Department of Agriculture (USDA), the survey captures household food purchases and acquisitions over a one-week period.

The key purpose of FoodAPS is to support research on: (1) the correlation between American households' food purchases, food demand, and household welfare (2) the relationship between food store type and food choices, (3) food security, (4) health, (5) and obesity. The survey was collected between April 2012 and January 2013. Over a one-week period, households recorded all at-home and away-from-home food purchases (USDA, 2019c).

Moreover, the FoodAPS dataset provides detailed information about each individual in the household. It provides several socio-demographic characteristics such as gender, rural area, household income, educational and marital status, race/ethnicity, food security, and region. It also provides information about each individual's age, height, weight, and gender in the household.

4.2 The reason behind using FoodAPS

The main objective of this study is to analyze the association between food assistance program participation and childhood obesity. To do so, the number of major food assistance programs households participate in is considered. FoodAPS is an ideal data source for conducting analysis on childhood obesity because it provides information on 4,161 children aged between 2 to 18. For each child, FoodAPS provides their age, height, weight, and gender, which allows for the calculation of Body Mass Index Z scores (BMI Z) and categorization of each child as normal weight, overweight or obese. Further, FoodAPS provides information on SNAP, WIC, NSLP, and SBP participation. It also characterizes each child's race, region, their household income, and the educational and marital status of their parents.

4.3 Sample size

In the FoodAPS dataset, there are 4,826 households with 14,317 individuals. In this analysis, we are only analyzing children and thus we limit the sample to individuals aged between 2 to 18. In total there were 4,161 children aged between 2 to 18 in the dataset. Next, we further limited the sample to children in households that met the following three criteria: (1) households that had a child aged under 5, (2) households that had a child aged between 5 to 18 and (3) households that had income less than 185% of the Federal Poverty Line. These sample restrictions were implemented to ensure that all households in the sample were likely eligible for SNAP, WIC, NSLP & SBP. In order to be eligible for WIC the household must have a child less than 5, to be eligible for school meal programs household must have a child 5-18, and to be eligible for all the programs

household gross income has to be less than 185% of the Federal Poverty Line.

Considering the age and income constraints, and missing information, the final sample included 3,783 children.

4.4 Definition of Body mass index (BMI)

The dependent variable of interest given this study's objective is whether each child is obese. In this analysis, obesity is characterized using Body Mass Index scores (BMI). Body Mass Index (BMI) is an index used to relate weight to the height of an individual. More specifically,

$$BMI = \frac{weight(kg)}{height(m^2)} \quad (4.1)$$

BMI plays an important role in defining an individual's weight status as underweight, normal weight, overweight or obese. For example, a BMI of less than 18.5 is underweight, a BMI of 18.5 to 24.9 is normal weight, a BMI of 25 to 29.9 is overweight and a BMI of 30 or more is considered obese (CDC, 2019).

4.5 Definition of BMI Z

A BMI measure adjusted depending on child age and gender is known as Body Mass Index z-score (BMI Z) or BMI standard deviation (S.D.) scores. A child's age, height, weight, and gender (CDC, 2019) are used to calculate their BMI Z score.

4.6 The reason behind using BMI Z

This study uses BMI Z scores, as opposed to BMI because the BMI score is used to determine weight status independent of age and gender. The problem arises while defining overweight and obesity in children because children's height and weight vary with their age and gender. For example, a BMI of 20 for a 5-year-old boy is considered overweight, while the same BMI score for a 15-year-old boy is considered underweight. In this case, the child's BMI should be associated with a reference-standard that accounts for the child's age and gender, in addition to height and weight, for identifying weight status (Must & Anderson, 2006).

4.7 Calculation of BMI Z

Flegal et al. (2013) established a comprehensive method to calculate BMI Z scores known as the LMS method (Flegal & Cole, 2013). To calculate the Z-score for a BMI value (BMI Z) with the LMS method, the following formula is used

$$BMI Z = \frac{\left(\frac{BMI}{M}\right)^L - 1}{L \times S} \quad (4.2)$$

where L is the power transformation to achieve normality, M is the mean or median, and S is the coefficient of variation parameters (CDC, 2019). These three parameters translate the BMI of any child to BMI Z. Values for the L, M, and S are provided on the Center for Disease Control and Prevention (CDC) website for each gender and age.

After calculation, BMI Z scores can be used to group children into weight categories. For a particular age and gender, if any child's BMI Z is less than the 5th

percentile then the child is underweight, if BMI Z is in the 5th-85th percentile the child is normal weight, if BMI Z is in the 85th-95th percentile the child is overweight and if BMI Z is in the 95th percentile or more the child is obese. The BMI and BMI Z weight categories are summarized in Table 4.1:

Table 4.1: BMI and BMI Z categories

	Underweight	Normal weight	Overweight	Obese
BMI (kg/m ²)	<18.5	18.5-24.9	25-29.9	≥30
BMI Z score (percentile)	<5 th	5 th -85 th	85 th -95 th	≥95 th

4.8 Calculating BMI Z using FoodAPS

To calculate BMI Z using FoodAPS, we used the *zanthro* command developed by Vidmar et al. (2018) in Stata version 12.1. To calculate BMI Z, we obtained children's age, height, weight and gender from the FoodAPS dataset (Vidmar, Carlin, Hesketh, & Cole, 2018). We used the *zanthro* command to calculate BMI Z scores for each child in the dataset. After using the *zanthro* command, we obtained different scores which allowed for categorization into three different categories: normal weight, overweight and obese. In this study, we are analyzing childhood obesity. Thus, the dependent variable is *obese*. For this purpose, we created a binary indicator variable *obese* based on the results obtained from the *zanthro* command and *zbmicat*.

4.9 Food assistance program participation variables

For this analysis, we also needed to create measures of participation in major food assistance programs. We created binary indicators of participation in SNAP, WIC, and

school meal programs. In addition, we created another variable, which indicates the number of programs a household participates in.

The individual program participation measures are binary, taking on values of 0 and 1. If a child does not participate in an individual program then the value is 0 and if that child participates in the program then the value is 1. The number of programs variable ranges from 0 to 4 programs.

We also created several control variables for socio-demographic characteristics including gender, race/ethnicity, region, food security, marital status, and educational status. All program participation and socio-demographic variables are defined in Table 4.2.

Table 4.2: Program participation and sociodemographic variable descriptions

Variable	Definition	Unit	Range
Obese	Child is obese	DV	0, 1
Num_programs	The major food assistance programs households participate in (SNAP, WIC & School meal programs (NSLP&SBP))	#	0, 4
AGE_R	Approximate midpoint of child's age group	#	2, 18
hispanic	Child is Hispanic	DV	0,1
rural	Child lives in rural tract	DV	0, 1
hhsiz	Number of people at child's residence, excluding guests	#	1, 14
inchhavg_r	Household average (monthly) income sum of average imputed income per member	\$	0, 25650
male	Child is male	DV	0,1
black	Child is non-Hispanic and black	DV	0,1

American_indian	Child is non-Hispanic and American Indian	DV	0, 1
Asian	Child is non-Hispanic and Asian	DV	0, 1
other_race	Child is non-Hispanic and other race	DV	0, 1
multiple_race	Child is non-Hispanic and multiple race	DV	0, 1
midwest	Child lives in the Midwest	DV	0, 1
south	Child lives in the South	DV	0, 1
west	Child lives in the West	DV	0, 1
ff3	Number of fast food restaurants within one mile of household	#	0, 43
widowed	Child's parent is widowed	DV	0, 1
divorced	Child's parent is divorced	DV	0, 1
separated	Child's parent is separated	DV	0, 1
never_married	Child's parent was never married	DV	0, 1
some_college	Child's parent has some college degree	DV	0, 1
baorhigher	Child's parent has a bachelor's degree or higher	DV	0, 1

Source: FoodAPS dataset, 2017

CHAPTER FIVE: METHODS

In this study, the following quantitative methods were used to analyze the association between food assistance program participation and childhood obesity: descriptive statistics, mean comparison tests, and probit regression analysis.

5.1 Descriptive statistics

Descriptive statistics were used to analyze all the children in the sample. The descriptive statistics provided information about the percentage of children that participated in the individual programs: SNAP, WIC, NSLP, and SBP. We also characterized how many programs each child participated in 0, 1, 2, 3, or 4. In addition, descriptive statistics were calculated for each sociodemographic variable defined in Table 4.2. For each variable, we estimated the *mean* and *standard deviation*.

5.2 Mean Comparison Tests:

Mean comparison tests were conducted based on descriptive statistics. We used two groups mean comparison tests (*ttest*). The base group was 0 children i.e. that did not participate in any food assistance programs. We then compared the characteristics of children participating in 0 programs to children participating in 1, 2, 3 or 4 programs. Mean comparison tests were conducted to examine differences in obesity across children that participated in a different number of food assistance programs.

5.3 Regression Analysis

5.3.1 Probit Model

Mean comparison tests were used to examine childhood obesity without controlling for sociodemographic variables when children participated in a different number of food assistance programs. Next, a probit model was used to examine the association between food assistance program participation and obesity while controlling for sociodemographic variables. As a standard statistical method, probit regression analysis has been used for a long period of time (Klieštik, 2015). In the cases when the dependent variable is binary rather than continuous, this method is primarily employed. In this analysis, if a child is obese, the value is 1, and if the child is not obese, the value is 0. We focus on obesity because obesity is associated with many serious problems involving health, social, academic and mental growth of children. Probit analysis predicts the probability of obesity among children with particular socio-demographic characteristics and food assistance program participation. Mathematically, the probit model is defined as:

$$P(y = 1|x_i) = G(x_i \boldsymbol{\beta}) \quad (5.1)$$

In this analysis, the dependent variable *obese* (y) is a binary response variable that takes on values 0 and 1. If a child is obese then the value is 1 and if the child is not obese then the value is 0. Further, x indicates sociodemographic variables such as age, household size, income, rural area, race/ethnicity, gender, educational and marital status, and the food assistance program participation of the i children. β is a set of coefficients to be estimated. For all values of $x_i \boldsymbol{\beta}$, the limit of function G is firmly between $0 < G(x_i \boldsymbol{\beta}) < 1$. G is expressed as the standard normal cumulative distribution function (CDF) in the probit model as per equation (5.2)

$$G(x_i \beta) = \Phi(x_i \beta) \quad (5.2)$$

5.3.2 Maximum Likelihood Estimation of Probit Model:

Because of the nonlinear behavior of the model, maximum likelihood estimation (MLE) was used to estimate the probit model (Wooldridge, 2002). Using MLE, the following log-likelihood function is estimated:

$$\ell_i(\beta) = y_i \log[G(x_i \beta)] + (1 - y_i) \log[1 - G(x_i \beta)] \quad (5.3)$$

5.3.3 Partial effects

From the MLE model, we got $\hat{\beta}$ coefficients which indicate whether the relationship between x and y is positive or negative but cannot indicate the magnitude of the relationship between the two variables. To obtain the magnitude of the relationship between the two variables, *partial effects at the average* (PAE) were estimated as follows:

$$\widehat{PAE} = \hat{\beta}_j g(\bar{x} \hat{\beta}) \quad (5.4)$$

CHAPTER SIX: RESULTS

6.1 Descriptive Statistics

Descriptive statistics describe all the children in the sample. Note that all children in the sample are eligible to participate in all four of the main food assistance programs: SNAP, WIC, NSLP, and SBP. Provided information in Table 4.2 characterizes the sociodemographic characteristics of sample children, including income, household size, race/ethnicity, region, gender, education, and marital status. Moreover, descriptive statistics categorize the weight status of the children i.e. normal weight, overweight, and obese. Additionally, children's participation in food assistance programs is characterized. Provided information for each variable includes means and standard deviations.

In Table 6.1, the sample size was 3,788 children. In terms of food assistance program participation 39%, 20%, 50%, and 33% of children participated in SNAP, WIC, NSLP and, SBP respectively and on average children participated in 1.43 programs. Overall, 22% of children were obese. Among sample children, there was no difference between males and females. Sample children had a mean age of 9. For the race category, the percentage of Hispanic was 32%, non-Hispanic whites were 44%, non-Hispanic blacks were 16%, non-Hispanic American Indians was 1%, non-Hispanic Asians were 2%, non-Hispanic other race was 1%, non-Hispanic multiple races were 3%. In terms of household characteristics, 26% lived in a rural area. On average, 5 people lived in a child's household and the average monthly household income was \$3,916. For the regional category, 14%, 23%, 37%, and 26% of children were from the Northeast, Midwest, South, and West respectively. An average of 5 fast food outlets was located

within 1 mile of the child's household. In terms of their parent's characteristics, 54%, 2%, 15%, 7%, and 22% were married, widowed, divorced, separated and never married respectively. Considering average educational attainment, 17% had a bachelor's degree or higher, 33% had some college and 50% had a high school degree or less.

Table 6.1: Descriptive statistics for all children

All children (N=3,788)			
	Variable	Mean	SD
Food Assistance Program Participation	SNAP	0.39	0.49
	WIC	0.20	0.40
	NSLP	0.50	0.50
	SBP	0.33	0.47
	Number of programs	1.43	1.18
Child Characteristics	Obese	0.22	0.42
	Male	0.51	0.50
	Female	0.50	0.50
	AGE_R	9.66	4.85
	Hispanic	0.32	0.467
	White	0.44	0.50
	Black	0.16	0.37
	American_indian	0.01	0.10
	Asian	0.02	0.14
	Other_race	0.01	0.10
Multiple_race	0.03	0.18	
Household Characteristics	Rural	0.26	0.43
	Hhsize	4.92	1.81
	Inchhavg_r	3916.85	3484.27
	Northeast	0.14	0.35
	Midwest	0.23	0.42
	South	0.37	0.48
	West	0.26	0.44
Ff3	5.54	5.96	
Parents Characteristics	Married	0.54	0.50
	Widowed	0.02	0.14
	Divorced	0.15	0.36
	Separated	0.07	0.25

Never_married	0.22	0.42
Baorhigher	0.17	0.37
Some_college	0.33	0.47
Hsorless	0.50	0.50

Source: FoodAPS dataset,2017

6.2 Mean comparison tests

Mean comparison tests used descriptive statistics to compare two groups for each variable included in the dataset. Two group mean comparison tests (*ttest*) were used to conduct this analysis. The base group is children who did not participate in any programs. This base group is compared to children who participated in 1, 2, 3 and 4 programs, respectively.

6.2.1 Comparing children in 0 versus 1 program

In Table 6.2, the given sample size was 1,126 for the children who did not participate in any programs and 868 children that participated in 1 program. Among sample children, 17% of children were obese who participated in 0 programs and 26% of children that participated in 1 program were obese. This implies that a child that participated in 1 program was more likely to be obese versus 0 program ($p < 0.01$). There was no significant difference in gender for children in 1 program versus 0 programs. In the age group, children that participated in 1 program were younger than those that participated in 0 programs ($p < 0.01$). In terms of race/ethnicity, Hispanics and non-Hispanic blacks were more likely to be in 1 program than in 0 programs. Non-Hispanic whites, non-Hispanic Asians and non-Hispanic other races were significantly less likely to be in 1 program ($p < 0.01$).

In Table 6.3, in terms of household characteristics, children participating in 1 program were significantly less likely to live in a rural area than those that participated in 0 programs ($p < 0.05$). Household size was higher among those in 1 program versus 0 programs. This difference was significantly different at the 1% significance level. In terms of household income, income was significantly lower among those participating in 1 program versus 0 programs ($p < 0.01$). In terms of region, children in the Northwest were significantly less likely to be in 1 program versus 0 programs ($p < 0.01$). Children located in the West were significantly more likely to be in 1 program versus 0 programs ($p < 0.01$). There were no major differences in program participation among those in 0 programs and 1 program. In terms of fast food retailers, a greater number of fast-food retailers were located near children who participated in 1 program than in 0 programs ($p < 0.01$).

In Table 6.4, in terms of parents' characteristics, parents who were married, separated and never married were significantly more likely to be in 1 program than in 0 programs ($p < 0.01$). There was no difference in the widowed and divorced variables among those in 0 programs and 1 program. In terms of educational attainment, children with parents who had a high school degree or less were significantly more likely to be in 1 program than in 0 programs ($p < 0.01$). Children with parents who had a bachelor's degree or higher were significantly less likely to be in 1 program than in 0 programs ($p < 0.01$).

6.2.2 Comparing children in 0 versus 2 programs

In Table 6.2, in terms of child characteristics, 17% of children were obese that were in 0 programs and 23% of children were obese that were in 2 programs. This difference was significant at the 1% significance level ($p < 0.01$), indicating that children participating in 2 programs were more likely to be obese than those participating in 0 programs. Children participating in 2 programs were significantly younger than children participating in 0 programs ($p < 0.01$). In terms of gender, there was no significant difference between children participating in 0 programs versus 2 programs. In terms of race/ethnicity, 19% of Hispanics participated in 0 programs and 39% of Hispanics participated in 2 programs, which was significantly different at the 1% significance level. Non-Hispanic whites, non-Hispanic Asians and non-Hispanic other races were significantly less likely to be in 2 programs than in 0 programs ($p < 0.01$). Non-Hispanic blacks were significantly more likely to be in 2 programs than in 0 programs ($p < 0.01$). Non-Hispanic American Indians were also significantly more likely to be in 2 programs than in 0 programs ($p < 0.05$). There was no significant difference in the share of non-Hispanic multiple races that participated in 0 programs and 2 programs.

In Table 6.3, in terms of household characteristics, living in a rural area was more common among those in 2 programs than in 0 programs, which was significantly different at the 1% significance level. Household size was significantly higher among those in 2 programs versus 0 programs ($p < 0.01$). A household who had less income was more likely to be in 2 programs versus 0 programs at the 1% significance level. In terms of region, those in the Northeast and Midwest were significantly less likely to be in 2 programs than in 0 programs ($p < 0.01$). Those in the South and West were more likely to

be in 2 programs than in 0 programs at the 1% and 5% significance levels respectively. Further, there was a significantly higher number of fast-food retailers within one mile of a child's household among those participating in 2 programs versus 0 programs ($p<0.05$).

In Table 6.4, in terms of parents' characteristics, those that were married and widowed were significantly less likely to be in 2 programs ($p<0.01$). There was no significant difference in the share of divorced parents among those in 0 programs and 2 programs. Children with parents that were separated or never married were more likely to be in 2 programs. In terms of educational attainment, children with parents with a high school degree or less were significantly more likely to be in 2 programs than in 0 programs ($p<0.01$). Children with parents who had a bachelor's degree or higher were less likely to be in 2 programs than in 0 programs, which was significantly different at the 1% significance level. There was no significant difference in program participation among those who had some college education.

6.2.3 Comparing children in 0 versus 3 programs

In Table 6.2, in terms of child characteristics, 17% of children were obese that were in 0 programs and 25% of children were obese that were in 3 programs. This difference was significantly different at the 1% significance level ($p<0.01$), which indicates that children participating in 3 programs were more likely to be obese than those participating in 0 programs. There was no significant difference in gender among those participating in 0 programs and 3 programs. Children participating in 3 programs were significantly older than those participating in 0 programs ($p<0.01$). In terms of race/ethnicity, Hispanics and non-Hispanic blacks were significantly more likely to be in

3 programs than in 0 programs ($p<0.01$). Non-Hispanic whites and Asians were less likely to be in 3 programs than those in 0 programs ($p<0.01$). Non-Hispanic other races were significantly less likely to be in 3 programs than in 0 programs ($p<0.05$). There was no significant difference in the share of non-Hispanic American Indians and non-Hispanic multiple races participating in 0 programs and 3 programs.

In Table 6.3, in terms of household characteristics, children participating in 3 programs were significantly less likely to live in a rural area than those that participated in 0 programs ($p<0.01$). Household size was significantly higher among those in 3 programs versus 0 programs ($p<0.01$). Average household income was significantly lower among those in 3 programs versus 0 programs ($p<0.01$). In terms of region, children in the Northeast and Midwest were significantly less likely to be in 3 programs than in 0 programs ($p<0.01$). Those in the South were more likely to be in 3 programs than in 0 programs ($p<0.01$). There was no significant difference in the share of children living in the West among those in 0 programs and 3 programs. Further, a greater number of fast food retailers were located within one mile of the child's household among those in 3 programs versus 0 programs ($p<0.01$).

In Table 6.4, in terms of parents' characteristics, children with parents who were married were significantly less likely to be in 3 programs versus 0 programs ($p<0.01$). Children with a widowed parent were more likely to be in 3 programs versus 0 programs ($p<0.05$). Those with parents that were divorced, separated or never married were significantly more likely to be in 3 programs than 0 programs ($p<0.01$). In terms of educational attainment, a child with parents that had a high school degree or less were significantly more likely to be in 3 programs than in 0 programs ($p<0.01$). A Bachelor's

degree or higher was significantly less common among those in 3 programs than in 0 programs ($p<0.01$). Children with parents who had some college education were significantly less likely to be in 3 programs than in 0 programs ($p<0.05$).

6.2.4 Comparing children in 0 versus 4 programs

In Table 6.2, in terms of child characteristics, 17% of children were obese that were in 0 programs and 26% of children were obese that were in 4 programs. This difference was significantly different at the 1% significance level ($p<0.01$), which implies that children participating in 4 programs were more likely to be obese than those that participated in 0 programs. There was no significant difference in gender among those participating in 0 and 4 programs. Children participating in 4 programs were younger than children that participated in 0 programs, which was significantly different at the 1% significance level. In terms of race/ethnicity, Hispanics (19% vs. 51%) were more likely to be in 4 programs than in 0 programs, which was significantly different at the 1% significance level. Non-Hispanics whites were significantly less likely to be in 4 programs than in 0 programs ($p<0.01$). Non-Hispanic blacks were significantly more likely to be in 4 programs versus 0 programs ($p<0.10$). Non-Hispanic Asians were significantly less likely to be in 4 programs than in 0 programs ($p<0.01$). There was no significant difference in program participation among non-Hispanic American Indians, non-Hispanic other races and non-Hispanic multiple races between 0 programs and 4 programs.

In Table 6.3, in terms of household characteristics, there was no significant difference in the share of children participating in 0 programs and 4 programs that live in

a rural area. Average household size was significantly higher among those in 4 programs versus 0 programs ($p<0.01$). A household who had less income was more likely to be in 4 programs than 0 programs ($p<0.01$). In terms of region, there was no significant difference in the share of children living in the Northeast and West among those that participated in 0 programs and 4 programs. Those in the Midwest were significantly less likely to be in 4 programs than in 0 programs ($p<0.01$). Those in the South were significantly more likely to be in 4 programs than in 0 programs ($p<0.05$). Further, a greater number of fast food retailers were located within one mile of the child's household among those in 4 programs versus 0 programs ($p<0.01$).

In Table 6.4, in terms of parents' characteristics, children whose parents were married was less likely to be in 4 programs than 0 programs ($p<0.01$). There was no significant difference in the widowed and divorced variables among those participated in 0 programs and 4 programs. Children with separated or never married parents were significantly more likely to be in 4 programs versus 0 programs ($p<0.01$). In terms of educational attainment, children with parents who obtained a high school degree or less were significantly more likely to be in 4 programs versus 0 programs ($p<0.01$). Those with a parent who obtained a bachelor's degree or higher (34% vs. 5%) or some college education (35% vs. 23%) were significantly less likely to be in 4 programs than in 0 programs ($p<0.01$).

6.3 Summary of Mean Comparison Test Results

In the mean comparison tests the key finding was that greater program participation was associated with higher levels of obesity among low-income children. In

total, 17% of children participating in 0 programs were obese. This percentage was significantly higher among those participating in 1, 2, 3, and 4 programs at 26%, 23%, 25% and 26% respectively. Additionally, children, household and parents' characteristics varied significantly with increasing participation in food assistance programs.

Table 6.2: Mean Comparison Test by comparing children participation in 0 to 4 programs.

Child Characteristics	Program											
	0 (N=1,126)		1 (N=868)		2 (N=968)		3 (N=703)		4 (N=123)			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Obese	0.17	0.38	0.26***	0.44	0.23***	0.42	0.25***	0.43	0.26***	0.44		
Male	0.51	0.50	0.49	0.50	0.51	0.50	0.53	0.50	0.51	0.50		
Female	0.49	0.50	0.51	0.50	0.49	0.50	0.47	0.50	0.49	0.50		
AGE_R	9.93	5.32	8.87***	5.36	9.42***	4.54	10.72***	3.6	8.89**	3.63		
Hispanic	0.19	0.39	0.35***	0.48	0.39***	0.49	0.36***	0.48	0.51***	0.50		
White	0.62	0.49	0.43***	0.49	0.35***	0.48	0.33***	0.47	0.30***	0.46		
Black	0.09	0.29	0.15***	0.36	0.19***	0.39	0.24***	0.43	0.14*	0.35		
American_indian	0.01	0.09	0.01	0.11	0.02**	0.12	0.01	0.10	0.01	0.09		
Asian	0.04	0.19	0.02***	0.14	0.01***	0.10	0.01***	0.10	0.00***	0.00		
Other_race	0.02	0.13	0.01**	0.11	0.00***	0.06	0.01**	0.08	0.01	0.09		
Multiple_race	0.04	0.19	0.03	0.16	0.04***	0.19	0.03	0.18	0.03	0.17		

Source: FoodAPS dataset,2017Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note that *, ** and *** indicates that the mean is significantly different from children participating in 0 programs at the 10%, 5% and 1% significance level.

Table 6.3: Mean Comparison Test by comparing children participation in 0 to 4 programs.

Household Characteristics		Program											
		0 (N=1,126)		1 (N=868)		2 (N=968)		3 (N=703)		4 (N=123)			
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Rural	0.29	0.45	0.25**	0.43	0.24***	0.43	0.23***	0.42	0.28	0.45			
Hhsize	4.40	1.38	5.10***	2.09	5.00 ***	1.80	5.19***	1.78	6.14***	2.12			
Inchhavg_r	6204.2	4413	3715.49***	2919	2861.14***	2210	2283.5***	1887	2129.26***	1536			
Northeast	0.19	0.39	0.13***	0.34	0.11***	0.32	0.11***	0.31	0.17	0.37			
Midwest	0.27	0.44	0.25	0.44	0.22***	0.41	0.17***	0.37	0.16***	0.37			
South	0.30	0.46	0.32	0.47	0.39***	0.49	0.50***	0.50	0.39**	0.49			
West	0.24	0.43	0.29***	0.45	0.28**	0.45	0.23	0.42	0.28	0.45			
Ff3	4.95	5.80	5.93***	6.10	5.38**	5.66	6.02***	6.09	6.46***	7.22			

Source: FoodAPS dataset,2017Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note that *, ** and *** indicates that the mean is significantly different from children participating in 0 programs at the 10%, 5% and 1% significance level.

Table 6.4: Mean Comparison Test by comparing children participation in 0 to 4 programs

Parents Characteristics		Program											
		0 (N=1,126)		1 (N=868)		2 (N=968)		3 (N=703)		4 (N=123)			
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Married	0.72	0.45	0.55***	0.5	0.48***	0.50	0.35***	0.48	0.30***	0.46			
Widowed	0.01	0.11	0.02*	0.15	0.03***	0.17	0.02**	0.12	0.02	0.15			
Divorced	0.13	0.34	0.15	0.36	0.15	0.36	0.17***	0.37	0.13	0.34			
Separated	0.03	0.18	0.06***	0.24	0.07***	0.26	0.12***	0.33	0.11***	0.31			
Never_married	0.10	0.30	0.21***	0.41	0.26***	0.44	0.35***	0.48	0.43***	0.50			
Hsorless	0.31	0.46	0.53***	0.50	0.57***	0.50	0.65***	0.48	0.72***	0.45			
Some_college	0.35	0.48	0.33	0.47	0.34	0.47	0.30**	0.46	0.23***	0.42			
Baorhigher	0.34	0.47	0.14***	0.35	0.09***	0.29	0.04***	0.21	0.05***	0.22			

Source: FoodAPS dataset,2017

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note that *, **, and *** indicates that the mean is significantly different from children participating in 0 programs at the 10%, 5% and 1% significance level.

6.4 Probit regression and partial effects

Table 6.5 shows the probit regression results, which examine the association between food assistance program participation and childhood obesity. Here the dependent variable is *obese*. In terms of child characteristics, results show that increasing participation by 1 program decreases the probability of being obese by 3% ($p < 0.05$). This implies that the more programs children participate in, the less likely they are to be obese.

The outcome of this analysis, that greater participation in the food assistance programs reducing obesity is logical for several reasons. In most FAPs, food benefits provided by the program must follow dietary recommendations. In case of WIC, to ensure the nutrition quality for both women and children, the provided food packages are prescribed based on healthy diets (Koleilat et al., 2017). Meals served in both NSLP and SBP must have to follow the nutrition standards established in the Dietary Guidelines for Americans (M. Story et al., 2009). To promote healthy food choices, SNAP benefit recipients are given nutrition schooling through SNAP-ED (USDA, 2018a). Koszewski et al. (2011) find that nutrition education programs such as SNAP-Ed motivate people to eat healthier food which is key to preventing obesity (Koszewski et al., 2011). Through both the provision of food in accordance with nutrition recommendations and nutrition education, the food assistance programs are potentially improving participants dietary quality thus reducing the likelihood of childhood obesity.

Among sample children, age is inversely related to childhood obesity ($p < 0.01$). Increasing age by 1 year decreases the probability of being obese by 2%. Hispanic and non-Hispanic blacks are more likely to be obese than non-Hispanic whites at the 5% and

1% significance levels respectively. Non-Hispanic Asians are more likely to be obese than non-Hispanic whites, which is statistically significant at the 1% significance level. There is no significant relationship between gender, other races or multiple races with childhood obesity.

In terms of household characteristics, the number of fast-food retailers within 1 mile of a child's household is positively related to obesity ($p < 0.05$). Increasing the number of fast-food retailers by one increases the probability of being obese by 1%. There is no significant relationship between rural location, household size, and region with childhood obesity.

In terms of parents' characteristics, divorced is positively related to childhood obesity at the 5% significance level. Results indicate that there is no significant relationship between widowed, separated or never married and childhood obesity. Educational attainment has an inverse association with childhood obesity. Having some college education or a bachelor's degree decreases the probability of being obese by 15% and 25% respectively relative to those who have no college education ($p < 0.01$).

6.5 Comparison of Mean Comparison Test and Probit Regression Results

The key finding of the mean comparison test results is that greater food assistance program participation is associated with higher levels of childhood obesity, which implies increasing participation in the number of programs is positively related to childhood obesity. It is important to note that mean comparison tests do not control for sociodemographic variables. On the other hand, after controlling for sociodemographic

characteristics, the probit regression model results indicate a negative association between childhood obesity and food assistance program participation.

Table 6.5: Summary statistics of probit regression and partial effects

Characteristics	Variable	Obese			
		Coef. (P> z)	Std. Err	PAE	Std. Err
Child	Num_programs	-0.10**	0.05	-0.03**	0.014
	Male	-0.05	0.10	-0.02	0.03
	AGE_R	-.070***	0.01	-0.02***	0.00
	Hispanic	0.27**	0.14	0.08**	0.04
	Black	0.38***	0.16	0.12***	0.05
	Asian	1.33***	0.54	0.41***	0.17
	Other_race	-0.04	0.61	-0.01	0.19
	Multiple_race	-0.73	0.60	-0.23	0.19
Household	Rural	-0.05	0.14	-0.01	0.42
	Hhsize	0.00	0.03	0.00	0.01
	Inchhavg_r	5.29 E-06	4.23 E-05	1.64 E-06	1.31 E-05
	Midwest	0.19	0.19	0.06	0.06
	South	0.20	0.18	0.06	0.06
	West	0.01	0.19	0.00	0.06
	Ff3	0.02**	0.01	0.01**	0.00
Parents	Widowed	-0.29	0.32	-0.09	0.10
	Divorced	0.30**	0.15	0.09**	0.05
	Separate	0.22	0.20	0.07	0.06
	Never_married	0.02	0.13	0.00	0.04
	Some_college	-0.49***	0.12	-0.15***	0.04
	Baorhigher	-0.80***	0.20	-0.25***	0.06

Source: FoodAPS dataset,2017

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note that standard errors are non-robust.

CHAPTER SEVEN: DISCUSSION

The objective of this study is to find the association between the number of major food assistance programs households participate in and childhood obesity. To achieve our goal, we have analyzed four major US food assistance programs: SNAP, WIC, NSLP, and SBP. To date, no prior study has considered the association between participation in all major US food assistance programs and childhood obesity. National Household Food Acquisition and Purchase Survey (FoodAPS) data were used to conduct mean comparison tests and probit regression analysis.

Prior to this analysis, only two studies focused on the association between participation in multiple food assistance programs and childhood obesity. The first study by Roy et al. (2012) considered participation in SNAP, NSLP, and SBP, while a second study by Millimet et al. (2010) considered participation in NSLP and SBP. Roy et al. (2012) found a positive relationship between participation in individual food assistance programs and childhood obesity and found an inverse relationship between participation in multiple food assistance programs and childhood obesity. On the other hand, Millimet et al. (2010) found no significant relationship between participation in NSLP and childhood obesity and a positive relationship between participation in SBP and childhood obesity.

This study adds to the literature as the first to analyze participation in all four major US food assistance programs: SNAP, WIC, NSLP and, SBP. Similar to Roy et al. (2012), we found an inverse relationship between participation in multiple food assistance programs and childhood obesity. Results from the mean comparison tests

indicated that greater food assistance program participation was associated with higher levels of obesity among low-income children. In total, 17% of children participating in 0 programs were obese. This percentage was significantly higher among those participating in 1, 2, 3, and 4 programs at 26%, 23%, 25% and 26% respectively. On the other hand, after controlling the sociodemographic characteristics, probit regression model results indicated an inverse association between the number of food assistance programs a child participated in and childhood obesity. Through both the provision of food in accordance with nutrition recommendations and nutrition education, it is logical that participation in food assistance programs reduces the likelihood of childhood obesity through improvements in the nutritional intake of program participants.

Further, we found that race/ethnicity and the number of fast-food retailers within 1 mile of a child's household were significantly and positively related to childhood obesity. Which implies that a greater number of fast-food retailers located within one-mile proximity of the child's household among those that participated in multiple food assistance programs were more likely to be obese.

Findings from this study can help inform the creation of policy, which more effectively supports the well-being of children from low-income households. The key objective of this study was to provide insight, which can help address the obesity epidemic in the United States, especially childhood obesity. Our study of the four major US food assistance programs indicates that participation in multiple programs reduces the prevalence of childhood obesity. Therefore, policymakers should encourage low-income households to participate in all programs for which they are eligible in order to have the greatest impact on childhood obesity.

The key driving point of economics is maximizing output from limited resources (O'Boyle, 1993). From our study's perspective, it is recommended that given limited resources, policymakers should target all the children, especially those at the greatest risk for childhood obesity. Results from this study indicate that Hispanic, non-Hispanic blacks and non-Hispanic Asian children are at a greater risk for obesity than non-Hispanic White children. Further, our study suggests that children who live in a poor food environment where there is an abundance of fast-food restaurants are the most vulnerable of being obese. This finding is in agreement with Currie et al. (2010) who found that the risk of being obese was greater among households located near fast-food restaurants (Currie, DellaVigna, Moretti, & Pathania, 2010).

Numerous schemes can be taken to enroll low-income children who are eligible for existing food assistance programs. Traditional outreach activities can make households aware of their children's eligibility for food assistance program benefits. For outreach, typical means, such as radio, television, and newspaper advertisements, distribution of posters and leaflets, mass mailings, setting up public information booths and 24/7 telephone information services can be effective in this case (Bendick Jr, 1980).

There are some limitations in our study. Firstly, the dataset used in this study, FoodAPS, is cross-sectional in nature. This cross-sectional nature limits the capability of this study to draw causal conclusions (Mary T. Gorski Findlin 2018). Secondly, participation in SNAP was verified by the USDA Economic Research Service (USDA, 2019a). However, NSLP, SBP (USDA, 2018b) and WIC participation were not verified by USDA researchers. Thus, it is likely that participation in these programs was misreported by some households, potentially biasing the results from this study. Thirdly, regression

analysis in this study may be impacted by endogeneity. We focus in this study on whether participation in food assistance programs impacts childhood obesity. However, a child's weight status can also impact their participation in a food assistance program, which can potentially bias the results. Lastly, another limitation of the food assistance program is that participation can only be identified at the household level as opposed to the individual level.

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