PRELIMINARY AND INCOMPLETE – PLEASE DO NOT CITE

Food Insecurity and Childhood Obesity: Beyond Categorical and Linear Representations

Yemisi Kuku (Iowa State University)

Craig Gundersen (Iowa State University)

Steve Garasky (Iowa State University)

Paper Prepared for Presentation at
American Agricultural Economic Association Annual Meetings

April, 2008

Corresponding Author: Yemisi Kuku, Department of Human Development and Family Studies, Iowa State University, Ames, IA 50011; email: yemik@iastate.edu

This research was supported by the U.S. Department of Agriculture (USDA), Cooperative State Research, Education, and Extension Service (CSREES) Grant Number 2007-35215-17871.

Food Insecurity and Childhood Obesity: Beyond Categorical and Linear Representations

Yemisi Kuku (Iowa State University)

Craig Gundersen (Iowa State University)

Steve Garasky (Iowa State University)

Abstract: Previous work on the relationship between food insecurity and childhood overweight has lead to a wide array of answers – some have found a positive relationship, others no relationship, and still others a negative relationship. This previous work has shared one thing in common – all have used parametric models. In this paper we move beyond parametric models by using non-parametric models. With data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES) and a wide array parametric methods, we find evidence across different samples of a positive relationship, no relationship, and a negative relationship between childhood overweight and food insecurity. When we turn to non-parametric methods, however, this ambiguity across samples is not as prevalent. Instead, across different samples, we find (a) increases in the probability of food insecurity in the middle of the BMI distribution, (b) increases in the probability at the very high end of the BMI, and (c) no relationship across the entire distribution. We present some parametric models that roughly mimic these relationships. Our results indicate that efforts to reduce food insecurity will either have no impact on childhood overweight or would lead to reductions in childhood overweight.

INTRODUCTION

Childhood obesity has become an important public health concern for policymakers in the United States. Recent estimates indicate that 17.1% of U.S. children are considered overweight (i.e., body mass indices (BMI) above the 95th percentile for age and gender) and another 16.5% are considered at risk of overweight (BMIs between the 85th and 95th percentile) (Ogden et al., 2006). Alongside this concern about childhood obesity, policymakers need to address the seeming opposite of childhood obesity - food insecurity, i.e., the uncertainty of having, or unable to acquire, enough food for all household members because of insufficient money or other resources. In 2005, 11.0% of the U.S. population reported that they suffered from food insecurity at some time during the previous year (Nord et al., 2006). For about 3.9% of the population, the degree of food insecurity was severe enough to be recorded as very low food security (formerly known as “food insecurity with hunger”). For households with children, the reported levels were higher: 15.6% and 4.1%, respectively

The research on the relationship between food insecurity and childhood obesity is mixed. Some have found a positive relationship (Dubois et al., 2006; Casey et al., 2001; Jyoti et al., 2005; Casey et al., 2006), others have found no relationship (Alaimo et al., 2001a; Kaiser et al., 2002; Martin and Ferris, 2007; Gundersen et al., 2007), and others have found a negative relationship (Jimenez-Cruz et al., 2003; Rose and Bodor, 2006; Matheson et al., 2002). All these papers have used parametric frameworks, which are statistical methods that depend on the parameters of populations or probability distributions.

In this paper, we depart from this previous work by using non-parametric approaches to analyze the relationship between food insecurity and child weight over the full range of percentiles derived from the body mass indices of children. This analysis examines data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). Parametric regressions (probits) are also included to better understand the potential advantages of using non-parametric approaches.

The rest of the paper is organized as follows: The background section provides insights into the extent, measurement, and consequences of obesity and food insecurity, as well as the connections between them. The methodology section provides the methodologies we employ for our parametric and non parametric models, while data sources are described in the data section. The results section contains an explanation of the empirical findings, while conclusions and policy recommendations round out the paper.

BACKGROUND

Childhood obesity

Extent

There has been a dramatic increase in the incidence of childhood obesity over the past few decades. Ogden et. al, (2002) carried out a comprehensive study of the prevalence of obesity among children in the United States between 1963 and 2000, based on the NHANES. Their findings revealed a marked upward trend in the incidence of obesity in the US. For children aged 6-11 (the only age group for whom data were available in the 1960s), obesity prevalence hovered around 4 percent between 1963 and 1974, and then increased steadily thereafter, to 6.5 percent in the late ‘70s, 11.3 percent between 1988 and 1994, to 15.3 percent between 1999-2000. The trend was very similar for children aged 12-19, increasing from 6.1 percent in the early ‘70s, to 15.5 percent in the 1999-2000. In addition to the fact that there have been major increases in overweight among all children, there have also been significant differences by racial groups. Indeed, African American and Hispanic American children and adolescents have significantly higher rates of obesity prevalence than white children. In 1999-2000, about 26 percent of white children aged 6-11 were at risk of overweight. Comparable figures for African American and Mexican American children were 35.9 and 39.3 percent respectively. Within the same age group, 11.5 percent of white children were found to be obese, while 19.5 percent of black children and 23.7 percent of Mexican American children were found to be obese. The pattern was similar for adolescents aged 12-19.

In a follow up paper to the aforementioned, Ogden et al. (2006) carried out another study on the prevalence of obesity among children in America between 1999 and 2004, also using the NHANES. They found that the prevalence of obesity continued to increase into the year 2000 and beyond. By 2004, the prevalence of obesity among all children (aged 2-19) was 17.1 percent. Obesity prevalence rates for children aged 6-11 had increased to 18.8 percent ,while the comparable figure among adolescents aged 12-19 was 17.4 percent. The breakdown by race however showed some flattening of prevalence rates, at least among non-white children. Prevalence rates among white children increased to 17.7 percent for children aged 6-11 (overweight classification) between 2003-2004, compared to 22 percent of black children, and 22.5 percent of Mexican American children.

Measurement

The measurement of child obesity begins with measuring a child's height and weight. From this information, one can calculate a body mass index (BMI, kg/m2) as follows: As children's height and weight naturally increase with age and differ by gender, BMI is mapped into a percentile using age- and sex-specific reference values of the CDC growth charts for the U.S.

From these percentiles, a child is classified into one of four weight status categories: (1) underweight (BMI < 5th percentile); (2) normal weight (BMI ≥ 5th and < 85th percentiles); (3) at risk for overweight or overweight (BMI ≥ 85th and <95th percentiles), and (4) overweight (BMI ≥95th percentile). Key limitations to this approach are the grouping of a wide range of children into the same classification and the potential reclassification of a child as a result of a small weight change should she or he be on the cusp of their classification range.

The CDC (Center for Disease Control) does not use the term obese for children. Instead, children at the 85th percentile of age and gender specific body mass indices are termed at risk of overweight, while children at the 95th percentile are termed overweight. (American Obesity Assoction, 2006). Determination of whether or not an individual is termed obese is exogenously determined.

Causes

There are several causes of overweight among children that have been identified, including biological and environmental causes. Among environmental causes, overweight has been linked to a sedentary lifestyle, poor eating habits, excessive viewing of television and excessive playing of video games. Robinson (2001) identifies three mechanisms through which increased television watching have contributed to increased obesity. They include displacement of physical activity; increased calorie consumption while watching or caused by the effects of advertising; and reduced resting metabolism. Another factor is socioeconomic status. Strauss and Knight (1999) examined the influence of the home environment on children's obesity, and found that children with obese mothers, low family incomes and lower cognitive stimulation were more likely to be obese, independent of other demographic and socioeconomic factors.

Among biological causes, genetics is an important factor (Maffeis, 1999). Studies have found that genetic factors are involved in the regulation of body weight and also determine how individuals respond to diet and exercise (Farooq, 2005). Specifically, the impact of energy intake/nutrient composition have differential impacts on individuals, based on the occurrence of mutations/polymorphisms, which make some individuals more prone to weight gain than others. Also individual abilities to lose weight have been found to depend on genotype (Marti et al, 2004). Another factor often examined in the literature is the relationship between health insurance and obesity. However, the evidence is not clear as to the direction of this relationship. While some studies suggest that health insurance may create incentives for individuals to exercise less and eat more if their insurance premiums are not risk rated for obesity (Bhattacharya & Sood, 2005); others do not find any proof of the existence of this moral hazard, and report no causal effect of health insurance status on the probability of being obese.(Rashad and Markowitz, 2007).

Consequences

Obesity has become a serious problem for both adults and children in the United States, and the costs of obesity in American society are well documented. Child obesity has negative physical, psychological and social consequences on children that extend into their adult lives (Gunnell et al., 1998; Mahoney et al., 1996; Nieto et al., 1992; Power et al., 1997; Schwimmer et al., 2003; Serdula et al., 1993; Smoak et al., 1987; Williams et al., 1992). There is an economic cost as well, as obesity related health care costs accounted for over 9% of national health care expenditures for all adults (Finkelstein et al., 2003). Children with obesity have health care cost that are on average three times as much that of a non-obese child, are more likely to be hospitalized (Marder & Chang, 2006), and tend to stay in the hospital longer with diseases related to obesity (Wang and Dietz, 2002).

Food insecurity

Measurement

The development of the methods of food security measurement that underlie these reports began in the early 1980s when policymakers began to ask for a better description of what was meant by poverty-related hunger in the US. As part of this drive, an expert panel was convened, which established definitions for “food security,” “food insecurity,” and “hunger” (Anderson 1990). Using these definitions, the National Nutrition Monitoring and Related Research Program (established by a 1992 Act of Congress) began to operationalize these concepts within a survey framework. The culmination of these efforts led to the current methods of measuring food insecurity.

If food insecurity were completely determined by other measures of constrained resources (e.g., poverty), the work of establishing the measurement of food insecurity would be largely irrelevant. However, research at the time and later showed that income-based measures and other measures of well being were not highly correlated with food insecurity and hunger.

Construction of food security scale

To calculate the official rates of food insecurity and food insecurity with hunger in the USA, a food security scale is constructed using a set of 18 questions if the household has children or 10 if it does not. Some of the conditions people are asked about include “I worried whether our food would run out before we got money to buy more,” (the least severe item), “Did you or the other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food," "Were you ever hungry but did not eat because you couldn't afford enough food," and "Did a child in the household ever not eat for a full day because you couldn't afford enough food" (the most severe item for households with children). Each of these questions is qualified by the proviso that the conditions are due to financial constraints. As a consequence, persons who have reduced food intakes due to, say, fasting for religious reasons or dieting, would not be responding affirmatively to these questions.

Using the full set of 18 questions, the USDA delineates households into the categories of food secure, food insecure without hunger, and food insecure with hunger. To map the 18 questions into food insecurity categories, the USDA first employs a Rasch model, a model emerging out of the broader class of Item Response Theory models [for more on Rasch scoring methods, see, e.g., Andrich (1988)]. The results from estimating the Rasch model yield a value for each number of affirmative responses. These values can be seen as a reflection of the underlying severity of food insecurity facing a household responding affirmatively to a particular number of questions.

Extent

In 2006, 11 percent of the US population was found to be food insecure. In addition, a third of that number (4 percent of total US population) had very low food security —"meaning that the food intake of one or more adults was reduced and their eating patterns were disrupted at times during the year because the household lacked money and other resources for food"(Nord, Andrews and Carlson, 2007). Rates of food insecurity were substantially higher than the national average for households with incomes below the poverty line (36.3 percent), households with children headed by single women (30.4 percent), or single men (17.0 percent); black households (21.8 percent) and Hispanic households (19.5 percent). Overall, households with children reported food insecurity at about double the rate for households without children (15.6 vs. 8.5 percent). Among households with children , those headed by a married couple showed the lowest rate of food insecurity (10.1 percent) (Nord, Andrews and Carlson, 2007).

Consequences

Children in food insecure settings are more likely to have poor health status (Casey, et al., 2001). More specifically, food insecure children have higher incidences of infection, stomachaches, headaches, colds, ear infections and iron deficiency (Alaimo, Olson & Frongillo, 2001a; Casey et. al, 2001). In addition, they are more likely to exhibit emotional and behavioral problems as well as experience more fatigue and irritability (Kleinman et. al 1998; Murphy et. al, 1998). Not surprisingly, they are also found to perform more poorly in school (Glewwe, Jacoby & King, 1999; Alaimo, Olson & Frongillo, 2001b). They are more likely to exhibit aggressive, destructive and suicidal behaviors (Reid , 2000; Alaimo, Olson & Frongillo, 2002) and also need more mental health and special education services (Alaimo, Olson & Frongillo, 2001b).

Connections between food insecurity and childhood overweight.

On the surface, we may imagine that childhood overweight and food insecurity would be inversely related insofar as reductions in food intakes would be expected to lead to reductions in weight. However, about a decade ago, research emerged that challenged this expected relationship (Dietz, 1995). This paradoxical and counter intuitive relationship has since been much discussed and investigated in the literature and two major pathways have been hypothesized to lead to a positive relationship between food insecurity and childhood overweight (Casey et. al, 2006). The first is binge eating, based on a variable food availability cycle (Townsend, 2001). In this case, when food is available, individuals tend to overeat, and even though there are periods when they cannot eat as well due to poor availability of food, they still gain weight (Polivy, 1996; Welde et. al, 2000; Polivy & Herman, 1985; Polivy et al, 1994). The better known pathway is the cheaper cost and consumption of energy dense foods (Drewnowski & Specter , 2004; Dietz, 1995). This idea has been popularized by Hollywood as well, with the emergence of documentaries like Super Size Me (2004) that blame the increasing obesity problem in America on the fast food culture. The argument here is that poor people cannot afford fresh healthy food, but tend to eat a lot of dense foods that are high in calories which are more affordable but much less healthy and lead to obesity.

Empirically, the evidence about the relationship between food insecurity and overweight is mixed. As noted above, Some have found a positive relationship (Dubois et al., 2006; Casey et al., 2001; Jyoti et al., 2005; Casey et al., 2006), others have found no relationship (Alaimo et al., 2001a; Kaiser et al., 2002; Martin and Ferris, 2007; Gundersen et al., 2007), and others have found a negative relationship (Jimenez-Cruz et al., 2003; Rose and Bodor, 2006; Matheson et al., 2002).

METHODOLOGY

We first estimate the relationship between food insecurity (FI) and child overweight using a simple probit model:

$FI_i=1$ if $FI_i^* > 0$; $FI_i = 0$ otherwise. (1)

$FI_i^* = \alpha_0 + \alpha_1 + W_i + \varepsilon_i$

where i denotes a child, W is the weight category to which the child belongs, and ε is an error term.[1] We define W in five ways: (a) a variable taking on a value of 1 if a child is overweight, 0 otherwise, (b) a variable taking on a value of 1 if a child is overweight or at-risk of overweight, 0 otherwise, and (c) a continuous measure of BMI percentile. These are the methods that have been employed in previous work.

The estimation of this probit model is one traditional way to measure the relationship between food insecurity and childhood overweight. We now turn to our alternative approach, namely our non- parametric approach. Under this approach, the functional form is not specified. The general form can be represented by

$$FI_i=f(BMIPCT_i)+\varepsilon_i \qquad (2)$$

where BMIPCT is the BMI percentile. While there are many methods of non parametric simple regression, we use the following method.[2]

The children in our sample are ordered by their BMIPCT values such that

$$BMIPCT_i \leq BMIPCT_{i+1} \text{ for } i=1,\ldots,N-1$$

where N is the number of children in our sample. For each value of FI_i a smoothed value is calculated. Denote this as FI_i'. The observations from BMIPCT used to calculate each value of FI_i' depends on the choice of bandwidth. Formally, observations $i_-=\max(1,i-k)$ to $i_+=\min(i+k,N)$ are used where

$$k=\frac{N*bandwidth-0.5}{2}$$

In our case, the bandwidth is 0.4.

---

[1] Our interest here is in the relationship between the variables rather than the direction of the relationship. Since no other covariates are included, this model is equivalent to the usual case of overweight status being regressed on food insecurity.

[2] This discussion borrows heavily from StataCorp, 2007.

The values of BMIPCT are weighted in each regression such that greater weight is placed on observations closest to $BMIPCT_i$ for any i. The weights used in this paper for the observations $BMIPCT_{i-}$ to $BMIPCT_{i+}$ are defined by the following:

$$w_j = \left\{1 - \left(\frac{|BMIPCT_j - BMIPCT_i|}{1.0001 * \max(x_{i+} - x_i, x_i - x_{i-})}\right)^3\right\}^3$$

Using these values of w_j for each observation within i_- to i_+, we then arrive at a value for each FI_i'.

The results from our non-parametric approach yields new insights into how one may wish to represent the relationship in parametric terms. We discuss these parametric representations after our analyses of the non-parametric models.

DATA

We used data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). NHANES is a program of studies conducted by the National Center for Health Statistics, Centers for Disease Control (NCHS/CDC) to assess the health and nutritional status of adults and children in the United States. NHANES examines a nationally representative sample of about 5,000 persons each year, about half of whom are children. Since food insecurity is rare among households above 200% of the poverty line the sample was limited to households below this threshold (Nord, et al, 2002; Nord et al., 2006).

Height and weight were measured with an automated data collection system by a trained technician in NHANES mobile examination centers. Body mass index (BMI, kg/m^2) was calculated from the child's weight and height and mapped into a percentile using age- and sex-specific reference values of the CDC growth charts for the U.S. A child was then classified into one of four weight status categories: (1) underweight (BMI < 5_{th} percentile); (2) normal weight (BMI ≥ 5_{th} and < 85_{th} percentiles); (3) at risk for overweight or overweight (BMI ≥ 85_{th} and <95_{th} percentiles), and (4) overweight (BMI ≥95_{th} percentile).

With respect to food insecurity, the children were also classified into several different food security categories based on answers to the questions on the CFSM. The categories utilized in our analyses are as follows: marginally food insecure (MFI : 1 or more affirmative food insecurity responses) vs. fully food secure (FFS : 0 affirmative); food insecure (FI : 3 or more affirmative) vs. food secure (FS : 0-2 affirmative); very low food secure (8 or more affirmative) vs. food secure (LFS : 3-7 affirmative) or FS.

Data description

Tables 1 and 2 present some descriptive statistics of the sample. From table 1, 55 percent of the children are fully food secure, while about 11 percent face very low food security. This is higher than the national average of about 4 percent because this is a low income sample. In terms of racial composition, whites are the largest group, consisting of 42 percent of the sample. Most of the children (53 percent) live slightly below poverty, while over 70 percent have access to health insurance. The breakdowns by food security status are similar to the full sample. For instance, of the 55 percent of children who are fully food secure, 49 percent are white, 19 percent black, while 26 percent are Hispanic. Majority of the children are slightly above poverty, and have health insurance. However, the percentage of children below the poverty line increases and children with health insurance decreases with lower food security status.

Table 2 provides similar information, this time by BMI characteristics. The first column provides the mean value of BMI percentile for all the different samples. On average, the children in all the samples are above the 60th percentile in terms of BMI. The other columns provide insight into the percentage of children who fall into each weight category, by all the different samples. For instance, of the 18 percent of the sample who are overweight, 34 percent are white, while 20 percent are black. More than 70 percent of the children have health insurance, and a slight majority (51 percent) live below the poverty line.

RESULTS

We first consider our estimations of the relationship between food insecurity and childhood overweight. In Tables 3 through 5 we present results from our probit estimations described above. These are the types of models used in previous work on this topic. In each table, the models are for the following groups: all children, white and black children; Hispanic and non-Hispanic children; children in households with incomes below the poverty line and children in households with incomes between 100 and 200 percent of the poverty line; and children with health insurance and children with no health insurance.

In Table 3, where the independent variable is OW vs ARO or NW, we find a similar pattern across all samples –the association between food security and weight is positive for the most part, and the more severe the food security status, the stronger the association between the two variables. A similar pattern exists when the independent variable is OW or ARO vs. NW (Table 4). While there are some significant associations, particularly involving health insurance and poverty status, with more food secure subsamples, the bulk of the strong associations occur with the VLFS versus LFS or FS subsamples.

In Table 5, the dependent variable is BMI percentile, looking at the association over the entire weight distribution. In this case, the pattern of association remains the same as in Tables 3 and 4, but now they are strengthened and more significant associations over the entire distribution are identified. For instance, a significant negative association emerges for the sample without health insurance, and also for non Hispanic children. There is a strong positive association for the sample with health insurance, white children, and children below the poverty line. Across all specifications, there is no relationship between the two variables for black children.

We now consider how non-parametric representations of the relationship between childhood overweight and food insecurity yields new insights into this relationship. As seen in the first panel of Figure 1 (all children) , starting at about the 97th BMI percentile, there is a sharp increase in the probability of being food insecure. This constitutes a non-trivial percentage of children – 13 percent of children fall into this category. Similarly in the second panel of this figure, the slope begins to rise after the 85th percentile . This general pattern can also be seen in the third panel of Figure 1.

The graphs tell a different story for white children (Figure 2). In each of the panels there is a hump in the middle of the distribution (especially pronounced in the first panel) and a curve upwards around the 95th percentile – pointing to a positive relationship between weight and food insecurity both for overweight children and children in the middle of the distribution. For black children, the graphs are mostly flat (Figure 3), pinpointing a lack of relationship between food insecurity and obesity for this group of children.

The results for Hispanic children are in Figure 4. There is a negative association between food insecurity and overweight for this population (as shown in panels one and two), but the relationship turns positive in panel three, for the food insecure children where the graph starts to curve upwards significantly around the 85th percentile.

For non-Hispanic children the relationship is positive as shown by the graphs in Figure 5, which tend to curve upwards sharply around the 85th percentile. There is however some volatility over the distribution in the first panel, with a hump in the middle between the 40th and 60th percentiles, then a fall between the 60th and 85th percentiles before a sharp rise thereafter.

For children below poverty (Figure 6), there is a strong positive association between obesity and food insecurity. For children slightly above poverty (income between 100 and 200 percent of the poverty line), the graphs in Figure 7 show a hump in the middle. There is therefore a positive relationship for individuals in the middle of the distribution, and the graphs are relatively flat thereafter. There is basically no relationship between the two variables in panel three of Figure 7. There is a strong and positive association between food insecurity and obesity for children with health insurance as shown by all three panels in Figure 8.

The preceding discussions indicate that there are aspects of the relationship between food insecurity and childhood overweight that cannot be portrayed by categorical or linear representations of childhood weight status. We now consider two other representations of this relationship – a quadratic in child BMI percentiles and logged child BMI percentiles.

Table 6 presents results for the quadratic specification. Once again, the non linear nature of the associations are clearly seen in this table, as there is a strong quadratic effect for all children, black children, Hispanic children, and children between 100 and 200 percent of the poverty line. However, the strong association for very low food secure children vanishes in this specification. Finally in table 7, where logged child BMI percentiles are the dependent variable, we find what appears to be the best characterization of the association between these two variables across all the samples. There are positive and significant associations for white children, black children, Hispanic children and children across the poverty line for all categorizations of food security. Clearly, the relationship between food insecurity and obesity is best captured by nonlinear methods.

CONCLUSION

Childhood obesity is a critical public health issue today (Hedley et al., 2004; Koplan et al., 2005; Marder and Chang, 2006). The prevalence and increase in childhood overweight in the U.S. is well documented (Ogden et al., 2006; Anderson and Butcher, 2006; Kumanyika and Grier, 2006; Wang and Zhang, 2006). Its negative physical, psychological, and social consequences that extend into adulthood have been identified as well (Gunnell et al., 1998; Mahoney et al., 1996; Nieto et al., 1992; Power et al., 1997; Schwimmer et al., 2003; Serdula et al., 1993; Smoak et al., 1987; Williams et al., 1992; Fontaine et al., 2003). Also well documented is the prevalence of food insecurity in the U.S. among households with children (Nord et al., 2006). The negative health consequences of food insecurity for children also have been well established. Children in food insecure households are more likely to suffer from a range of physical, psychosocial, and other issues (Cook et al., 2004; Dunifon & Kowaleski-Jones, 2003; Kleinman et al., 1998; Murphy et al., 1998; Weinreb et al., 2002).

The relationships between childhood obesity and food insecurity, however, are inconsistent in the literature. Some studies have found a positive relationship (Dubois et al., 2006; Casey et al., 2001; Jyoti et al., 2005; Casey et al., 2006). Others have found a negative relationship between childhood obesity and food insecurity (Jimenez-Cruz et al., 2003; Rose and Bodor, 2006; Matheson et al., 2002). More recently, Martin and Ferris (2007) and Gundersen et al. (2007) have found no relationship. All these papers employed parametric methods for their empirical analyses. As such, they have been limited by these statistical methods that depend on the parameters of populations or probability distributions.

We depart from this previous work by using non-parametric approaches to analyze the relationship between food insecurity and child weight. This study advances the literature in two important ways. First, the analyses are not constrained by assumptions about the distribution of the population. Parametric regressions (probits) are presented to better understand the potential advantages of using non-parametric approaches. Second, we are not constrained by the standard child weight classification cutoffs, but, instead, examine the full range of percentiles derived from the body mass indices of children. This analysis examines data from the 1999-2002 National Health and Nutrition Examination Survey (NHANES).

Accurately understanding the relationship between childhood obesity and food insecurity has considerable policy relevance. The economic dimensions of these problems are tremendous. For example, children treated for being overweight are roughly three times more expensive for the health care system than the average insured child. Children diagnosed with obesity are over twice as likely to be hospitalized compared to non-obese children (Marder and Chang, 2006). Policy makers are understanding the importance of cross-program effects in addressing public needs. The central goal of the Food Stamp Program -- the largest food assistance and the largest near-cash entitlement program in the United States -- is to alleviate food insecurity and hunger in the United States (U.S. Department of Agriculture, Food and Nutrition Service, 1999). While food stamps have been successful in reducing food insecurity (Gundersen and Oliveira, 2001; Wilde and Nord, 2005), they are not designed to reduce obesity. Nevertheless, food stamps can play a role in helping reduce obesity by, for example, providing incentives to families to purchase healthier foods and discouraging the purchase of less healthy foods. Nutrition education programs and other nutrition interventions have demonstrated some success in addressing poor nutrition habits as well (Kramish et al., 2002; Ikeda et al., 2002; Havas, 2003;

Fries et al., 2005; Ammermann et al., 2002). The cross-program gains from these efforts to the Medicaid program and State Child Health Insurance Programs (SCHIP) from reduced health care expenditures may be substantial.

Table 1: Descriptive Statistics, by Food Insecurity Status

	All	FFS	MFI	FI	VLFS
All Children	1.00	0.55	0.13	0.20	0.11
White Children	0.42	0.49	0.33	0.31	0.43
Black Children	0.20	0.19	0.24	0.18	0.24
Hispanic Children	0.32	0.26	0.41	0.45	0.30
Non-Hispanic Children	0.67	0.74	0.59	0.55	0.70
Below Poverty Line	0.47	0.35	0.57	0.64	0.65
Between 100 and 200 Percent of the Poverty Line	0.53	0.65	0.43	0.36	0.35
With Health Insurance	0.78	0.80	0.78	0.73	0.76
Without Health Insurance	0.22	0.20	0.22	0.27	0.24

Notes: Data is taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). N=6724. MFI denotes marginally food insecure (1 or more affirmative food insecurity responses), FFS denotes fully food secure (0 affirmative), FI denotes food insecure (3 or more affirmative), FS denotes food secure (0-2 affirmative), VLFS denotes very low food secure (8 or more affirmative), and LFS denotes low food secure (3-7 affirmative). Standard errors are in parentheses. * significant at 5%; ** significant at 1%.

Table 2: Descriptive Statistics, by BMI Characteristics

	BMI	NW	ARO	OW
All Children	64.11	0.62	0.16	0.18
	(0.362)			
White Children	60.99	0.45	0.38	0.34
	(0.561)			
Black Children	63.55	0.20	0.19	0.20
	(0.809)			
Hispanic Children	67.81	0.30	0.36	0.40
	(0.619)			
Non-Hispanic Children	62.35	0.70	0.64	0.60
	(0.445)			
Below Poverty Line	64.26	0.47	0.45	0.51
	(0.529)			
Between 100 and 200 Percent of the Poverty Line	63.99	0.53	0.55	0.49
	(0..498)			
With Health Insurance	63.38	0.78	0.74	0.76
	(0.418)			
Without Health Insurance	66.71	0.22	0.26	0.24
	(0.721)			

Notes: Data is taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). N=6724. OW denotes overweight (BMI>95th percentile), ARO denotes at-risk of overweight (85th percentile<BMI≤95th percentile), and NW denotes normal weight (5th percentile<BMI≤85th percentile).
Standard errors are in parentheses. * significant at 5%; ** significant at 1%.

Table 3: The Effect of Childhood Overweight on Food Insecurity where the Independent Variable is OW versus ARO or NW: Various Samples with Incomes Under 200 Percent of the Poverty Line

	MFI vs. FFS	FI vs. FS	VLFS vs. LFS or FS
All Children	0.034	0.079	0.243
	(0.040)	(0.041)	(0.050)**
White Children	-0.102	0.094	0.294
	(0.069)	(0.071)	(0.082)**
Black Children	0.009	-0.054	-0.024
	(0.090)	(0.094)	(0.115)
Hispanic Children	-0.039	-0.034	0.204
	(0.065)	(0.066)	(0.084)*
Non-Hispanic Children	0.022	0.111	0.275
	(0.051)	(0.053)*	(0.062)**
Below Poverty Line	0.088	0.139	0.389
	(0.057)	(0.057)*	(0.064)**
Between 100 and 200 Percent of the Poverty Line	-0.084	-0.058	-0.059
	(0.060)	(0.065)	(0.087)
With Health Insurance	0.102	0.144	0.306
	(0.046)*	(0.047)**	(0.057)**
Without Health Insurance	-0.198	-0.139	0.029
	(0.083)*	(0.086)	(0.107)

Notes: Data is taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). N=6724. OW denotes overweight (BMI>95th percentile) and NW denotes normal weight (5th percentile<BMI≤85th percentile). MFI denotes marginally food insecure (1 or more affirmative food insecurity responses), FFS denotes fully food secure (0 affirmative), FI denotes food insecure (3 or more affirmative), FS denotes food secure (0-2 affirmative), VLFS denotes very low food secure (8 or more affirmative), and LFS denotes low food secure (3-7 affirmative). Standard errors are in parentheses. * significant at 5%; ** significant at 1%.

Table 4: The Effect of Childhood Overweight on Food Insecurity where the Independent Variable is OW or ARO versus NW: Various Samples with Incomes Under 200 Percent of the Poverty Line

	MFI vs. FFS	FI vs. FS	VLFS vs. LFS or FS
All Children	0.045	0.082	0.171
	(0.033)	(0.034)*	(0.042)**
White Children	0.001	0.092	0.191
	(0.053)	(0.056)	(0.067)**
Black Children	0.014	-0.026	0.024
	(0.073)	(0.076)	(0.092)
Hispanic Children	-0.052	0.011	0.186
	(0.055)	(0.056)	(0.074)*
Non-Hispanic Children	0.046	0.085	0.172
	(0.041)	(0.043)*	(0.052)**
Below Poverty Line	0.148	0.176	0.262
	(0.047)**	(0.047)**	(0.056)**
Between 100 and 200 Percent of the Poverty Line	-0.070	-0.043	0.0260
	(0.047)	(0.051)	(0.067)
With Health Insurance	0.100	0.123	0.173
	(0.037)**	(0.039)**	(0.048)**
Without Health Insurance	-0.159	-0.070	0.157
	(0.067)*	(0.069)	(0.086)

Notes: Data is taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). N=6724. OW denotes overweight (BMI>95th percentile), ARO denotes at-risk of overweight (85th percentile<BMI≤95th percentile), and NW denotes normal weight (5th percentile<BMI≤85th percentile). MFI denotes marginally food insecure (1 or more affirmative food insecurity responses), FFS denotes fully food secure (0 affirmative), FI denotes food insecure (3 or more affirmative), FS denotes food secure (0-2 affirmative), VLFS denotes very low food secure (8 or more affirmative), and LFS denotes low food secure (3-7 affirmative). Standard errors are in parentheses. * significant at 5%; ** significant at 1%.

Table 5: The Effect of Childhood Overweight on Food Insecurity where the Independent Variable is BMI Percentile: Various Samples with Incomes Under 200 Percent of the Poverty Line

	MFI vs. FFS	FI vs. FS	VLFS vs. LFS or FS
All Children	0.097	0.086	0.247
	(0.052)	(0.054)	(0.070)**
White Children	0.081	0.184	0.310
	(0.081)	(0.086)*	(0.107)**
Black Children	0.181	0.070	-0.006
	(0.117)	(0.122)	(0.147)
Hispanic Children	0.158	0.177	0.258
	(0.063)*	(0.067)**	(0.084)**
Non-Hispanic Children	-0.207	-0.213	0.254
	(0.094)*	(0.094)*	(0.130)
Below Poverty Line	0.164	0.215	0.424
	(0.075)*	(0.075)**	(0.094)**
Between 100 and 200 Percent of the Poverty Line	0.030	-0.078	-0.016
	(0.075)	(0.080)	(0.107)
With Health Insurance	0.184	0.158	0.287
	(0.058)**	(0.061)**	(0.079)**
Without Health Insurance	-0.305	-0.243	0.085
	(0.116)**	(0.118)*	(0.152)

Notes: Data is taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). N=6724. MFI denotes marginally food insecure (1 or more affirmative food insecurity responses), FFS denotes fully food secure (0 affirmative), FI denotes food insecure (3 or more affirmative), FS denotes food secure (0-2 affirmative), VLFS denotes very low food secure (8 or more affirmative), and LFS denotes low food secure (3-7 affirmative). The BMI percentiles are divided by 100. Standard errors are in parentheses. * significant at 5%; ** significant at 1%.

Table 6: The Effect of Childhood Overweight on Food Insecurity where the Independent Variable is BMI Percentile and BMI Percentile Squared: Various Samples with Incomes Under 200 Percent of the Poverty Line

	MFI vs. FFS	FI vs. FS	VLFS vs. LFS or FS
All Children: BMI Percentile	0.596	0.052	0.090
	(0.225)**	(0.234)	(0.307)
BMI Percentile Squared	1.496	0.681	0.501
	(0.342)**	(0.362)	(0.460)
White Children: BMI Percentile	0.884	0.307	-0.090
	(0.521)	(0.542)	(0.654)
BMI Percentile Squared	-0.625	-0.211	0.074
	(0.451)	(0.470)	(0.567)
Black Children: BMI Percentile	1.217	0.498	0.208
	(0.274)**	(0.289)	(0.364)
BMI Percentile Squared	-0.961	-0.291	0.045
	(0.241)**	(0.254)	(0.316)
Hispanic Children: BMI Percentile	-0.894	-0.980	-0.213
	(0.418)*	(0.418)*	(0.576)
BMI Percentile Squared	0.599	0.671	0.402
	(0.355)	(0.356)	(0.484)
Non-Hispanic Children: BMI Percentile	-0.894	-0.980	-0.213
	(0.418)*	(0.418)*	(0.576)
BMI Percentile Squared	0.599	0.671	0.402
	(0.355)	(0.356)	(0.484)
Below Poverty Line: BMI Percentile	-0.175	-0.446	-0.299
	(0.321)	(0.323)	(0.406)
BMI Percentile Squared	0.305	0.592	0.635
	(0.281)	(0.282)*	(0.349)
Bet. 100 and 200 % of PL: BMI Percentile	1.631	0.848	0.871
	(0.332)**	(0.355)*	(0.484)
BMI Percentile Squared	-1.434	-0.832	-0.794
	(0.288)**	(0.310)**	(0.419)
With Health Insurance: BMI Percentile	0.413	-0.032	0.102
	(0.247)	(0.260)	(0.340)
BMI Percentile Squared	-0.208	0.173	0.164
	(0.218)	(0.229)	(0.295)
Without Health Insurance: BMI Percentile	0.802	-0.221	-0.193
	(0.563)	(0.570)	(0.733)
BMI Percentile Squared	-0.945	-0.019	0.237
	(0.470)*	(0.477)	(0.612)

Notes: Data is taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). N=6724. MFI denotes marginally food insecure (1 or more affirmative food insecurity responses), FFS denotes fully food secure (0 affirmative), FI denotes food insecure (3 or more affirmative), FS denotes food secure (0-2 affirmative), VLFS denotes very low food secure (8 or more affirmative), and LFS denotes low food secure (3-7 affirmative). Standard errors are in parentheses. * significant at 5%; ** significant at 1%.

Table 7: The Effect of Childhood Overweight on Food Insecurity where the Independent Variable is Natural Log of BMI Percentile: Various Samples with Incomes Under 200 Percent of the Poverty Line

	MFI vs. FFS	FI vs. FS	VLFS vs. LFS or FS
All Children	0.060	0.048	0.092
	(0.014)**	(0.015)**	(0.023)**
White Children	0.060	0.077	0.118
	(0.020)**	(0.022)**	(0.034)**
Black Children	0.097	0.038	0.017
	(0.040)*	(0.041)	(0.050)
Hispanic Children	0.079	0.076	0.102
	(0.017)**	(0.019)**	(0.027)**
Non-Hispanic Children	-0.058	-0.069	0.070
	(0.031)	(0.031)*	(0.046)
Below Poverty Line	0.071	0.077	0.121
	(0.020)**	(0.021)**	(0.031)**
Between 100 and 200 Percent of the Poverty Line	0.058	0.015	0.049
	(0.022)**	(0.023)	(0.034)
With Health Insurance	0.070	0.059	0.100
	(0.015)**	(0.017)**	(0.025)**
Without Health Insurance	-0.087	-0.103	0.028
	(0.048)	(0.048)*	(0.063)

Notes: Data is taken from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). N=6724. MFI denotes marginally food insecure (1 or more affirmative food insecurity responses), FFS denotes fully food secure (0 affirmative), FI denotes food insecure (3 or more affirmative), FS denotes food secure (0-2 affirmative), VLFS denotes very low food secure (8 or more affirmative), and LFS denotes low food secure (3-7 affirmative). Standard errors are in parentheses. * significant at 5%; ** significant at 1%.

Figure 1: The Effect of Childhood Overweight on Food Insecurity:
All Children in Households with Incomes Below 200 Percent of the Poverty Line

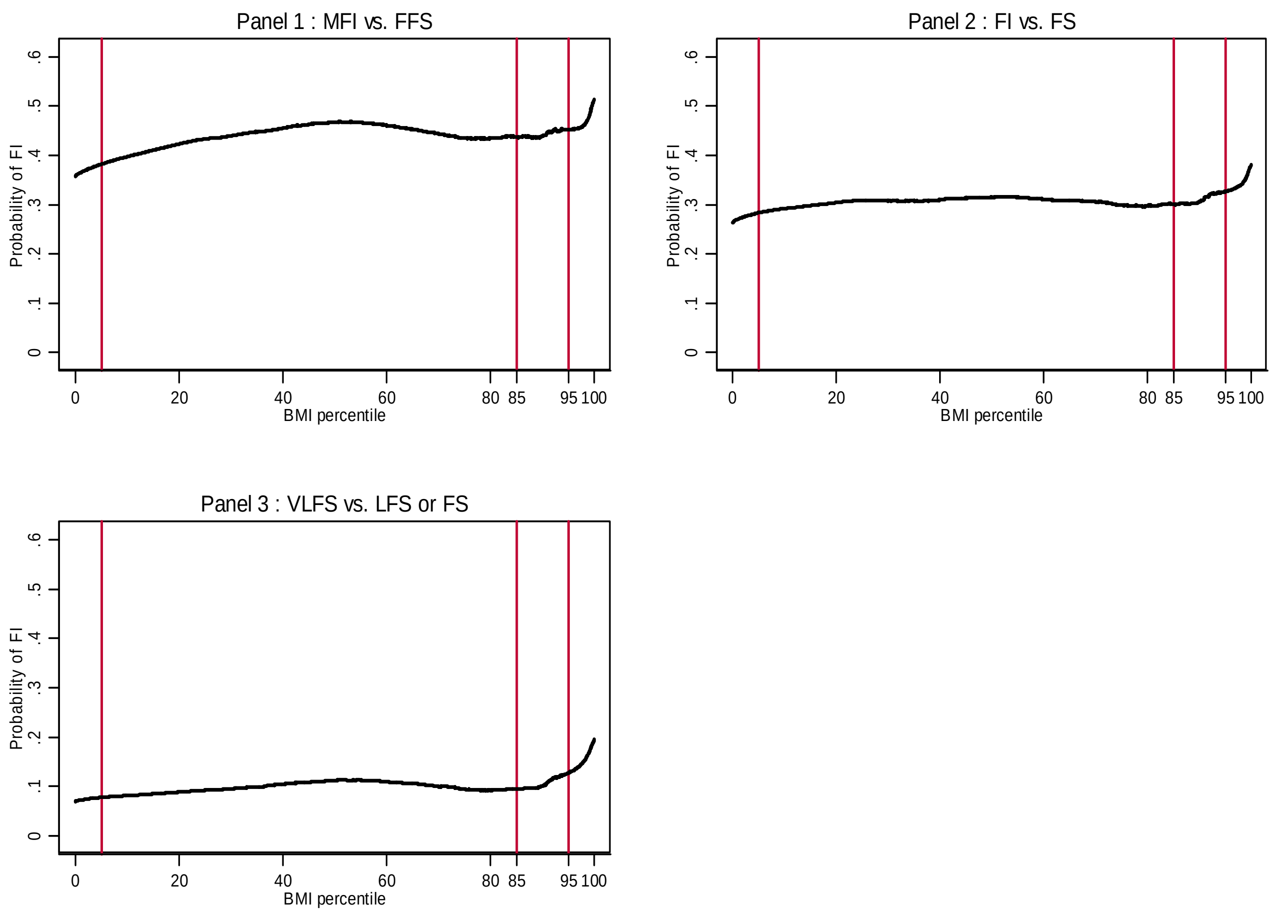


Figure 2: The Effect of Childhood Overweight on Food Insecurity,
Children in Households with Incomes Below 200 Percent of the Poverty Line,White Children

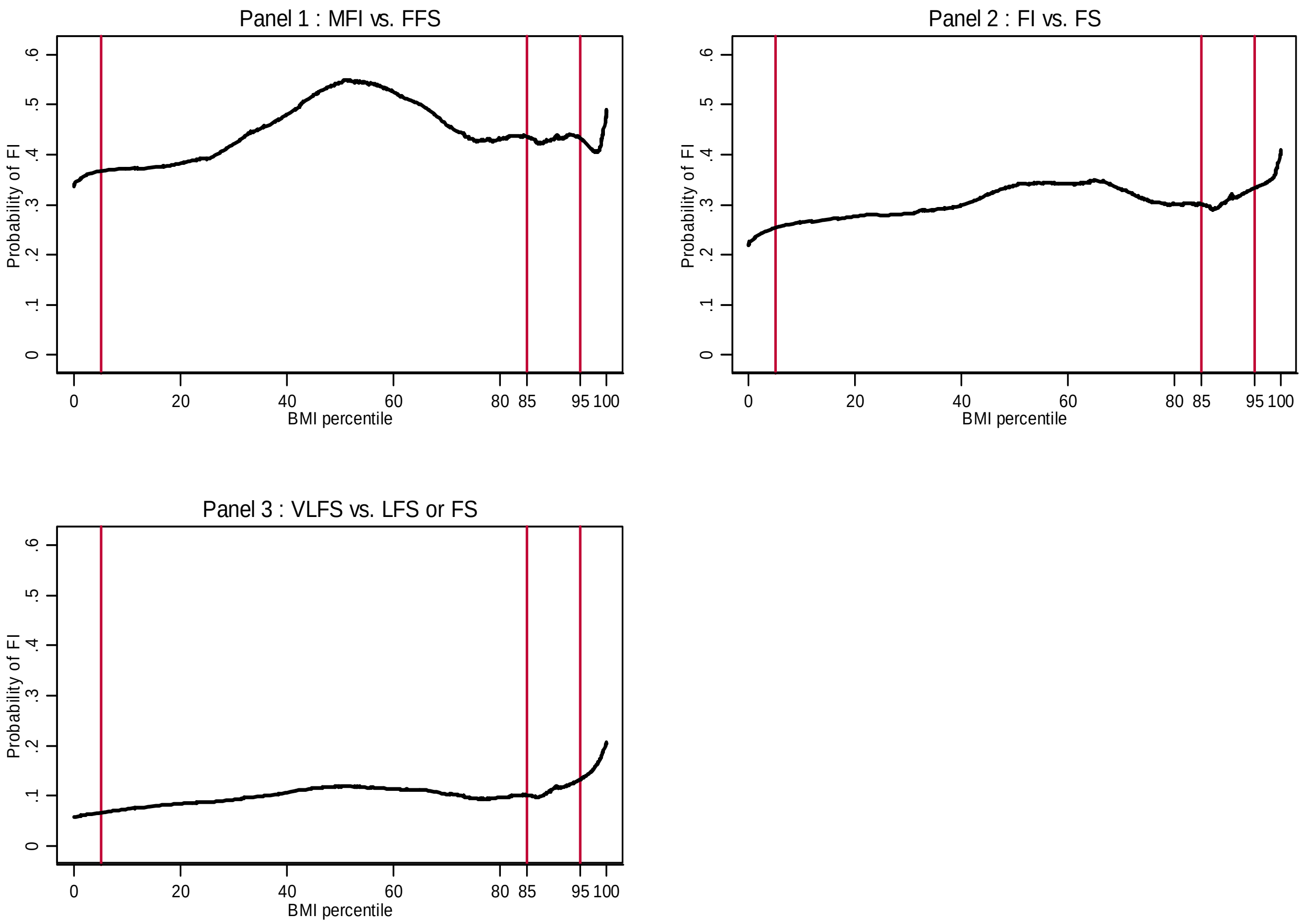


Figure 3: The Effect of Childhood Overweight on Food Insecurity:,

Children in Households with Incomes Below 200 Percent of the Poverty Line, Black Children

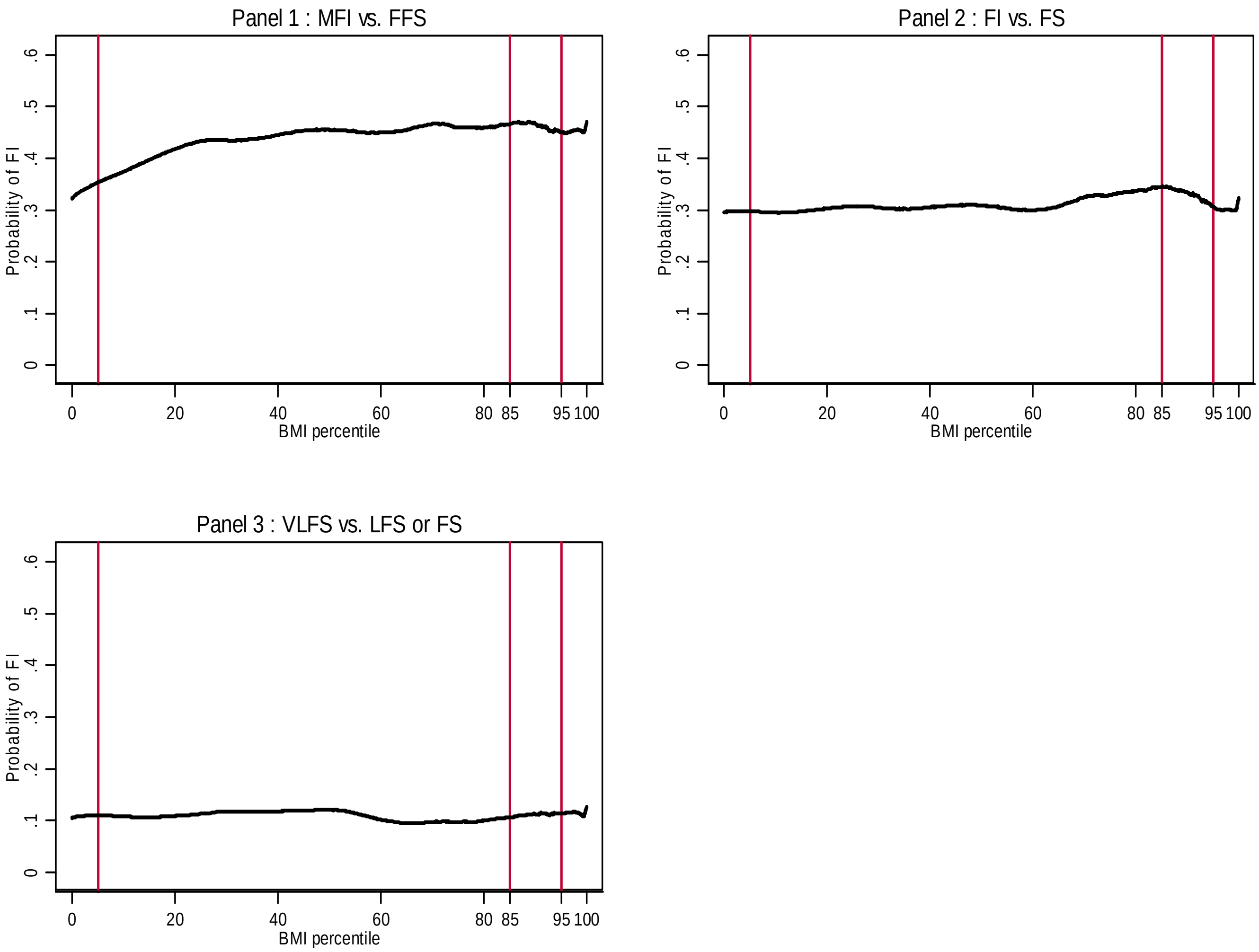


Figure 4: The Effect of Childhood Overweight on Food Insecurity:,
Children in Households with Incomes Below 200 Percent of the Poverty Line, Hispanic Children

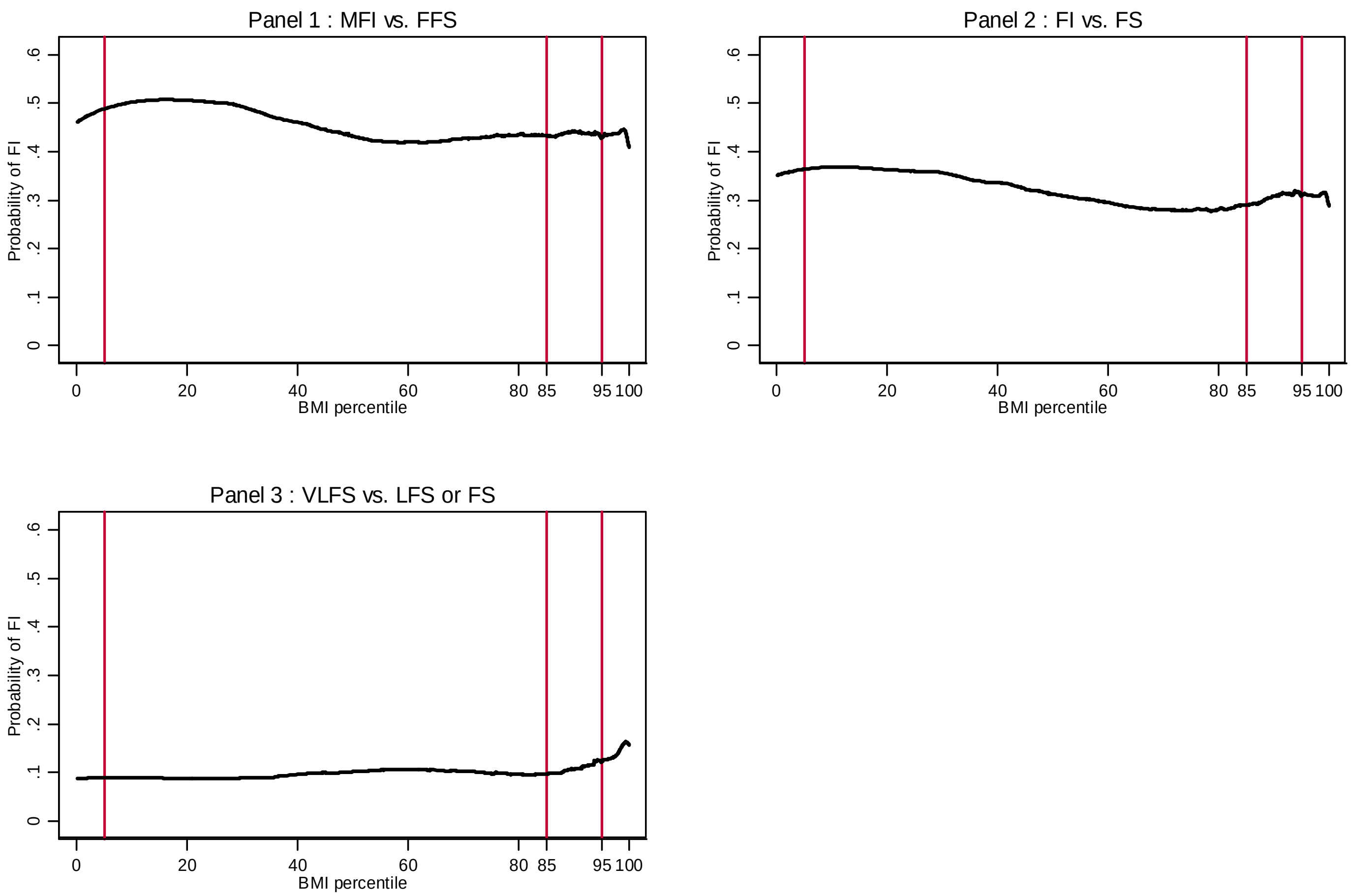


Figure 5: The Effect of Childhood Overweight on Food Insecurity:,
Children in Households with Incomes Below 200 Percent of the Poverty Line, Non Hispanic Children

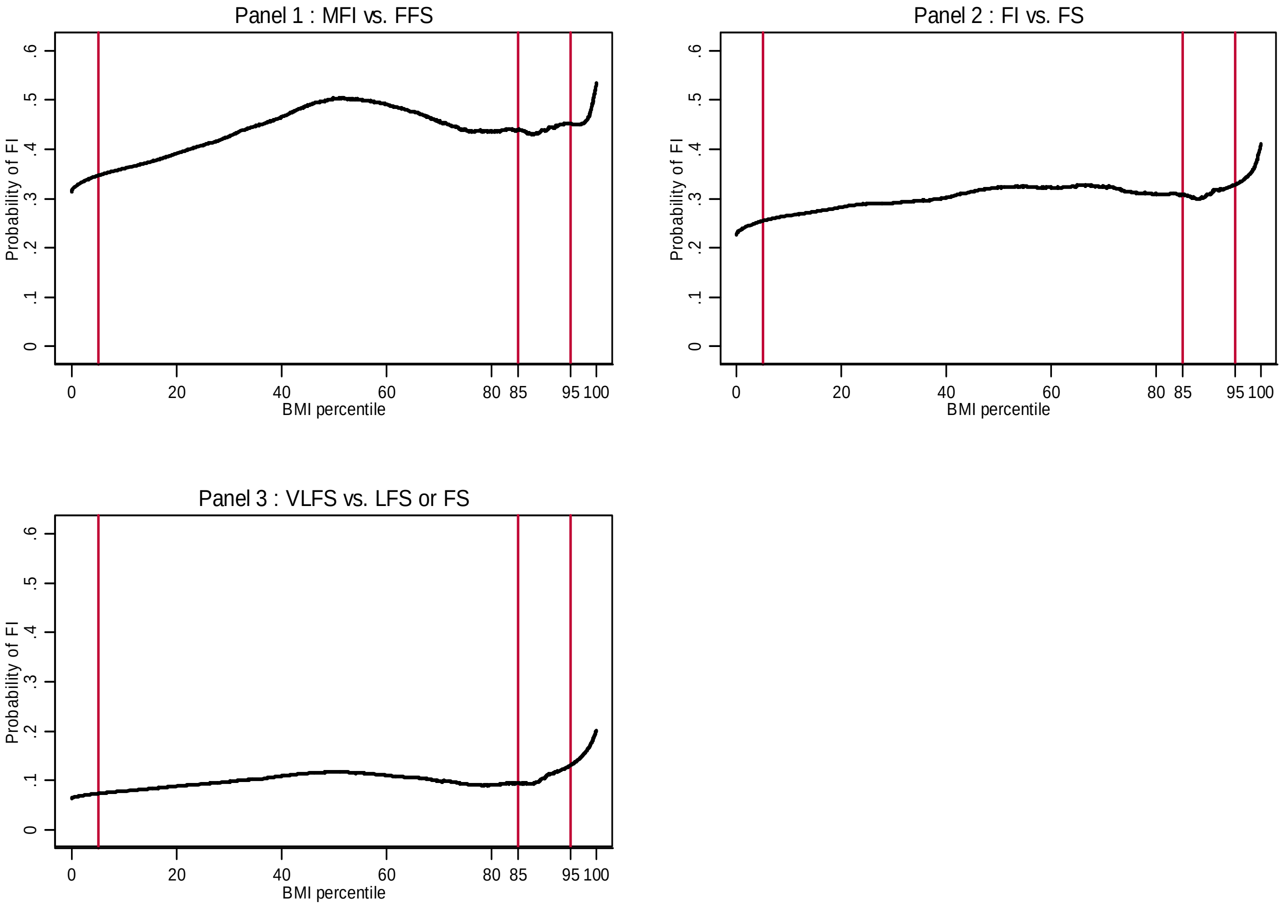


Figure 6: The Effect of Childhood Overweight on Food Insecurity:,
Children in Households with Incomes Below 200 Percent of the Poverty Line, Income below the Poverty Line

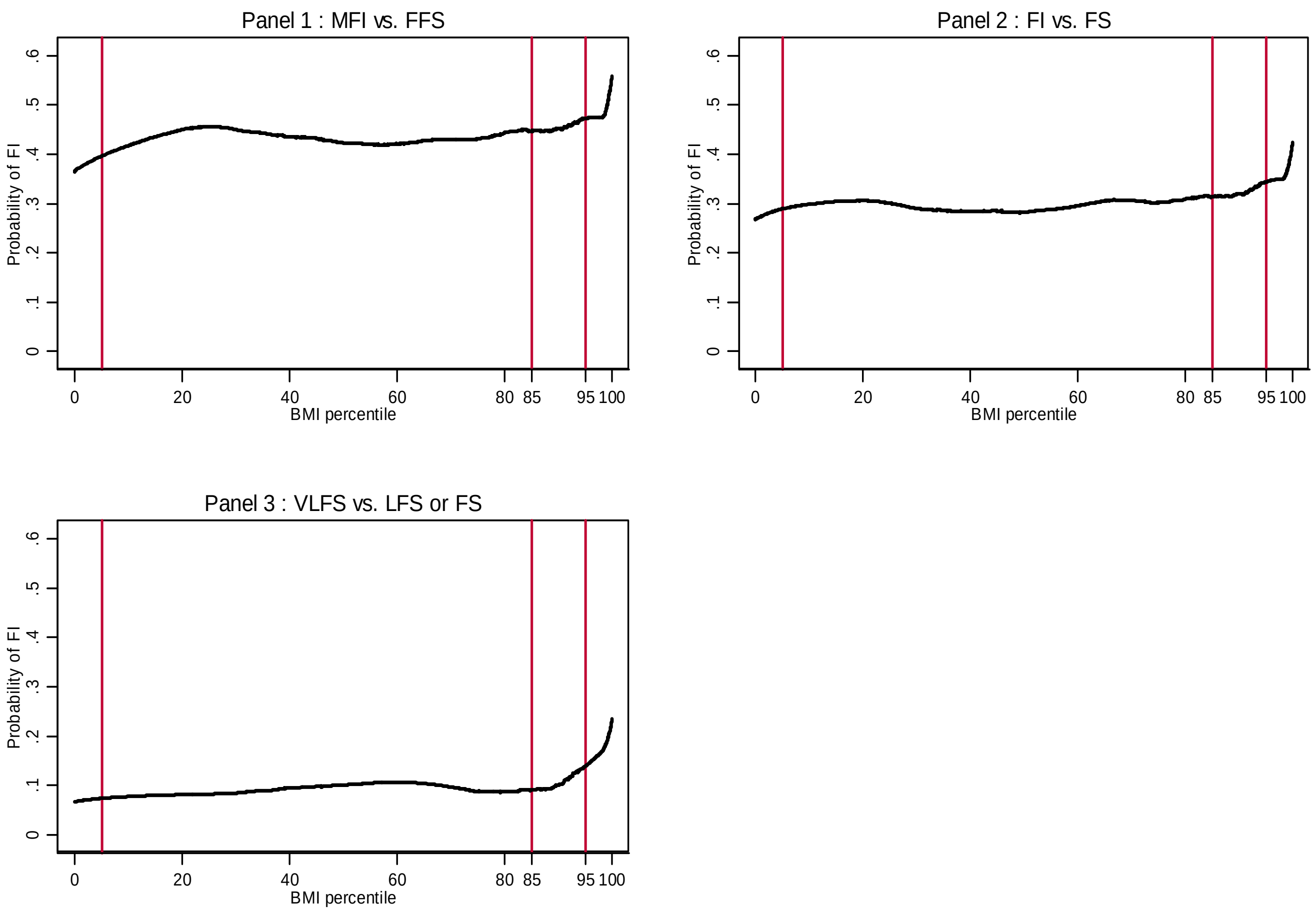


Figure 7: The Effect of Childhood Overweight on Food Insecurity:,

Children in Households with Incomes Below 200 Percent of the Poverty Line, Income between 100 and 200 percent of the Poverty Line

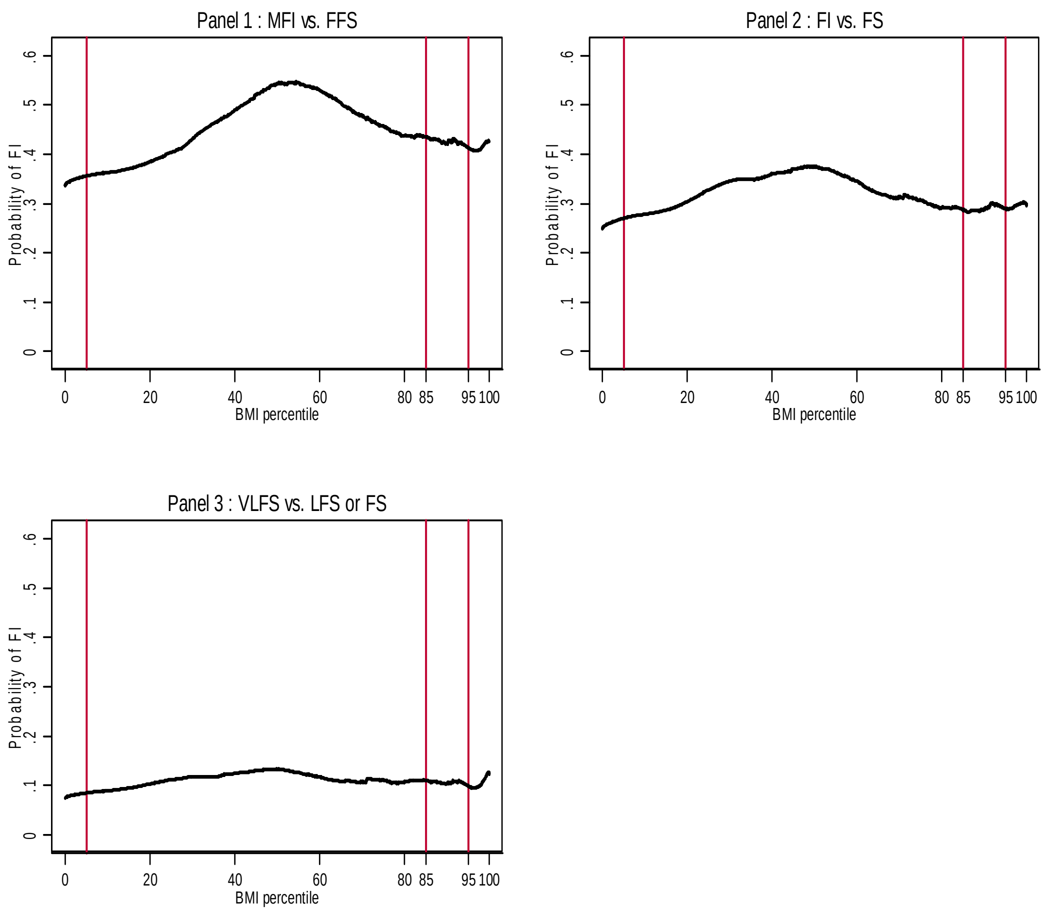


Figure 8: The Effect of Childhood Overweight on Food Insecurity:,

Children in Households with Incomes Below 200 Percent of the Poverty Line, With health insurance

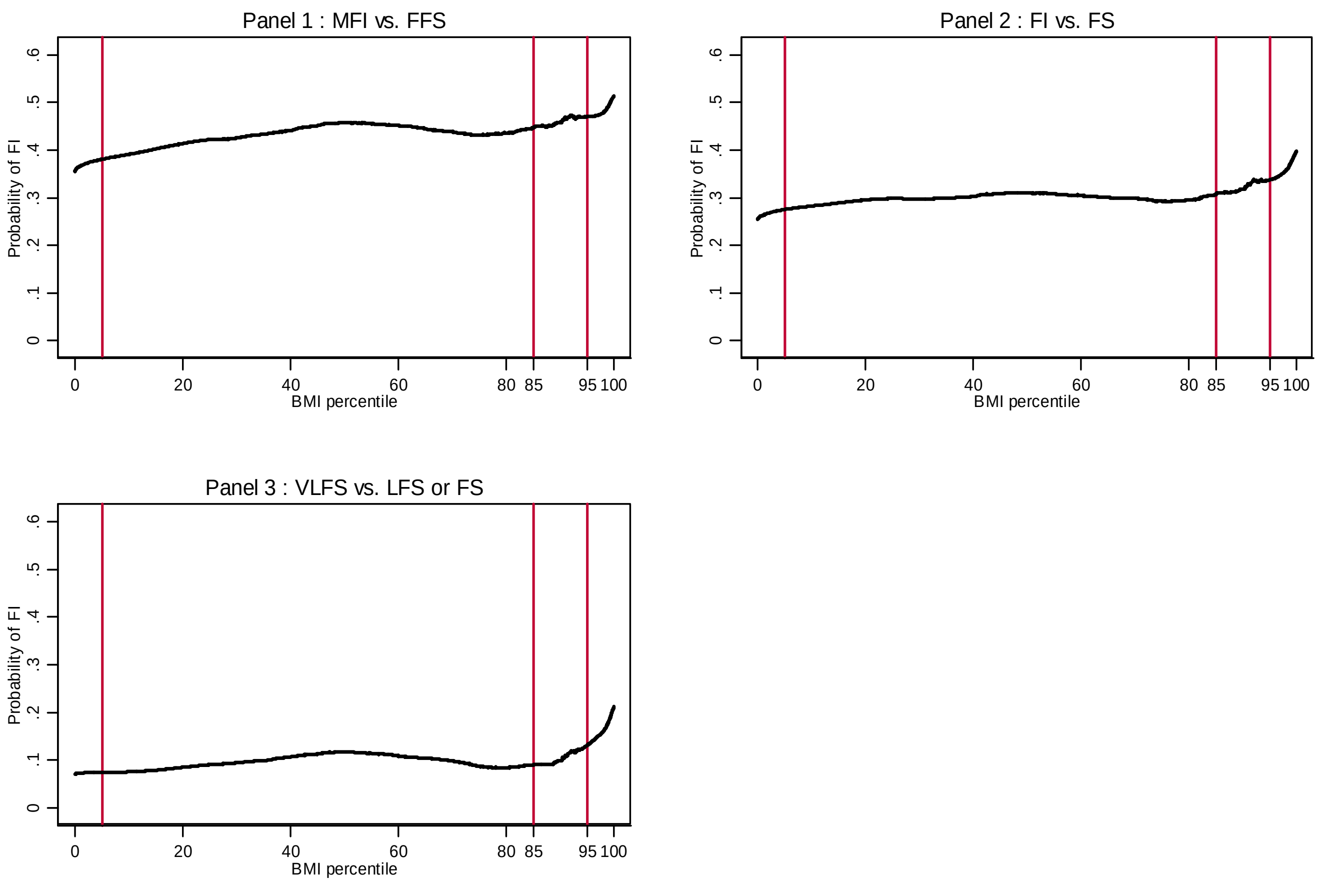
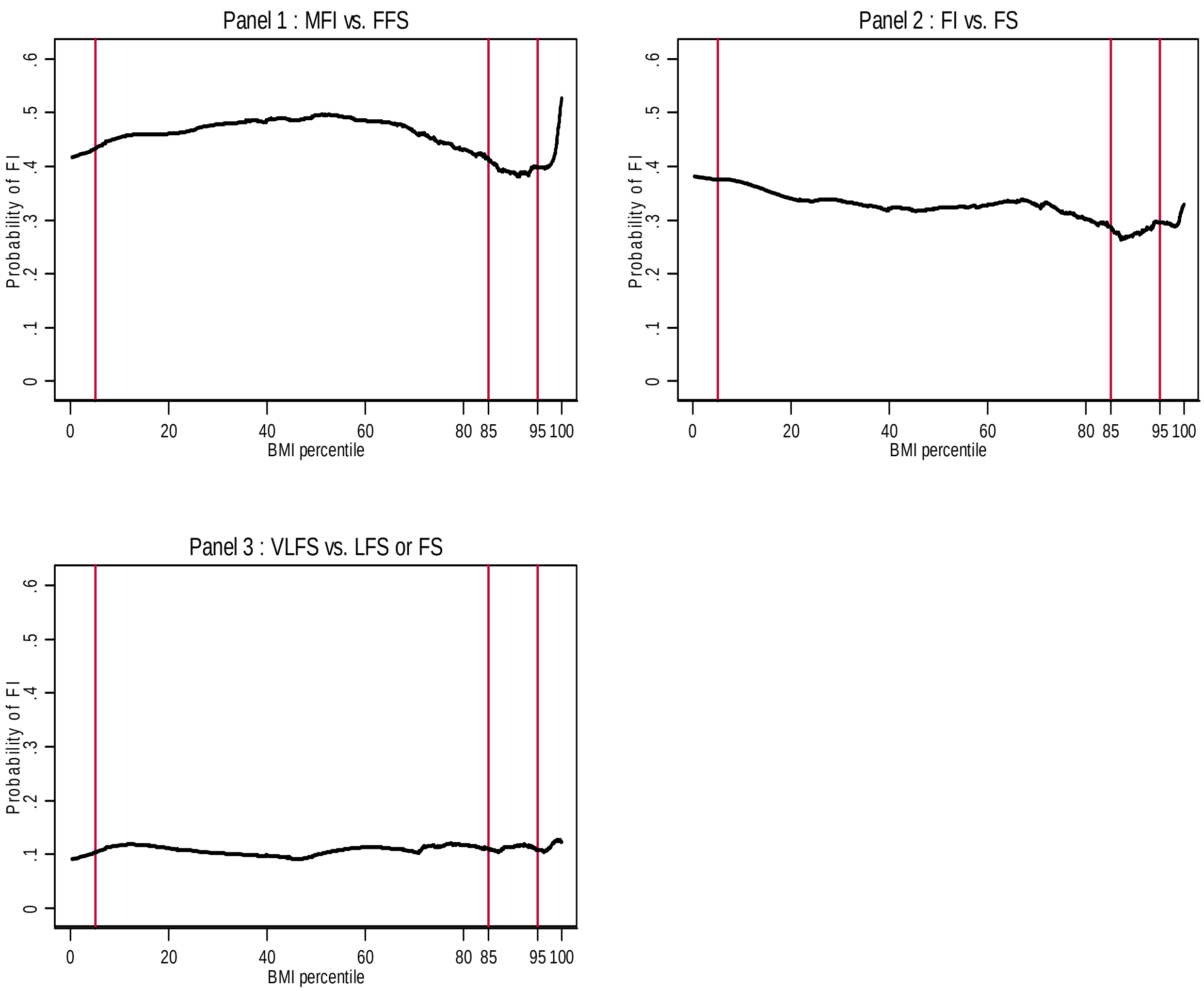


Figure 9: The Effect of Childhood Overweight on Food Insecurity:,

Children in Households with Incomes Below 200 Percent of the Poverty Line, Without health insurance



References

Alaimo, K., Olson, C.M., Frongillo, E.A. Jr., & Briefel, R.A. (2001a). Food insufficiency, family income, and health in U.S. preschool and school-aged children. American Journal of Public Health, 91(5), 781- 786.

Alaimo, K., Olson, C.M., & Frongillo, E.A., Jr. (2001b). Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. Pediatrics, 108(1), 44-53.

Alaimo, K., Olson, C.M., & Frongillo, E. A., Jr. (2002). Family food insufficiency, but not low family income, is positively associated with dysthymia and suicide symptoms in adolescents. Journal of Nutrition, 132(4), 719-725.

American Obesity Association (2008). Childhood Obesity.

Ammermann A, Lindquist C, Lohr K, Hersey J. The efficacy of behavioral interventions to modify dietary fat and fruit and vegetable intake: A review of the evidence. Prev Med 2002;35:25-41.

Anderson P, Butcher K. Childhood obesity: trends and potential causes. Future Child. 2006;16:19-45.

Andrich, D. (1988). Rasch models for measurement. Sage, Newbury Park, CA, USA

Jay Bhattacharya, J & Sood, N (2005). Health insurance and the obesity externality. NBER Working Paper 11529. http://www.nber.org/papers/w11529

Casey, P., Szeto, K., Lensing, S, Bogle, M, & Weber, J.(2001). Children in food-insufficient, low-income families: prevalence, health and nutrition status. Arch Pediatr Adolesc Med. 155, 508-514.

Casey, P., Simpson, P., Gossett, J., et al.(2006). The association of child and household food insecurity with childhood overweight status. Pediatrics, 118, 1406-1413.

Dietz, W.H. (1995). Does hunger cause obesity? Pediatrics, 95,766–767

Drewnowski, A., & Specter, S.E. (2004). Poverty and obesity: the role of energy density and energy costs. Am J Clin Nutr. 79, 6–16

Dubois, L., Farmer, A., Girard, M., & Porcherie, M. (2006). Family food insufficiency is related to overweight among preschoolers. Soc Sci Med. 6, 1503-1516.

Farooq, S. (2005) Genetic and hereditary aspects of childhood Obesity. Best Practice & Research Clinical Endocrinology & Metabolism 19(3), 359–374.

Finkelstein, E., Fiebelkorn, I., & Wang, G. (2003). National medical spending attributable to overweight and obesity: How much, and who's paying? Health Affairs, Supplemental Web Exclusives, W3-219-26.

Fontaine K, Redden D, Wang C, Westfall A, Allison D. Years of life lost due to obesity. JAMA. 2003;289:187-193.

Fries E, Edinboro P, McClish D, Manion L, Bowen D, Beresford S, Ripley J. Randomized trial of a low-intensity dietary intervention in rural residents. Am J Prev Med 2005;28:162-168.

Glewwe, P., Jacoby, H. & King, E. (1999). Early Childhood nutrition and Academic achievement: A longitudinal analysis. FCND Discussion paper No. 68. IFPRI

Gundersen C, Oliveira V. The Food Stamp Program and food insufficiency. Am J Agric Econ 2001;83:875-87.

Gundersen C, Lohman B, Eisenmann J, Garasky S, & Stewart S.(2007). Lack of association between child-specific food insecurity and overweight in a sample of 10-15 year old low-income youth. J Nutr,138,371–378.

Gunnell, D., Frankel, S., Nanchahal, K., Peters, T., & Smith G. (1998). Childhood obesity and adult cardiovascular mortality: a 57-y follow-up study based on the Boyd Orr cohort. Am J Clin Nutr, 67,1111-1118.

Guo, SS, Roche AF, Chumlea WC, Gardner JD, Siervogel RM. The predictive value of childhood body mass index values for overweight at age 35 y. Am J Clin Nutr. 1994;59:810–819

Hamilton, W., Cook, J., Thompson, W., Burn, L., Frongillo E, Olson, C., & Wehler, C. (1997). Household food security in the United States in 1995: technical report of the food security measurement project. US Department of Agriculture, Food and Consumer Service, Office of Analysis and Evaluation

Havas S, Ankiker J, Greenberg D, Block G, Block T, Blik C, Langenberg P, DiClemente C. Final results of the Maryland WIC Food for Life Program. Prev Med 2003;37:406-416.

Hedley A, Ogden C, Johnson C, Carroll M, Curtin L, Flegal K. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. JAMA. 2004;291:2847-2850.

Ikeda M , Pham L, Nguyen K, Allhoff Mitchell R. Culturally relevant nutrition education improves dietary quality among WIC-eligible Vietnamese immigrants. J Nutr Educ Beh 2002;34:151-158.

Jimenez-Cruz, A., Bacardi-Gascon, M., & Spindler, A.(2003). Obesity and hunger among Mexican-Indian migrant children on the US-Mexico border. Int J Obes, 27,740-747.

Jyoti, D.F., Frongillo, E.A., & Jones, S.J.(2005). Food insecurity affects school children's academic performance, weight gain, and social skills. J Nutr,135, 2831-2839.

Kaiser, L., Melgar-Quiñonez, H., Lamp, C., Johns, M., Sutherlin, J., & Harwood, J.(2002). Food security and nutritional outcomes of preschool-age Mexican-American children. J Am Diet Assoc,102, 924-929.

Kleinman, R.E., Murphy, J.M., Little, M., Pagano, M., Wehler, C.A., Regal, K., & Jellinek, M.S. (1998). Hunger in children in the United States: Potential behavioral and emotional correlates. Pediatrics 101 (1)

Koplan J, Liverman C, Kraak, V, eds. Preventing Childhood Obesity: Health in the Balance. Washington, DC: National Academies Press; 2005.

Kramish Campbell M, Tessaro I, DeVellis B, Benedict S, Kelsey K, Belton L, Sanhueza A. Effects of a tailored health promotion program for female blue-collar workers: Health Works for Women. Prev Med 2002;34:313-323.

Kumanyika S, Grier S. Targeting interventions for ethnic minority and low-income populations. Future Child. 2006;16:187-207.

Maffeis, C. (1999). Childhood obesity: the genetic-environmental interface. Baillière's best practice & research. Clinical endocrinology & metabolism, 1, 13-46.

Lake, J.K, Power, C, Cole, T.J (1997). Child to adult body mass index in the 1958 British birth cohort: associations with parental obesity. Arch Dis Child, 77(5), 375-376.

Mahoney, L., Burns, T., Stanford, W., Thompson, B., Witt, J., Rost, C., & Lauer, R. (1996).Coronary risk factors measured in childhood and young adult life are associated with coronary artery calcification in young adults: the Muscatine Study. J Am Coll Cardiol, 27,277-284.

Marder, W. D., & Chang, S. (2006). Childhood Obesity: Costs, Treatment Patterns, Disparities in Care, and Prevalent Medical Conditions. Stamford, CT: Thomson Medstat Research Brief.

Marti,A., Moreno-Aliaga, M., Hebebrand, J & Martinez J. (2004). Genes, lifestyles and obesity International Journal of Obesity, 28, S29–S36.

Martin, K.S. & Ferris, A.M. (2007). Food insecurity and gender are risk factors for obesity. J Nutr Educ, 39, 31-36.

Matheson, D., Varady, J., Varady, A., & Killen, J.(2002) Household food security and nutritional status of Hispanic children in the fifth grade. Am J Clin Nutr, 76, 210-217.

Murphy, J.M., Wehler, C.A., Pagano, M.E., Little, M., Kleinman, R.E., & Jellinek, M.S. (1998). Relationship between hunger and psychosocial functioning in low-income American children. Journal of the American Academy of Child & Adolescent Psychiatry 37(2), 163-170.

Nord, M., Andrews, M. & Carlson, S. (2006). Household Food Security in the United States, 2005, Washington, DC: U.S. Department of Agriculture, Economic Research Report 29 (ERR-29).

Nord, M., Andrews, M. & Carlson, S. (2007). Household Food security in the United States, 2006. Washington, DC: U.S. Department of Agriculture, Economic Research Report 49 (ERR-49).

Nord, M., Andrews, M. & Winicki, F. (2002). Frequency and Duration of Food Insecurity and Hunger in U.S. Households. Journal of Nutrition Education, Fall.

Nieto, F., Szklo, M., & Comstock, G. (1992). Childhood weight and growth rate as predictors of adult mortality. American Journal of Epidemiology, 136, 201-13.

Ogden, C., Carroll, M., Curtin, L., McDowell, M.., Tabak, C. & Flegal K. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. JAMA, 29,1549-1555.

Ogden, C., Flegal, K., Carroll M., & Johnson, C. (2002). Prevalence and Trends in Overweight Among US Children and Adolescents, 1999-2000. JAMA, 288,1728-1732.

Polivy, J. (1996). Psychological consequences of food restriction. J. Am. Diet. Assoc. 96, 589–592.

Polivy, J. & Herman, C. P. (1985) Dieting and binging: a causal analysis. Am. Psychologist 40, 193–201.

Polivy, J., Zeitlin, S. B., Herman, C. P. & Beal, A. L. (1994) Food restriction and binge eating: a study of former prisoners of war. Abnormal Psychol,103,409–411

Power, C., Lake, J., & Cole, T. (1997). Measurement and long-term health risks of child and adolescent fatness. International Journal of Obesity and Related Metabolic Disorders, 21,507-26.

Rashad, I & Markowitz, S (2007). Incentives in obesity and health insurance. NBER Working Paper 13113. http://www.nber.org/papers/w13113

Reid, L.L. (2000). The Consequences of Food Insecurity for Child Well-Being: An Analysis of Children's School Achievement, Psychological Well-Being, and Health. JCPR Working Paper #137. Chicago, IL: Joint Center for Poverty Research

Robinson, T. N. (2001). Television viewing and childhood obesity. Pediatric Clin North Am, 48(4), 1017-25

Rose, D, & Bodor, J. (2006). Household food insecurity and overweight status in young school children: results from the early childhood longitudinal study. Pediatrics,117, 464-473.

Schwimmer, J., Burwinkle, T., & Varni, J. (2003). Health-related quality of life of severely obese children and adolescents. Journal of the American Medical Association, 289, 1813-1819

Serdula, M., Ivery, D., Coates, R., Freedman, D., Williamson, D., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. Preventive Medicine, 22, 167-77.

Smoak, C., Burke, G., Webber, L., Harsha, D., Srinivasan, S., & Berenson, G. (1987). Relation of obesity to clustering of cardiovascular disease risk factors in children and young adults. The Bogalusa Heart Study. American Journal of Epidemiology, 125, 364-72.

Strauss, R. S., & Knight, J. (1999). Influence of the Home Environment on the Development of Obesity in Children. Pediatrics,103, e85-e93.

Townsend, M. S., Peerson, J., Love, B., Achterberg, C., & Murphy, S. (2001). Food Insecurity Is Positively Related to Overweight in Women J. Nutr. 131,1738-1745.

U.S. Department of Agriculture, Food and Nutrition Service. Annual Historical Review: Fiscal Year 1997. 1999.

Wang, G., & Dietz, W. H. (2002). Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. Pediatrics. 109, e81.

Wang Y, Zhang Q. Are American children and adolescents of low socioeconomic status at increased risk of obesity? Changes in the association between overweight and family income between 1971 and 2002. Am J Clin Nutr. 2006;84:707-716.

Wilde P, Nord M. The effect of food stamps on food security: A panel data approach. Rev Agric Econ 2005;27:425-32.

Wilde, P. E. & Ranney, C. K. (2000) The monthly food stamp cycle:shopping frequency and food intake decisions in an endogenous switching regression framework. Am. J. Agric. Econ, 82, 200–213

Williams, D., Going, S., Lohman, T., Harsha, D., Srinivasan, S., Webber, L., & Berenson, G. (1992). Body fatness and risk for elevated blood pressure, total cholesterol, and serum lipoprotein ratios in children and adolescents. American Journal of Public Health, 82, 358-63.