The Supplemental Nutrition Assistance Program, Financial Stress, and Childhood Obesity

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The Supplemental Nutrition Assistance Program (SNAP) is the largest nutritional assistance program addressing food insecurity in the United States. Due to the program's reach, SNAP has been called upon to address other nutrition-related challenges facing low-income Americans, including childhood obesity. This study considers the effect of SNAP participation on child weight outcomes after controlling for household financial stress, an important determinant of child overweight status that disproportionately affects low-income households. Using data from the *Survey of Household Finances and Childhood Obesity* and instrumental variable methods, we find that SNAP participation is negatively associated with obesity among eligible children.

Key Words: Supplemental Nutrition Assistance Program (SNAP), Food Stamp Program, financial stress, childhood obesity, poverty, nutrition

The Supplemental Nutrition Assistance Program (SNAP) (formerly known as the Food Stamp Program) is the largest food assistance program in the United States. The program is large, both in terms of benefit size and in number of people served. In terms of number of people served, the program reached about 40.3 million individuals in each month in 2010, with an annual benefit distribution of about $68.3 billion. A recent study demonstrated that almost half of all American children will have resided in a household that received food stamps by the time they reach 20 years of age (Rank and Hirschl 2009).

The central goal of SNAP has been and remains the alleviation of food insecurity (USDA 1999). In 2010, the average monthly benefit was $288/month for a family of four, with the maximum benefit for a family of four of $668. This can represent a considerable share of low-income households' total income. Research has demonstrated that the receipt of SNAP benefits may lead to reductions in food insecurity (DePolt, Moffitt, and Ribar 2009, Kreider et al. forthcoming). Given the size of SNAP, there has been an increased call for the program to address other nutrition-related challenges facing low-income Americans. Most prominently, there have been calls for SNAP to help in the efforts to alleviate childhood obesity.

As has been well documented, there has been a marked increase in rates of childhood obesity over the past five decades, and today over one in six children are obese (Jolliffe 2011). Although these rates have leveled off over the past 10 years, the concern among policymakers and program administrators remains. This concern is likely due to a wide range of near- and long-term physical, mental, and social health outcomes associated with obesity among children and adults, including cardiovascular disease, hypertension, diabetes, lower health-related quality of life, social stigmatization, and social adjustment outcomes (Puhl and Latner 2007, Raman 2002, Reilly et al. 2003, Schwimmer, Burwinkle, and Varni 2003). Obesity rates

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have historically been especially high among low-income Americans (Jolliffe 2011), the very group that is eligible for SNAP benefits.

The effect of SNAP on childhood obesity is *a priori* ambiguous. The literature on SNAP has demonstrated that food expenditures increase due to SNAP participation (e.g., Breunig and Dasgupta 2002, Levedahl 1995). This is not surprising as food expenditures are central to SNAP goals. Nevertheless, this increase in food expenditures may lead to proportional increases in consumption across both "good" and "bad" foods. However, it may also lead consumers to purchase proportionally more "good" foods. This ambiguity is mirrored in empirical findings of the effect of SNAP on obesity reviewed below. Some studies have found participation in SNAP is positively associated with obesity, while others have found negative associations (e.g., Baum 2011, Fan 2010, Gibson 2003, Gibson 2004, Kreider et al. forthcoming, Meyerhoefer and Pylypchuk 2008, Ver Ploeg et al. 2007).[1]

Further complicating our understanding of the relationship between SNAP and obesity is the role of stress. Recent work has demonstrated that an important determinant of overweight status in children is stress at the household level. [For a review, see Gundersen et al. (2011).] This work is part of a broader literature that shows the negative behavioral and health consequences associated with stress (e.g., Compas 1987). If stress, especially financial stress, induces persons to enter SNAP, the true effect of SNAP may be distorted insofar as a positive relationship between SNAP and obesity may, in reality, be reflecting the increased levels of stress experienced by the household.

In this paper, we consider the joint influences of SNAP on childhood obesity using recently collected data from households in low-income counties in three states. Critical for this paper, this dataset is one of the few datasets with information on SNAP participation, objective and subjective measures of financial stress, and information to calculate BMI percentiles. With the use of instrumental variable methods to correct for selection into SNAP, we find that SNAP participation is negatively associated with childhood overweight among eligible children. We further find that households experiencing financial stress are more likely to enter SNAP, but, that after controlling for SNAP participation, stress does not have a statistically significant effect on childhood obesity.

Background

Supplemental Nutrition Assistance Program

The Supplemental Nutrition Assistance Program (SNAP) provides a nutritional safety net for low-income adults and children by supplementing food purchasing power. Program participants receive benefits that can be used to purchase food at participating grocery stores for home consumption. In 2010, program participants received an average monthly benefit of $134 per individual. At a federal level, the program is administered by the U.S. Department of Agriculture, and individual states have designated program administration agencies.

SNAP program eligibility and benefit levels depend upon household size and three tests: the gross income test, net income, and an asset test. Federal eligibility requirements specify that household gross monthly income must be less than 130 percent of the poverty line and net monthly income must be less than 100 percent of the poverty line.[2] This means that in 2010, a family of four must have gross monthly income less than $2,380 and net monthly income less than $1,838 to meet the income tests.[3] Income-eligible households must also have assets less than $2,000 ($3,000 if at least one household member is over 60 years of age or disabled). However, the federal government granted individual states specific implementation options, resulting in some variation in eligibility guidelines across states. For example, by 2009 a majority of states had either removed the federal asset test for many SNAP households or

[1] This ambiguity is found in studies of other food assistance programs as well. For example, in the case of the National School Lunch Program, some have found that receipt of free or reduced-price lunches is positively associated with childhood obesity (e.g., Schanzenbach 2009) and others have found that it is negatively associated with childhood obesity (e.g., Gundersen, Kreider, and Pepper 2012).

[2] Households with an elderly member or member receiving certain types of disability payments are exempt from the gross income test.

[3] Net income is equal to gross income minus eligible deductions. These deductions include a standard deduction, a deduction of up to 20 percent of earned income, child care expenses, out-of-pocket medical expenses of elderly or disabled household members, legally owed child support payments, and shelter costs in excess of 50 percent of a household's net income.

exempted the value of all household vehicles from the asset test (USDA 2009). In addition, with particular relevance to this study, the gross monthly income tests may vary by state. For example, Iowa and Michigan permit gross monthly incomes up to 165 percent and 200 percent of the poverty line, respectively, rather than 130 percent of the poverty line; however, their net income tests remain equivalent to federal guidelines.

Despite establishing program eligibility, not all individuals choose to participate in SNAP. In 2008, an estimated 66 percent of eligible individuals nationwide participated (Cunnyngham and Castner 2010). A household's participation decision is influenced by program and eligibility awareness, perceived stigma associated with participation, the transaction costs of participating, and other factors. Stigmas include the self-imposed and perceived negative perceptions of others (Moffitt 1983). This suggests that individuals residing in areas with higher program participation may be more likely to participate as perceived disapproval from others diminishes. Transaction costs that may deter eligible households include (i) time spent compiling and completing paperwork, traveling to program sites, and enrolling and recertifying eligibility, and (ii) the availability and cost of transportation (Gundersen and Oliveira 2001). This suggests that there are location- and household-specific factors that affect participation. Additional factors such as recent unexpected expenses, other expenditures, perceived future earnings potential, and the availability of financial support from other sources including family, friends, and religious institutions may also impact participation decisions.

The effect of SNAP participation on obesity is theoretically ambiguous. In response to increases in income brought about by SNAP participation, individuals may choose to purchase and consume more "bad" foods, which could lead to increases in weight. In addition, individuals may increase their consumption of food overall, which, in the absence of other changes, can lead to increases in weight. Conversely, individuals may choose to purchase and consume more "good" foods, which could lead to reductions in weight. Further complicating theoretical predictions, the receipt of SNAP enables households to reallocate overall household resources and potentially consume more other goods, goods which could lead to increases in weight (e.g., more sedentary activities) or decreases in weight (e.g., more exercise).

The theoretical ambiguity is matched in the empirical findings, where some have found SNAP to be associated with increases in obesity among young girls (Gibson 2004) and adult women (Baum 2011, Gibson 2003, Meyerhoefer and Pylypchuk 2008), while others have found SNAP to be associated with decreases in obesity among children (Kreider et al. forthcoming), young boys (Gibson 2004), and non-Hispanic, white men (Ver Ploeg et al. 2007). Further reflecting this theoretical ambiguity, studies have found no statistically significant effect of SNAP on obesity among older children (Gibson 2004), foreign-born, unmarried mothers (Kaushal 2007), children (Ver Ploeg et al. 2007), adult women (Fan 2010, Ver Ploeg et al. 2007), Mexican-American men (Ver Ploeg et al. 2007), and adult men (Baum 2011, Gibson 2003, Meyerhoefer and Pylypchuk 2008).

Household Financial Stress

Family stress has been defined as "pressure of tension in the family system," or disturbances to the steady state (Boss 1988, p. 12). It results from stressor events that provoke unexpected and nonroutine changes in the family system (Boss 1988). These changes may impact children directly or indirectly. For example, as stressors accumulate, their impact on parenting behavior and the home environment would grow, resulting in heightened exposure to environmental stress among children in the household. Exposure to household-level stressors has been associated with childhood obesity (Garasky et al. 2009). Household stress may potentially affect child weight status directly via physiological responses or indirectly through behavioral changes influencing diet and exercise, which in turn affect weight. Physiologically, stressful experiences activate two functionally related stress centers in the body, the hypothalamic-pituitary-adrenal axis and the central sympathetic nervous system. Evidence suggests that through these reactions, perceived stress influences cortisol and hormone secretion, resulting in metabolic abnormalities linked to weight gain (Björntorp 2001). Stress may also influence body weight indirectly via child-specific behavioral changes in response to the stress, such as "stress eating" or changes in physical activity levels (Gundersen et al. 2011).

This paper focuses specifically on household financial stress because such stress may in part be ameliorated by nutritional safety net program participation. SNAP participation may reduce stress resulting from financial uncertainty at the household level by providing a designated stream of income for food. Financial strain may lead parents to choose low-cost food alternatives. Empirical studies have found that individuals under stress tend to consume more energy-dense snack-type foods and less meal-type foods (Oliver and Wardle 1999, Zellner et al. 2006). In addition, families who were previously financially able to dine at restaurants may replace this experience with more affordable alternatives such as purchasing take-out or fast-food, or dining at home.

Given the potential linkages between financial stress and obesity outcomes in children, we focus on the impact of stress arising from household finances. At its most basic level, household financial stress arises from an inability to meet basic financial obligations with household resources. Within households, researchers have found positive associations between a variety of household environmental stressors and obesity (see Gundersen et al. 2011 for a review). For example, Garasky and colleagues (2009) found that mental and physical health problems in the household and household financial strain were significantly positively related to overweight and obesity among older children, while living in household environments with little cognitive stimulation or emotional support was positively related to overweight and obesity among younger children. Maternal factors including maternal stress (Stenhammar et al. 2010, Gundersen et al. 2008), maternal distress (Zeller et al. 2007), and maternal depression (Gibson et al. 2007) have also been associated with obesity among children. This suggests that deepening our understanding of the way stress influences obesity outcomes, particularly in relation to household resources such as nutritional safety net programs, may inform better policy.

Empirical Model

Our interest is in whether participation in SNAP or SNAP participation in the presence of household financial stress affects childhood obesity. The central models we estimate are as follows:

$$(1) \qquad OB_{ij} = \alpha + \beta \text{SNAP}^*_i + \lambda FS_i + \gamma \mathbf{X_i} + \varepsilon_i$$

$$\text{SNAP}_i = \alpha + \lambda FS_i + \gamma \mathbf{Z_i} + \varepsilon_i,$$

where i denotes an individual child; j denotes the measure of obesity being used (discussed below); SNAP = 1 if a household participates in SNAP, 0 otherwise; FS is an index of financial stress; $\mathbf{X}$ and $\mathbf{Z}$ are vectors of covariates, $\mathbf{X} \neq \mathbf{Z}$; and ε is an error term. We estimate the models both with and without the financial stress index. In estimating these models, we account for potential clustering at the household level due to multiple children residing in the same household.

Data

Data for this study originate from the *Survey of Household Finances and Childhood Obesity*, a sample survey of households with children conducted from 2009–2010. The focus of the survey was on households experiencing financial stress. As a consequence, the survey sampling frame was composed of low-income metro and non-metro counties (poverty rates above 20 percent) in three Midwestern states: Illinois, Iowa, and Michigan. Relevant for this paper, the survey includes household demographic information including age and gender of children, child height and weight, objective and subjective household financial stress indicators, and SNAP participation. Data were collected in two stages: (i) a telephone interview, involving the majority of data collection, and (ii) a mailed survey to gather the measured height and weight of children in participating households. Surveyors interviewed the adult in the household deemed most knowledgeable about household finances, hereinafter called "respondent." This survey was conducted by the Center for Survey Statistics and Methodology at Iowa State University.

For the present study, this dataset has three key advantages. First, there is a rich array of variables portraying financial stress at the household level. These include objective indicators of financial stress such as whether someone has missed a credit card payment, or whether someone has postponed needed medical care due to financial constraints. In contrast, previous studies have relied on a more limited set of measures (e.g., Garasky et al. 2009, Gundersen et al. 2008). Second, the survey data include county-level resi-

dency information, enabling us to control for potential self-selection bias using county-level characteristics such as the SNAP participation rate. Finally, the survey data provide children's height and weight, used in the derivation of BMI percentiles. In this paper, we use respondent-reports of each child's weight.

Measures

Indicators of Weight Status

This article uses three different measures of overweight in children: overweight status, depth of overweight, and severity of overweight. To determine these, we first calculated each child's body mass index (BMI, kg/m^2) using child height and weight data. Next, we assigned each child's BMI to a percentile for age and gender. Respondents reported obtaining child height information from the child's school, doctor, or home measurement in 45 percent of cases and estimating height in another 55 percent of cases. In contrast, respondents reported obtaining child weight data from a measured source (school, doctor, or home measurement) in 57 percent of cases and estimating in 43 percent of cases. Over 93 percent of measurements were taken within 6 months of the survey. The percentile assignments were based on the Centers for Disease Control and Prevention (CDC) BMI-for-Age growth charts for the United States (Ogden et al. 2002). In this study, a child is classified as overweight if his or her BMI exceeds the 85th percentile of BMI for age and gender.

Using the BMI percentile and the overweight cutoff, we establish three measures of overweight status. These can be expressed as follows:

$$(2) \quad OB^{\alpha} = \left(\frac{BMIPER - s}{z - s} \right)^{\alpha} \text{ if } BMIPER \geq s,$$

$$OB^{\alpha} = 0 \text{ otherwise,}$$

where *BMIPER* is the BMI percentile, *s* is the overweight cutoff (in this case, the 85th percentile for BMI), and *z* is the maximum value of the BMI percentile. When α is equal to 0, this results in a binary measure of obesity/overweight, i.e., a child is obese or not obese. When α is equal to 1, the result is a measure of overweight depth (also called "overweight gap") as defined by Jolliffe (2004). Similarly, when α is equal to 2, the result is a measure of the severity of overweight (also called "overweight gap squared"). These measures of a child's weight status are similar to those defined for poverty by the Foster-Greer-Thorbecke class of poverty measures (Foster, Greer, and Thorbecke 1984).

The primary advantage of moving beyond the standard binary measure is that these alternative measures capture differences in BMI percentiles above the overweight threshold. Such changes would not be reflected in the binary overweight status measure but may have real health effects (Jolliffe 2004). These measures recognize that the risk of negative health related outcomes increases with BMI, so a child who far exceeds the overweight threshold has a greater risk of negative health outcomes than a child with a BMI in the 86th percentile. To facilitate comparisons across the different measures of obesity, we use standard two-stage least squares models in all cases. This holds even when we consider the binary measure of childhood obesity.

Financial Stress Index

Financial stress indicators in the literature are diverse in composition, ranging from major life events to daily stressors such as meeting day-to-day expenses. We draw upon existing measures of a household's ability to meet current needs and expenses in our conceptualization of financial stress. Several recent studies have linked difficulties meeting daily expenses to adverse mental and physical child health outcomes (Jackson et al. 2000, Wadsworth and Compas 2002, Gutman, McLoyd, and Tokoyawa 2005, Garasky et al. 2009).

Empirical evidence suggests that the stress experience can be cumulative in nature, so stress level often depends on an accumulation of stressor events. In addition, events are often clustered as one stressor event can trigger a series of additional events, amplifying the stress experienced through "stress pile-up" or stress proliferation (McKenry and Price 2005, Pearlin et al. 2005). Because the degree to which a child perceives household stress is likely influenced by the magnitude of such stress, an accumulation of stressors measure is more appropriate for the present study than individual stressor events.

Our measure of financial stress is derived from a series of six objective questions in which respondents were asked about experiences over the last twelve months. The implicit time lag recognizes that obesity outcomes are not instantaneous, but rather result from stress-induced metabolic abnormalities or other energy imbalances that persist over time. Specifically, the survey asked respondents whether in the last twelve months they had (i) been late paying their utility or phone bill(s), (ii) ever missed a credit card or other loan payment by 60 days or more, (iii) ever been late on a mortgage or rent payment by 30 days or more, (iv) used a payday loan or other high interest rate loan, (v) had to sell property or possessions to pay their bills, and (vi) postponed medical or dental care because they could not afford it. Dichotomous responses (yes = 1, no = 0) are summed to create an objective financial stress index ranging from 0 (experienced none of the 6 stressors) to 6 (experienced all 6 stressors). Equal weight is given to all stressor events given the highly individual nature of the stress experience, which confounds efforts to weight particular stressor events.

McKenry and Price (2005) suggest that the magnitude of stress experienced often depends upon family-specific characteristics and perspectives. This suggests that subjective measures of financial stress may also be beneficial as they can reflect an individual's perception of stressor events. So, we re-estimate the models using a subjective measure of stress. Specifically, respondents were asked how often they struggle to make ends meet. "Always" or "often" responses were considered a sign of financial stress and assigned a value of 1; all other responses (i.e., sometimes, rarely, or never) received a value of 0.

Instruments for SNAP Participation

The central variable in our analysis is SNAP participation. As discussed above, we instrument for SNAP participation. To do so, we utilize geographic information available in the dataset about county of residence. Previous work examining the effect of SNAP on other health outcomes has utilized information defined at the state level as instruments (e.g., Yen et al. 2008). In this paper, we use county-level data from the U.S. Census Bureau, including the county SNAP participation rate, defined as the estimated number of SNAP participants in the county divided by the number of county residents with income below 150 percent of the poverty line as an instrument. We would expect county SNAP participation rates to be positively associated with individual SNAP participation, as counties with higher participation rates may have diminished stigma associated with participation and/or more program outreach, and there may be easier access to the program. We also control for other county-level socioeconomic and demographic factors that may also influence selection, using data from the 2005–2009 American Community Survey including county unemployment rate, median income, percent of the population that is black or African American, and percent of the population that is Hispanic or Latino, as additional controls to help identify the model. County-level need, observed through unemployment rate and median income, is likely associated with participation rates due to higher levels of program outreach in high-need areas, word of mouth, and more social support (less stigma) associated with participation.

Other Covariates

We employ a standard set of other variables that are commonly used in the literature. Namely, we include variables reflecting the education level of the respondent (high school graduate versus non-graduate from high school), household income (defined as the midpoint of income brackets),[4] health insurance status (with insurance versus without insurance), race (black versus non-black), ethnicity (Hispanic versus non-Hispanic), household size, and marital status (currently married versus currently not married). Given the importance of genetic factors in determining a child's weight, we include a variable reflecting whether the respondent is overweight or not (based on respondents' self-reports of whether they consider themselves to be underweight, normal weight, or overweight).[5]

[4] Income brackets in the *Survey of Household Finances and Childhood Obesity* include the following: less than $10,000, $10,000 to $15,000, $15,000 to $20,000, $20,000 to $25,000, $25,000 to $30,000, $30,000 to $40,000, $40,000 to $50,000, $50,000 to $60,000, $60,000 to $75,000, $75,000 to $100,000, and more than $100,000.

[5] In our sample, the child's parent was the respondent in 87.8 percent of cases, and the child's grandparent was the respondent in an additional 8.9 percent of cases (totaling 96.7 percent of cases), so respondent weight serves as a reasonable proxy for genetic factors influencing child weight.

We restrict our sample to children who are eligible for SNAP (see Ver Ploeg et al. 2007). As discussed above, to be eligible for SNAP, a household must meet the gross and net income tests and the asset test. Since our data do not provide sufficient information to measure net income and assets, we focus on gross income eligibility as discussed below. With respect to the net income test, virtually all gross income eligible households are also net income eligible.[6] Given our focus on children, however, this data limitation should not lead to substantial errors in defining eligibility (Gundersen and Offutt 2005). In contrast, the asset test could be important for a sample that includes a high proportion of households headed by an elderly person (Haider, Jacknowitz, and Schoeni 2003). As discussed, this is not the case for this sample.

Our sample included 374 children between the ages of 2 and 18 who live in households with income less than 130 percent of the poverty line. Children under two years of age are not included because there is no consensus method for establishing BMI percentiles for young children. After dropping observations with incomplete data, our final sample includes 360 income-eligible children.

Results

Descriptive Results

The analysis sample includes 360 children ages 2 to 18. Within the sample, 45.4 percent of children are overweight (BMI ≥ 85th percentile for age and gender based on CDC growth charts) and 70.3 percent participate in SNAP. SNAP participation in the sample is consistent with the estimated 66 percent participation rate among eligible individuals nationwide (Cunnyngham and Castner 2010). Approximately 8 percent of the sample is Hispanic and an additional 18 percent is black.[7] Program participation rates do not differ significantly by child overweight status. In addition, the average household financial stress index level does not differ significantly by SNAP participation status or by child overweight status (see Table 1). Though the sample was limited to children in households with incomes below 130 percent of the poverty line (SNAP-eligible households), average household income is, as expected, lower among children in households that participate in SNAP. Half (49.7 percent) of children live in households headed by married couples, though parental marital status differs significantly for children who are SNAP participants versus non-participants; non-participant children are more likely to live in households with married parents than program participants. As reported in Table 1, the average household size for children in the sample is nearly five people, though it is smaller for children who are overweight (average household size of 4.72 people for overweight children compared to 5.22 people among healthy weight children). Given the importance of genetic and environmental factors, it is also worth noting that nearly three out of every five children in the sample lived in households in which at least one adult self-identified as overweight.

Excerpts from the multivariate regression results including the estimated marginal effect of SNAP participation on each overweight measure are presented in Table 2. Using instrumental variable methods, we find that participation in SNAP has a significant negative effect on overweight status, depth of overweight, and severity of overweight when estimated with and without controlling for financial stress.[8] Specifically, in both cases, a 10 percent increase in an eligible child's probability of entering SNAP leads to an estimated 5.7 percent decrease in the probability that the child will be overweight. These findings suggest that policies and outreach aimed at increasing the propensity of eligible households to enter the SNAP program may lead to reductions in

[6] The gross income thresholds for Iowa and Michigan were both higher than 130 percent of the poverty line—165 percent and 200 percent respectively. However, at the higher income cutoffs, fewer families are likely to be net income eligible. As a consequence, we use the 130 percent threshold for all families (see also footnote 9).

[7] These percentages are lower than a nationally representative sample of low income individuals. However, this is not surprising given the demographic makeup of the three states from which the sample was drawn. Nationwide, approximately 21.9 percent of individuals with incomes below 125 percent of poverty thresholds are black, and 28.6 percent are Hispanic.

[8] Due to the potential for reporting or measurement error of child height and weight, we re-estimate the models using several subsamples. The coefficient estimates for SNAP participation remain negative when estimating the model using two separate subsamples: children for whom both height and weight information originate from measured sources (n = 138), and children for whom reported height and/or weight data are estimates (n = 222). The coefficient estimates for SNAP participation remain significant across all models when the sample is restricted to observations with estimated child height and/or weight data.

Table 1. Descriptive Statistics

Variables	Eligible Sample (1)	SNAP Participants (2)	SNAP Non-Participants (3)	Overweight (4)	Not Overweight (5)
SNAP participant	0.703	1.000	0.000	0.693	0.711
Hispanic	0.083	0.067	0.121	0.092	0.076
Black	0.178	0.178	0.178	0.172	0.183
Respondent is high school graduate	0.858	0.842	0.897	0.847	0.868
Respondent is married	0.497	0.423	0.673**	0.479	0.513
Whether respondent is overweight	0.597	0.601	0.589	0.669	0.538*
Household has health insurance	0.661	0.672	0.636	0.693	0.635
Respondent's age	41.244	40.154	43.822*	41.202	41.279
	(0.824)	(0.949)	(1.600)	(0.975)	(1.051)
Household size	4.997	5.079	4.804	4.724	5.223*
	(0.198)	(0.248)	(0.318)	(0.172)	(0.259)
Household income / 10,000	2.051	1.918	2.367*	2.055	2.048
	(0.082)	(0.093)	(0.157)	(0.086)	(0.104)
Financial stress index	2.072	2.198	1.776	2.086	2.061
	(0.122)	(0.141)	(0.235)	(0.153)	(0.139)
County SNAP participation rate	0.552	0.560	0.535	0.541	0.562
	(0.010)	(0.012)	(0.018)	(0.011)	(0.012)
County unemployment rate	0.111	0.112	0.109	0.111	0.112
	(0.004)	(0.004)	(0.007)	(0.004)	(0.004)
County median income / 10,000	4.245	4.240	4.254	4.240	4.248
	(0.037)	(0.044)	(0.069)	(0.051)	(0.038)
County percent black	0.122	0.120	0.127	0.119	0.124
	(0.012)	(0.013)	(0.025)	(0.015)	(0.014)
County percent Hispanic	0.058	0.056	0.063	0.060	0.056
	(0.005)	(0.006)	(0.009)	(0.007)	(0.005)

Note: Number of observations is 360. Linearized standard errors are reported in parentheses. * indicates different from column (2) or (4), $p \leq 0.05$. ** indicates different from column (2) or (4), $p \leq 0.01$.

childhood obesity.[9] Table 2 also includes regression results when the model is estimated by ordinary least squares. In this case, the coefficient estimates for SNAP participation are closer to zero and insignificant. Taken together, the negative and significant instrumental variable estimates and insignificant OLS estimates suggest that there may be negative selection into SNAP.

Complete results of the models estimated with and without controlling for financial stress are presented in Appendix Tables A1 and A2 respectively. As expected, the respondent's (parental) overweight status is positively associated with the binary measure of child overweight status (p-value: 0.068) when estimated without including the financial stress index. However, the respondent's overweight status is not significantly related to depth or severity of overweight. In addition, the respondent's marital status and age are negatively associated with the depth of over-

[9] In recent years, some states have increased the gross income cutoff above 130 percent of the poverty line, including two of the states used in this paper. The gross income cutoffs are 130 percent of the poverty line for Illinois, 165 percent of the poverty line for Iowa, and 200 percent of the poverty line for Michigan. When re-estimating the model using state gross income cutoffs as the sample inclusion criteria (n = 501), the coefficient estimates for SNAP participation remain negative and are -0.491, -0.425, and -0.063 in the overweight, overweight depth, and overweight severity models respectively (compared to -0.566, -0.533, and -0.079 in the models estimated using the 130 percent of the poverty line cutoff). SNAP participation remains a significant predictor of overweight severity when using the less stringent eligibility criteria. We wish to emphasize, though, that numerous households that are gross-income eligible under the higher cutoff are not net income eligible. In contrast, virtually all households that have gross incomes under 130 percent of the poverty line are also net income eligible. Thus, we continue to use the 130 percent cutoff as our preferred cutoff.

Table 2. Results, Effect of SNAP Participation and Household Financial Stress on Overweight Status, Depth, and Severity

				Instrumental Variables		
	Overweight	Depth of Overweight	Severity of Overweight	Overweight	Depth of Overweight	Severity of Overweight
	(1)	(2)	(3)	(4)	(5)	(6)
MODEL ESTIMATED WITHOUT FINANCIAL STRESS INDEX						
SNAP participant	-0.566	-0.533	-0.079	0.000	0.009	0.000
	(0.279)**	(0.250)**	(0.036)**	(0.063)	(0.056)	(0.008)
MODEL WITH FINANCIAL STRESS INDEX						
SNAP participant	-0.566	-0.534	-0.080	-0.005	0.007	-0.000
	(0.285)**	(0.255)**	(0.037)**	(0.063)	(0.056)	(0.008)
Financial Stress Index	0.038	0.029	0.004	0.011	0.004	0.000
	(0.028)	(0.025)	(0.004)	(0.019)	(0.017)	(0.002)

Note: Number of observations is 360. Standard errors are reported in parentheses. * indicates significant at the 10 percent level. ** indicates significant at the 5 percent level. *** indicates significant at the 1 percent level.

weight (the overweight gap measure) and the severity of overweight (the overweight gap squared measure). The multivariate regression results for the models estimated with the financial stress index presented in Table A2 are roughly similar to those in Table A1. Surprisingly, model results suggest that household financial stress level is not significantly associated with child overweight status, depth, or severity. The determinants of SNAP participation, shown in Table 3, are largely as expected. Larger families, poorer families, and families headed by younger persons are more likely to participate. When included in the model, household financial stress is also a significant predictor of SNAP participation.

Validity of the Instruments

County SNAP participation rate, the central instrument for SNAP participation, is likely associated with propensity to enter SNAP because it may reflect perceived stigma associated with SNAP participation as well as ease of participation within a county of residence. It is unlikely that this measure is related to other potentially omitted variables that may influence obesity status; however, it is possible that the other county-level instruments included as additional controls may be related to obesity via other mechanisms such as peer or contextual effects. Given this possibility, we formally test the strength of the instruments, including their association with the endogenous variable of interest and their exogeneity. As seen in Table 3, county SNAP participation rate and county median income are both individually significant determinants of SNAP participation when the model is estimated without controlling for individual financial stress, and county median income remains significant when controlling for household financial stress (see Table 3). When considered jointly, an adjusted Wald Test suggests that at least one instrument significantly predicts propensity to enter SNAP. We reject the null hypothesis that the coefficients for the instruments are zero at a 0.003 significance level when the model is estimated without the financial stress index, and at a 0.004 significance level in the model estimated with the financial stress index (f-statistics = 3.68 and 3.52 respectively). Given that the model is over-identified, we also test the second condition, that the chosen instruments are uncorrelated with the error term and exogenous with respect to the structural equation. Both the Sargan chi-squared statistic (0.939) and the Basmann chi-squared statistic (0.902) are insignificant (p-values are 0.919 and 0.924 respectively),[10] so the tests provide no evidence that the chosen instruments are invalid or endogenous.

[10] Test statistics are reported for the overweight status dependent variable model which does not control for financial stress. Test statistics in models which control for financial stress were similarly insignificant.

Table 3. First-Stage Regression Results

	No Financial Stress Index	With Financial Stress Index
	SNAP Participation	SNAP Participation
Variables	(1)	(2)
Household size	0.061	0.057
	(0.017)***	(0.018)***
Hispanic	-0.169	-0.139
	(0.151)	(0.148)
Black	-0.108	-0.109
	(0.092)	(0.095)
Respondent is high school graduate	-0.053	-0.080
	(0.084)	(0.086)
Respondent's age	-0.008	-0.007
	(0.003)**	(0.003)**
Respondent is married	-0.200	-0.206
	(0.090)**	(0.089)**
Whether respondent is overweight	0.045	0.031
	(0.070)	(0.069)
Household income / 10,000	-0.160	-0.163
	(0.059)***	(0.058)***
Household has health insurance	0.042	0.058
	(0.073)	(0.072)
Financial stress index	--	0.045
	--	(0.025)*
County SNAP participation rate	0.847	0.742
	(0.453)*	(0.464)
County unemployment rate	-0.200	0.022
	(1.525)	(1.531)
County median income / 10,000	0.246	0.258
	(0.133)*	(0.133)*
County percent black	-0.392	-0.414
	(0.374)	(0.376)
County percent Hispanic	-1.197	-1.245
	(1.001)	(0.986)
Constant	-0.193	-0.283
	(0.621)	(0.610)
R^2	0.210	0.227
F-statistic for excluded instruments	3.68[a]	3.52[a]
Partial R^2	0.05[a]	0.05[a]

[a] Test-statistic was calculated without controlling for clustering of children within households.

Note: Number of observations is 360. Standard errors are reported in parentheses. * indicates significant at the 10 percent level. ** indicates significant at the 5 percent level. *** indicates significant at the 1 percent level.

We did several robustness checks. First, using the full sample, the findings with respect to the effects of SNAP participation and financial stress (after controlling for SNAP participation) on overweight status, depth, and severity were robust to alternative definitions of financial stress. The

models estimated with the subjective measure of financial stress in place of the financial stress index were similar in significance (e.g., SNAP participation was significantly negatively associated with all measures of child weight, financial stress was not significantly associated with any measure of child weight, respondent weight was significantly positively associated with child overweight status, and respondent age and marital status were significantly positively associated with the depth and severity of overweight). In addition, when used independently in the model, after controlling for SNAP participation, only one component of the financial stress index (being late on utility or phone bills) was significantly related to child overweight status, depth, or severity. Second, researchers have found that the impact of household stress on child obesity varies by child age (Garasky et al. 2009). This suggests that developmental stage likely impacts the stress experience and stress response. When estimating the models using a subsample of low-income teenagers (child age > 12 years), financial stress was not associated with any of the 3 weight status measures; however, the sample size is relatively small (n = 139). In addition, respondent's weight was consistently significantly related to child overweight status, depth, and severity in this subsample.

Conclusion

Using data from the 2009–2010 *Survey of Household Finances and Childhood Obesity* to compare child obesity outcomes among SNAP participants and eligible non-participants, we find that SNAP participation is negatively associated with obesity status, depth, and severity in children in low-income counties in Illinois, Iowa, and Michigan, with and without controlling for household financial stress. Our findings reject the conjectures of some observers that SNAP participation leads to obesity; in fact, this study finds the opposite is true.

This study benefits from a rich array of household demographic, program participation, and financial stress variables contained in the *Survey of Household Finances and Childhood Obesity.* The study builds on prior work using continuous measures of child weight in addition to a more traditional binary measure in order to analyze factors that may influence child weight with real health outcomes entirely above overweight thresholds. Because obesity results from energy or metabolic imbalance over time, further research may consider the relationships between financial stress, program participation, and child obesity using longitudinal data including financial stress, body weight, and other factors over time to further understand these dynamic relationships. Further research may also wish to consider datasets from a broader population. This work uses a survey of households in counties with high concentrations of poverty. While this sample selection is intended to reflect households more likely to be under financial stress, broadening to include other counties may present some new insights. Finally, this sample is drawn from three states in the Midwest. Other areas of the country may have different relationships between stress, SNAP participation, and childhood obesity.

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Appendix

Table A1. Full Results, Effect of SNAP Participation and Household Variables on Overweight Status, Depth, and Severity

	Overweight	Depth of Overweight	Severity of Overweight
Variables	(1)	(2)	(3)
SNAP participant	-0.566 (0.279)**	-0.533 (0.250)**	-0.079 (0.036)**
Household size	-0.007 (0.026)	-0.004 (0.022)	0.000 (0.003)
Hispanic	-0.040 (0.137)	-0.019 (0.114)	-0.003 (0.016)
Black	-0.039 (0.090)	0.010 (0.077)	0.003 (0.011)
Respondent is high school graduate	-0.064 (0.098)	-0.003 (0.081)	0.002 (0.011)
Respondent's age	-0.006 (0.004)	-0.006 (0.003)*	-0.001 (0.000)*
Respondent is married	-0.136 (0.107)	-0.164 (0.096)*	-0.028 (0.014)**
Whether respondent is overweight	0.128 (0.070)*	0.065 (0.062)	0.007 (0.009)
Household income / 10,000	-0.023 (0.059)	-0.007 (0.052)	-0.001 (0.007)
Household has health insurance	0.099 (0.070)	0.065 (0.059)	0.008 (0.008)
Constant	1.155 (0.384)***	0.970 (0.340)***	0.131 (0.048)***

Note: Number of observations is 360. Standard errors are reported in parentheses. * indicates significant at the 10 percent level. ** indicates significant at the 5 percent level. *** indicates significant at the 1 percent level.

Table A2. Full Results, Effect of SNAP Participation and Household Financial Stress on Overweight Status, Depth, and Severity

	Overweight	Depth of Overweight	Severity of Overweight
Variables	(1)	(2)	(3)
SNAP participant	-0.566 (0.285)**	-0.534 (0.255)**	-0.080 (0.037)**
Household size	-0.009 (0.025)	-0.006 (0.022)	0.000 (0.003)
Hispanic	-0.016 (0.134)	-0.001 (0.111)	-0.001 (0.016)
Black	-0.042 (0.089)	0.008 (0.076)	0.003 (0.011)
Respondent is high school graduate	-0.084 (0.101)	-0.019 (0.083)	0.000 (0.012)
Respondent's age	-0.005 (0.004)	-0.005 (0.003)*	-0.001 (0.000)*
Respondent is married	-0.143 (0.106)	-0.170 (0.097)*	-0.029 (0.014)**
Whether respondent is overweight	0.119 (0.070)*	0.058 (0.062)	0.006 (0.009)
Household income / 10,000	-0.024 (0.058)	-0.008 (0.052)	-0.001 (0.008)
Household has health insurance	0.116 (0.070)*	0.078 (0.059)	0.010 (0.008)
Financial stress index	0.038 (0.028)	0.029 (0.025)	0.004 (0.004)
Constant	1.079 (0.368)***	0.912 (0.327)***	0.123 (0.047)***

Note: Number of observations is 360. Standard errors are reported in parentheses. * indicates significant at the 10 percent level. ** indicates significant at the 5 percent level. *** indicates significant at the 1 percent level.