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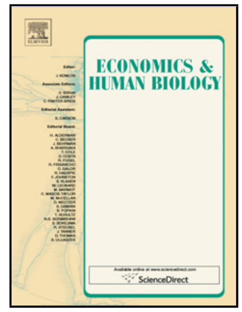

Title: MEASURING EFFECTS OF SNAP ON OBESITY AT THE INTENSIVE MARGIN

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MEASURING EFFECTS OF SNAP ON OBESITY AT THE INTENSIVE MARGIN

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HIGHLIGHTS:

- We investigate the effects of additional SNAP benefits on adult weight.
- School meals represent a non-trivial part of the food budget for SNAP families.
- Additional SNAP benefits due to free school meals has no effect on adult obesity.
- In families with younger children additional SNAP benefits reduce adult BMI and obesity.

Abstract. The effects of the Supplemental Nutrition Assistance Program (SNAP) on obesity have been the focus of much debate. However, causal interpretation of estimates from previous studies, comparing participants to non-participants, is complicated by endogeneity and possible misreporting of participation in SNAP. In this paper, we take a novel approach to examine quasi-experimental variation in SNAP benefit *amount* on adult obesity. Children of SNAP households qualify for free in-school meals, thus freeing some additional benefits for the household. A greater proportion of school-age children eligible for free in-school meals proxies for an exogenous increase in the amount of SNAP benefits available per adult. Using data from the National Longitudinal Survey of Youth-1979 we show that school meals represent a non-trivial part of the food budget for SNAP households. We find that increases in SNAP benefits have no effect on obesity levels for the full sample of those who report SNAP participation. To better isolate the effects of additional benefits from other potential changes we restrict our analysis to adults living in households with at least one child under 5 years of age. In this setting, we find that additional SNAP benefits reduce BMI and the probability of being obese for SNAP adults. Specifically, when one child in a household of four becomes school-aged, adult BMI is expected to decrease by 0.23 units and the probability of being obese decreases by 2.58 percentage points or by about 10%.

Keywords: Obesity, Supplemental Nutrition Assistance Program, Food Stamps, Intensive Margin Effects, National School Lunch Program, School Breakfast Program, Direct Certification Rules

JEL Codes: I1, I38, H51, H53

INTRODUCTION

Obesity rates among the U.S. adult population have reached staggering numbers. Flegal et al. (2010) reports that as of 2008, over one third of U.S. adults were considered obese and that 72.3% of men and 64.1% of women were considered overweight or obese.[1] The prevalence of obese adults hovered around 13-15% during the 1960's and 1970's, but striking increases in the 1980's and 1990's have elevated obesity rates to 31% by the year 2000 and 35.7% by 2010 (Flegal et al., 2002; Ogden et al., 2012). The increase in obesity prevalence is of major concern to public health officials and researchers. Overweight and obese adults have a much higher risk of developing coronary heart disease, type 2 diabetes, cancer, high blood pressure, and other adverse health conditions (Dixon, 2010). Furthermore, obesity has surpassed cigarette smoking as the leading cause of preventable morbidity in the United States (Jia and Lubetkin, 2010).

The higher prevalence of obesity found in low-income households has reinforced the focus of examining food assistance programs that are targeted to the poor. [2] The Food Stamp Act of 1964 led to the creation of the federally funded Food Stamp Program (Supplemental Nutrition Assistance Program or SNAP as of October 2008) in charge of reducing food insecurity and providing adequate levels of nutrition to families with financial constraints.[3] Fewer than 10 million low-income Americans were participating in the program in the early 1970's, but by 2014 over 46

[1] Obesity in adults is defined as having a Body Mass Index (BMI) of 30 or higher while overweight adults fall under a BMI range of 25-29.9. Adult BMI is calculated as weight divided by height squared (kg/m^2). For more information see http://www.cdc.gov/healthyweight/assessing/bmi/.

[2] See Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity (2001).

[3] More information about SNAP is available at http://www.fns.usda.gov/snap/rules/Legislation/Default.htm

million received some amount of SNAP benefits (USDA, 2015). The introduction and growth of the largest food assistance program in the nation coinciding with the dramatic increase in obesity rates has prompted the question of whether the social program that was implemented to reduce hunger among the poorest families in the U.S. has in fact been contributing to the rise in obesity rates.

Previous studies have focused on estimating the effects of SNAP on weight outcomes at the extensive margin by comparing participants and income-eligible non participants (Baum, 2011; Fan, 2010; Gibson, 2003; Meyerhoefer and Pylypchuk, 2008; Kaushal, 2007; Zargosky and Smith 2009). Overall, the findings suggest SNAP participation may have a small positive effect on weight gain for women and no significant effect on men. However, causal interpretation of estimates from previous research is complicated by endogenous participation and misreporting of SNAP. Much of the effort has centered on addressing endogenous participation into SNAP, but far less has been spent dealing with misreporting of SNAP participation. Previous studies have shown that misreporting of SNAP in surveys, in some instances over 30% of participants, is a serious issue that has significant consequences when overlooked (Bitler et al., 2003; Brachet, 2008; Meyer et al., 2009). A recent paper by Almada, McCarthy, and Tchernis analyzes the effects of participation in SNAP on obesity and show that the estimates of the effects are exceptionally sensitive to misreporting (Almada et al., 2016).

This article adds to the existing literature on SNAP and adult obesity by being the first to estimate the causal effects of changes in SNAP benefit *amount*. To examine the intensive margin effects of SNAP we focus only on households who report SNAP participation. We identify exogenous variations in SNAP amount through changes in the proportion of school-age children (share of family members who are between the ages of 6 and 14) in SNAP households who qualify for in-school nutrition assistance programs (i.e. the National School Lunch Program and School Breakfast Program). A greater proportion of school-age children eligible for free in-school meals proxies for an exogenous increase in the amount of SNAP benefits available per adult. Although the identification relies on receipt of free in-school meals, we consider this study an examination of SNAP benefits given that weight outcomes of adults are only impacted through changes SNAP benefit availability, and not the consumption of in-school meals.

Using data from the National Longitudinal Survey of Youth-1979, we show that school meals represent a non-trivial part of the food budget for the family. We find that increases in SNAP benefits have no effect on obesity levels for the full sample of those who report SNAP participation. To isolate the effect of SNAP from other potential changes when a child enters school our preferred specification examines adults living in SNAP households with at least one school-age child and at least one child under 5 years of age who is not yet school-age eligible. For this subsample we find that increases in SNAP benefits, due to increases in the share of children eligible for in-school meals, reduce BMI and the probability of being obese. Specifically, when one child in a household of four becomes school-aged, adult BMI is expected to decrease by 0.23 units (approximately 1.4 pounds assuming height of 5’5’’) and the probability of being obese decreases by 2.58 percentage points or by about 10%.

Intensive margin effects of SNAP are relevant to recent policy debates discussing changes to the amount of benefits households receive through changes in allowable income deductions as well as benefit indexing adjustments (CBO Report, 2012). Our identification strategy allows us to estimate unbiased effects of changes in effective benefit amount for a selective subsample of low-income households while minimizing concerns with selection and misreporting of true SNAP participation. However, because our approach is based on a unique subset of low-income households, we must caution against generalizing our findings to all low-income households. Additionally, because our data do not contain direct information on child's in-school meal participation we use school-age eligibility as proxy for additional benefits. As such, our results should be interpreted as lower bound estimates of the true effect given the potential of attenuation bias from relying on this proxy treatment measure.

BACKGROUND

Basic rules of eligibility are set and administered by federal legislation and the United States Department of Agriculture – Food and Nutrition Service. [4] Although certain eligibility rules have been amended over time, generally household SNAP eligibility is based on income and household size. A "Gross Income Test[5]" establishes that household income must be at or below 130% of the federal poverty line (FPL) to qualify for SNAP. The gross income limits vary according to household size such that larger households have higher income limits. A lower monthly income limit (100% FPL) is also considered once certain allowable deductions are applied to household

[4] http://www.fns.usda.gov/snap/rules/Legislation/about.htm

[5] According to the state of New York "Income can include: Regular job (wages), income before strike, on-the-job-training, military reserves, national guard, work study, alimony, child support, educational assistance (grants, scholarships, etc.), friends or relatives (other than loans), public assistance, pensions or retirement, Supplemental Security Income (SSI), Social Security benefits, veterans benefits, unemployment benefits, worker's compensation, babysitting, taxi driving, cleaning homes or other buildings, farming/ranching, income from a roomer, income from a boarder or arts and crafts."

income. [6] Some states also consider a "Resources Test[7]" where households may have no more than a set amount in countable resources in order to qualify for SNAP.

If the criteria for eligibility is met, the household is provided with an Electronic Benefit Transfer (EBT) card, similar to a debit or credit card, which is credited with funds (SNAP benefits) on a monthly basis that can be used to purchase food items at SNAP participating stores. [8] Prior to the introduction of EBT cards in the late 1990s, SNAP benefits were issued via mail or through local agencies in the form of monthly paper coupons or stamps. The amount of benefits received varies according to the size, expenses, and income of each household. For example, in 2015, a two-member household receives at most $357 per month in SNAP benefits, and a four-member household could receive at most $649 per month. SNAP eligible households with other income

[6] The "Net Income Test" allows certain amounts of standard deductions based on household size and earned income. Deductions are also allowed for dependent care costs (when needed for work, training, or education), medical expenses for elderly or disabled, legally owed child support payments, and certain shelter costs. After any deductions are made, the household must not exceed a net income limit in order to pass the net income test.

[7] According to the USDA-FNS, the exact procedure for handling certain resources is determined by individual states. Furthermore, resource test are only considered in a handful of states. (http://frac.org/federal-foodnutrition-programs/snapfood-stamps/eligibility/)

[8] Several restrictions are placed on SNAP benefits including the purchase of alcohol, tobacco, and pet food products and other non-food items. The EBT system has been implemented in all States since June of 2004 (source: http://www.fns.usda.gov/ebt/general-electronic-benefit-transfer-ebt-information)

sources are allotted less than the maximum benefit amount as these households are expected to spend a portion of their earned income on food. [9]

Literature on SNAP and Obesity

The intended purpose of SNAP is to provide adequate levels of nutrition to families in need. However, economic theory cannot definitively predict the effect of SNAP participation on obesity outcomes. Weight gain and SNAP participation can be modeled through an intra-household utility maximization framework. SNAP benefits increase disposable income. Depending on preferences, recipients may choose to maximize their utility by either using SNAP benefits to increase food expenditure or using benefits to offset spending and increase non-food expenditure. Earlier observational studies suggest that SNAP substantially increases food consumption more than equivalent cash transfers (Fraker, 1990). More recent work using quasi-experimental variation finds mixed results on the effects of SNAP on expenditure (Fraker et al., 1995; Hoynes and Schanzenbach, 2009; Beatty and Tuttle, 2015). Potential reasons for the observed differences in the marginal propensity of food consumption by SNAP participation status are considered in detail by Wilde et al. (2009). Nevertheless, the effects of greater food expenditure on body weight are contingent not only on the quantity, but also the nutritional quality of the diets afforded.

Overall, studies have found mixed evidence on the effects of SNAP participation on diet quality and nutrient intake. Earlier research that generally ignore program selection find

[9] According to the USDA-FNS "The net monthly income of the household is multiplied by 0.3, and the result is subtracted from the maximum allotment for the household size to find the household's allotment." (source: http://www.fns.usda.gov/snap/eligibility)

deleterious effects from SNAP. For example, Wilde et al. (2000) examine food choices of a sample of SNAP recipients and find that, on average, SNAP recipients consume greater amounts of meats, sugars, and fats compared to non-recipients. Similarly, Whitmore (2002) finds that recipients who are constrained by the in-kind nature of the benefits spend more on soft drinks and juices than if they had received the equivalent amount of benefits in cash. Cole and Fox (2008) find that SNAP participants obtain a significantly larger percentage of their total energy intake from solid fats, alcoholic beverages, and added sugars compared to low-income nonparticipants. In addition, they find that, relative to higher-income nonparticipants, SNAP participants are far less likely to consume sufficient quantities of vitamins and minerals. However, more recent studies that account for selection into SNAP find more favorable effects of participation on nutritional intake. Using variation in state-level SNAP policy, Gregory et al. (2013) find that SNAP participants consume more whole fruits while decreasing their intake of saturated fats and sodium compared to similar nonparticipants. Applying a similar methodology to control for selection into SNAP, Todd and Ver Ploeg (2014) find that caloric intake from sugar sweetened beverages is lower among current SNAP participants compared to similar nonparticipants. Finally, several researchers exploited the changes to benefit levels as a result of the 2009 American Recovery and Reinvestment Act. For example, Nord and Prell (2011) find that the increase in SNAP benefits due to the ARRA policy change significantly reduced food insecurity. Waehrer et al. (2015) find that SNAP benefit increases due to ARRA are not associated with any significant changes in diet quality for eligible respondents from the National Health and Nutrition Examination Survey (NHANES). Meanwhile, Beatty and Tuttle (2015) find that the marginal propensity to consume food out of SNAP benefits among infra-marginal households is much higher compared to that of cash meaning additional SNAP benefits results in a relatively larger amount of food purchases.

Another potential mechanism linking SNAP to changes in body weight depends on the timing of benefit distribution in conjunction with the harmful consequences of chronic dieting, often referred to as the "Food Stamp Cycle". Blackburn et al. (1989) found that a persistent pattern of over- and under-consumption of calories (binge eating followed by periods of restricting food intake) can lead to "permanent metabolic and physiologic alterations which promote weight gain and make subsequent loss of weight more difficult" (Blackburn et al., 1989). Chronic dieting may be an issue for SNAP participants because benefits are received on a monthly basis. Monthly distribution of SNAP benefits may induce recipients to over-consume foods at the beginning of the month and then unintentionally under-consume at the end of the month when benefits are running low or completely used up. This can be particularly problematic for the poorest participants who do not have other sources of income to help smooth their caloric intake throughout the month. A recent report from New York City's Human Resources Administration (Fellner, 2012) finds that half of all SNAP recipients had redeemed 80% of their benefit allotment by the second week of receipt. Wilde and Ranney (2000) find that SNAP recipients who shop once a month for groceries have a significantly lower caloric intake during the week immediately prior to receiving next month's benefits. For those who do not shop once a month, they find that food expenditures for SNAP recipients are highest immediately after receiving the benefits. Further evidence of chronic dieting by SNAP recipients and its adverse effects are reported by Hastings and Washington (2008), Seligman et al. (2014), and Shapiro (2005). If difficulties smoothing one's food consumption can lead to weight gain, then greater amounts of benefits have the potential to reduce obesity for those receiving SNAP. Ultimately, the effects of additional SNAP benefits on adult weight must be sought out empirically.

SNAP *Participation* and Obesity

In order to determine the causal effects of SNAP on obesity researchers usually must deal with two main sources of bias. First, estimates can be biased if one does not account for non-random selection into SNAP. [10] Second, the effects of SNAP can suffer from misreporting bias if true participation is misclassified. Most of the literature focuses on comparing participants to income eligible non-participants while attempting to address issues of selection. Far less has been done to address participation misclassification or to examine intensive margin effects of SNAP participation on obesity.

Ver Ploeg and Ralston (2008) and Gundersen (2015) conduct thorough reviews of the existing literature on SNAP and adult obesity. Their analyses of the more rigorous studies in which attempts were made to control for selection bias and time-invariant characteristics suggests that, in general, SNAP participation appears to be positively related to BMI measures and obesity in adult women, but has no significant impact on adult men.[11] For example, to control for selection bias, both Baum (2011) and Gibson (2003) estimate fixed-effect models using longitudinal survey data and find positive effects of SNAP participation on BMI and the probability of being obese for adult women. In an attempt to control for participation endogeneity, Meyerhoefer and Pylypchuk (2008) use variation in state-level SNAP outreach expenditures, electronic fingerprint requirement, and recertification periods to instrument for SNAP participation. Their estimates suggest that

[10] Selection bias occurs if those who choose to participate in SNAP are systemically different (preferences and/or behaviors) than those who do not, and this distinction affects weight. For example, suppose only individuals who have a stronger preference for food, and are eligible, choose to participate in SNAP. This group would show a positive correlation between SNAP participation and higher weight level.

[11] A review of the literature generally finds reductions in obesity among children of SNAP participating households (Gundersen, 2015).

SNAP participation increases the probability of being obese by 6.7% in adult women but has no significant impact on adult men. Kaushal (2007) exploits the variation in state responses to the federal ban of SNAP benefits for immigrants in accordance to the 1996 Personal Responsibility and Work Opportunity Reconciliation Act. Estimating a difference-in-difference model, she finds that SNAP participation is not associated with any significant increases in BMI in both adult immigrant men and women. A more recent study by Fan (2010) applies a difference-in-difference strategy with propensity score matching and finds no statistically significant effects of SNAP participation on BMI or probability of being overweight or obese for low-income women.

A recent look at the extent of misclassification of SNAP participation in survey data suggests the issue is quite problematic. Meyer et al. (2009) find that under-reporting of program participation in five nationally representative surveys is highly prevalent and increases over time. Their estimates suggest that one third of SNAP beneficiaries do not report participation in the program which can significantly bias estimates of the effects of participation. Bitler et al. (2003) find under-reporting of SNAP recipients by about 15 percent in both the CPS Food Security Supplements and Survey of Income and Program Participation. Bollinger and David (1997) also examine cases of under and over-reporting of SNAP participation in the SIPP. Although they find that cases of over-reporting (false positives) are rare and minimal (approximately 0.3 percent), under-reporting is nontrivial and accounts for approximately 12 percent of all responses.

To our knowledge, only two published studies have considered participation misreporting while estimating treatment effects of SNAP on obesity. Kreider et al. (2012) examine the effects of SNAP participation on child obesity and other health outcomes also utilizing data from National Health and Nutrition Examination Survey (NHANES). The authors simultaneously address selection and misreporting bias using partial identification (layering process) and bounding methods. Their analyses consider the effects of misreporting bias by testing various restrictions on the size of the classification errors. The findings of their study suggest that SNAP participation reduces the likelihood that a child is obese only when misreporting rates are less than 4%. Utilizing similar methods, Almada et al. (2016) find considerable rates of SNAP participation underreporting in the NLSY79 and that failing to account for misreporting overstates program effects by nearly 100 percent. Taken together, these findings warrant research that accounts for potential misreporting bias to obtain more accurate effects of SNAP on obesity.

SNAP *Benefit Amount* and Obesity

Our review of the literature points to only two studies that consider associations between SNAP benefit *amount* and adult weight outcomes. Jilcott et al. (2011a) examine weight outcomes of low income adults from the 2005-2006 NHANES. Stratifying by gender and controlling for race, education, and age they find that receiving a greater amount of SNAP benefits in the prior month is associated with lower BMI and waist circumference among females. In Jilcott et al. (2011b), researchers recruited approximately 200 female SNAP participants from eastern North Carolina to examine the associations between SNAP benefits and multiple measures of health and wellbeing. Their study finds that adult females who receive less than $150 in monthly SNAP benefits per child have significantly higher BMIs than females receiving more than $150 in benefits per child. Although failing to account for selection or misreporting, both studies show a negative relationship between benefit amount and weight outcomes.

More broadly, research on SNAP benefit amount and obesity is related to the body of literature exploring the effects of income transfers on weight gain. Lakdawalla et al. (2005) argue that the relationship between income and weight is theoretically U-shaped depending on income levels of households while Barfteld et al. (2015) argue that there exists a negative relationship between income and obesity. Empirical studies are largely mixed with some finding that income transfers/shocks increase obesity among poorer households while others find no effect. For example, Schmeiser (2009) found that an additional $1,000 in income from more generous EITC (Earned Income Tax Credit) benefits increased obesity among poor women by approximately 3.6 percentage points, but no effect was found among low-income men. Cawley et al. (2010) do not find any significant effects of additional income on weight for elderly Americans through more generous Social Security benefits. More recently, Akee et al. (2013) find that additional unearned household income increases BMI among youth from low-income Native American households, but no significant effect among their wealthier counterparts.

METHODS AND DATA

Our paper adds to the existing literature on SNAP and adult obesity by proposing a unique identification strategy that estimates the causal effects of changes in SNAP benefit *amount*. To examine intensive margin effects, we rely on a strategy that focuses only on households who report SNAP participation. This approach minimizes our concerns with selection and misreporting of true SNAP participation. [12] However, our approach will ultimately only yield unbiased estimates for this selective subsample of low-income households and, as such, we must caution against generalizing our findings to all low-income households.

[12] Our approach will inevitably include a very small percentage of non-participants who falsely report receiving SNAP benefit while excluding individuals who under-report participation. See Almada et al. (2016) for discussions of SNAP misreporting in the NLSY79 and its consequences for analyses in the context of obesity.

Identification

Our identification strategy relies on the direct certification program enacted by The Richard B. Russell National School Lunch Act of 1986. The implementation of the program requires States and local educational agencies to certify children from SNAP households for in-school food assistance programs forgoing a formal application process from parents/guardians (USDA: Moore et al., 2013; USDA: Jackson et al., 2000). By 1992, forty-five states had implemented direct certification in school districts within their state. At the start of the 1996 school year, 48 states and Washington D.C. had used direct certification to verify the eligibility of over 10 million students for free in-school meals, representing 72% of all students certified for free meals that academic year (USDA: Jackson et al., 2000). Specifically, school-age children from SNAP households are eligible to receive up to two free meals per day as part of the National School Lunch Program (NSLP) and School Breakfast Program (SBP).[13] Furthermore, there is no reduction in SNAP benefits once children from these households become eligible for these in-school programs. Therefore, we can identify exogenous variations in effective benefits from variations in the proportion of school-age children in SNAP households. As the share of school-age children

[13] According to the USDA-FNS (http://www.fns.usda.gov/cnd/lunch/AboutLunch/NSLPFactSheet.pdf) "Children from families with incomes at or below 130 percent of the poverty level are eligible for free meals." The NSLP and SBP are federally assisted meal programs for low income children attending public and nonprofit private schools. Households who receive SNAP benefits automatically qualify NSLP and SBP. Legislation mandates states and local education agencies to use direct certification to automatically enroll children of SNAP recipients into NSLP. The NLSP (SBP) are administered in over 100,000 (89,000) schools nationwide and currently serves over 31 million (12 million) children each day.

increases, the same amount of SNAP benefits are available, but are needed for fewer in-home meals.

We can get a sense of the income effect from the additional SNAP resources available when children participate in the in-school meals programs by means of an example for a typical SNAP household. In 2015 a family of four received on average $459 in SNAP benefits while reimbursement rates for the NSLP and SBP in the contiguous states were $3.30 and $1.99, respectively. [14,15] When a child in the household becomes school-age eligible, she automatically qualifies for a free breakfast and lunch at school. Using these reimbursement rates, we calculate that in a typical month with 20 school days in-school meals average to just over $100 in additional food assistance, or approximately 23% of the average amount of SNAP benefits allotted to this household. We consider this amount to be a conservative estimate given that meal production at schools benefit from greater economies of scale. In addition, households that receive less than the maximum amount of SNAP benefits (due to some earned income) would experience an even greater percentage increase in benefit amount. To put this into perspective, the temporary SNAP benefit increases from the 2009 American Reinvestment and Recovery Act (ARRA) amounted to $80 a month for a family of four.[16]

[14] See CBPP report for additional information on household-level benefit receipt (http://www.cbpp.org/research/a-quick-guide-to-snap-eligibility-and-benefits)

[15] For more information on school meal reimbursement rates see http://www.fns.usda.gov/school-meals/rates-reimbursement

[16] Additional information on SNAP and the ARRA is available at: http://www.ers.usda.gov/topics/food-nutrition-assistance/supplemental-nutrition-assistance-program-%28snap%29/arra.aspx

Our identification strategy captures the dynamics of various food assistance programs available to families as children become school-age eligible, however, our approach also opens the potential for other changes in household circumstances that could impact weight gain. For instance, a household may no longer need to pay for childcare once the child enrolls in school. Although this change in household resources could be substantial for many families, several studies indicate that the majority of low-income households do not rely on relatively expensive formal care centers (Burstein and Layzer, 2007; Chaudry et. al., 2011; Sandstrom and Chaudry, 2012). Because most low-income households utilize informal, home-based childcare (either parental or family relative), we do not suspect changes in household resources due to childcare are significantly biasing our findings. Nonetheless, in later sections we attempt to further separate effects of free meals (additional food assistance) from other potential mechanisms affecting obesity when children enter school.

Econometric Model

To estimate the effects of additional SNAP benefits on obesity we are interested in changes in the proportion of school-age children within SNAP households. The effects can be estimated from the following fixed-effect model:

$$Y_{it} = c + \delta PSAC_{it} + \beta X_{it} + \alpha_i + \pi_t + u_{it} \qquad (1)$$

In equation (1) our outcome of interest, Y_{it}, takes the form of a continuous measure of BMI and the linear probability of being obese (BMI of 30 or more) for respondent, *i*, in year, *t*. The parameter of interest, δ, captures the effects of changes in the amount of available SNAP benefits for respondent, *i*, on the outcomes described above. We estimate this effect for respondent, *i*, at time, *t*, from changes in the proportion of school-age children, $PSAC_{it}$ while controlling for a vector of time-varying demographic controls, X_{it}, and unobserved individual and time fixed-effects α_i, π_t. Specifically, we control for the respondents' age, household size, education level, income (logged and squared), as well as indicators for poverty status, marital status, employment status, living in an urban area, and year dummies. In this setting, adult weight and the treatment variable are reported contemporaneously. Given that SNAP receipt is reported since the prior survey wave (1 or 2 years) as is the child aging into school eligibility, there is sufficient time for the treatment to affect weight outcomes that we do not use time lags for our treatment measure.

Computationally, equation (1) estimates the impact of exogenous variation in SNAP benefit amounts on the BMI and likelihood of being obese over time within each adult respondent. A fixed-effect approach minimizes bias stemming from the inability to control for unobservable time-invariant characteristics that differ between respondents that may influence weight outcomes. However, fixed-effects models are still susceptible to bias if some unobserved characteristics that impact obesity are changing over time. We further discuss and address these concerns in the empirical results section.

In our empirical analysis, a positive coefficient for δ would indicate that additional benefits are contributing to weight gain for adults in SNAP households. Conversely, a negative coefficient on δ would point to decreases in adult weight from additional SNAP benefits. More precisely, the sign and magnitude of δ indicates how changes in SNAP benefit availability from changes in the share of school-age children in a respondent's household affect BMI and likelihood of being obese.

Data: National Longitudinal Survey of Youth - 1979 Cohort

The NLSY79 contains data on a nationally representative sample of 12,686 men and women who were between the ages of 14 and 22 when they were first surveyed in 1979. The dataset is comprised of three subsamples: 1) a cross-sectional sample of 6,111 youths designed to be representative of non-institutionalized civilian youths, 2) A supplemental sample of 5,295 youths designed to oversample civilian Hispanic, black, and economically disadvantaged nonblack/non-Hispanic youths[17], and 3) a military sample of 1,280 youths. The cohort was interviewed annually through 1994 and then every two years until present time. Retention rates for NLSY79 respondents who were still considered eligible for interviews were close to 90 percent during the first 16 waves and since then have only decreased slightly (BLS, 2012).

The NLSY79 contains several key variables that are useful for our analysis. Measures of weight were self-reported in pounds for the following survey years: 1981, 1982, 1985, 1986, 1988, 1989, 1990, 1992, 1993, 1994, 1996, 1998, 2000, 2002, 2004, 2006, and 2008. Height measures were self-reported in 1981, 1982 and 1985. We use the 1985 height measure to calculate each respondent's BMI for all the corresponding years with weight information.[18] [19] We exclude from

[17] The oversampling of economically disadvantaged non-black and non-Hispanic individuals were no longer interviewed after the 1990 survey wave.

[18] We use 1982 measures of height if height was not reported in 1985 (N=1515).

[19] Although self-reported weight and height measures could suffer from systematic reporting error that may bias coefficient estimates, several studies have indicated that the extent of weight and height misreporting in the NLSY79 has trivial impact on coefficient estimates (Baum 2011; Cawley 2000; Lakdawalla and Philipson 2009) and that correction methods may not be appropriate for NLSY cohorts (Courtemanche et al. 2015). Results are qualitatively similar when adjusting for height and weight according to Cawley (2004). More generally, research has shown that measures of BMI, although convenient in social science research, do not perfectly distinguish fat from fat-free mass and as such may misclassify the health risks associated with certain weight and height combinations, particularly in men (Burkhauser and Cawley, 2008; Wada and Tekin, 2010).

the analysis any observations without a BMI measure and females in years they indicated being pregnant. This produces a subsample of 132,349 respondent-year observations.

We also utilize a number of respondent demographic variables including household size, ages of household members, indicators for race/ethnicity, gender, marital status, employment status, number of hours worked per calendar year, as well as some limited measures of physical activity. In addition, the survey collects information on the total net income of each respondent's household, the respondent's (and respondents' mother's) highest level of education, and total dollar amount of SNAP benefits received during the past year for each surveyed wave. The intention of this study is to model only adults who report receiving SNAP benefits. Therefore, we begin observing individuals in the 1985 survey wave once all respondents have reached adult age.[20] Furthermore, we are interested only in observations for years when respondents report receiving SNAP benefits. The final sample consists of 2,078 individual adults with BMI measures who report receiving SNAP in at least 2 survey waves. The 2,078 adults are observed across 15 different survey waves (unbalanced) resulting in 10,634 respondent-year observations.

Because we are unable to determine a child's actual in-school food assistance program participation status in the NLSY79, we use child school-age eligibility to proxy for participation.[21] Both direct certification efforts and identical income requirements as SNAP make it highly probable that school-age eligible children from SNAP households are also receiving free in-school meals (Bartfeld, 2015). Studies using different surveys reveal that a vast majority of school-age

[20] Average age in the 1985 wave is 23.7 ranging from 20 – 28 years of age.

[21] NLSY79 Child and Young Adult supplement survey reveals that over 95% of surveyed children of NLSY79 respondents attend public schools where NSLP and SBP are primarily administered.

children from SNAP households are also participating in both the NSLP and SBP. Tchernis et al. (2012) find that 97% of children from SNAP households in the Early Child Longitudinal Study – Kindergarten 1998 cohort participate in the NSLP, while 70% also participate in the SBP. An examination of the 2001-2004 Survey of Income and Program Participation finds that approximately 78% of female SNAP households have children who receive free and/or reduced school meals (Reese, 2006). Finally, Bartfeld (2015) thoroughly examines SNAP and in-school meal program participation during and after the great recession also finding that the vast majority of SNAP participating households with children in the 2008 SIPP panels are also participating in the NSLP (90%) and SBP (72%). In this setting, we argue that the proportion of school-age eligible children in a SNAP household is a reliable proxy for additional benefit per household member, and any attenuation bias from using a proxy variable is relatively minor. Consequently, our results should be interpreted as a lower bound estimate of the true effect.

For our analysis we use information on the age of all household members who live with the respondent to calculate the number of school-age children living with the respondent.[22] We consider a child to be of school-age if she is between the ages of 6 and 14 as determined on the date of interview. We start the cutoff at six years old given that the average age when a child first enters kindergarten is just over five and a half, and because only a small fraction (9%) of children are older than six years old when they first enter kindergarten (U.S. Dept. of Education, 2012). Although the majority of U.S. children are enrolled in school through age 17, because of lower NLSP and SBP participation rates among high school students due to stigma concerns and higher

[22] Child's date of birth, date of death, and date of interview/survey was also used to cross check the age of the various children in the household and to address missing information in the data.

average household incomes, we limit our school-age eligibility cutoff to 14 years of age (Ralston et al., 2008). We test the sensitivity of our age restrictions in subsequent sections.

Summary Statistics

A summary of descriptive statistics for the sample of NLSY79 respondents who report receiving SNAP benefits throughout the 15 waves are presented in Table 1.[23] The respondents are grouped into three pooled survey wave categories to provide average measures over time. Waves 1985, 1986, 1988, and 1989 are pooled in column 1, waves 1990, 1992, 1993, and 1994 in column 2, and waves 1996, 1998, 2000, 2002, 2004, 2006, and 2008 in column 3. SNAP benefits are reported in 2008 dollars adjusted by the CPI Food and Beverage index. The weighted sample means show that the average amount of SNAP benefits per household per year decreases from $3,347 to $2,989 from the 1985-1989 waves to the 1990-1994 waves and down to $1,881 for the most recent pooled waves. We see similar reductions over time of SNAP benefits per person and per adult in households. Interestingly, average household incomes also decrease over time. A share of the reductions in household benefits and incomes can be attributed to the reductions in household size over time. Average number of children increases and later decreases as household compositions change over time. We find that the percent of respondents who hold a high school degree or higher increases over the time period indicating the possibility of continued educational training in later years. Not surprising, the education level of the respondent's mother stays fairly constant. The percent of respondents who report working 20 or more hours per week in the past year increases slightly after the first pooled waves. We find that approximately 27% of respondents

[23] We use the NLSY79 sampling weights for longitudinal analysis to calculate all descriptive statistics (variable name: *SAMPWEIGHT*)

were employed at least part-time during the 1985-1989 waves, while in the later pooled waves the employment rate is closer to 31%.

Race, ethnicity, gender, regional locations are all relatively constant over the different time periods. In regards to various obesity measures the data do show significant increases over time. Average BMI increases from 25.38 in the early periods to 27.38 in the middle periods and up to 29.55 in the later periods. Obesity rates increase from 18.8% to 28% and up to 39.8% in the later periods. The percent of respondents who are overweight or obese increases by almost 30 percentage points throughout our time period. The data show that in the latest survey waves almost 70% of all respondents are considered overweight. The increases in obesity rates observed in the NLSY79 sample of SNAP adults are slightly larger than the national average obesity rates documented by the CDC.[24]

EMPIRICAL RESULTS

Before estimating the model described in the methodology section, we first present some supporting evidence that our proxy variable for changes in effective SNAP benefit amount (proportion of school-age children in the household) is not endogenous to SNAP participation. We might be concerned that parents are more likely to apply for SNAP benefits in order to make their school-age children eligible to receive free in-school meals.[25] Such households may be more concerned about food intake and understand the importance of nutrients which might also be

[24] For more information on national adult obesity rates and trends see http://www.cdc.gov/obesity/data/adult.html

[25] Intuitively, we suspect households are not signing up for SNAP in order for their children to receive free in-school meals given the greater difficulties (documentation needed and recertification requirements) of applying for SNAP relative the NSLP and SBP.

related to their own food consumption. On the other hand, parents from these households may prefer school meals to avoid the hassle of preparing food at home which can also be related to their own food consumption and a myriad of other unobservable factors. More generally, we might worry that there could be selection into our treatment measure that could bias our estimates of the intensive margin effects of SNAP benefits on adult weight.

In column 1 of Table 2 we present the coefficient from an individual fixed-effect regression estimating the effect of changes in the proportion of school-age children on the probability of reporting SNAP participation among households at or below 130% of the federal poverty line. The estimated effect is relatively small and statistically insignificant providing some evidence that parents are not applying for SNAP benefits as their children become school-age eligible, on average.[26] The second column of Table 2 indicates that, among households who report SNAP receipt, changes in the proportion of school-age children does not significantly impact the amount of benefits received per household member. However, if we assume children do not "consume" household SNAP benefits when they reach school-age, then our treatment variable predicts a significant increase in the amount of benefits available per adult among SNAP households (column 3, Table 2). Specifically, if one child in a household of four becomes school-age eligible, effective SNAP benefits per adult per year would increase by about $100. This predicted effect is surprisingly low given our assumption that children do not "consume" any SNAP benefits once they become school-age, and we suspect it is largely due to the high degree of underreporting of SNAP benefit amount in the survey data. Nevertheless, our treatment variable appears to be

[26] For comparison purposes, the coefficient estimate for the change in the number of children in the household is four times larger and estimated very precisely.

exogenous to participation in SNAP and a reliable (and perhaps even better) proxy for changes in effective benefits among SNAP households.

In row 1 of Table 3 we present the estimates of changes in effective SNAP benefit amount on adult weight outcomes using the individual fixed-effects specification. Our results are estimated using robust standard errors clustered at the individual level. In this longitudinal framework the fixed-effects specification uses within respondent variation to estimate treatment effects. Specifically, we are interested in the variation of effective SNAP benefits from changes in the proportion of school-age children within each respondent's household, net of household demographic factors and yearly indicators.[27]

Our coefficient estimates have signs consistent with a positive, albeit minute, relationship between SNAP benefits and obesity. The estimated point estimate for BMI suggests that additional SNAP benefits available to adults when one child in a household of four becomes school-age eligible (PSAC from 0 to 0.25), increases adult BMI by 0.036 units. This effect amounts to an increase of approximately 0.2 pounds for a typical 5'5'' (65 inches) tall individual. We find an even smaller and statistically insignificant percentage point increase for the probability of being obese. Overall, we find that additional SNAP benefits have no effect on adult weight outcomes. Thus far, our intensive margin results are in line with previous work that finds no effect of SNAP participation on obesity (Fan, 2010; Kaushal, 2007).

Subsample Analysis

[27] In our dataset 85% of the observations experience changes in the share of school-age children over time while only 15% experienced no variation.

In this section we examine a subsample of our SNAP respondents in an attempt to isolate the effect of increased benefits versus other potential mechanism affecting obesity. When children enter school there are many changes at the household level that are not accounted for in a fixed-effect framework. For example, when a child enters school time spent on childcare can be replaced with other activities that influence obesity such as devoting more time to employment, preparing home cooked meals, exercising, sleeping, etc. Courtemanche (2009) and Ruhm (2005) separately show that additional hours dedicated to labor force participation lead to increases in BMI and the probability of being obese in adults. To eliminate some of these channels we concentrate on a subsample of individuals living with at least one child under the age of five for every year of participation. Focusing on households with at least one child who is not yet school-age eligible allows us to isolate the exogenous increase in SNAP availability from other behavioral changes.[28] Morrill (2011) applies a similar strategy in which a child's youngest sibling's eligibility for kindergarten is used to instrument for maternal labor force participation.

To examine how the age of the youngest child affects employment decisions among our low-income sample of NLSY79 households we estimate our model on labor force participation outcomes. In Table 4 we present the regression coefficients for changes in the proportion of school-age children on an indicator for working 20 or more hours per week in the last year and two measures of the number of hours worked in the past year. The first panel of Table 4 presents the

[28] The American Time Use Survey reports average hours per day spent on various activities by presence and age of youngest child in the household. According to the 2012 ATUS, adults living in households with the youngest child under the age of 6 spend, on average, 30 minutes less (60 minutes less if not employed) on leisure and sport activities (exercise, socializing, watching TV, relaxing, playing games and computer use, etc.) per day compared to adults in households with the youngest child between 6-17 years of age.

results for the full sample of SNAP adults (row 1) and the subsample of SNAP adults living with at least one child under the age of five (row 2). The results suggest that adults in SNAP households living with children who are not yet school-age eligible are significantly less likely to be employed at least part-time and, if employed, less likely to work more hours when the proportion of school-age children increases. We examine the same relationship for SNAP income-eligible adults who do not report receiving benefits in the second panel (rows 3 and 4) and third panel (row 5 and 6) of Table 4. We find similar differences, yet less pronounced, for adults who do not report receiving SNAP with incomes at or below 130% of the federal poverty line (rows 3 and 4). The differences for the full and subsample of adults between 130% and 200% of the federal poverty line who do not report receiving SNAP (rows 5 and 6) are less evident. More generally, these findings provide some evidence that we can better isolate the effects of SNAP from unobserved potential changes in behavior by focusing on adults living in households with at least one child who is not yet school-age eligible.

The effect of additional SNAP benefits on obesity outcomes for both the full sample and the subsample of SNAP adults with at least one child under the age of five are presented in panel 1 of Table 3. As described earlier, row 1 of Table 3 presents the results for the fixed-effects specification that controls for time-varying demographic characteristics and year dummies on the full sample of SNAP adults. The results for the subsample of SNAP adults are presented in row 2 of Table 3 with a separate obesity outcome under each column. For the sample of SNAP adults living in households with at least one child under five years of age we find that greater amounts of SNAP benefits significantly *reduce* adult BMI. The effect on BMI has the opposite sign compared to the point estimate for the full sample of SNAP adults (-0.924 versus 0.143) and is statistically significant at the 5% level. Our results indicate that, for adults living with a child under the age of five, additional SNAP benefits from one child entering school in a household of four reduces adult BMI by 0.23 units (-0.924 x 0.25). Once again, if we consider an individual with a height of 5'5'' (65 inches), the estimated reduction in body weight is approximately 1.4 pounds. We find that the effect on the probability of being obese is also reversed and substantially larger in magnitude compared to the estimate for the full sample of SNAP adults (-0.101 versus 0.005).[29] The coefficient estimate suggests that one child entering school (from a household of four) decreases the probability an adult is obese by 2.53 (-0.101 x 0.25) percentage points, statistically significant at the 5% level. This is equivalent to approximately a 10% reduction in obesity.[30] The subsample of SNAP recipients with at least one non-school-aged child consist of fewer observations (4,929 compared to 10,634 from the full sample), but we are better able to isolate the direct effects of SNAP on this smaller sample. The sign reversal of our effects suggests that the full sample estimates may be affected by other potential channels affecting weight when all children enter school.

Sensitivity Analyses and Robustness Checks

In this section we discuss sensitivity analyses that further propose the effects on obesity outcomes for our preferred sample (adults in households with at least one child less than 5 years of age) are driven primarily by additional SNAP benefit receipt from children entering school.

[29] The reductions in BMI fall primarily on respondents who are obese. We do not find increases in the underweight category suggesting the reductions in BMI are towards healthier levels of weight. Previous versions of this paper examined underweight, overweight, and severely obese categories and found no meaningful effects. The results are available upon request.

[30] Baseline obesity rate for subsample of SNAP adults living with at least one child less than 5 years of age is 25.4%.

Analogous results for the full sample are presented in the appendix. First, we estimate the effect of changes in the proportion of school-age children on obesity for income eligible non-SNAP participating households. If we find changes in obesity levels in these adults it would not be due to SNAP benefits, but rather other mechanisms.[31] Next, we perform sensitivity tests on the school-eligible age cutoffs. If we find effects of SNAP on obesity when children are not old enough to participate in the SBP and NSLP then it is possible that changes in weight are driven by other mechanisms. In this section we also discuss our findings when restricting our preferred analytical sample by gender and by length of SNAP participation.

To examine how changes in the proportion of school-age children affect weight outcomes of non-SNAP adults living with a child less than 5 years we use the sample of NLSY79 respondents who do not report receiving SNAP and who have household incomes at or below 130% of the federal poverty level. The results for the subsample of these non-participants with at least one child not yet school-age eligible are presented in panel 2 of Table 3. In contrast to the SNAP sample, we find that an increase in the proportion of school age children in these income eligible but non-participating households has a positive albeit statistically insignificant effect on BMI and obesity. We perform similar analysis for non-SNAP reporting adults with incomes between 130% and 200% of the federal poverty lines (panel 3) of Table 3. For this group, the point estimates are negative as found in the SNAP sample, but are smaller in magnitude and measured with less

[31] We suspect that many of the income eligible non-participants are indeed receiving SNAP but incorrectly reporting their status and potentially bias the comparisons. Meyer et al. (2009) find that false negative rates of SNAP reporting in survey data can be over 30%. In addition, even if these households are not participating in SNAP, their children still qualify for free school meals but would not be signed up through the direct certification protocol. For further discussion on SNAP misreporting rates and its implications particular to the NLSY79 see Almada et al. (2016).

precision. Eligibility for reduced priced lunches and breakfasts for this less disadvantaged group may help explain the resemblance to our SNAP sample point estimates. [32]

To further test whether our findings are in fact driven by additional SNAP benefits rather than other potential mechanisms when children enter school we examine the interaction of SNAP participation and the proportion of school-age children on weight outcomes. This approach is analogous to a difference-in-difference design that estimates the effect of SNAP on adult obesity before and after children are school-age eligible (with varying degrees of intensity). Each panel in Table 5 presents the point estimates for the interaction term between proportion of school-age children and a SNAP dummy variable for the adults in the two different income groups. In the first panel of Table 5 we combine the sample of adults with at least one younger child who report receiving SNAP benefits with the sample of adults living in households at or below 130% of the federal poverty level who did not report participating in SNAP with at least one younger child. Our analysis (row 1) shows that a greater availability of SNAP benefits from increases in the proportion of school-age children significantly reduces adult BMI and the probability of being obese for adults who report participating in SNAP relative to adults who report no participation. The intensive margin effects of SNAP on obesity are seen primarily for the poorer income group (at or below 130% FPL). We find smaller and less precise effects for the sample of adults between 130% and 200% of the federal poverty level whose children are only eligible for reduced price lunches and breakfasts. Altogether, these results are suggestive that the reductions in obesity found in the subsample analyses are driven primarily by increases in SNAP benefits.

[32] Children qualify for reduced price meals if family income is between 130% - 185% of the FPL (USDA-FNS).

We next test whether our results are sensitive to age of school eligibility. We repeat the analyses performed above but now assume school-age eligibility to be between the ages of 4 and 14 rather than ages 6 to 14. This analysis allows us to test whether other sources of benefits may increase the availability of SNAP resources for adults with children who are slightly younger than the average age of entering kindergarten. For example, mothers with children up to the age of 5 are eligible to receive WIC benefits for additional food purchases. [33] Similarly, some children may be receiving other in-school meals available through Head Start or other preschool programs such as the Child and adult Care Food Program (CACFP).[34] Panel 1 of Table 6 presents the results for the new school-age eligibility cutoff of 4-14. Additional SNAP benefits have a negative yet statistically insignificant effect on adult obesity levels using the younger school-age eligibility cutoff (row 1 of Table 6). The effect size on BMI is about half while the effect on obesity is significant smaller relative to the results from our preferred age eligibility cutoff (ages 6 – 14). We do not find strong evidence that suggests WIC, CAFP, or preschool programs, in conjunction with SNAP, affect adult obesity levels. The implicit increase in SNAP benefits may not be as "effective" if families are simultaneously losing benefits from other programs. However, we might expect families that are not receiving other program benefits prior to the start of school to experience a relatively larger effect from the implicit increase in SNAP from school meals. Row 3 of Table 6 present the estimated effects when we expand the age cutoff to also include children in high school

[33] Our results are robust to the inclusion of a WIC dummy control variable which is not available prior to 1990. Results are not shown but available upon request.

[34] CACFP provides nutrition assistance to child care institutions and day care homes to contribute to the wellness, healthy growth, and development of young children prior to joining the k-12 school system. For additional information on CACFP see: https://www.fns.usda.gov/cacfp/child-and-adult-care-food-program

(ages 6 – 18). For this range, the point estimates are similar but less precise compared to those using our preferred age cutoff range. We posit the difference could be attributed to lower NSLP and SBP participation rates among high school-aged children (Ralston et al., 2008). The likelihood that older children consume larger amounts of food, and thus use more household SNAP benefits, could also explain our findings.

We further explore whether our findings differ by gender. In Tables 7 and 8 we re-estimate our preferred sample results from Table 3, limiting our analysis to only women and only men living with at least one child less than 5, respectively. In general, stratifying across gender reveals that the reductions in BMI and obesity are driven primarily by women SNAP participants. The effects of additional SNAP benefits on women with at least one child less than 5 (Row 1, Table 7) are very similar, and in fact slightly larger, to the estimates from the full sample with younger children (Row 2, Table 3). The decrease in the probability of being obese for women is significant at the 1% level. For men we find smaller effects, albeit in the same direction, which are not statistically significant at conventional levels (Row 1, Table 8). The results for income-eligible women and men who report not receiving SNAP benefits are largely mixed, with some evidence suggesting that increases in the proportion of school-age children *increase* BMI in women (Row 2, Table 7) and *increase* the probability of being obese for men (Row 2, Table 8).

We also test whether our findings are sensitive to fluctuations in SNAP participation status. In the first panel of Table 9 we present results from specifications that limit the analysis to respondents who reported receiving SNAP benefits in 4 or more consecutive waves. The results presented in panels 2 and 3 of Table 9 are from income-eligible and near income-eligible respondents who reported never receiving SNAP benefits in any of the survey waves. For our preferred group, adults with a child less than 5 (Row 1, Table 9), we find that the results are robust to the continuous participation specification, but the effects are not estimated with more precision.

To further explore the potential mechanisms behind our findings we also consider three additional subsample restrictions among NLSY79 SNAP recipients. First, instead of relying on the presence of a child under 5, we examine how changes in the proportion of school-age children affects BMI and obesity among SNAP adults that experienced little to no change in their employment level across surveys. Specifically, we restrict our sample to SNAP adults who either 1) consistently worked 20 or more hours per week, 2) consistently worked between 1 and 19 hours per week, or 3) were consistently unemployed across all observed survey waves. We don't find significant effects on BMI or obesity when limiting our sample to consistent levels of employment (see Table 10; Row 1). We attempt to address similar concerns regarding additional benefits due to changes in household composition by limiting our analytical sample to observations where there were no changes in the number of children, for example a birth of a child, (Table 10; Row 2) or changes in household size such as a birth of a child or exit of a parent or guardian (Table 10; Row 3). Again, we don't find statistically significant effects on BMI or obesity when restricting to these subsamples of SNAP recipients. In all three cases the results are similar to the full sample results from Table 3 suggesting that these subsamples may not fully isolate the additional SNAP benefit effect from other potential changes that occur when children enter school.

As a final sensitivity check, in table 11 we explore how the "treatment" affects BMI and obesity among various other samples to gain a better understanding of how the treatment operates across different households. For example, a possible concern may be that our treatment may combine both in-kind food benefits (variations in SNAP amount) as well as other in-kind transfers (i.e., free and reliable childcare). To address this concern we first examine the effects of changes in the proportion of school-age children across much wealthier households that have never received SNAP benefits. Rows 1 and 2 of table 11 examine the effects for adults in households living above 200% and 400% FPL, respectively. Among these wealthier non-SNAP households, we find that adult BMI decreases and the probability of being obese declines as children enter school. The reduction in BMI is approximately one fourth in magnitude and the effect on obesity is approximately one tenth in magnitude compared to the effects found among SNAP adults. These findings among wealthier non-SNAP households suggest that the treatment could operate through other mechanisms besides in-kind food benefits. Among these wealthier households, we suspect that resources allocated to childcare are available for other uses once children enter school. This mechanism could also be operating among the SNAP households that we cannot fully account for through our preferred sample strategy. As such, our findings may be picking up the effects of additional SNAP benefits as well as other freed up resources (time) when children enter school. If these mechanisms work similarly across the different sample groups, then the effects of additional SNAP benefits are likely overstated by 10-25%.

To further explore the possibility that the treatment may be picking up effects from other in-kind benefits, in rows 3 and 4 of table 11 we examine how the effects of changes in the proportional of school-age children are driven only by children aging out of school. Specifically, we focus on households whose youngest child is 6 years or older across SNAP households and all NLSY79 households. Overall, we do not find a strong effect of children aging out of school on the BMI or obesity of adults across these samples. These findings suggest that household resources (monetary or time) are not significantly altered as children age out of school in contrast to children aging into school. Finally, rows 5 and 6 of table 11 present results that examine how variations in SNAP benefits affects adults in households where there is only one adult (single parent) as well as

SNAP households with two or more adults, respectively. Although there are no statistically significant effects among either group, the sign of the estimates suggests that reductions in obesity are more likely to be seen in households with more than one adult compared to single parent households.

DISCUSSION

In this article we present the first causal effects of additional SNAP benefits on adult obesity. Our focus is only on individuals who report SNAP participation and we use variation in household composition to examine differences in the effective amount of SNAP benefits available to adults in the NLSY79. We find no effect of increased SNAP benefits on weight outcomes for the full sample. In our preferred specification we find that additional SNAP benefits per adult, proxied by a greater proportion of school-age children in the household, decreases weight among adult recipients. Specifically, when one child in a household of four enters school, adult BMI is expected to decrease by 0.23 units (roughly 1.4 pounds) while the probability of being obese decreases by about 10% or 2.58 percentage points.

Our causal estimates are in line with the negative relationship between SNAP amount and BMI levels found in Jilcott et al. (2011a) and Jilcott et al. (2011b). Specifically, our estimated effect on BMI is larger than the association found in Jilcott et al. (2011a) such that an additional $1,000 in SNAP benefits per household member is associated with a decrease of 0.1 BMI points. However, the magnitude of our effect is well within the bounds of the effect estimated in Almada et. al. (2016) examining SNAP participation and obesity such that the bounds of the effect of a comparable amount of SNAP benefits would fall between 0 and -6 percentage points. Our findings are also in line with the inverse relationship found between income and obesity across children and adults (Bartfeld et al., 2015). However, our results contradict some of the research exploring the effects of other earned and unearned income transfers (e.g., SSI benefits, EITC, Casino Cash Transfers) on weight (Akee et al., 2013; Cawley et al., 2010; Lakdawalla et al., 2005; Schmeiser, 2009).

There are a number of possible mechanisms discussed in the literature that can explain reductions in BMI and the likelihood of being obese from exogenous increases in SNAP benefits. Decreases in BMI levels from increases in SNAP benefits may be the result of a transition from lower quality (cheap) to higher quality (more expensive) foods that help maintain or even reduce weight (Drewnowki and Specter, 2004; Meyerhoefer and Yang, 2011). Another potential mechanism may be that additional SNAP benefits are alleviating the negative consequences of chronic dieting stemming from the "Food Stamp Cycle" hypothesis (Ver Ploeg and Ralston, 2008; Meyerhoefer and Yang, 2011). An increase of SNAP benefits to households with little to no additional sources of income may be providing enough income to purchase food for the entire month greatly reducing the need to restrict consumption and calories towards the end of the cycle. Although the data do not allow us to explore mechanisms behind differences in results by gender, the stronger effect found among women could be the result of mothers being the primary food shopper for the household. Because we are unable to fully isolate the effects of SNAP benefits from other in-kind benefits we cannot rule out the possibility that other changes in household production (e.g., informal childcare) could also be affecting BMI, particularly among the mothers in our sample. Finally, we cannot rule out the possibility of a pure income effect from additional SNAP benefits that frees up non-SNAP income for the consumption of goods that promote weight loss. However, our analysis on non-SNAP reporting adults suggests that the pure income effect may not be the primary driver of our findings.

Our findings have several implications relevant to current deliberations regarding SNAP policy. On April of 2012, the Congressional Budget Office discussed the possibilities of changing benefit amounts by adjusting how SNAP is indexed with the Thrifty Food Plan or by changing the number and/or amount of deductions from individuals' gross income. Likewise, the American Reinvestment and Recovery Act (ARRA) of 2009 included provisions that increased the amount of SNAP benefits available to participants by approximately 15 percent. Recent legislation repealed the ARRA benefit increases in late 2013 resulting in approximately a 10 percent drop in overall benefits per household amounting to a little over one dollar in benefits per day for a family of four. Based on our results, intensive margin changes could have significant impacts on the prevalence of obesity among SNAP recipients. Presumably, decreasing the amount of SNAP benefits to each household could amount to significant cuts in government spending but may have adverse health consequences to the millions of households who rely on these benefits. However, again, we caution against generalizing our findings to the entire population of low-income households. The effects we find are identified among a fairly unique subset of SNAP households that may differ across multiple dimensions compared to the average SNAP household. Furthermore, government policies that change the generosity of SNAP have the potential to increase or decrease overall participation further complicating the external validity of our findings.

Future research is needed to help uncover the exact mechanisms through which a greater amount of SNAP benefits leads to healthier weight outcomes. Using consumer expenditure or administrative data to examine purchasing behavior and redemption patterns amongst SNAP households with and without school-age children could shed light on such mechanisms involving food choice. Changes in food choices amongst adults with school-age children could stem from healthier eating habits learned in school and then brought home. Healthier eating habits learned at school in conjunction with an exogenous increase in SNAP may help explain the weight loss we find among adult SNAP recipients in the NLSY79. Future work should also examine food consumption choices of SNAP recipients pre and post-ARRA policy changes to provide additional insights on purchasing behavior and redemption patterns given changes in SNAP benefit amounts.

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Table 1. Descriptive Statistics of NLSY79 SNAP Recipients Over Time

Variable Name	(1) 1985-1989	(2) 1990-1994	(3) 1996-2008
SNAP Benefits per HH per year (2008 USD)	3,347	2,989	1,881
	[5,920]	[2,550]	[1,990]
SNAP Benefits per Person in HH per year (2008 USD)	969	877	699
	[1,603]	[670]	[648]
SNAP Benefits per Adult in HH per year (2008 USD)	2,246	2,380	1,674
	[4,502]	[1,951]	[1,900]
Total Net Family Income per year (2008 USD)	22,518	19,310	17,099
	[82,960]	[14,252]	[16,508]
Age (years)	25.64	30.87	40.08
	[2.68]	[2.68]	[4.67]
Household Size	3.86	3.67	2.91
	[1.78]	[1.78]	[1.69]
Number of Children	1.96	2.17	1.64
	[1.38]	[1.51]	[1.55]
Proportion of Children in HH	0.466	0.525	0.435
	[0.228]	[0.256]	[0.310]
Proportion of School-Age Ch. in HH	0.172	0.288	0.251
	[0.207]	[0.248]	[0.261]
Education (1= High School or more)	0.606	0.669	0.738
	[0.488]	[0.470]	[0.439]
Mother’s Education (1= High School or more)	0.357	0.374	0.379
	[0.479]	[0.484]	[0.485]
Employed (1= Worked 20 hrs./wk. or more past year)	0.267	0.314	0.305
	[0.468]	[0.464]	[0.500]
Hours Worked per year if Employed	1,812	1,916	2,040
	[667]	[594]	[830]
Marital Status (1= Married)	0.337	0.324	0.236
	[0.473]	[0.468]	[0.424]
Urban (1= lives in urban area)	0.699	0.746	0.682
	[0.458]	[0.435]	[0.465]
Hispanic (1= Hispanic)	0.104	0.113	0.100
	[0.305]	[0.317]	[0.300]
Black (1= Black)	0.353	0.356	0.342
	[0.478]	[0.479]	[0.475]
Female (1= Female)	0.766	0.695	0.696
	[0.422]	[0.460]	[0.460]
Body Mass Index	25.38	27.38	29.55
	[6.09]	[6.70]	[7.59]
Obese (1= BMI equal to 30 or more)	0.188	0.280	0.398
	[0.391]	[0.449]	[0.489]
Overweight (1= BMI equal to 25 or more)	0.409	0.574	0.698
	[0.491]	[0.495]	[0.459]
Underweight (1= BMI equal to 18.5 or less)	0.064	0.034	0.019
	[0.246]	[0.180]	[0.135]
WIC (1= currently participates in WIC)	-	0.247	0.141
		[0.431]	[0.347]
Number of Observations	3,608	3,745	3,281

Note: Weighted sample means with standard errors in brackets using NLSY79 sample weights for longitudinal analyses. All SNAP benefits are reported in 2008 dollars adjusted by the CPI Food and Beverage Index. Total Net Family Income is reported in 2008 dollars adjusted by the CPI Index.

Table 2. Changes in the Proportion of School-age Children on SNAP Participation and Benefit Amount

VARIABLES	(1) SNAP Participation	(2) Benefits per Person in HH	(3) Benefits per Adult in HH
Proportion of School-Age Children	0.0208	-70.99	431.0***
	(0.0175)	(51.87)	(154.2)
Household Demographic Controls	Y	Y	Y
Year Dummies	Y	Y	Y
Observations	25,256	10,634	10,634
R-squared	0.095	0.072	0.111
Number of Respondents	6,152	2,078	2,078

Note: Column 1 provides estimates from an individual fixed-effect specification of changes in the proportion of school-age children on SNAP participation status for all households at or below 130% of the Federal Poverty Line. Column 2 provides estimates from an individual fixed-effect specification of changes in the proportion of school-age children on SNAP benefits per person among households reporting SNAP receipt. Column 3 provides estimates from an individual fixed-effect specification of changes in the proportion of school-age children on SNAP benefits per adult among households reporting SNAP receipt. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3. Proportion of School-age Children on Adult Obesity by SNAP Reporting Status and Household Income Level

VARIABLES (Specification)	**(1)** **BMI**	**(2)** **Pr(Obese)** **BMI ≥ 30**	**N-T**
Panel 1: SNAP Recipients			
(1) Proportion of School-Age Children (Full Sample)	0.143 (0.194)	0.00526 (0.0189)	10,634
(2) Proportion of School-Age Children (HHs with Child < 5)	-0.924** (0.435)	-0.101** (0.0402)	4,929
Panel 2: Non-SNAP ≤130% FPL			
(3) Proportion of School-Age Children (HHs with Child < 5)	0.278 (0.437)	0.0415 (0.0401)	4,784
Panel 3: Non-SNAP 130% – 200% FPL			
(4) Proportion of School-Age Children (HHs with Child < 5)	-0.276 (0.373)	-0.0579 (0.0469)	5,413

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. Row 1 examines the changes in the proportion of school-age children in SNAP households on obesity. Row 2 examines SNAP households with at least one child under the age of five. Rows 3 and 4 examine adults who do not report using SNAP benefits at or below 130% and between 130% and 200% of the Federal Poverty Level, respectively while restricting each income group subsample to adults living in households with a child under the age of five. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 4. Living with Children Who Are Not yet School Eligible Significantly Reduces Adult Labor Force Participation

VARIABLES (Sample)	(1) Employed PT or +	(2) Hours Worked/yr.	(3) Zero Hours Worked/yr.	N-T
Panel 1: SNAP Recipients				
(1) Proportion of School-Age Children (Full Sample)	0.129*** (0.0223)	256.3*** (44.20)	-0.124*** (0.0256)	10,634
(2) Proportion of School-Age Children (HHs with Child < 5)	0.0591 (0.0437)	127.6 (80.04)	-0.0832 (0.0513)	4,929
Panel 2: Non-SNAP ≤130% FPL				
(3) Proportion of School-Age Children (Full Sample)	0.113*** (0.0245)	199.1*** (53.54)	-0.0859*** (0.0229)	16,336
(4) Proportion of School-Age Children (HHs with Child < 5)	0.0834 (0.0606)	52.15 (131.9)	-0.107* (0.0587)	4,784
Panel 3: Non-SNAP 130% – 200% FPL				
(5) Proportion of School-Age Children (Full Sample)	0.0357* (0.0215)	59.19 (53.04)	-0.0189 (0.0167)	15,082
(6) Proportion of School-Age Children (HHs with Child < 5)	0.0854 (0.0519)	192.9 (152.0)	-0.0273 (0.0488)	5,413

Note: Column 1 provides estimates from an individual fixed-effect specification of changes in the proportion of school-age children on an indicator of part-time or more employment status. Column 2 provides estimates from an individual fixed-effect specification of changes in the proportion of school-age children on number of hours worked in the past year. Column 3 provides estimates from an individual fixed-effect specification of changes in the proportion of school-age children on an indicator for working zero hours in the past year. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 5. Interaction of Proportion of School-Age Children and SNAP dummy on Adult Obesity by Income Level

VARIABLES (Specification)	(1) BMI	(2) Pr(Obese) BMI ≥ 30	N-T
Panel 1: At or Below 130% FPL			
(1) PSAC x SNAP	-0.800*	-0.0836**	9,713
(HHs with Child < 5)	(0.428)	(0.0424)	
Panel 2: 130% – 200% FPL			
(2) PSAC x SNAP	-0.0951	-0.0585	10,342
(HHs with Child < 5)	(0.442)	(0.0453)	

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. Rows 1 and 2 examine the interaction between the proportion of school age children and reporting receiving SNAP benefits (1 = yes) at or below 130% and between 130% and 200 of the Federal Poverty Level, among adults living in households with at least one child under the age of five. Specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 6. Variations in School-Age Eligibility Cutoffs on Adult Obesity Levels

VARIABLES (Specification)	**(1) BMI**	**(2) Pr(Obese) BMI ≥ 30**	**N-T**
Panel 1: Ages 4 to 14			
(1) Proportion of School-Age Children	-0.516	-0.0363	4,194
(HHs with Child < 4)	(0.425)	(0.0452)	
Panel 2: Ages 6 to 18			
(2) Proportion of School-Age Children	-0.866*	-0.0627	4,929
(HHs with Child < 5)	(0.471)	(0.0408)	

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. All specifications use baseline controls and year dummies. Row 1 assumes school-age eligibility between the ages of 4 and 14 years of age for the sample of adults living in households with a child under the age of four to test for potential effects from participation in WIC, CACFP, the Head Start Program or other preschool programs that may increase availability of SNAP resources for adults. Row 2 assumes school-age eligibility between the ages of 6 and 18 years of age among the sample of adults living in households with a child under the age of five. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 7. Proportion of School-age Children on Obesity of Women by SNAP Reporting Status and Household Income Level

VARIABLES (Specification)	(1) BMI	(2) Pr(Obese) BMI ≥ 30	N-T
Panel 1: SNAP Recipients			
(1) Proportion of School-Age Children (Women: HHs with Child < 5)	-1.090** (0.498)	-0.115*** (0.0445)	3,862
Panel 2: Non-SNAP ≤130% FPL			
(2) Proportion of School-Age Children (Women: HHs with Child < 5)	0.911 (0.623)	0.0241 (0.0538)	2,687
Panel 3: Non-SNAP 130% – 200% FPL			
(3) Proportion of School-Age Children (Women: HHs with Child < 5)	-0.296 (0.565)	-0.0515 (0.0694)	2,777

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. Row 1 examines women from SNAP households with at least one child under the age of five. Rows 2 examines women with at least one child under the age of five and who do not report using SNAP benefits at or below 130% of FPL. Row 3 examines women with at least one child under the age of five and who do not report using SNAP benefits between 130% and 200% of FPL. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 8. Proportion of School-age Children on Obesity of Men by SNAP Reporting Status and Household Income Level

VARIABLES (Specification)	(1) BMI	(2) Pr(Obese) BMI ≥ 30	N-T
Panel 1: SNAP Recipients			
(1) Proportion of School-Age Children (Men: HHs with Child < 5)	-0.188 (0.657)	-0.0661 (0.0997)	1,067
Panel 2: Non-SNAP ≤130% FPL			
(2) Proportion of School-Age Children (Men: HHs with Child < 5)	0.103 (0.515)	0.110* (0.0613)	2,097
Panel 3: Non-SNAP 130% – 200% FPL			
(3) Proportion of School-Age Children (Men: HHs with Child < 5)	0.0968 (0.456)	-0.0482 (0.0587)	2,636

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. Row 1 examines men from SNAP households with at least one child under the age of five. Rows 2 examines men with at least one child under the age of five and who do not report using SNAP benefits at or below 130% of FPL. Row 3 examines men with at least one child under the age of five and who do not report using SNAP benefits between 130% and 200% of FPL. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 9. Proportion of School-age Children on Adult Obesity: Continuous SNAP Participation and Income-Eligible Adults who Never Participated

VARIABLES (Specification)	**(1) BMI**	**(2) Pr(Obese) BMI ≥ 30**	**N-T**
Panel 1: 4+ Waves of Continuous SNAP Receipt			
(1) Proportion of School-Age Children	-1.088**	-0.110**	3,148
(HHs with Child < 5)	(0.538)	(0.0503)	
Panel 2: Never Received SNAP ≤130% FPL			
(2) Proportion of School-Age Children	0.289	-0.0236	2,970
(HHs with Child < 5)	(0.517)	(0.0523)	
Panel 3: Never Received SNAP 130% – 200% FPL			
(3) Proportion of School-Age Children	-0.181	-0.0519	4,332
(HHs with Child < 5)	(0.409)	(0.0515)	

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. Row 1 examines SNAP households with at least one child under the age of five who report receiving SNAP for at least 4 consecutive waves. Rows 2 examines adults in households with at least one child under the age of five and who never report receiving SNAP benefits and are at or below 130% of FPL. Row 3 examines households with at least one child under the age of five and who never report receiving SNAP benefits and are between 130% and 200% of FPL. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 10. Proportion of School-age Children on Adult Obesity: Additional SNAP Subsample Restrictions

VARIABLES (Specification)	(1) BMI	(2) Pr(Obese) BMI ≥ 30	N-T
(1) Proportion of School-Age Children (Employment Level)	0.215 (0.529)	-0.0573 (0.0531)	2,275
(2) Proportion of School-Age Children (Number of Children)	0.185 (0.249)	0.00889 (0.0245)	7,585
(3) Proportion of School-Age Children (Household Size)	0.255 (0.251)	0.00805 (0.0263)	6,619

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. Row 1 restricts analyses to SNAP adults who did not change labor force participation level across survey waves. Row 2 restricts analyses to observations where there were no changes in the number of children from the prior wave among SNAP households. Row 3 restricts analyses to observations where there were no changes in household size from the prior wave among SNAP households. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1

Table 11. Proportion of School-age Children on Adult Obesity: Additional Sample Sensitivity Analyses

VARIABLES (Specification)	(1) BMI	(2) Pr(Obese) BMI ≥ 30	N-T
(1) Proportion of School-Age Children (Never SNAP & > 200% FPL)	-0.240*** (0.0568)	-0.0118* (0.00694)	82,226
(2) Proportion of School-Age Children (Never SNAP & > 400% FPL)	-0.146* (0.0860)	-0.000467 (0.0107)	39,189
(3) Proportion of School-Age Children (SNAP & Youngest Child > 5)	0.540 (0.383)	0.0311 (0.0361)	5,082
(4) Proportion of School-Age Children (Youngest Child > 5)	0.0204 (0.0814)	0.00916 (0.00889)	89,376
(5) Proportion of School-Age Children (SNAP & One Adult)	0.154 (0.244)	-0.00630 (0.0243)	6,407
(6) Proportion of School-Age Children (SNAP & Two or more Adults)	-0.108 (0.485)	-0.0244 (0.0471)	4,227

Note: Results from Column 2 are estimated using an individual fixed-effect linear probability model. Rows 1 and 2 restricts analyses to non-SNAP adults living above 200% and 400% FPL, respectively. Rows 3 and 4 restrict analyses to adults whose youngest child is 6 years of age or older (SNAP and all adults, respectively). Rows 5 and 6 restrict analyses to SNAP households with only one adult (single parents) and two or more adults, respectively. All specifications include time-varying household demographic controls and year indicators. Robust standard errors in parentheses clustered on individuals *** p<0.01, ** p<0.05, * p<0.1