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Did the 2009 American Recovery and Reinvestment Act affect Dietary Intake of Low-Income Individuals?

Geetha Waehrer,
Pacific Institute for Research and Evaluation

Partha Deb,
Department of Economics, Hunter College, CUNY

Sandra L. Decker
National Center for Health Statistics

Abstract

This paper examines the relationship between increased Supplemental Nutritional Assistance Program (SNAP) benefits following the 2009 American Recovery and Reinvestment Act (ARRA) and the diet quality of individuals from SNAP-eligible compared to ineligible (those with somewhat higher income) households using data from the 2007–2010 National Health and Nutrition Examination Survey. The ARRA increased SNAP monthly benefits by 13.6% of the maximum allotment for a given household size, equivalent to an increase of $24 to $144 for one-to-eight person households respectively. In the full sample, we find that these increases in SNAP benefits are not associated with changes in nutrient intake and diet quality. However, among those with no more than a high school education, higher SNAP benefits are associated with a 46% increase in the mean caloric share from sugar-sweetened beverages (SSBs) and a decrease in overall diet quality especially for those at the lower end of the diet quality distribution, amounting to a 9 percent decline at the 25th percentile.

Introduction

The great recession of 2007–2009 was the longest contraction of the US economy since the depression of the 1930s. Persistent unemployment and falling incomes strained family budgets and depressed consumer spending, including a reduction in food expenditures (Kumcu and Kaufman, 2011). The American Recovery and Reinvestment Act of 2009 (ARRA) aimed to provide temporary relief to families affected by these unfavorable economic conditions, including a boost to the Supplemental Nutritional Assistance Program (SNAP), the largest food assistance program in the country. As a result of the ARRA, the median value of SNAP benefits in participating households rose by approximately 17% and eligibility rules were relaxed (Nord and Prell, 2011a). - Enrollment in SNAP rose by 53% from 2007 to 2010 and peaked in 2013 with over 47 million people enrolled in the program (USDA, 2014b).

Recent research has documented that the ARRA expansions in SNAP (formerly known as food stamps) benefits have improved food security and increased food expenditures among low- income families (Nord and Prell, 2011b). However, little is known about the impact of the benefit expansion on diet quality of recipients. Although the intent of the ARRA increase in SNAP benefits may have been to maintain food budgets during an economic downtown, such information on the effects of increased benefits on diet quality may be especially useful in light of studies linking past participation in SNAP to unhealthy weight outcomes (e.g. Gibson, 2003, Zagorsky and Smith, 2009) and related concerns about the adequacy of pre-ARRA SNAP allotments for a healthy diet (Institute of Medicine, 2012). The ARRA expansions provide a unique opportunity to examine the change not only in food security and food expenditures but also on dietary intake and food consumption patterns that may follow an exogenous increase in SNAP benefits.

This paper analyses the impact of the ARRA on diets of low-income individuals using 2007–2010 data from the National Health and Nutrition Examination Survey. Cross-sectional data on the diets of individuals in SNAP-eligible and SNAP-ineligible low-income households pre- and post ARRA allow us to estimate difference-in-difference models of the effects of SNAP changes in the ARRA. In addition to identifying the impact of the ARRA on the diets of millions of low-income Americans, our study also examines whether this effect varies across the dietary intake and quality distributions.

Background

Under federal rules, households with gross monthly incomes less than 130% of the federal poverty threshold (FPL) and net income under the FPL are eligible to receive SNAP benefits. The maximum SNAP allotment for eligible households is based on the Thrifty Food Plan (TFP), a guide for a low-cost meal plan that also aims to be nutritionally adequate. While the 2006 TFP does allow the purchase of some prepared foods, the market basket emphasizes home food production. SNAP benefits may not be used on ready-to-eat hot meals or in restaurants. In 2013, the average monthly SNAP benefit was approximately $275 per household (USDA, 2014a).

Studies have suggested that the TFP may be insufficient for providing a nutritionally adequate diet and may assume that more time is spent in home food preparation than the data indicates (Rose, 2007; Mancino and Newman, 2007, Davis and You, 2010). Concerns have also been expressed that the TFP may be difficult to afford and implement in low-income food environments characterized by corner stores and smaller groceries (Neault et al., 2005). More generally, studies report that healthy eating costs more (e.g. Townsend et al., 2009). Weighing in on the issue of SNAP allotment size, the Institute of Medicine has recommended that any assessment of the adequacy of the SNAP allotment should include the evaluation of the program's impact on food security and access to a healthy diet (Committee for the Examination of the Adequacy of Food Resources and SNAP Allotments, IOM, 2012).

The 2009 ARRA SNAP provisions (effective April 2009) provide a unique opportunity to assess how higher SNAP benefits may improve the food intake and diet quality of program participants. As part of the ARRA, SNAP benefits were increased by a constant dollar amount according to household size. This increase is equivalent to a 13.6% increase in the maximum allotment for that household size, with proportionally greater increases for families receiving less than the maximum allotment. Also, the 3 month time limits on program participation by jobless, working-age adults with no children was relaxed. In 2009, the average monthly SNAP benefit was $125 per person, up nearly 22.6% from $102 in 2008 (USDA, 2014b).

These ARRA expansions in SNAP were reported to increase the food security and food expenditures of program participants (Nord and Prell, 2011b). Specifically, between 2008 and 2009, food insecurity was estimated to decrease by 2.2 percentage points from 25.03% in 2008 for low-income households (SNAP-eligible). Very low food security was estimated to decrease by 2 percentage points from 11.27% in 2008.[2] In addition, average food spending increased in these households by 2.2% as a result of the ARRA expansion in benefits. However, it is unclear whether the improved food security and increased food spending translate into improved diet quality.

Prior studies show that SNAP participation is consistently associated with increased expenditure on food (Fraker, 1990) but its association with diet quality or nutrient intake varies across studies and types of nutrients (e.g. Butler and Raymond, 1996; Rose et al., 1998; Wilde et al., 1999; Gleason et al., 2000; Leung et al., 2012). A recent study by Castner and Mabil (2010) reports that higher food expenditures among SNAP participants are associated with an improved overall diet quality with higher fruit and vegetable intake though also with a lower whole grain intake and an increase in calories from SoFAAS (solid fats, alcohol and added sugars). While this suggests that increasing SNAP benefits may improve dietary intake of program participants, this study is cross-sectional and like most prior research on program effects, does not control for self-selection into SNAP. Little is known about the causal effect of SNAP benefit expansions under ARRA on food intake and diet quality of SNAP recipients.

More generally, epidemiological studies show that higher socioeconomic status (SES) is associated with better diet quality and lower dietary energy density (Kant and Graubard, 2007; Darmon and Drewnowski, 2008). Higher SES is linked to greater consumption of whole grains, lean meats, fish, fruits and vegetables while low-SES groups show higher consumption of fatty meats, refined grains, added fats, sugars and sweetened beverages (e.g. Cronin et al., 1982; La Vecchia et al., 1992; Shimakawa et al., 1994; van Rossum et al., 2000). Consistent with these socioeconomic differences in food types consumed, higher SES groups also have a greater intake of vitamins, minerals, and fiber than low-SES groups. Fat intake was also significantly associated with SES with more total fat and saturated fat intake among lower SES groups; however these differences were small in magnitude (Lopez-Azpiazu et al., 2003). SES is not significantly or consistently related to macronutrient intake including proteins, carbohydrates, or sucrose (Galobardes et al., 2001; Bolton-Smith et al.,

[2]Food security status is based on responses to a series of questions in the Food Security Survey of the Current Population Survey that indicate whether households are having difficulty meeting basic food needs including being unable to afford balanced meals, cutting the size of meals because of too little money for food, or being hungry because of too little money for food. Food security status is determined by the number of food insecure conditions the household reports.

1991). Similarly, the relationship between SES and total energy intake is not consistent (La Vecchia et al., 1992; Roos et al, 1996; Hulshof et al., 2003; van Rossum et al., 2000). Finally, a recent study of trends in overall dietary quality indicated that diet quality was consistently higher among high SES groups relative to low SES, and the quality gap widened over time from 1999–2000 to 2009–2010 (Wang et al., 2014). These associations of diet quality and SES suggest that the inome effects from the SNAP benefit expansions may result in improved diet quality for program recipients.

Data

We analyze data from the 2007–2008 and 2009–2010 National Health and Nutrition Examination Surveys (NHANES). The NHANES is an ongoing cross-sectional survey of the civilian non-institutionalized U.S. population which combines household interviews with standardized physical examinations. [3] The survey examines a nationally-representative sample of individuals residing in counties across the country. It includes demographic, socioeconomic, dietary, and health-related questions designed to assess the health and nutritional status of adults and children in the United States, and a physical examination and testing component administered by trained medical personnel in a mobile examination center (MEC).

All NHANES respondents are eligible for two 24-hour dietary recall interviews. The first dietary recall interview is collected in-person in the MEC and the second interview is collected by telephone 3 to 10 days later. The dietary interview data contain information about each food eaten by a respondent during the previous 24-hour period (interview day of week, name and time of day of eating occasion, food code, food source, whether food was eaten at home or not, amount eaten in grams, and amounts of energy and 62 nutrients/food components) as well as daily aggregates of energy and nutrients/food components and information about water intake. For these latter data, USDA’s Food and Nutrient Database for Dietary Studies (FNDDS) is used to code individual foods and portion sizes reported by survey participants and to calculate nutrient intakes.

Dependent Variables:

We analyze diet quality using the 2005 Healthy Eating Index (HEI-2005) (Guenther et al., 2008). The HEI-2005 is a summary measure of overall diet quality with 12 components that compare reported dietary intake with recommendations in the 2005 Dietary Guidelines for America (USDA, 2007). We generate the index by applying publicly available algorithms to two days of NHANES’ dietary recall data (USDA, 2012). Specifically, the dietary recall data are linked to the MyPyramid Equivalents Database (MPED) which calculates the dietary constituents of each food to facilitate comparisons with dietary guidance reflected in MyPyramid. [4] Scores for the HEI-2005 and its components are then created by dividing the

[3]More information about the NHANES data is available at http://www.cdc.gov/nchs/nhanes.htm (accessed March 4, 2014). The unweighted response rates for NHANES interviews were 78% in 207–2008 and 79% in 2009–2010.

[4]For example, the MPED separates whole milk into the skim milk fraction and the solid fat fraction (see Guenther et al., 2008 and Reedy et al., 2010 for a full description of the calculation and application of the HEI-2005).

amount of each dietary constituent by total energy intake and comparing the ratio to standards that reflect the prevailing dietary guidance.

Of the 12 HEI-2005 components, 9 assess intake of total fruit; whole fruit; total vegetables; dark green vegetables, orange vegetables, and legumes; total grains; whole grains; milk; meats and beans; and oils. The 3 remaining components assess intake of saturated fats, sodium, and calories for solid fats, alcohol, and added sugars (SoFAAS), greater consumption of which is discouraged.[5] HEI-2005 and component scores are calculated per 1000 calories to reflect the view that dietary recommendations should be met while maintaining energy balance (rather than by just eating large amounts of food).

In this study, we focus on overall HEI-2005 scores and the SoFAAS component of the HEI-2005 to measure diet quality. The score for the overall HEI-2005 ranges from 0 to 100 and for the SoFAAS component, from 0 to 20, with higher scores indicating improved diets. Thus, a higher score on the overall HEI-2005 implies an improved overall diet quality, while higher scores on the SoFAAS component indicate a healthier diet with lower consumption of these discretionary calories. The HEI-2005 has been widely used in studies of diet quality (e.g. Beydoun et al. 2008, Mancino et al. 2009, Grimstvedt et al 2010, Todd et al 2010, Blake et al. 2011, Leung et al. 2012, Hanson and Olson 2013, and Gregory et al. 2013).

Note that the HEI was updated in 2010 to reflect revisions in federal dietary guidelines (USDHHS, 2010). While the revised HEI-2010 may be a better measure of dietary quality[6], we use the HEI-2005 in our analysis because it reflects the dietary guidance available at the time of the ARRA. In addition to the HEI-2005, we analyze separate models for the effect of increased SNAP benefits on total daily energy intake, fruit and vegetable consumption[7], and sugar- sweetened beverages (SSB)[8]. We also examine the intake of selected micronutrients (fiber, vitamins C & D, sodium) and macronutrients (protein, carbohydrates, total fat and saturated fat). The Dietary Guidelines recommend increasing the intake of fiber and vitamin D while reducing intake of total fats, saturated fat, and sodium. We also analyze vitamin C intake as another indicator of fruit and vegetable consumption. Finally, while inadequate protein or carbohydrate intake is not an issue in American diets, we chose to include them in our analyses because of the increasing popularity of high-protein, and low-carbohydrate diets as weight-loss strategies.

Because our objective is to estimate the average (mean) treatment effect of SNAP on dietary intake, we follow prior analyses (Todd et al., 2010; USDA, 2012) and analyze intake using the average of two days of dietary recall data collected for each respondent. Although Tooze et al. (2010, p. 2858) argue that the average of two recalls is not the best way to estimate the

[5]Note that while SNAP dollars cannot be used to purchase alcohol, for those SNAP recipients whose food expenditures are greater than their SNAP benefit, an increase in SNAP benefit can free up out-of-pocket money previously spent on food items to be spent on other non-food or non-allowed items including alcohol.

[6]Relative to the 2005 version, the HEI-2010 emphasizes more consumption of dark green vegetables and legumes and protein from plants and seafood over meat and poultry sources, while discouraging intake of refined grains and saturated fats.

[7]We calculate the total number of fruit and vegetable cup equivalents (excluding legumes) using the MPED database, but we exclude white potatoes from our analysis.

[8]This category includes soft drinks, carbonated; fruit drinks; non-fruit beverages (incl. energy drinks); nonalcoholic beers, wines, cocktails; beverage concentrates, dry not reconstituted; and presweetened iced tea from frozen concentrate or powdered mix. Beverages are also restricted to those with at least 50 kcal per 8 ounces.

distribution of dietary intake, they also argue that …"the mean of the distribution of individual means provides an unbiased estimate of mean usual intake." Also, although an alternative to analyzing the average of two recalls would be to model the them separately with random individual intercepts, there is a possibility that the random intercepts might be correlated with observed covariates or that the distribution of the random intercepts may not be normal as assumed, which renders estimates from random effects models inconsistent (Wooldridge, 2010).

Sample Selection:

According to federal rules, families with gross monthly incomes under 130% of the federal poverty threshold (FPL) are eligible to receive SNAP benefits if their net incomes are also under the FPL and they meet certain asset tests.[9] In this study, we identify SNAP-eligible respondents as those with gross household income less than 150% of the federal poverty threshold for that household size.[10] While this is higher than the federal criterion of 130% of the FPL, we adopt this higher threshold to account for possible imprecision in the household income data and also because of the argument that if the elasticity of labor supply is not zero, the sample of "eligible" persons should be larger than the sample who qualify for benefits (Ashenfelter, 1983; Newman, 2006). In addition, many states have adopted broad-based categorical eligibility rules to expand eligibility to households with incomes higher than 130% of the FPL. [11] Finally, we also define SNAP eligibles to include those with incomes higher than the 150% threshold who report current receipt of SNAP benefits.[12]

Our sample includes SNAP-eligible NHANES respondents who had two days of dietary recall data recorded between the official start of the recession in October 2007 and December 2010. Since youth have access to food from school meal programs, we focus our analysis on those aged 18 and over, yielding a sample of 2,844 adult eligibles.

Estimating Framework

Analyses of the causal effects of SNAP on diet are complicated by the well-known problem that SNAP participants self-select into the program based on unobservable characteristics that may also be correlated with their diet quality. If, for example, SNAP participants are more (less) health-conscious than non-participants even in the absence of SNAP, simple estimates of the relationship between SNAP participation and diet quality would

[9]Note that households with elderly or disabled members are not subject to gross income limits.

[10]Since the NHANES does not provide enough information to measure net income, or assets, we follow the literature (eg. Todd and Ver Ploeg, 2014; Kreider et al., 2012; Nord and Prell, 2011) and use the gross income criterion to define eligible households. Therefore, our classification of SNAP eligibility is subject to measurement error. However, such error is unlikely to be large. In 2010, 85% of all gross-income-eligible households were also eligible under net income criteria with even higher rates for households with children(Rosenbaum et al., 2013).

[11]Note that starting in 2000, states have increasingly adopted broad-based categorical eligibility (BCE) rules to expand program access to households, often with gross incomes as high as 200% of the poverty threshold. We do not use these BCE rules to define SNAP eligibility because few of those rendered financially eligible under these relaxed gross income thresholds actually receive SNAP benefits because their net incomes are higher than the FPL. For example, the Congressional Budget Office estimated that on average, 1.8 million people annually would lose access to benefits if BCE was restricted (CBO, 2012), a small percentage of the 46 million receiving benefits in 2012..

[12]SNAP data in the recent NHANES are collected at the household level. Information includes whether anyone in the household ever received SNAP benefits; benefit receipt in the past 12 months; and time since last received benefits within the past 12 months. We define SNAP recipients as those reporting benefit receipt during the 30 days prior to the interview in order to ensure that program participation information roughly corresponds to the period covered by the dietary recall interviews.

overestimate (underestimate) the causal relationship. The ARRA-changes to SNAP provide a "natural experiment" whereby pre-post ARRA changes in diet quality can be linked to an exogenous increase in SNAP benefits that, controlling for household size, is unrelated to any unobserved characteristics that may also alter diet quality. However, other changes between the pre- and post-ARRA periods could also impact diet quality independently of the stimulus. For example, food prices were extremely volatile during this period with large increases during the early part of the recession, followed by a decline in 2009. From December 2008 to December 2009, the cost of the Thrifty Food Plan (TFP) declined by 3.5 to 4.0 percent and prices for a broader set of foods also declined. At the same time, prices for non-food items rose by 1.8% resulting in a large drop in the relative price of food (Nord and Prell, 2011b). To control for changes in these non-ARRA related factors, we could compare pre-post ARRA changes in the diet quality of SNAP participants to those of a control group of income-eligible non-participants using a standard difference-in-difference model. However, a potential complication to the above scenario necessitates a slightly different comparison.

Specifically, as detailed by Nord and Prell (2011b), the ARRA may induce changes in the composition of SNAP participants. This is because the increased benefits and relaxed eligibility rules for some may induce post-ARRA participation among those who may have been program- eligible prior to the ARRA but chose not to participate because the time and other costs of applying were greater than the expected benefits of participation. In addition, the Great Recession has also created an influx of new SNAP participants due to under- or unemployment. These induced post-ARRA SNAP participants may be less food-needy and otherwise systematically different in their consumption patterns from pre-ARRA participants. In addition, those who stayed out of the program even when the benefits were increased may also be better off than those non-participants prior to the ARRA. These composition changes in SNAP participant and non-participant groups make it difficult to estimate effects of the benefit increase or even to gauge the direction of bias in any estimated effects.

Following the approach of Nord and Prell (2011b), we estimate difference-in-difference (DD) models comparing differences in pre-post ARRA diets *for SNAP-eligible* respondents (rather than participants) compared to those for *ineligible* respondents (rather than non-participants) with incomes just greater than 150% but less than 250% of the federal poverty threshold. This group has been used as a comparison for SNAP-eligibles in recent studies (eg. Todd and Ver Ploeg, 2014; Condon et al., 2015) and have been treated as "nearly SNAP-eligible households" by Nord and Prell (2011b).[13] While respondents in this income range are likely to be more economically secure than those who are eligible, many are still considered low-income for public health insurance programs. For example, 250% FPL is used to define Medicaid and Children's Health Insurance Program eligibility in 13 states (Kenney and Pelletier, 2009) while another 11 states have higher limits of at least 300% FPL

[13]Nord and Prell (2011b), in their analysis of the ARRA effects on food expenditures, define "nearly SNAP eligible households [ ] as those with incomes from 150 percent to 250 percent of the poverty line". Similarly, a recent study by Todd and Ver Ploeg (2014) on the utility of beverage restrictions on SNAP participants uses the 250% PIR threshold to define the low-income sample. Finally, a recent USDA study on the diet quality of Americans by SNAP participation status also used those with incomes between 130% FPL and 300% FPL as a comparison group for SNAP-eligibles (Condon et al., 2015).

for these programs. At the same time, respondents with incomes in the 150%−250% FPL range are unlikely to receive SNAP benefits even in states with broad-based categorical eligibility (see footnote 11). Since a large percentage of SNAP-eligible households do not participate in SNAP, the DD approach will underestimate the effect of the increase in benefits on SNAP participants but is a valid intent-to-treat effect. In equation (1) below,

$$E(\text{Diet Quality}_i) = f(\alpha + \beta X_i + \gamma ARRA_i + \delta ELIG_i + \theta ARRA * ELIG_i) \quad (1)$$

Here ARRA is an indicator for dietary recall data collected from April 1, 2009 onward and ELIG identifies those who are eligible for SNAP.[14] Assuming that changes in diet quality would be similar for both program eligibles and ineligibles in the absence of SNAP changes due to the ARRA (ie. parallel trends in the pre-ARRA period), the difference-in-difference, θ, estimates the effect of the ARRA-related SNAP changes on average diet quality. Note that these estimates will incorporate changes in mean diet quality due to both higher SNAP benefits and expanded participation in SNAP as a result of the ARRA. Our analysis also controls for respondent characteristics X_i such as age, gender, education, employment status, and race/ethnicity, in addition to household-level covariates including the ratio of household income to the federal poverty threshold, household size, family structure (presence of a spouse or partner in the household), and fixed effects for calendar quarter. State dummies control for regional differences in food tastes and preferences that may be correlated with diet outcomes.

To further minimize the effect of compositional changes in SNAP participants, we also estimate the effects of SNAP expansion among those with a high school or lower education. If the less-educated group of low-income individuals faces a tighter food budget and is therefore more likely to enroll in SNAP even at the pre-ARRA benefit levels than those with higher education, the DD estimates for this group should more closely approximate the effect of higher SNAP benefits on dietary outcomes separate from any compositional changes due to expanded participation in the program.

We test the DD assumption of parallel trends by estimating a second model of diet quality and interacting quarter dummies with an indicator for SNAP eligibility. Specifically, we estimate the following:

$$E(\text{Diet Quality}_i) = f(a + bX_i + c\,ELIG_i + \sum\nolimits^{13}{}_{j=2} d_j Q_{ji} + \sum\nolimits^{13}{}_{j=2} f_j Q_{ji} * ELIG_i) \quad (2)$$

In equation (2), Q_{ji} are 12 dummy variables indicating the quarter of the sample period from October 2007 to December 2010 in which the dietary recall data was recorded. The coefficients d_j represents the change in dietary outcome by quarter while f_j represents differences in this trajectory between SNAP-eligibles and near-eligibles. A joint test of these differences in the pre- ARRA period, $\sum^{6}{}_{j=2} f_j = 0$, will indicate the validity of the parallel trend assumption underlying the DD model.

[14]Dates of the dietary recall interviews and state identifiers are extracted from restricted data files in the NHANES.

The statistical distributions of diet quality and intake can be quite skewed in some instances because a large number of people may have very low or zero intakes and a few may have high levels of intake. While OLS regressions are unbiased, tests of the hypotheses of interest can be considerably underpowered when the outcomes are substantially skewed. Therefore, we use Stata to estimate generalized linear models (GLM) based on gamma distributions which are known to accommodate a variety of skewed distribution shapes to obtain more efficient results.[15]

Our final sample including both SNAP eligible and near-eligibles consists of 4,158 NHANES respondents. All estimates are weighted using the 2-day dietary recall weight in the NHANES, thus making our estimates nationally representative, and standard errors reflect the complex design of the NHANES survey. In addition to GLM analyses of the conditional mean, we also estimate quantile regressions to minimize the effect of outliers and allow for heterogeneous responses to the ARRA at different points in the intake distribution.

Results

Table 1 presents characteristics of those over 18 years of age in SNAP-eligible and nearly-eligible households, in pre- and post-ARRA time periods. More than a third of those in SNAP-eligible households report participation in SNAP over the past 30 days and these rates increase from 34% pre-ARRA to 39% in the post-ARRA period.[16] In spite of restricting the sample to those with incomes under 250% FPL, significant pre-ARRA differences in race/ethnicity, education and family structure remain between near-eligible and eligible respondents. Respondents in SNAP-eligible households are significantly less likely to be white compared to those in ineligible households; approximately 52% of SNAP-eligible respondents are non-Hispanic black, Hispanic or from other races compared to 30% of those in near-eligible households. Compared to those who are ineligible for SNAP, pre-ARRA SNAP-eligible respondents appear significantly less likely to have education greater than high school (27% versus 52% for near-eligibles), and significantly more likely to be single (52% versus 41%). Notably, the education profile of SNAP-eligible respondents indicates a more educated group post-ARRA compared to pre-ARRA - 40% report college experience post-ARRA, a significantly higher rate than the 27% pre-ARRA. There are no other significant pre- versus post-ARRA differences in the composition of SNAP-eligible respondents.

Table 2a presents means of pre- and post-ARRA dietary intake and quality by SNAP eligibility status, while Table 2b presents selected measures at different points in the sample distribution. There are few differences in dietary intake between SNAP-eligible and ineligible respondents. Average pre-ARRA daily energy intake is 1,990 calories for program

[15]Some sources (e.g. NCHS 2014) recommend a Box-Cox transformation to account for skewness in measures of diet quality. We instead account for skewness by using GLM models that have superior robustness properties (McCullagh and Nelder, 1989) and predictions after GLM models do not have issues of retransformation that are ubiquitous in Box-Cox models (Blough, Madden, and Hornbrook 1999; Manning, Basu and Mullahy 2005).

[16]Although also not reported, past-year SNAP participation in our sample is 43%, consistent with other evidence that 30-day SNAP participation is underreported in the NHANES to a greater extent that past-year participation (Castner and Mabil, 2010). Note that our focus on eligible households sidesteps the issue of underreporting of SNAP participation.

eligible respondents, statistically similar to the 2,034 calorie intake reported by SNAP-ineligible respondents.[17] Pre-ARRA saturated fat intake is significantly higher among SNAP-ineligible respondents but accounts for approximately 1/3 of total fat intake for both program eligible and ineligibles, in line with the overall population (USDA & USDHHS, 2010). Total fat intake is approximately 36% of total energy intake for both groups, on the high end of the 20–35% caloric share recommended in the dietary guidelines.[18] Consistent with the findings in the US population overall, sodium intake for both groups is well above the upper limit of 2,300 mg a day in the dietary guidelines (USDA & USDHHS, 2010).

Relative to those eligible for SNAP, fiber intake and consumption of fruit and vegetables is not significantly different from those who are SNAP-ineligible. Program eligibles consume 1.85 cups of fruit and vegetables pre-ARRA, a fifth cup less than those ineligible for the program, a statistically insignificant difference. At the same time, pre-ARRA SSB consumption for SNAP-eligible respondents is 178 calories per day, significantly higher than 131 calorie consumption of those ineligible for SNAP.

These mean intakes mask a large variation in consumption and dietary quality. As Table 2b shows, a quarter of the overall sample reports consumption of over 218 SSB calories while a quarter of the sample records no SSB consumption and half of the sample reports fewer than 74 SSB calories consumed per day.Similarly, a quarter of the sample reports less than a cup of fruit and vegetable consumption while another quarter reports three times as much of such consumption.

Unsurprisingly, given the similarity of pre-ARRA dietary intake between SNAP-eligible and ineligible respondents, scores on the HEI 2005 show that on average, the pre-ARRA overall diet quality of eligible respondents is not significantly different from that for ineligibles (53.9 versus 54.9). Both groups achieve just over half of the maximum score for overall dietary quality indicating substantial room for improvement. Similarly, SoFAAS scores of 10.1 and 10.5 for SNAP eligible and near-eligibles respectively suggest that consumption of empty calories from solid fats and added sugars is well over the limit of 20% of energy intake associated with the maximum score of 20 for this component.[19]

Tables 3, 4, and 5 report estimates from DD models of intake for the sample of individuals older than 18 years of age. Since micro- and macronutrient intake is likely to increase with higher calorie diets, we also estimate models that control for total energy intake to highlight changes in nutrient density or caloric share. We present these energy-adjusted estimates in the lower half of the tables indicating ARRA associations with the share of calories consumed in the different categories. Note that the HEI and SoFAAS component scores are already energy- adjusted, therefore these latter models will indicate how diet quality varies with total energy intake.

[17]Estimates of average energy requirements range from 1,600 to 2,400 calories per day for adult women and 2,000 to 3,000 calories per day for adult men, depending on age and physical activity level (USDA & USDHHS, 2010).
[18]This calculation assumes there are 9 calories in a fat gram.
[19]SoFAAS refers to the 12th component of the HEI-2005.

Models adjusting for differences in socioeconomic and regional characteristics indicate that SNAP-eligibles prior to the ARRA are not significantly different in total energy intake from those ineligible for the program. Models controlling for total energy intake (in logarithms) reveal that pre-ARRA, SNAP-eligibles consume a significantly larger share of total calories from SSBs and also have lower intake of vitamin D, but are not different from ineligible respondents in overall diet quality, consumption of fruits and vegetables, and intake of other micro- and macronutrients examined in Tables 3 to 5. Perhaps reflecting the decline in food prices in 2009 (Nord and Prell, 2011b) and provisions of the ARRA, results from Tables 3 to 5 show that the post-ARRA period is associated with a significant increase in total energy intake. Controlling for this increase, the post-ARRA period is also linked to a higher relative intake of fiber, sodium, and fruits and vegetables, and a significant reduction in the share of calories from SSBs.[20]

DD estimates in Table 3 indicate that the ARRA-related SNAP changes (henceforth referred to as "SNAP expansions") have an insignificant effect on daily energy intake as well as consumption of fruits and vegetables (both in absolute amounts and as a share of total energy intake). Models that control for daily energy intake indicate a 17.4% increase in SSB calories associated with SNAP expansions though this effect falls short of standard levels of statistical significance ($p=0.13$).[21] HEI scores indicate that the SNAP expansion results in a significant 4% reduction in overall diet quality but no significant change in the HEI component related to the consumption of empty SoFAAS calories. Results from the test of the parallel trends assumption indicate that, given the pre-ARRA trends, a casual interpretation of DD estimates is valid for all the outcomes studied in Table 3.

Results in Tables 4 and 5 suggest that the SNAP expansion has no significant effect on the intake of fiber, sodium, vitamin C, carbohydrates, protein or total fat (both in absolute amounts and caloric shares), but resulted in a significant 5% increase in the share of calories from saturated fats. While the DD coefficients are positive and significant in models of vitamin D intake both in absolute levels and in share models (Table 4), the parallel-trends assumption is rejected in these models suggesting that the DD estimates may not indicate the effect of the SNAP expansions but may instead reflect pre-existing differences in vitamin D intake trends between SNAP eligibles and ineligibles prior to the passage of the SNAP changes.

The above results suggest that the SNAP expansion resulting from the ARRA had a negative effect on mean diet quality as measured by the HEI, but no other significant effects on mean intake of selected micro- and macronutrients and food types except for saturated fats. However, as the descriptive statistics in Table 2b indicate, the intake and diet quality distributions are skewed so that effects measured at the mean may not accurately represent changes at the upper or lower ends of the intake distribution.

[20]Among other results not presented here, overall diet quality has a significant, negative relationship with total energy intake. Similarly, the consumption of discretionary SoFAAS calories also increases with high calorie diets suggesting that such diets may generally be less healthy. A full set of results can be provided upon request.

[21]The percentage change is calculated as $\exp(\beta) - 1$.

Table 6 presents quantile regression estimates of the effects of SNAP expansions on dietary intake and quality at the median, 25th, and 75th percentiles of the intake distributions. Results show a more nuanced portrait of changes across the intake distributions. Controlling for total energy intake and contrary to expectations, the SNAP expansion is associated with a significant decrease in fruit and vegetable consumption by approximately 0.2 cups at the 25th percentile, equivalent to almost 22% decrease in at this level of consumption (relative to consumption at the 25th percentile as reported in Table 2b of 0.93 cups). At the same time, those reporting higher levels of fruit and vegetable intake in the upper half of the distribution appear to be unaffected by the SNAP expansion. Similarly, the decrease in mean diet quality reported in Table 3 appears to be driven by reductions among those with poor quality diets to begin with. Thus, the HEI scores are 4.4 points lower at the 25th percentile (equivalent to approximately 10% decline relative to the 25th percentile in Table 2b), and SoFAAS component scores are 1.4 points lower for those at the 25th percentile (equivalent to a 25% reduction). These changes suggest that the SNAP benefit increases due to ARRA are associated with higher consumption of empty calories among those who are already consuming greater than recommended amounts of such food. Finally, controlling for total daily energy intake, the SNAP expansion is linked to significantly higher share of saturated fat intake for those at both ends of the intake distribution.

Compositional Changes:

Recall that the DD estimates in Tables 3 to 6 indicate the combined change in diet quality or intake as a result of both the ARRA-related increase in SNAP benefits and potential post-ARRA changes in the composition of SNAP participants. As Table 2a indicates, the education profile of SNAP-eligible respondents shifted significantly in the post- ARRA period toward those with at least some college experience. To the extent that this more-educated pool may be less food-needy or have other unobserved differences in their dietary habits compared to longer-term program participants, the estimates in Tables 3 to 5 may not represent the true effect of the SNAP expansions on pre-ARRA program participants.

Wee attempt to control for these compositional changes by examining the impact of SNAP expansions for those with high school or lower education who may be more likely to be longer-term SNAP participants. We estimate these effects by interacting the SNAP, ARRA, and ARRA*SNAP variables in (1) with two indicators for education level (high school and lower versus more than high school). Coefficients for the less educated group should more closely reflect the effect of higher SNAP benefits on dietary outcomes, separate from any compositional changes.

Table 7 presents estimates of the triple interaction between SNAP, ARRA, and the low education indicator. In addition, Table 7 also repeats the SNAP-ARRA interactions from Tables 3–5 for comparison. Results suggest that among those with a high school education or lower, the increased SNAP benefits due to the ARRA may significantly increase the share of total energy intake from SSBs by 46%. While the full sample results indicate a significant 4% reduction in mean HEI-2005 scores, there are no significant changes in HEI for those with less education.

Table 8 presents estimates of the triple interaction between SNAP, ARRA, and the low education indicator from quantile regressions with and without controls for daily energy intake. Results link the SNAP expansions to significant 33.8 calorie increase in median SSB consumption (equivalent to almost a 50% increase at the median SSB intake of 74 calories) and a 22 calorie increase in SSB intake at the 75th percentile, but this change was not statistically significant. Controlling for daily energy intake, SNAP expansions are linked to significant increases in saturated fat consumption at either end of the intake distribution for the less educated. At the same time, higher benefits have no significant effects on the consumption of fruits and vegetables among the less educated sample. In contrast to the insignificant effects on mean dietary quality among the less educated in Table 7, Table 8 shows that, among this group, the SNAP benefit expansions are associated with a significant 4.03 point reduction in overall diet quality for those at the 25th percentile of the diet quality distribute, a 9% decline (relative to the 25th percentile of HEI as reported in Table 2b). For those with less education, Table 8 also shows a significant 1.9 point reduction in the 25th percentile of the SoFAAS component of the HEI-2005, equivalent to a 34% reduction (relative to the 25th percentile of SoFAAS scores in Table 2b). Thus, the SNAP benefit expansions appear to have reduced both overall diet quality and increasedconsumption of empty calories among those with low HEI and SoFAAS scores at the 25th percentile (ie those already consuming poor quality diets). [22]

Regional Composition:

A complication with the DD strategy presented above relates to the NHANES data collection schedule in which Mobile Examination Centers visit different regions of the country in different times of the year. Consequently, no dietary recall data is recorded from the Midwest region in the analysis period prior to the passage of the ARRA from October 2007 to the end of March 2009. We check the robustness of the GLM results to this pre-ARRA regional exclusion by re-estimating models including only the northeast, west, and southern regions in the analysis. Results from this smaller sample of 3,415 cases are presented in Table 9. and indicate no substantive changes compared to results from the full sample. Analysis of caloric share for those over 18 years show similar, insignificant changes in most of the dietary outcomes associated with the ARRA as were presented for the full sample. These results give us reasonable confidence that the DD estimates are not affected by the data collection schedule of the NHANES.

Conclusion

The 2009 ARRA increased SNAP benefits by an average of 17% per person and relaxed eligibility rules for participation in the SNAP program (Nord and Prell, 2011a). Recent studies have identified improvements in food security and increases in food expenditures among low- income households due to these SNAP expansions in the ARRA (Nord and Prell, 2011b). In this study, we find that these increases may not translate into consistent

[22]Tables 7 and 8 are estimated using 4,151 respondents over 18 years with valid information on educational attainment. Results are similar when we restrict the sample to 2,669 cases with high school or lower educationexcept for smaller, less significant 21% increase ($p<0.10$) in mean SSB consumption, and a larger, more significant 46 calorie increase in SSB intake at the 75th percentile (equivalent to 21% of the 75th percentile intake).

improvements in nutrient intake and diet quality. Instead, the SNAP expansions from the ARRA may have simply encouraged pre-existing patterns of consumption, especially among those with poor dietary habits.

The ARRA-related SNAP expansions may affect dietary intake and quality via both higher SNAP benefits and expanded or induced participation in SNAP. To control for the compositional changes in SNAP participants, we focus on the effects of SNAP expansions among those who are less educated and potentially longer-term pre-ARRA program participants. Results suggest that the increased SNAP benefits increase the mean caloric share from SSBs and these changes are driven by those in the upper half of the SSB intake distribution. Among those with less education, higher SNAP benefits are related to lower overall diet quality and increased consumption of SoFAAS calories for those who already have a poor quality diet to begin with, with scores at the 25th percentile of the diet quality distributions.

The apparent lack of improvement in dietary quality following the SNAP benefit increase is not surprising given that prior SNAP studies do not indicate consistent relationships between program participation and diet quality or nutrient intake (eg. Gleason et al., 2000). There are several explanations for our findings. First, among SNAP households that spend more on food than their monthly SNAP allotment, the higher benefits free money previously spent on basic food consumption for spending on discretionary food and other non-food items. This could result in increased consumption of undesirable foods with positive income elasticities such as SSBs or at least a less than dollar-for-dollar increase in food expenditures (eg., Fraker, 1990; Hoynes and Schanzenbach, 2009). Second, as Mancino and Guthrie (2014) point out, SNAP households are less likely to be aware of the Dietary Guidelines or the Food Pyramid recommendations for a healthy diet. Moreover, SNAP households tend to shop less frequently and are more interested in purchasing foods that keep well, implying a lower consumption of perishable items such as fresh fruits and vegetables. Third, studies suggest that low-income families spend less time in food preparation than the SNAP benefit calculation assumes (Rose 2007, Mancino and Newman, 2007). Higher SNAP benefits may enable these time-constrained recipients to trade money for time and purchase more costly convenience foods of lower quality.

Finally, note that our results only pertain to the specific increase in SNAP benefits contained in the ARRA, and should not be interpreted to mean that any increase in SNAP benefits will fail to yield healthier diets. Instead, the SNAP expansions undertaken by the ARRA may not have been large enough or focused enough to change pre-existing dietary habits. Results from the Healthy Incentives Pilot program aimed at reducing prices and increasing consumption of fruits and vegetables suggest that targeted increases in SNAP benefits may be more effective (Klerman et al., 2014). Higher food budgets, on their own, may not be sufficient to change dietary habits and may need to be combined with nutrition education and structural improvements in food environments to improve dietary outcomes.

Our study results may also be affected by the lingering effects of induced SNAP participation in the post-ARRA period, even in the less educated sample. To the degree that these newer, induced enrollees are more or less health conscious, the effects of the SNAP changes may be over- or underestimated.[23] Since a large percentage of SNAP-eligible households do not participate in the program, our study's focus on SNAP-eligibles also means that our results may understate the effect of SNAP expansions on program participants. Measurement error in dietary recall data may also reduce overall significance of our estimates. While the two days of 24-hour dietary recall data in the NHANES should reflect average intake patterns, the data may be susceptible to underreporting, especially for overweight or obese respondents (Archer et al., 2013; Black and Cole, 2001; Subar et al., 2003). Longitudinal data on program participation and dietary intake would enable more precise estimates of the effect of increasing SNAP benefits on dietary outcomes of program participants.

In spite of these caveats, this study provides useful information for efforts aimed at improving the health and nutrition of SNAP participants. By exploiting a natural experiment provided by the ARRA, we address well known problems of self-selection into the program and estimate causal effects of the changes in the SNAP program due to the ARRA. Overall, the results suggest that the ARRA-related increase in SNAP benefits did not improve overall diet quality or nutrient intake of recipients.

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[23]To proxy for differences in health consciousness, we examined the number of fast food eating occasions in the past 7 days using data from the Flexible Consumer Behavior module of the NHANES. We found no significant differences betwee SNAP-eligible respondents, pre- and post-ARRA, suggesting that compositional changes due to the ARRA benefit expansion are less of an issue among the less educated SNAP eligibles. However, there may be other unobserved differences in health consciousness that we cannot fully account for.

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Table 1:

Mean Characteristics by SNAP Eligibility (n=4158)

Variable	SNAP Eligible (Income <=150% FPL[a])		Ineligible for SNAP (150–250% FPL)	
	Pre-ARRA	Post-ARRA	Pre-ARRA	Post-ARRA
Past 30-day SNAP	34%	39%	0	0
Male	42%	44%	46%	45%
Age				
Age 19–24 years	20%	20%	12%	10%
Age 25–34 years	20%	22%	19%	18%
Age 35–44 years	19%	19%	17%	20%
Age 45–54 years	17%	16%	15%	15%
Age 55–64 years	11%	10%	12%	12%
Age 65 years and older	15%$^{++}$	13%	25%$^{++}$	26%
Race/Ethnicity				
White	48%$^{+}$	51%	70%$^{+}$	66%
Non-Hispanic Black	15%	20%	9%	13%
Hispanic	32%	23%	17%	13%
Other Race	5%	7%	4%	7%
Education				
Less than High School/GED	46%*	35%*	22%	19%
High School/GED	27%	25%	26%	29%
Some College	21%* $^{++}$	28%*	38%$^{++}$	31%
College Graduate	6%* +++	12%*	14%* $^{+++}$	21%*
Missing Education	0.04%	0.4%	0.4%	0.2%
Employed	43%	45%	59%	59%
Marital Status				
Single	52%$^{+}$	50%	41%$^{+}$	39%
With Spouse/Partner	46%	48%	57%	59%
Missing Marital Status	3%	2.5%	1%	1.5%
Family Size	3.2	3.1	2.7	2.8
Income/FPL	0.92 $^{+++}$	0.92	2.01 $^{+++}$	2.01
n	2844		1314	

Weighted means. Sample comprised of respondents over 18 year with two days of dietary recall data recorded between October 2007 and December 2010 and household incomes < 250% FPL. The symbols ***(p<0.01), ** (p<0.05), and *(p<0.10) indicate the significance level of the difference, conditional on SNAP eligibility, between pre- and post-ARRA periods (based on a two-tailed t-test). The symbols + (p<0.10), ++ (p<0.05), +++ (p<0.01) indicate significance level of pre-ARRA differences between SNAP eligible and ineligibles.

[a]FPL=Federal Poverty Threshold

Source: NHANES 2007–2010.

Table 2a:

Mean Daily Consumption by SNAP Eligibility (n=4158)

Outcomes	SNAP Eligible (Income <=150% FPL[a])		Ineligible for SNAP (150–250% FPL)	
	Pre-ARRA	Post-ARRA	Pre-ARRA	Post-ARRA
Total Energy (calories)	1990	2050	2034	2072
Fat (% energy)	36%	36%	36%	36%
Saturated Fat (% energy)	11%$^{+}$	11%	12%$^{+}$	11%
Sodium (mg)	3213	3402	3310	3474
Protein (% energy)	16%	16%	16%	16%
Carbohydrates (% energy)	51%	51%	50%	50%
Fiber (gms)	14.7	15.5	15.5	16.8
Vitamin C (gms)	78.5	84.5	81.1	82.5
Vitamin D (mcg)	4.1**	4.9**	4.8	4.9
SSB calories	178^{++}	164	131^{++}	105
Fruit & Vegetable cups	1.85	2.07	2.05	2.33
BMI	29.3	29.5	28.6	28.7
Overall HEI-2005	53.9	53.5	54.9	56.6
SoFAAS (HEI-12)	10.1	10.3	10.5	11.3

Weighted means. Sample comprised of respondents over 18 years with two days of dietary recall data recorded between October 2007 and December 2010 and household incomes under 250% of FPL. SSB stands for sugar- sweetened beverages. HEI-2005 stands for the 2005 Healthy Eating Index. SoFAAS stands for solid fats, alcohol and added sugars.

The symbol ** ($p<0.05$) indicates the significance level of the difference, conditional on SNAP eligibility, between pre- and post-ARRA periods (based on a two-tailed t-test). The symbol ++ ($p<0.05$) indicates the significance level of the pre-ARRA difference between SNAP eligibles and ineligibles based on a two-tailed t-test.

[a]FPL=Federal Poverty Threshold

Source: NHANES 2007–2010

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Table 2b:

Intake and Diet Quality Percentiles (n=4,158)

	25th Percentile	**50th Percentile**	**75th Percentile**
Total calories	1442	1891	2425
SSB calories	0	74	214
Fruit-veg cups	0.93	1.72	2.75
HEI-2005	44.61	54.19	64.19
SoFAAS	5.56	10.57	15.50

Weighted percentiles. SSB stands for sugar- sweetened beverages. SoFAAS stands for solid fats, alcohol and added sugars.

Source: NHANES 2007–2010

Table 3:

DD Estimates of Changes in Food Intake and Diet Quality (n=4,158)

	Total Energy	SSB Calories	Fruit-Veg Cups	HEI 2005	SoFAAS
ARRA	0.12*** (0.03)	−0.50** (0.25)	0.31** (0.15)	0.04 (0.04)	0.07 (0.12)
SNAP-ELIG	−0.02 (0.03)	0.21 (0.14)	−0.03 (0.06)	0.006 (0.02)	−0.04 (0.07)
SNAP-ELIG*ARRA	−0.02 (0.03)	0.11 (0.12)	−0.07 (0.06)	−0.04** (0.02)	−0.06 (0.06)
Parallel Trends (p-value)	0.51	0.79	0.18	0.96	0.35
Controlling for Total Energy Intake					
ARRA	-	-0.59*** (0.22)	0.30** (0.15)	0.05 (0.04)	0.10 (0.13)
SNAP-ELIG	-	0.27** (0.12)	0.0005 (0.06)	0.006 (0.02)	−0.03 (0.06)
SNAP-ELIG*ARRA	-	0.16 (0.10)	−0.08(0.06)	−0.04** (0.02)	−0.06 (0.06)
Parallel Trends (p-value)	-	0.82	0.20	0.95	0.33

*** p<0.01

** p<0.05

* p<0.10 Standard errors are in parentheses.

Models also control for age, gender, education (high school/ged; some college; college grad; missing education), employment status, race/ethnicity, the ratio of household income to federal poverty threshold, household size, family structure (divorced/separated/widowed/never married, missing marital status), quarterly time trend, and state fixed effects. SSB stands for sugar- sweetened beverages. SoFAAS stands for solid fats, alcohol and added sugars. HEI-2005 stands for 2005 Healthy Eating Index. The percentage change is calculated as exp(β) – 1.

Source: NHANES 2007–2010

Table 4:

DD Estimates of Changes in Selected Micronutrient Intake (n=4,158)

	Total Calories	Fiber (gms)	Sodium (mg)	Vitamin C (mg)	Vitamin D (mcg)
ARRA	0.12 *** (0.03)	0.28 *** (0.09)	0.18 *** (0.03)	0.16 (0.13)	0.15 (0.18)
SNAP-ELIG	−0.02 (0.03)	−0.03 (0.04)	0.004 (0.03)	−0.03 (0.07)	−0.19 ** (0.08)
SNAP-ELIG *ARRA	−0.02 (0.03)	−0.05 (0.05)	−0.03 (0.04)	0.02 (0.08)	0.16* (0.09)
Parallel Trends (p-value)	0.51	0.15	0.70	0.97	0.09
Controlling for Total Energy Intake					
ARRA	-	0.21 ** (0.09)	0.09 *** (0.03)	0.19 (0.14)	−0.03 (0.17)
SNAP-ELIG	-	−0.02 (0.04)	0.02 (0.02)	−0.04 (0.07)	−0.20 ** (0.08)
SNAP-ELIG *ARRA	-	−0.04 (0.05)	−0.004 (0.03)	0.03 (0.07)	0.19 ** (0.08)
Parallel Trends (p-value)	-	0.29	0.75	0.73	0.03

Standard errors are in parentheses.

*** p<0.01

** p<0.05

* p<0.10

Models also control for age, gender, education (high school/ged; some college; college grad; missing education), employment status, race/ethnicity, the ratio of household income to federal poverty threshold, household size, family structure (divorced/separated/widowed/never married, missing marital status), quarterly time trend, and state fixed effects.

The percentage change is calculated as exp(β) – 1.

Source: NHANES 2007–2010

Table 5:

DD Estimates of Changes in Selected Macronutrient Intake (n=4,158)

	Total Calories	Protein (gms)	Carb (gms)	Total fats (gms)	Saturated Fats (gms)
ARRA	0.12*** (0.03)	0.10*** (0.03)	0.12*** (0.04)	0.11** (0.05)	0.15** (0.07)
SNAP-ELIG	−0.02 (0.03)	−0.04 (0.03)	0.001 (0.04)	−0.04 (0.04)	−0.08 (0.05)
SNAP-ELIG*ARRA	−0.02 (0.03)	−0.002 (0.03)	−0.01 (0.03)	−0.03 (0.04)	0.02 (0.05)
Parallel Trends (p-value)	0.51	0.91	0.42	0.35	0.50
Controlling for Total Energy Intake					
ARRA	-	−0.005 (0.03)	0.02 (0.02)	−0.02 (0.03)	−0.02 (0.05)
SNAP-ELIG	-	−0.02 (0.03)	0.02 (0.02)	−0.01 (0.02)	−0.04 (0.03)
SNAP-ELIG*ARRA	-	0.01 (0.02)	0.005 (0.02)	−0.01 (0.02)	0.05* (0.03)
Parallel Trends (p-value)	-	0.74	0.86	0.84	0.55

Standard errors are in parentheses.

*** p<0.01

** p<0.05

* p<0.10

Models also control for age, gender, education (high school/ged; some college; college grad; missing education), employment status, race/ethnicity, the ratio of household income to federal poverty threshold, household size, family structure (divorced/separated/widowed/never married, missing marital status), quarterly time trend, and state fixed effects.

The percentage change is calculated as exp(β) – 1.

Source: NHANES 2007–2010

Table 6:

DD Estimates from Quantile Regressions (n=4,158[1])

	Total Daily Kcal	SSB Calories	Fruit-Veg Cups	Saturated Fat (gms)	Sodium (mg)	HEI 2005	SoFAAS
25th pctile	−16.45 (48.15)	0.00 (3.51)	−0.23*** (0.08)	−1.36* (0.80)	−68.68 (97.41)	−4.12*** (1.00)	−1.30** (0.61)
Median	32.21 (52.65)	3.06 (9.13)	−0.30** (0.12)	0.38 (0.95)	119.39 (95.99)	−1.17 (1.11)	−0.59 (0.55)
75th pctile	−32.77 (62.26)	−19.03 (19.0)	−0.18 (0.14)	3.51*** (1.27)	−204.23 (140.10)	−1.29 (1.08)	0.005 (0.58)
Controlling for Total Energy Intake							
25th pctile	-	1.47 (3.51)	−0.20** (0.09)	1.52*** (0.56)	−74.88 (54.29)	−4.43*** (1.01)	−1.40** (0.55)
Median	-	7.06 (9.44)	−0.03 (0.11)	0.86 (0.57)	29.62 (63.05)	−0.89 (1.10)	−0.84* (0.49)
75th pctile	-	−5.67 (14.66)	−0.14 (0.12)	2.62*** (0.68)	17.60 (84.59)	−1.74* (1.03)	−0.18 (0.50)

Standard errors are in parentheses.

*** $p<0.01$

** $p<0.05$

* $p<0.10$

Weighted quantile regressions with robust standard in parentheses.

Models also control for age, gender, education (high school/ged; some college; college grad; missing education), employment status, race/ethnicity, the ratio of household income to federal poverty threshold, household size, family structure (divorced/separated/widowed/never married, missing marital status), quarterly time trend, and state fixed effects. SSB stands for sugar- sweetened beverages. SoFAAS stands for the solid fats, alcohol and added sugars component score of the HEI-2005. HEI-2005 stands for 2005 Healthy Eating Index.

Source: NHANES 2007–2010

Table 7:

DD Vs. DDD estimates (with Additional Interaction with Less Educated) (n=4,148)

	Total Energy	SSB Cal.	Fruit-Veg Cups	Saturated Fat (gms)	Sodium (mg)	HEI 2005	SoFAAS
All	−0.02 (0.03)	0.11 (0.12)	−0.07 (0.06)	0.02 (0.05)	−0.03 (0.04)	−0.04** (0.02)	−0.06 (0.06)
Parallel Trends (p-value)	0.51	0.79	0.18	0.50	0.70	0.96	0.35
Among Less Educated[1]	−0.05 (0.04)	0.28 (0.18)	0.03 (0.07)	−0.02 (0.06)	−0.03 (0.05)	−0.02 (0.03)	−0.08 (0.07)
Parallel Trends (p-value)	0.67	0.24	0.72	0.20	0.01	0.35	0.67
Controlling for Total Energy Intake							
All	-	0.16 (0.10)	−0.08 (0.06)	0.05* (0.03)	−0.004 (0.03)	−0.04** (0.02)	−0.06 (0.06)
Parallel Trends (p-value)		0.82	0.20	0.55	0.75	0.95	0.33
Among Less Educated	-	0.38** (0.16)	0.06 (0.07)	0.04 (0.04)	0.01 (0.03)	−0.02 (0.03)	−0.09 (0.07)
Parallel Trends (p-value)		0.24	0.80	0.69	0.00	0.31	0.59

Standard errors are in parentheses.

*** $p<0.01$

** $p<0.05$

* $p<0.10$

[1] Dummies for SNAP-eligibility, ARRA, and SNAP*ARRA are further interacted with education category (high school and lower vs. more than high school). The table reports the triple interaction between SNAP, ARRA, and low education.

Models also control for age, gender, education (high school/ged; some college; college grad; missing education), employment status, race/ethnicity, the ratio of household income to federal poverty threshold, household size, family structure (divorced/separated/widowed/never married, missing marital status), quarterly time trend, and state fixed effects. SSB stands for sugar- sweetened beverages. SoFAAS stands for the solid fats, alcohol and added sugars component score of the HEI-2005. HEI-2005 stands for 2005 Healthy Eating Index.

The percentage change is calculated as exp(β) – 1.

Source: NHANES 2007–2010

Table 8:

DD Estimates from Quantile Regressions (Additional Interaction with Less Educated) (n=4,151)

	Total Daily Kcal	SSB Calories	Fruit-Veg Cups	Saturated Fat (gms)	Sodium (mg)	HEI 2005	SoFAAS
25th pctile	−41.21 (64.97)	0.00 (4.24)	−0.19* (0.10)	−2.01** (0.97)	−73.61 (122.75)	−4.26*** (1.21)	−1.26* (0.73)
Median	3.77 (73.08)	25.72** (12.97)	−0.02 (0.15)	0.03 (1.20)	−72.73 (129.49)	1.37 (1.38)	−0.05 (0.67)
75th pctile	−197.97** (93.51)	20.70 (20.08)	0.12 (0.19)	1.79 (2.34)	−178.03 (199.51)	0.24 (1.41)	−0.22 (0.76)
Controlling for Total Energy Intake							
25th pctile	-	5.16 (5.28)	−0.11 (0.11)	1.13* (0.69)	−68.09 (86.51)	−4.03*** (1.30)	−1.86*** (0.64)
Median	-	33.79** (13.43)	0.24 (0.15)	1.33* (0.77)	−20.56 (89.32)	0.36 (1.28)	−0.41 (0.59)
75th pctile	-	22.33 (17.11)	0.26 (0.17)	2.16*** (0.84)	100.98 (118.19)	−0.81 (1.29)	−0.33 (0.72)

Standard errors are in parentheses.

*** p<0.01

** p<0.05

* p<0.10

Weighted quantile regressions with robust standard errors.

Dummies for SNAP-eligibility, ARRA, and SNAP*ARRA are further interacted with education category (high school and lower vs. more than high school). The table reports the triple interaction between SNAP, ARRA, and low education.

Models also control for age, gender, education (high school/ged; some college; college grad; missing education), employment status, race/ethnicity, the ratio of household income to federal poverty threshold, household size, family structure (divorced/separated/widowed/never married, missing marital status), quarterly time trend, and state fixed effects. SSB stands for sugar- sweetened beverages. SoFAAS stands for the solid fats, alcohol and added sugars component score of the HEI-2005. HEI-2005 stands for 2005 Healthy Eating Index.

The percentage change is calculated as exp(β) – 1.

Source: NHANES 2007–2010

Table 9:

DD Estimates Excluding Midwest Region – (n=3,415[1])

	Total Daily Kcal	SSB Calories	Fruit-Veg Cups	Saturated Fat (gms)	Sodium (mg)	HEI 2005	SoFAAS
Full	−0.02 (0.03)	0.11 (0.12)	−0.07 (0.06)	0.02 (0.05)	−0.03 (0.04)	−0.04** (0.02)	−0.06 (0.06)
Parallel Trends (p-value)	0.51	0.79	0.18	0.50	0.70	0.96	0.35
Excl. Midwest	0.007 (0.03)	0.02 (0.12)	−0.07 (0.07)	0.06 (0.05)	−0.001 (0.05)	−0.04** (0.02)	−0.05 (0.07)
Parallel Trends (p-value)	0.04	0.84	0.23	0.15	0.10	0.66	0.19
Controlling for Total Energy Intake							
Full	-	0.16 (0.10)	−0.08 (0.06)	0.05* (0.03)	−0.004 (0.03)	−0.04** (0.02)	−0.06 (0.06)
Parallel Trends (p-value)		0.82	0.20	0.55	0.75	0.95	0.33
Excl. Midwest	-	0.05 (0.12)	−0.08 (0.07)	0.06** (0.03)	−0.003 (0.03)	−0.04** (0.02)	−0.04 (0.07)
Parallel Trends (p-value)		0.91	0.37	0.41	0.72	0.71	0.22

Standard errors are in parentheses.

*** p<0.01

** p<0.05

* p<0.10.

Models also control for age, gender, education (high school/ged; some college; college grad; missing education), employment status, race/ethnicity, the ratio of household income to federal poverty threshold, household size, family structure (divorced/separated/widowed/never married, missing marital status), quarterly time trend, and state fixed effects. SSB stands for sugar- sweetened beverages. SoFAAS stands for the solid fats, alcohol and added sugars component score of the HEI-2005. HEI-2005 stands for 2005 Healthy Eating Index.

The percentage change is calculated as exp(β) – 1.

Source: NHANES 2007–2010