The Effects of the American Recovery and Reinvestment Act of 2009 on the BMI of SNAP-Eligible Individuals

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Abstract

The Supplemental Nutrition Assistance Program (SNAP) is the largest program in the U.S. to protect low-income families from hunger. Although food security is universally approved, the SNAP program is not without its critiques. Many studies have reported a link between participation in the SNAP and obesity among the poor. Accounting for the endogeneity of an explanatory variable and systematic underreporting of participation status are the most challenges of finding the causal impacts of the SNAP. In this study, I analyze the effects of an expansion of SNAP benefits on the BMI of SNAP-eligible individuals, compared to ineligible people. The expansion was introduced by the American Recovery and Reinvestment Act of 2009 (ARRA). ARRA increased the average value of benefits for SNAP recipients by about 13.6% compared to the previous year. I estimated the ARRA-related SNAP-expansion on SNAP-eligible households by difference-in-differences model, to address both mentioned challenges. Restricted data from NLSY79 is used which is a panel of 12,686 individuals who were between 14 to 22 years old in the first year of the interview in 1979. The results estimated by fixed effect suggest that SNAP expansion had a positive effect on BMI rates among SNAP-eligible adults, however, quantile regression shows an interesting portrait of changes across the whole sample. People in lower quantiles of BMI started to lose BMI, however, in higher quantiles people react to this event significantly different.

1 Introduction

The Great Recession of 2007-2009 created severe economic upheaval in the United States. This recession disrupted the lives of millions of people in the U.S. through its impact on economic factors. In particular, the number of jobs and the median family income declined by 6% and 8%, respectively (Kalleberg and Von Wachter (2017)), and the unemployment rate doubled compared to its long-term historical value (Song and Von Wachter (2014)).

One of the consequences of such significant disruption in the U.S. economy caused by the recession was that households' food expenditure declined dramatically by 5% - a phenomenon which was unprecedented for at least 25 years (Kumcu and Kaufman (2011)). In response to the Great Recession, The American Recovery and Reinvestment Act of 2009 (ARRA) was enacted in 2009. The primary goal of this act was preventing further economic depression through an increase in public spending. One goal of ARRA was to boost low-income families' food security. Low-income households' food expenditures increased by 5.4% with ARRA (Nord and Prell (2011)).

To meet this objective, ARRA supported the largest food assistance program in the U.S. by temporarily expanding the benefits this program provides to low-income families to help with their food expenditures. This program is known as the Supplemental Nutrition Assistance Program (SNAP - formerly known as the Food Stamp Program). ARRA increased SNAP benefits by a fixed dollar amount for each household size, so that the median value of its benefits was boosted by about 13.6% of the maximum allotment. Furthermore, some SNAP eligibility rules were relaxed by ARRA, so this program could support more households affected by the recession. For instance, jobless adults with no child became eligible for the SNAP during ARRA for the first time (Nord and Prell (2011)).

As a result of the changes that ARRA made to SNAP, participation increased. According to data released by the USDA, SNAP enrollment expanded by 53% from 2007 to 2010 and the number of recipients reached its peak in 2013 with roughly 47 million registrants (FNS (2018)).

A large and growing body of literature has investigated the causal effect of SNAP participation on various health determinants such as dietary intake, food security, and BMI. SNAP with providing low-income households with more money, encourage buying more food and increasing BMI. Besides, foods that are high in sugar and fat content are cheaper and more appealing for SNAP recipients. A great deal of previous research into SNAP participation has focused on BMI but the evidence is mixed. For example, Gibson (2003), Zagorsky and Smith (2009), Townsend, Peerson, Love, Achterberg, and Murphy (2001), and Chen, Yen, and Eastwood (2005) find that participation in the SNAP increases BMI; however, Hofferth and Curtin (2005) and Fan (2010) show little to no evidence that SNAP participation affects BMI.

The existing contradiction was the main motivation of this study. Most of the previously mentioned papers suffer from the systematic under-reporting participation status and endogeneity bias. The first mentioned drawback is the primary obstacle for finding the effects of government assistance programs on various economic and health factors. I use SNAP-eligible in comparison with SNAP-ineligible households to address the problem of underreported participation status. To deal with the second challenge, I use difference-in-difference estimation pre/post ARRA2009 to resolve the endogeneity bias of the explanatory variable. Third I use restricted NLSY79 which is a panel of 12,686 individuals and enables us to follow the same individuals over more than 20 years and track their BMI changes over time. Furthermore, with having access to restricted data, I added a state fixed effect to the model along with the year and individual fixed effects. Fourth, I applied quantile regression to find the pattern of changes of BMI across the whole sample, which has not previously been estimated in the most studies.

ARRA-related SNAP-benefits expansion acting as an income shock provided us with a great opportunity to track the changes in the individuals' BMI through an exogenous increase in their income. In this study, we follow the works of Waehrer, Deb, and Decker (2015) and Nord and Prell (2011) to analyze the causal effect of SNAP on the BMI of low-educated SNAP-eligible individuals pre/post ARRA. Ten waves of the National Longitudinal Survey of Youth 1979 (NLSY79) help us to have the same individuals pre and post-ARRA. With this dataset and a difference-in-difference model for pre-post ARRA, it would be feasible to find the mentioned causal effect.

Consistent with the literature, this research found that BMI of SNAP-eligible individuals increased by 0.51 units after ARRA compare to nearly SNAP-eligible people, which is about 1.77% rise in the average BMI of this group. Although the results from the quantile model indicate that people with BMI in higher quantile pre-ARRA will have significantly higher BMI after SNAP expansion. But this effect is different for individuals with a different pattern of BMI pre-ARRA. These results are in accord with the findings of the recent study of Waehrer et al. (2015) indicating that pre-ARRA pattern of dietary intake will affect post-ARRA changes significantly.

The next section presents a background on obesity and SNAP concerning the requirements of SNAP eligibility. Related works are discussed in Section 3. In Section 4 dataset is briefly introduced. In section 5, the methodology of this work is precisely described, and the results are stated in section 6. Finally, Section 7 concludes the paper.

2 Background

2.1 Obesity

Body Mass Index (BMI) is a beneficial measurement for determining if someone is overweight or obese. According to the Centers for Disease Control and Prevention (CDC (2018)) BMI is measured by dividing each person's weight in kilogram over the square of height in meters. Any BMI equals or higher than 25 but less than 30, is considered overweight. A BMI equals and higher than 30 is defined as obese, and if the number is beyond 40 is extreme or severe obesity.

The two most significant reasons that lead to obesity are people's behavior and genetics. Dietary habits, amount of exercise, medication use, and lifestyle are a few examples of behaviors that affect BMI. The role of genetics in BMI is undeniable. Genetics influence an individual's height and the amount of calories that a person can consume in a day. We cannot modify genetics, but we can educate them to change their behaviors toward healthier eating and doing regular exercise; leading to a healthier society with lower chances of obesity-related diseases.

Besides health-related problems of obesity, it affects the U.S. health care system and the whole economy. Problems associated with obesity will increase direct medical and indirect non-medical costs. The vast sum of money that people pay for preventive, diagnostic, and treatment services as direct costs, is not the only cost that society incurs. The indirect cost of obesity is also significant. Indirect costs that are related to morbidity, mortality, and the decreasing rate of workers' productivity are enormous.

Trogdon, Finkelstein, Hylands, Dellea, and Kamal-Bahl (2008) shows in a paper reviewing 31 works that were published from 1992 to 2008 about the indirect costs of obesity. They presents that the number of days that obese workers are absent in their work due to an ailment, injury, and disability are significantly higher than non-obese workers. It was determined that the annual nationwide consequences to society from the decrease in workers' productivity are between \$3.38 billion (\$79 per obese individual) and \$6.38 billion (\$132 per obese individual).

Obesity in the U.S. has become a crucial issue over the past few decades. According to the NCHS data, figure 1 shows the number of obese adults was as high as 39.6% during 2015 to 2016. Although, the high rate of obesity is evident in all age ranges, this rate varies among different age groups. Young adults aged between 20 to 39 had the lowest rate of obesity (35.7%). The highest rate of obesity was 42.8% which was identified among middle-aged groups (40 - 59), and 41% for adults older than 60 years old.

The interesting observation is the prevalence of obesity is higher among women compared to men in all age groups, although this difference is more significant among people younger than 60. Looking at the other source of data provided by the CDC in the previous years, increase in the obesity among adults and youth from 1999 to 2014 is noticeable.

Beside the different mentioned factors that cause higher BMI, some other reasons lead to having more obese people in the U.S. There are various government-related programs for assisting poor people to buy food. Some believe that these kinds of food-assisting programs might cause a higher rate of obesity in the society. Supplemental Nutrition Assistance Program (SNAP) and Women, Infants, and Children (WIC) are the two largest programs in the U.S. to prevent low-income families from hunger.

2.2 SNAP

2.2.1 The History of SNAP

The largest government food-assistance program in the U.S. is the Supplemental Nutrition Assistance Program (formerly called the Food Stamp Program). The SNAP was introduced in 1933 and was a part of the Agricultural Adjustment Act (AAA). It was created in the middle of the Great Depression to diminish the negative results of crop surplus for farmers. In 1939 Secretary of Agriculture, Henry Wallace institutionalized this program in the United States and named it the Food Stamp Program. This food assistance program was only accessible to low-income families during that time.

Between 1988 and 1990 the Electronic Benefit Transfer (EBT) card was proposed to integrate the Food Stamp Program administration and make using this benefit more convenient for the program participants. The name of the Food Stamp Program changed to the Supplemental Nutrition Assistance Program (SNAP) with the 2008 Farm Bill.

In 2016 the SNAP program was the most significant Federal food assistance program in the U.S. and served more than 44 million Americans (FSP (2018)). Many studies have been examining the effects of the SNAP on poor people's health determinants to find the effective economic motivations to convince the government to improve this program such as, excluding unhealthy products from SNAP-qualified food list (like sugar-sweetened beverages).

President Obama signed Farm Bill on February 7, 2014, which significantly modified this program. Based on the new changes, some specific items excluded from the list of qualified items, including alcoholic beverages, tobacco products, and restaurants (FNS (2018)).

2.2.2 The Eligibility for SNAP

- Income

In order to be eligible for various government food assistance like SNAP, some specific requirements have to be met. Income is the primary requirement that people have to meet for SNAP participation. A person could receive SNAP benefits if his/her income is lower than a specific threshold, which varies with household size levels. Both gross and net income are required for determining SNAP-eligibility. Table 1 shows the income thresholds for different household sizes. If someone is gaining income above these limits, they would not be allowed to participate in the SNAP[1]. The government determines thresholds for receiving SNAP benefits yearly. Federal Poverty Thresholds are different for each household sizes (table 2). As it will be explained in section 5, this table is used to determine eligible people in this study.

- Resources

The asset is another determinant of SNAP-eligibility. Assets generally are resources like bank accounts which are easily available for buying food. Any family with $2,250 or less in their accountable resources can be considered eligible for participation, however, their assets could be as high as $3,500 with a disabled member or someone older than 60 years old (FNS (2018)).

- Employment Requirements

Another condition that should be satisfied for being eligible for SNAP program is the work requirement. People have to be registered for work, and they cannot reject a job opportunity. Moreover, if they quit their job or choose to work less voluntarily, they will not be eligible for SNAP anymore. Children, seniors, pregnant women, and physically or mentally disabled people do not need

[1] Gross income means a household's income before any deductions, and net income means their income after allowable deductions.

to meet these requirements.

- Benefits

The amount of money that individuals receive as the SNAP assistance is called allotment. The amount of monthly allotment is calculated based on people's net income and their household sizes. First of all, households' monthly income is multiplied by 0.3. This number is subtracted from the maximum allotment for that specific level of household size.

The remaining number shows the SNAP allotment for that household. The maximum monthly allotments for each level of household sizes are provided in Table 3. As it is mentioned on the Food and Nutrition Service's website "*SNAP benefits are available to all eligible households regardless of race, sex, religious creed, national origin, or political beliefs*" (FSP (2018)).

The number of benefits or allotment for SNAP recipients increased temporarily with ARRA 2009. Table 3 shows the change in maximum allotment for households pre-ARRA and after its expiration. As a result of SNAP benefits expansion, people had more incentives to participate in the program during the years that ARRA was effective. Since receiving more allotment could cover all the cost related to register and participate in the SNAP, which was not attractive enough for some SNAP-eligible individuals pre-ARRA.

2.3 American Recovery and Reinvestment Act of 2009 (ARRA)

The great recession of 2007 - 2009 made a tough economic situation for so many Americans. Because of the recession, the unemployment rate went up, households' income and spending money on food purchasing decreased substantially (Kumcu and Kaufman (2011)). To alleviate the hardship caused by this recession, ARRA 2009 was enacted and signed by President Obama in February 2009. The principal targets of ARRA were creating jobs and boosting economic standards. The benefits of this act became available in 2009 and expired at the end of 2013.

One of this act's main channels for correcting adverse economic condition was through SNAP.

The ARRA 2009 increased the amount of the allotment for SNAP recipients by a constant dollar amount for each household size. Although the amount of percentage rise in benefits was different for each income level, the median value of SNAP benefits went up about 17%. Furthermore, some eligibility rules were relaxed by this act; for instance, unemployed childless adults became eligible for SNAP during the years that ARRA was effective. Based on the data released by USDA, SNAP enrollment expanded by 53% from 2007 to 2010 and the number of recipients reached its peak in 2013 with about 47 million registrants (FNS (2018)).

3 Literature Review

The reduced form models have been the most common research method employed in the studying of the relationship between body weight and health. When it comes to SNAP, the link between program participation and the probability of being more obese have got the most attention. Townsend et al. (2001) present that being a SNAP participant leads to a 38% higher risk of obesity. A cross-sectional Logit model is used to control demographics, food insecurity, exercise, and TV watching. Since then, many researchers have studied this causal effect, however, results from most papers show a lower effect of SNAP participation on overweight among women and almost no effect among men.

Gibson (2003) and Baum (2011) in their papers employ fixed effects linear regression models to account for time-invariant unobserved characteristics of individuals to analyze the effects of SNAP on obesity. Gibson' results show that the rise in obesity is as low as 9.1% among women, while latter work by Baum finds 13.5% increase. Also, they observe that being in the SNAP program for 2 years inflate this rate by 25%.

In order to find the outcomes of SNAP participation on obesity or BMI, we face two main challenges; endogenous selection into participation and systematic underreporting of participation status (Kreider, Pepper, Gundersen, and Jolliffe, 2012).

For solving endogeneity problem, some researchers focused on food stamp policies as instruments in panel data. Meyerhoefer and Pylypchuk (2008) find that women participants in the SNAP program are less likely to have normal weight by 5.9% and more likely to be obese by 6.7%. Their results are compatible with Baum (2007) which shows a positive influence of SNAP participation on being overweight among women. Both works were done by the same method for identification which was state-level policy instruments.

Kaushal (2007) uses 1996 Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) as an IV to evaluate the causal effect of SNAP participation on BMI. He investigated the changes in BMI of low-educated unmarried immigrant women before and after this act. Since this act made so many immigrants unqualified for SNAP who were eligible before, could be considered a good instrument for SNAP. He finds a small 0.3% increase in people's BMI which was statistically insignificant.

Fan (2010) presents almost the same result by a difference-in-difference model. He identified a little evidence for any impact of SNAP on obesity and body mass index of low-income women.

Recent studies mostly show almost no causal effect of SNAP participation on higher BMI among men and a minimal effect amongst women. But the results are different when it comes to children's obesity. for example, Gibson (2004) uses fixed effects linear regression to identify the connection between SNAP participation and BMI among girls and boys between 5 to 11 years old. He finds that the girls participating in the SNAP program for at least five consecutive years would be more obese by 42.8%, however, this link is not the same among boys. The same-aged boys are being less obese by 28.8% in the same situation. Also, SANP did not affect older boys and girls.

Gibson (2006) continued his work and showed in another paper that the effect of SNAP on being overweight that he found in the previous paper, was only seen in families that both mothers and daughters were overweight.

On the other hand, Schmeiser (2012) uses Earned Income Tax Credit and state-level SNAP eligibility rule as an IV and the same dataset as Gibson (2006) was used. He shows different results that present SANP program will even decrease the chance of being overweight among 5 - 18-year-old boys and 5 - 11-year-old girls. The decrease in this probability is even higher among girls than boys.

The extensive systematic underreporting of participation status still remains as a primary problem in considering the causal effect of SNAP participation on BMI. Waehrer et al. (2015) followed Nord and Prell (2011) approach to examine the effect of SNAP on dietary intake of low-income individuals for pre and post American Recovery and Reinvestment Act of 2009 (ARRA).

They used 2009-2010 NHANES data set to find the effect of an increase in the SNAP benefits on diet quality of SNAP-eligible compared to SNAP-ineligible ones. They find that a higher level of SNAP benefit does not influence diet quality in full sample, however, it caused a reduction in diet quality for low-educated individuals. They also show that people with different pre-ARRA diet quality pattern would have a different post-ARRA dietary intakes. Therefore the effects of SNAP on dietary intakes is not the same across the sample of SNAP-eligible individuals.

The SNAP participation rate among SNAP-eligible people are available on the USDA website. For instance, in 2014 the number of SNAP-eligible people were about 51 million and about 42 million received the benefits. So the participation rate among eligible people was about 83%. In 2016, the number of eligible ones were 47 million and 40 million were paid, which means about 85% SNAP-recipients.

As a result, there is always a high rate of SNAP-participation amongst SNAP-eligible group, however, the rate of self-reported SNAP participation in different surveys are always much lower than this number for different reasons such as perceived social stigma associated with program participation. These numbers are another proof for underreporting participation status which is mentioned in some studies, for instance Colby, Debora, and Heggeness (2016).

In this work, to deal with the two mentioned huge problems of endogeneity and underreporting participation status, the approach of Waehrer et al. (2015) are being followed. The main target of this study is finding the causal effect of the ARRA-related increase in the SNAP benefits on the BMI of SNAP-eligible compared with nearly SNAP-eligible individuals. Changes in People's BMI pre and post-ARRA helps us to use a difference-in-difference model. The SANP-eligibility is being used in this study as an index for defining the SNAP-eligible individuals instead of SNAP participants.

4 Data

4.1 NLSY79

We examine restricted data from the 1996 to 2014 National Longitudinal Surveys of Youth 1979 (NLSY79) which is a part of the National Longitudinal Surveys (NLS (2018)) program. The U.S. Bureau of Labor Statistics has been conducting this survey since 1979 which is a nationally representative sample of 12,686 individuals residing in the country. The questionnaires were filled by respondents annually up to 1994 and biennially since then. The respondents aged from 14 to 22 years old at the starting year of the survey.

The gathered information from respondents are being categorized in different groups including; 1) Household, Geography and Contextual Variables 2) Dating, Marriage, and Cohabitation 3) Sexual Activity, Pregnancy, and Fertility 4) Income, Assets and Program Participation 5) Health 6) Crime and Substance Use 7) Survey Methodology 8) Education, Training and Achievement Scores 9) Employment 10) Children 11) Parents, Family Process and Childhood 12) Attitudes, Expectations and Non-cognitive Tests.

NLSY79 has several enticing aspects for this study. First, due to the longitudinal framework of this dataset, we can track the same individuals and observe their BMI changes over time. Second, this dataset has all information about respondents' demographic and socioeconomic characteristic that affect people's BMI. Third, the last wave of this dataset is in 2014 which provides us with information about individuals' BMI and is a long enough period after ARRA 2009. As a result, it helps us to capture respondents' BMI changes due to an increase in ARRA-related SNAP expansion. Finally, In the NLSY79 all the information about net household income are available, which is the primary indicator of SNAP eligibility.

4.2 Summary Statistics

This paper is constructed based on the restricted data of NLSY79. Table 4 presents the percentage of obese, overweight, normal, underweight, and fat (obese and overweight) respondents in 2 different categories. SNAP-eligible individuals with a household income lower than 100% of FPL in both 2008 and 2012, and SNAP-ineligible (nearly-eligible) household with an income between 100% and 250% of FPL in the same two years. These people can be described as individuals with long-term SNAP eligibility and ineligibility.

First 2 columns of table 4 present different characteristics of these groups in the year of 2008 and the rest is for 2012. This table shows the percentage of obese people increased among both SNAP-eligible and ineligible groups pre/post-ARRA, however, this increase is higher among the eligible group. Although Percentage of overweight people decreased within the eligible group, this number increased slightly among ineligible ones.

Individuals were categorized into two groups, SNAP-eligible and SNAP-ineligible. The index for eligibility will be explained in more detail in the next section. Table 5 presents different characteristics (weighted means) of NLSY79 respondents from 1996 to 2014 in 2 groups, SNAP-eligible, and SNAP-ineligible (nearly SNAP-eligible) ones, in the year of 2008 (1 year before ARRA 2009), and 2012 (3 years after ARRA was started).

In 2008 39% of SNAP-eligible respondents participated in SNAP, however, is more accurate to say that only 39% reported their participation. But during ARRA in 2012 this number increased to 50%. Mean of BMI in the eligible group increased from 29.14 to 29.54, while this rise in the ineligible group was from 29 to 29.37. The percentage of single SNAP-eligible respondents are much higher than SNAP-ineligible ones. SNAP-eligible people are more likely to be black compared to near SNAP-ineligible group. The possibility of having a grade lower than high school among SNAP-eligible people is higher compared to ineligible ones. The same thing is right about their parents' education. In this work's sample, everyone with an education higher than high school and all pregnant women is dropped from the sample. [2]

Figure 2 shows the trend of BMI from 1996 to 2014 for 3 different groups, full sample or low-educated people (with a degree of high school or lower), SNAP-eligible and SANP-ineligible (nearly SNAP-eligible) adults. Amongst respondents of NLSY79, those who are SNAP-eligible have a higher rate of BMI during all years. SNAP-ineligible respondents always had a lower mean of BMI compared to eligible ones, however, higher BMI than the full sample.

Furthermore, the trend shows that mean of BMI increased for all 3 groups during these years. This is another proof for showing that BMI in the U.S. is increasing. So this increasing rate of BMI is turning into a serious issue and we need to take action to solve this problem.

5 Empirical Strategy

Self-selection bias is the most challenging part of finding the causal effect of the SNAP on participants' BMI. The SNAP participants might have some unobserved characteristics that correlate with their BMI. For instance, SNAP participants might pay less (more) attention to nutrition facts while purchasing foods. As a result, they would have higher (lower) BMI even with the absence of SNAP. So we would end up with overstating (understating) this causal effect.

The best way to solve this issue is considering changes in SNAP benefits made by ARRA2009 as a natural experiment. Pre-post ARRA2009 provides us with an exogenous increase in SNAP benefits, which is unrelated to any unobserved characteristics that correlate with BMI.

Waehrer et al. (2015) and Nord and Prell (2011) in their studies were concerned about the

[2] Weight of a pregnant woman is not a good measurement for finding her BMI.

different composition of SNAP participants pre-post ARRA. Because ARRA made an excellent incentive for participating in the SNAP by increasing its benefits and relaxing some requirements. Due to all the costs related to applying for the SNAP, some eligible people were not willing to participate in this program pre-ARRA, however, they might be enticed to register for that during the ARRA.

Furthermore, the Great Recession of 2008-09 made more people unemployed or eligible for SNAP. So there was a new flow of SNAP-eligible people requesting for its benefits. Although these people are SNAP-eligible now, they might have different characteristics and lifestyles than pre-ARRA eligible ones. Therefore, they claim that concluding the results with this mentioned change in SNAP-participants group pre-post ARRA might cause a biased estimation.

Table 6 shows the number of SNAP-eligible and ineligible individuals pre-post ARRA. The number of SNAP-eligible people increased from 817 in 2008 (before ARRA) to 1,242 in 2012 (after ARRA). These numbers prove that their concern about an influx of new SNAP-eligible people by ARRA was correct.

In this study the approach of Waehrer et al. (2015) is followed. In our estimation, the difference-in-difference model was applied to find the changes in BMI of SNAP-eligible individuals (instead of SNAP participants) compared to SNAP-ineligible ones (instead of SNAP non-participants) pre-post ARRA. The main requirement for SNAP-eligibility is households' net income. Anyone with income just greater than 100% of federal poverty thresholds could be eligible for SNAP. In the NLSY79 data set, all respondents' net household income are provided.

The criteria for finding SNAP-eligible and ineligible in Waehrer et al. (2015) is as following; Everyone with income equal or lower than 100% of FPL is considered SNAP-eligible, and with income above 100% and below 250% of FPL is called SNAP-ineligible collected from NHANES in 2009, or as Nord and Prell (2011) named ”nearly SNAP-eligible households”.

Although SNAP-ineligible households are less economically stable than eligible ones, they are considered eligible for some public health insurance programs. For instance, the threshold for finding eligible people for Medicaid and the Children's Health Insurance Program in most states is income lower than 250% of FPL. So, however they are not eligible for SNAP benefits, most of them are not economically secure. Which means that they are low-income households and can make a good comparison group for SNAP-eligible ones.

Also, since not all SNAP-eligible people are participating in the SNAP, treating all SNAP-eligible households as SNAP participants might not be a perfect assumption. Although, this will lead us to find an inaccurate effect of the increased benefits on BMI, using DD is still a valid intent-to-treat effect. On the other hand, this method would solve the substantial problem of systematic underreporting participation status. This is the main challenge to find the causal effect of assistance programs on different economic or health determinants. Using the intent-to-treat effect method would lessen the negative effect of aforementioned problem.

In this work, to deal with the specified concern in the studies of Waehrer et al. (2015) and Nord and Prell (2011) about having new SNAP-eligible people post-ARRA, eligibility criteria are changed as follows; Households with income equal or lower than 100% of FPL in both 2008 and 2012 are considered SNAP-eligible. The year of 2008 is 1 years before ARRA was started and 2012 is 3 years after ARRA. Eligibility in these 2 years was selected to make sure that SNAP-eligible households in the sample are low-income even before ARRA, and events like the Great Depression did not make them SNAP- eligible.

Using these criteria helps us to track the same people over time who have long-term SNAP-eligibility and are more economically insecure. With the same logic, SNAP-ineligible households are people who have an income higher than 100% of FPL but just lower than 250% of FPL in both years of 2008 and 2012. Based on the mentioned framework, the number of SNAP-eligible and ineligible households are determined in Table 6. Total number of SNAP-eligible and SNAP-ineligible individuals in this work are 714 and 475 people. Equation 1 is estimated below:

$$BMI_{its} = \alpha + \beta X_{its} + \gamma ARRA_t + \delta ELIG_{its} + \theta ELIG_{its} * ARRA_t + \omega_i + \lambda_t \mu_s + \varepsilon_{its} \quad (1)$$

In this model, the independent variable is Body Mass Index (BMI is calculated by dividing the weight in kilograms by square of height in meters). BMI_{its} shows individual i lives in year t in state s. In the analysis, variable X_{its} is added to the model to control for respondents characteristics such as age, household size, marital status, highest degree completed, urban, etc. Variable $\lambda_t \mu_s$ controls for interactions of year and state fixed effects, which latter are only available in the confidential NLSY79. ω_i is added to the model to control for individuals' unobserved characteristics.

Survey respondents' age is between 14 and 22 years old in the year of 1979 (the starting year of the survey) and between 31 and 57 years old in the last year of this study. Considering the target sample of this work, the education level of participants is essential for us. To have more similar eligible and ineligible groups, all respondents with a degree higher than high school diploma were eliminated from the sample.

Variable $ARRA_{its}$ is an indicator for the years after ARRA 2009, and $ELIG_{its}$ shows the eligible individuals based on the criteria explained before. Therefore, θ estimates the effect of the ARRA-related increase in SNAP benefits after 2009. So, equation 1 were estimated with both OLS and Fixed Effect models to control for individuals' unobserved characteristics. Quantile regression is also estimated to show the heterogeneous response to increased in SNAP-benefits and its different effects on people's BMI. It also lessens the effect of outliers.

6 Results

This section presents the main findings of the paper; The results from the effects of SNAP participation on BMI, the causal role of ARRA2009 in the BMI of SNAP-eligibles (intent-to-treat effect) with OLS and FE estimation, quantile regression, and the effects of ARRA on obesity rates of SNAP-eligible individuals, together with robustness checks.

6.1 The Effect of SNAP Participation on BMI with OLS and Fixed Effect Models

Table 7 reports estimates of changes in BMI among SNAP participants and SNAP-eligible individuals after starting ARRA with OLS and Fixed Effect models, including individual, year and state fixed effects. The individual fixed effect is added to the model to control for individuals' unobserved characteristics. The year and state fixed effects are also included in this estimation to control for government programs, policies, and other trends that might take place in those years or specific states. Ten waves of NLSY79 data set is used to create this estimation, and all individuals are aged between 37 and 57 years old from 1996 to 2014 with education just lower than high school.

First column of Table 7 shows a naive OLS regression of BMI on SNAP participation. The coefficient shows 1.42 units higher BMI among the program's participants. In column 2 all control variables are added to the model. For example, age, region, urban, race, parents' education, and family structure. The result presents a positive and significant coefficient in the 99% confidence interval. This number suggests 3.6% increase in the average BMI of SNAP-participants.

There are individuals' unobserved characteristics that cannot be controlled by OLS, and they might correlate with BMI. Therefore the difference-in-difference estimation was applied in the last 3 columns of table 7. The coefficient in column 4 shows a positive and significant increase in BMI of SNAP-participants. These results are consistent with previous studies such as Gibson (2003), Zagorsky and Smith (2009), Townsend et al. (2001), and Chen et al. (2005). All of these studies proved a higher BMI among SNAP-participants.

The coefficient found by FE (0.3) is substantially lower in comparison with OLS (1.04), which means a high part of that rise was due to unobserved characteristics that affect BMI. It indicates that using OLS is subject to omitted variable bias and fixed effects model is preferred.

6.2 Intention-To-Treat Analysis with Difference-In-Difference Estimation

In the next step, the SNAP-participation was replaced by SNAP-eligibility to solve the substantial problem of under reporting participation status. The criteria for determining eligibility and ineligibility was described in detail in section 5. The main variable estimated by difference-in-difference estimation would be SNAP-ELIG*ARRA (θ in equation 1) in columns 3 and 6. This coefficient presents the effect of an increase in SNAP-benefits by ARRA2009 on the BMI of SNAP-eligible individuals.

The coefficient estimated by OLS model in column 3 indicates an increase in BMI of SNAP-eligible people by 0.4 units after ARRA which is statistically significant in a confidence interval of 90%. After controlling for all independent variables, and individual, year and state fixed effect, the sample size decreased to 4,900 individuals.

To control for individuals' characteristics that do not vary over time, such as the initial health endowment of the individual, the fixed effect estimation was applied in column 6 of this table. This coefficient shows a positive and statistically significant increase in BMI of SNAP-eligible people by 0.51.

The last column of this table is the most significant estimation of this study. In this part, the SNAP-eligibility is used instead of SNAP participation and also individual, year, and state fixed effect are applied in the estimation. DD estimation indicates that the effect of the boost in benefits of SNAP because of ARRA on BMI of SNAP-eligible ones was positive.

This number shows a person who was eligible for SNAP gain more BMI by 0.51 unit that is statistically significant in a confidence interval of 95%. It also shows about 1.77% rise in the average BMI of this group. FE estimation's result presents that ARRA-related SNAP expansion caused higher BMI among SNAP-eligible individuals.

These results suggest that the SNAP expansion by ARRA positively affected SNAP-eligible individuals' BMI, and increased their BMI through this program compared to ineligible ones. All

SNAP-eligible people in the sample of this study are low-educated with household income just lower than 100% of FPL in both 2008 and 2012. Therefore, all have long-term SNAP-eligibility and are highly sensitive to income shocks, such as ARRA-related SNAP changes.

6.3 Quantile Regression

In addition, it is important to ask the following questions; If BMI of all SNAP-eligible people increased by ARRA? If all SNAP-eligible individuals with different BMI pattern pre-ARRA reacted the same to the SNAP expansion? Or some people changed their behavior after ARRA-related raise in benefits?

To answer the above questions, quantile regression was applied to find the causal effect of SNAP-expansion on BMI at the median, 25th, 75th, etc. Although the previous results have shown that after ARRA, eligible people for SNAP are gaining higher BMI due to increase in SNAP, the results from quantile regression show a different trend. The results from quantile regression provided in table 8 show an interesting portrait of changes across the whole sample.

Changes in People's BMI who are in the lower percentiles shows a different pattern. The coefficient of SNAP-ELIG*ARRA for this group is negative but statistically insignificant, however, these numbers are significantly different than FE coefficient were shown in table 7. The negative and small numbers indicate that SNAP-eligible ones in just below the 40th percentile pre-ARRA reacted differently to the ARRA-related SNAP expansion. Their BMI is getting smaller after ARRA, which is a reverse trend compared with the previous results of this study.

People at the median had a higher BMI by 0.96 units after ARRA establishment. As we increase the percentiles, the coefficient is getting larger. All numbers are statistically significant in the 99% confidence interval, and significantly different than FE results. For example, the coefficient in the 90th percentile is as high as 1.17 , which shows 4.05% increase in the average BMI.

The results from quantile regression present that even though ARRA-related SNAP-expansion caused a higher BMI for SNAP-eligible group, its effect is not the same for everyone. Although obese and overweight people closer to obese were gaining more BMI after SNAP expansion, normal people and overweight closer to normal weight are losing BMI.

This represents that not everyone in this sample reacted to change in the benefits in the same way. Some lower weight people changed their behavior and maybe started to eat healthier, however, overweight or obese people bought more unhealthy food and became more obese. So we cannot conclude that higher SNAP benefits negatively affected everyone.

6.4 Obesity and Overweight Rates

The last section has analyzed the causes of ARRA-related SNAP-expansion on BMI of different quantiles. The results show that people with different BMI pre-ARRA reacted differently to change in the benefits. In the following part of this paper, the mentioned causal effect on obesity, overweight, and fat rates of SNAP-eligible individuals will be examined.

People are categorized in six groups based on their BMI, and the results are shown in table 9. According to the Centers for Disease Control and Prevention (CDC (2018)), a BMI less than 18.5 is underweight. A number just higher than 18.5 but lower than 25 is a normal BMI. Any number equals or higher than 25 but less than 30, is considered overweight, and a BMI equals and higher than 30 is defined as obese.

In this study, two more groups are added to the existing ones and called fat25 and fat24. Individuals that have a BMI higher than 25 are included in the first group, which shows the total number of overweight and obese people. The threshold decreased to 24 in the latter group. Therefore, anyone in the fat24 has a BMI higher than 24. All of these six new variables are used as dependent variable in separated fixed effect regressions with individuals, state, and year FE. The results from difference-in-difference estimations are presented in table 9.

All of the coefficients estimated by FE models with individual, state, and year fixed effects are statistically insignificant, however, it is interesting to look at the signs. The positive sign of normal group indicates that there is a higher chance of being included in this category among eligible people for SNAP after ARRA. Also, there is 1% higher chance of obesity after an increase in SNAP benefits. These results are consistent with our main findings in section 6.2 and most studies that are examined this causal effect so far; The more significant the SNAP allotments, the higher SNAP-eligibles' BMI.

The coefficient of overweight and fat25 rates are negative and their signs are noticeable. It means that SNAP eligible persons are 3% and 2% less likely to be overweight and fat respectively after ARRA versus before, relative to SNAP ineligible persons. Even though this result contradicts with most papers that show a positive effect of SNAP participation on people's obesity and overweight rates, it is consistent with my paper's findings with quantile regression (6.3).

In the next step, the threshold of determining fat people (overweight and obese) is slightly changed from greater than 25 to 24. Its coefficient became positive which indicates a slight increase in the chance of gaining a BMI higher than 24 after ARRA among SNAP-eligible people. According to the results, a minor change in the thresholds of overweight and fat people will change the likelihood of being included in these groups significantly. Therefore, overweight people with a BMI close to 25 (close to normal) are the more sensitive group to income changes.

The outcomes derived from this part is compatible with quantile regression's findings. Overweight SNAP-eligible people with a BMI close to normal, respond differently to the changes in SNAP benefits after ARRA. They may alter their lifestyle and eating habits by receiving more benefits and start living healthier. As a result, the likelihood of being overweight decreased slightly after ARRA. So, it again proves that some SNAP-eligible people gain higher BMI with more income, however, some of them change their behavior, live healthier, and become less overweight.

6.5 Robustness Check

In this section, the sensitivity of the estimations to the methods of constructing the SNAP-eligible and SNAP-ineligible thresholds is tested. Besides, we verify whether our obtained results are robust to various specifications. The results for robustness check are provided in table 10.

First, the coefficient of SNAP-EIG*ARRA from main DD estimation with an individual, state and year FE is compared with OLS estimation. Its coefficient is 0.4 and it is statistically significant in 90% confidence interval which is not that different from our main coefficient (0.51**). Also, the main FE model was estimated again without state and year fixed effects, and the results were similar in magnitude and significance (results not shown).

Second, to check the sensitivity of our results to SNAP-eligible and ineligible thresholds, the determinants of eligibility are changed. In the model (1) the threshold of SNAP-eligibility increased from 100% of FPL to 130%. Also, SNAP-ineligibility thresholds changed from higher than 100% and just lower than 250% to higher than 130% and just below 300%. However, they still have to meet the requirements in both years of 2008 and 2012. The coefficient is provided in the first column of table 10 which is slightly smaller in magnitude but similar in significance. It is smaller since the individuals in this sample are slightly less needy than the primary model.

Third, in the model (2) we keep the same thresholds, however, short-term eligibility are considered. People who meet the eligibility and ineligibility requirements in 2008 will be in the sample. The year of 2008 is one year before the ARRA and at the beginning of the recession, so it can be valid to assume that they have been at the eligible group since years ago, and have similar characteristics to the main sample. The coefficient from this model is provided in column 2 of table 10. The number is almost the same as the main coefficient, which proves our assumption.

Forth, the same thresholds of the primary model are applied in (3), however, the requirements have to be met only in the year of 2012 (three years after ARRA establishment). 2012 is a few years after the great recession, and many new people might be unemployed and moved to an eligible group. Also, some eligibility rules are relaxed by ARRA, for example, jobless childless adults can be eligible for SNAP. Statistically speaking according to the USDA website, SNAP participation rate reached its peak during ARRA. Also, in accordance with NLSY79 provided in table 6, the number of eligible people increased from 817 in 2008 to 1242 in 2012. Therefore, new people added to the SNAP-eligible group and changed the pattern of the sample. These new eligible people might have a different lifestyle and eating habit than old eligible ones, and not be as sensitive as them to the income shocks. So we expect to see a smaller coefficient which is presented in the third column of table 10.

Fifth, in the model (4) we run the main FE model with all the control variables excluding the household income. The result is shown in the fourth column. The coefficient is still similar in size and significance to the main result presented before. Also as the sixth robustness check, the same model was run including pregnant women or women who had recently given birth and found similar results (results not shown). Therefore, the findings of this study are robust to different specifications and not sensitive to different eligible thresholds.

7 Conclusion

In this study, the effect of ARRA-related SNAP expansion on SNAP-eligible individuals was examined. The ARRA2009 increased the SNAP benefits by 17% per person on average. It also relaxed some SNAP eligibility rules (Nord and Prell (2011)). Most studies such as Baum (2007) and Meyerhoefer and Pylypchuk (2008) used government policies as an instrument and found a positive effect of SNAP on BMI, however, Kaushal (2007) and Fan (2010) showed no causal effect with DD estimations.

Recent studies like Nord and Prell (2011) used SNAP-eligibility instead of SNAP participation to lessen the unfavorable effect of under-reported participation status. They found an improvement in people's diet quality and increase in food expenditure after ARRA-related SNAP expansion.

Following their study, Waehrer et al. (2015) show that the rise in diet quality of SNAP-eligible people is not consistent across the whole sample and it is related to their pre-ARRA diet quality pattern. This discrepancy is more evident among people with insufficient nutrition fact and poor diet quality. They present in their work that low-educated people have potentially a more extended period of SNAP eligibility and located in the lower 25th percentile of diet quality patten pre-ARRA. Their results show a higher mean caloric intake distribution among these people, that means an inconsistent effect across the sample.

In this study, the causal effect of ARRA-related SNAP expansion on BMI of SNAP-eligible individuals with DD model is examined. SNAP benefits expansion after ARRA might induce some people to register in the SNAP or made some individuals eligible for that. To control for the change in the composition of SNAP participants pre-post ARRA, SNAP-eligibility in 2007 and 2011 were used to determine the sample. The results suggest 1.77% increase in the BMI of people who had long-term SNAP eligibility and also have education lower than high school.

This finding is consistent with the results of Waehrer et al. (2015) presenting lower diet quality and higher food expenditure among these people. Furthermore, quantile regression was applied to test the consistency of the results through the whole sample. The findings derived from this regression show different coefficients for various percentiles. Individuals located at the lower percentile of the BMI distribution reduced their BMI after receiving higher benefits by ARRA, however, BMI increased substantially among people with high BMI pre-ARRA.

The results from this part is also consistent with Waehrer et al. (2015)'s work and suggest that change in people's BMI post-ARRA, is significantly connected to their pre-ARRA BMI pattern. Therefore, we can conclude that people with diverse BMI pre-ARRA do not react the same to the increase in SNAP benefits.

There could be several explanations for these findings. First, some SNAP recipients were able to buy only their basic foods with SNAP allotment pre-ARRA. They had access to more money by ARRA and might be ended up buying more unhealthy foods and drinks. Or after ARRA they allocated the whole SNAP benefits on purchasing basic food and spent some portions of their salaries on fast foods and junk foods, which they could not afford them before.

Second, as Mancino and Guthrie (2014) mentioned in their work, the SNAP households are apt to purchase their food as less frequently as possible since they are not informed about Food Pyramid recommendations. Therefore, they buy less fresh vegetables and tend to buy more freezable meals. They also prefer to spend less time on food preparation. As a result, the more money they receive, the more unhealthy food they purchase.

Finally, As we conclude based on quantile regression, people with higher BMI react to this income shock differently. The possible explanation is according to one of the main principles of Economics; people respond to incentives! With the different situation, people behave differently. Therefore, Overweight people close to normal weight thresholds might start purchasing food more wisely and try to live healthier, however, obese people respond to this new incentive (income shock) negatively. So they might need more education, more guides, and maybe stricter rules to spend their SNAP benefits.

Therefore, increasing the amount of money for SNAP recipients might not be enough to make them healthier or less obese. Providing food assistance for low-income and low-educated individuals along with providing them with nutrition information and education will make structural improvements in the whole nation.

8 Figures and Tables

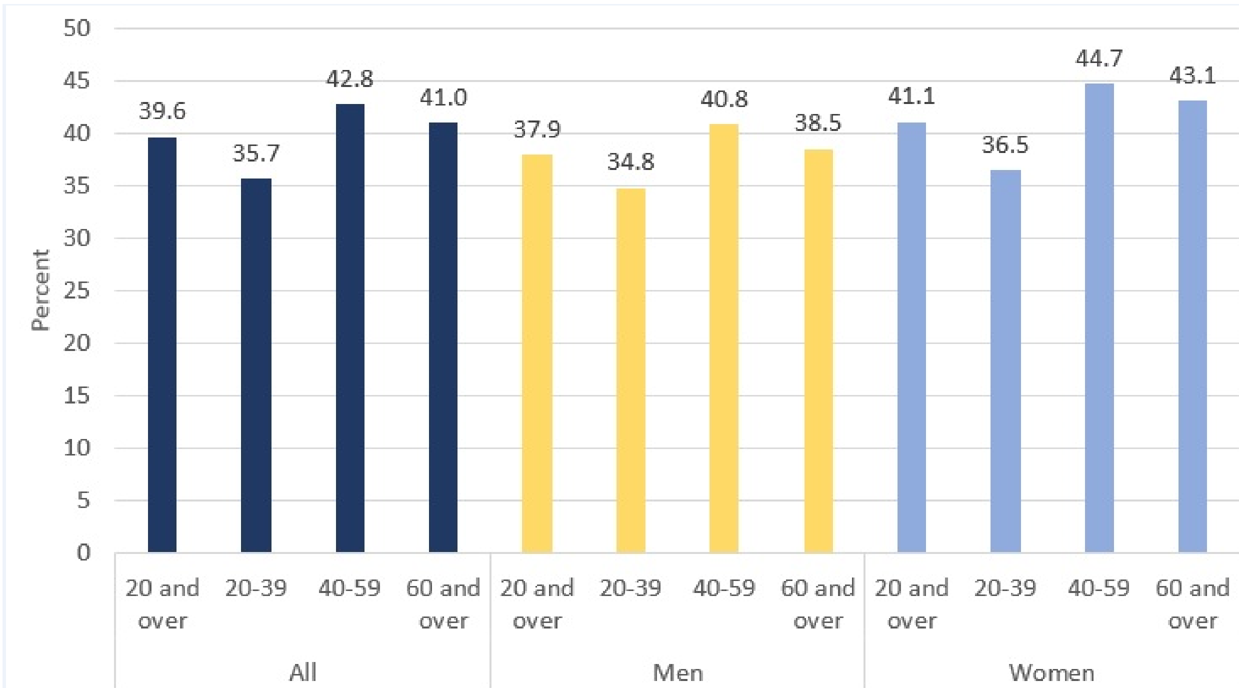

Figure 1: Prevalence of obesity among adults from the age 20 and over in the United States from 2015 to 2016 (CDC (2018))

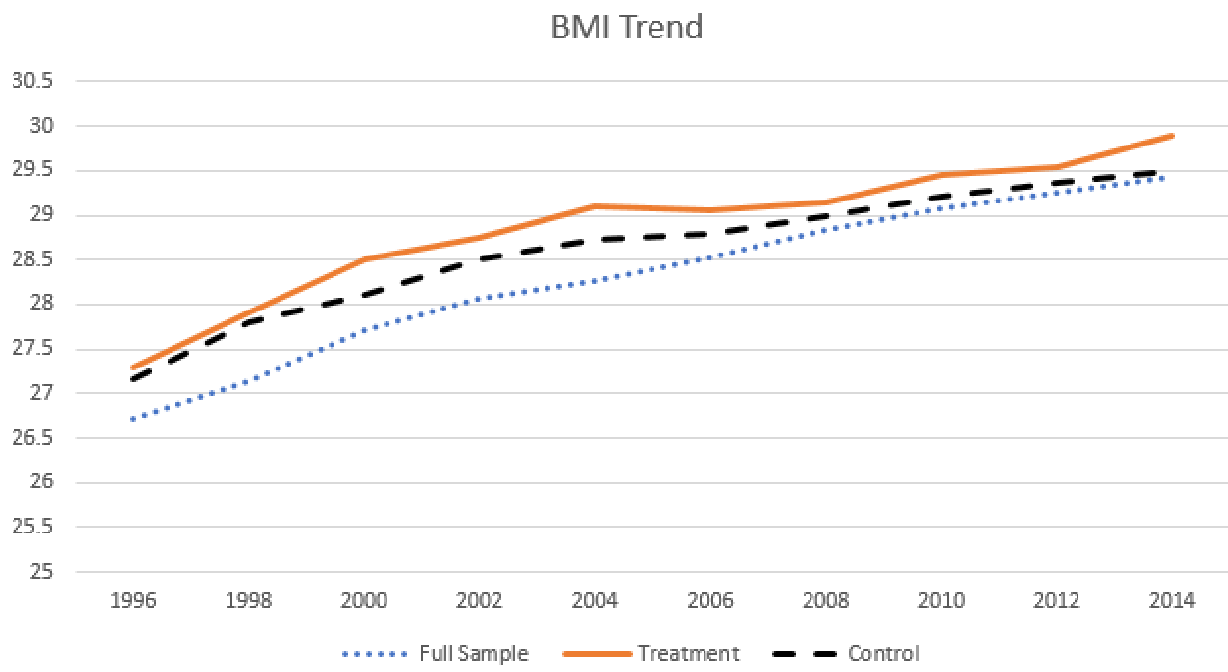

Figure 2: Prevalence of obesity among low-educated adults in the U.S. from 1996 to 2014.

Table 1: SNAP gross and net income thresholds in 2017

Household Size	Gross monthly income (130 percent of poverty)	Net monthly income (100 percent of poverty)
1	$1,307	$1,005
2	$1,760	$1,354
3	$2,213	$1,702
4	$2,665	$2,050
5	$3,118	$2,399
6	$3,571	$2,747
7	$4,024	$3,095
8	$4,477	$3,444
Each additional member	+453	+349

Table 2: Federal Poverty Threshold

Federal Poverty Threshold	HH_Size = 1	HH_Size = 2	HH_Size = 3
2008	$10,400	$14,000	$17,600
2009	$10,830	$14,570	$18,310
2010	$10,830	$14,570	$18,310
2011	$10,890	$14,710	$18,530
2012	$11,170	$15,130	$19,090

Table 3: Maximum Monthly Allotment before and after ARRA2009

People in Household	2008(before ARRA)	2009(during ARRA)	2014(after ARRA)
1	$162	$200	$ 189
2	$298	$ 367	$347
3	$426	$526	$497
4	$542	$668	$632
5	$643	$793	$750
6	$772	$952	$900
7	$853	$1,052	$995
8	$975	$1,202	$1,137
Each additional member	$122	$150	$142

Table 4: Percentage of obese & overweight people in 2008 (1 year before ARRA) & 2012 (3 years after ARRA)

	SANP-eligible2008	SANP-ineligible2008	SANP-eligible2012	SANP-ineligible2012
Obese	35.76%	40%	40.14%	43.28%
Overweight	36.98%	28.63%	32.79%	29.55%
Normal	24.48%	26.57%	25.99%	25.64%
Underweight	0.7%	1.4%	0.7%	1.1%
Fat	72.75%	68.65%	72.93%	72.83%

Notes: Sample comprised of respondents between 1996 and 2014 with education lower than high school.
SNAP-eligible group are individuals with a net household income lower than 100% of FPL in 2008 and 2012.
SNAP-ineligible group are with a net income lower than 250% FPL and higher than 100% of FPL in 2008 and 2012.
FPL = federal poverty thresholds

Table 5: Descriptive Analysis for NLSY79 low-educated respondents in 2008 and 2012

	SNAP-ELIG 2008		SNAP-INELIG 2008		SNAP-ELIG 2012		SNAP-INELIG 2012	
Variable Name	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.	Mean	Std. Err.
SNAP recipient	0.39		-		0.5		-	
Female	0.56		0.52		0.56		0.52	
BMI	29.14	0.26	29.0	0.34	29.54	0.3	29.37	0.34
Marital Status								
Single	0.33		0.14		0.31		0.13	
Married	0.18		0.46		0.19		0.48	
Separated	0.49		0.4		0.5		0.39	
Grade	10.86	0.1	11.56	0.07	10.9	0.7	11.62	0.08
Urban	0.7		0.64		0.73		0.66	
Race								
Hispanic	0.11		0.10		0.11		0.10	
Black	0.36		0.15		0.36		0.15	
Non-black, Non-hispanic	0.53		0.75		0.53		0.75	
Parents' Education								
Father's education	9.28	0.17	9.8	0.21	9.28	0.17	9.8	0.21
Mother's education	9.69	0.12	10.28	0.15	9.69	0.12	10.28	0.15
Age	46.47	0.09	46.33	0.12	50.47	0.09	50.33	0.12
Income	6.67	0.26	31.21	0.68	11.41	0.52	38.25	1.08
Family size	2.43	0.07	2.93	0.9	2.36	0.06	2.55	0.07
Region								
South	0.52		0.4		0.52		0.4	
West	0.13		0.17		0.13		0.17	

Notes: Values reported are the means and weighted by the NLSY 1979 population weights.
Sample comprised of respondents between 1996 and 2014, whose education is lower than high school.
SNAP-ELIG indicated SNAP-eligible who are individuals with a net household income lower than 100% of FPL in years 2008 & 2012. SNAP-INELIG is ineligible ones who are with net HH-income lower than 250% FPL and higher than 100% of FPL in both 2008 & 2012.
FPL = federal poverty thresholds

Table 6: Number of SNAP-eligible and SNAP-ineligible people pre/post-ARRA

	SNAP-eligible 2012	SNAP-ineligible 2012
SNAP-eligible 2008	714	103
SNAP-ineligible 2008	528	475

Table 7: Association between SNAP eligibility and adults BMI

Dependent Variable	OLS			Fixed Effect		
BMI	SNAP Participation		DD estimation	SNAP Participation		DD estimation
SNAP participation	1.42***	1.04***		0.33***	0.3***	
	(0.22)	(0.26)		(0.08)	(0.1)	
Female		-0.14	1.43***			
		(0.2)	(0.5)			
Household size		0.13**	0.1		0.002	-0.04
		(0.05)	(0.11)		(0.02)	(0.05)
Age		0.34***	0.49		0.18**	0.32
		(0.13)	(0.3)		(0.1)	(0.21)
$Region(= South)$		15.15***	-0.35		-2.97***	3.42
		(1.05)	(1.66)		(0.4)	(2.31)
$Father's\ education$		-0.06*	0.004			
		(0.03)	(0.08)			
SNAP-ELIG			0.09			
			(0.57)			
*SNAP-ELIG*ARRA*			0.4*			0.51**
			(0.3)			(0.25)
$IndividualFE$	NO	NO	NO	YES	YES	YES
$Year\&StateFE$	NO	YES	YES	NO	YES	YES
Observations	41456	23354	4900	41456	23354	4900
R^2	0.005	0.06	0.13	0.001	0.12	0.18

Notes: Standard deviations are in parenthesis.

Sample comprised of respondents between 1996 and 2014, whose education is lower than high school.

The symbols ***($p < 0.01$), **($p < 0.05$), and *($p < 0.10$) indicate significance levels.

Models also control for highest grade completed (high school or lower), age square, region, urban, race/ethnicity, net household income, parents' education, family structure (never married/married/separated) and individual, year and state fixed effects.

Table 8: Quantile Regression

Quantiles	Coefficients	Significant than FE (0.51**)
25	-0.14 (0.22)	✓
40	-0.21 (0.3)	✓
50	0.96*** (0.14)	✓
70	0.95*** (0.21)	✓
90	1.17*** (0.3)	✓
95	1.2* (0.7)	

Notes: Standard deviations are in parenthesis.

The symbols ***(p < 0.01), **(p < 0.05), and *(p < 0.10) indicate significance levels.

Symbol of ✓ means significantly different than FE coefficient.

Table 9: DD estimations on the obesity and overweight Rates

	DD estimate				
Dependent Variable	Normal	Overweight	Obese	Fat25	Fat24
*SNAP-ELIG*ARRA*	0.01	-0.03	0.01	-0.02	0.007
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
IndividualFE	YES	YES	YES	YES	YES
Year&StateFE	YES	YES	YES	YES	YES

Notes: Standard deviations are in parenthesis.

The symbols ***(p < 0.01), **(p < 0.05), and *(p < 0.10) indicate significance levels.

Normal means any BMI lower than 25. Overweight means any BMI equal or higher than 25 but less than 30. Obesity means any BMI equal or higher than 30. Fat25 means any BMI equal or higher than 25. Fat24 means any BMI equal or higher than 24.

Table 10: Robustness Check

Dependent Variable	(1)	(2)	(3)	(4)
*SNAP-ELIG*ARRA*	0.39**	0.43**	0.2*	0.4*
	(0.22)	(0.2)	(0.12)	(0.24)
$Individual FE$	YES	YES	YES	YES
$Year\&State FE$	YES	YES	YES	YES

Notes: Standard deviations are in parenthesis.

The symbols ***($p < 0.01$), **($p < 0.05$), and *($p < 0.10$) indicate significance levels.

(1) The threshold of the SNAP eligible people increased from household net income lower than 100% of FPL to 130% in both 2008 and 2012. (2) Eligible people are determined by net HH-income just lower than 100% FPL in the only year of 2008 (short-term eligibility). (3) Eligible people are determined by net HH-income just lower than 100% FPL in the only year of 2012 (during ARRA with including new eligible people). (4) The same model FE model is estimated excluding income as an independent variable.

9 Appendix

Table 11: Association between SNAP eligibility and adult BMI

Dependent Variable	Individual Fixed Effect		
BMI	SNAP Participation		DD estimation
SNAP participation	0.32***	0.3***	
	(0.08)	(0.1)	
Female			
Household size		0.002	-0.04
		(0.02)	(0.05)
Age		0.18**	0.32
		(0.1)	(0.21)
Age^2		-0.0008	-0.003
		(0.001)	(0.002)
Net household income		0.002*	0.004
		(0.001)	(0.003)
Race			
Black			
Non-black/non-hispanic			
Region			
North central		-1.47	-12.17***
		(0.99)	(3.4)
South		-2.97***	3.42
		(0.4)	(2.13)
West		2.92***	14.54***
		(0.45)	(3.02)
Urban		-0.04	-0.24
		(0.07)	(0.19)
Marital status			
Married		0.18	-0.06
		(0.2)	(0.4)
Separated		-0.4*	-0.42*
		(0.22)	(0.43)
Parents' education			
Father's education			
Mother's education			
SNAP-ELIG			
ARRA			
*SNAP-ELIG*ARRA*			0.51**
			(0.25)
Constant	28.65***	25.22***	16.85***
	(0.01)	2.36	(5.26)
IndividualFE	YES	YES	YES
Year&StateFE	NO	YES	YES
Observations	41456	23354	4900
R^2	0.001	0.17	0.18

Table 12: Regression for BMI categories

Dependent Variable	Fixed effect estimates with year FE			
BMI	BMI<25	$25 \leq$ BMI < 30	BMI≥30	BMI≥25
*SNAP-ELIG*ARRA*	0.007	-0.03	0.62	0.51*
	(0.23)	(0.22)	(0.53)	(0.29)

Notes: Standard deviations are in parenthesis.
Sample comprised of respondents between 1996 and 2014, whose education is lower than high school.
The symbols ***($p < 0.01$), **($p < 0.05$), and *($p < 0.10$) indicate significance levels.
BMI<25 : normal weight
BMI⩾25 : overweight or obese
BMI⩾30 : obese

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