USDA

United States Department of Agriculture

Economic Research Service

Economic Research Report Number 147

April 2013

Supplemental Nutrition Assistance Program (SNAP) Participation Leads to Modest Changes in Diet Quality

Christian Gregory
Michelle Ver Ploeg
Margaret Andrews
Alisha Coleman-Jensen

United States Department of Agriculture

Economic Research Service
www.ers.usda.gov
Follow us on twitter at http://twitter.com/USDA_ERS

Recommended citation format for this publication:

Gregory, Christian, Michelle Ver Ploeg, Margaret Andrews, Alisha Coleman-Jensen. *Supplemental Nutrition Assistance Program* (*SNAP) Participation Leads to Modest Changes in Diet Quality,* ERR-147, U.S. Department of Agriculture, Economic Research Service, April 2013.

Cover photo credit: Shutterstock.

Economic Research Report Number 147 • A Report from the Economic Research Service • April 2013

Supplemental Nutrition Assistance Program (SNAP) Participation Leads to Modest Changes in Diet Quality

Christian Gregory, cgregory@ers.usda.gov

Michelle Ver Ploeg, Margaret Andrews, Alisha Coleman-Jensen

Abstract

Recent research has shown that the Supplemental Nutrition Assistance Program (SNAP) effectively reduces food insecurity. Questions remain, however, about the extent to which SNAP affects the quality of adult participants' diets. These questions have surfaced in the context of the increasing public costs of diet-related illnesses, such as diabetes, high blood cholesterol, and heart disease, and have led to discussions about restricting the use of SNAP benefits to purchase some food items. This report examines Healthy Eating Index (HEI) scores for adults in low-income households that do and do not participate in SNAP. To disentangle the choice of whether to participate in SNAP from diet choices, this model uses a unique data set that matches State-level SNAP policy variables to individual-level data from four waves of the National Health and Nutrition Examination Survey (NHANES). Two important kinds of results emerge: the effect of SNAP on the diet quality of those who choose to enroll, and a total comparison of SNAP participants and nonparticipants after SNAP's effects are taken into account. On the first, this report shows that SNAP participation results in a large increase in the likelihood of consuming whole fruit and a slightly lower consumption of dark green/orange vegetables. On the second, the report finds that SNAP participants have slightly lower HEI scores (both total and components) than nonparticipants, meaning that they have slightly lower diet quality. They do, however, consume less saturated fat and sodium than nonparticipants.

Keywords: Supplemental Nutrition Assistance Program, food stamp, Healthy Eating Index, food insecurity, diet quality, fruit and vegetable consumption, National Health and Nutrition Examination Survey, ordinary least squares model, treatment effects model, average treatment effect

Acknowledgments

The authors would like to thank Vicki L. Burt and staff at the National Center for Health Statistics for providing data and service for this report; USDA's Economic Research Service employees Jay Variyam, Dave Smallwood, Ephraim Leibtag, Susmita Pendurthi, and Wynnice Pointer-Napper for their input; and three anonymous reviewers for their comments.

Contents

Summary

What Is the Issue?

The Supplemental Nutrition Assistance Program (SNAP, formerly the Food Stamp Program) is the largest food assistance program administered by the Food and Nutrition Service of the U.S. Department of Agriculture (USDA). Approximately 47 million people participated in SNAP in 2012, at a cost of almost $75 billion. While much of the policy interest in SNAP involves its effectiveness in combating food insecurity—defined as uncertain access to enough healthy, nutritious food for an active life—another goal of the program is to support low-income families in making food choices consistent with dietary guidance. This goal of SNAP has recently received public attention, illustrated by suggestions that SNAP participants should be prevented from using benefits to purchase certain foods that are perceived to contribute to poor dietary health—sugar-sweetened beverages, for example.

Social scientists have been interested in SNAP's possible dietary effects since the program's inception, but much of the existing research is inconclusive and limited; namely, it cannot address the unobserved characteristics (for example, preferences for nutritious food) that could affect SNAP participation and diet quality simultaneously. This report examines Healthy Eating Index (HEI) scores for adults in low-income households that do and do not participate in SNAP, taking factors into account that could influence both SNAP participation and diet quality. HEI measures survey respondents' adherence to dietary guidance (as detailed in the 2005 Dietary Guidelines for Americans) and is USDA's primary tool for monitoring the diet quality of the U.S. population.

What Did the Study Find?

The evidence as to whether SNAP participation is beneficial or adverse regarding diet quality is inconclusive. Nevertheless, two sets of observations emerge from the study.

First, the study shows the effects of SNAP participation on those who choose to participate. SNAP increases the likelihood that participants will consume whole fruit by 23 percentage points; it also induces participants to decrease their intake of dark green/orange vegetables by a modest amount—the equivalent of about 1 ounce for a 2,000-calorie diet.

These effects could be the result of both time constraints associated with SNAP's work requirements and extra income—people participating in SNAP may see whole fruit as more affordable with a little extra income, and they may consume more of it because it requires no preparation time. At the same time, dark green/orange vegetables could be less attractive to SNAP participants because these foods may require more preparation time. Moreover, this could also be due to the substitution of one convenient snack food for another—apples or bananas for baby carrots, for example.

The study also revealed a difference in diet quality between SNAP participants and low-income nonparticipants once the effects of SNAP and other unobserved characteristics are taken into account. For most components of diet (e.g., fruits,

vegetables, whole grains) measured by HEI scores, SNAP participants are at a small, statistically significant disadvantage in terms of diet quality relative to comparable nonparticipants. SNAP participants' total HEI score was about 1.25 points (about 2.5 percent) lower than that for similar nonparticipants. In terms of dietary components, this difference amounts roughly to a half a cup of fruit, two-thirds of a cup of vegetables, or 1-1/3 ounces of whole grain products. At the same time, SNAP participants do better on some aspects of diet; for example, they eat less sodium and saturated fat than nonparticipants.

How Was the Study Conducted?

The study used a unique data set that took HEI scores based on responses from four waves of the National Health and Nutrition Examination Survey (NHANES) and matched them to State-level policies (eligibility/poverty thresholds and vehicle exemption allowances) that affect SNAP participation. These State-level variables identify the effect of SNAP participation on HEI total and component scores. The study used a model that accounts for unobserved, individual-level differences in diet quality that affect the likelihood of SNAP participation.

Introduction

The Supplemental Nutrition Assistance Program (SNAP, formerly the Food Stamp Program) is the largest food assistance program administered by the Food and Nutrition Service (FNS) of the U.S. Department of Agriculture (USDA). Approximately 47 million persons participated in SNAP in 2012, at a cost of almost $75 billion. One goal of SNAP is to minimize food insecurity—uncertain access to enough healthy, nutritious food for an active life—by providing low-income households with the resources to purchase food. Recent research shows that SNAP is effective at accomplishing this aim (DePolt et al., 2009; Mykerezi and Mills, 2010; Nord and Golla, 2009; Nord and Prell, 2011; Yen et al., 2008). Indeed, some estimates indicate that SNAP reduces food insecurity by between 33 and 40 percent (Ratcliffe et al., 2011; Shaefer and Gutierrez, 2012) at any given time.

Another goal of SNAP is to improve the quality of low-income families' diets. This aspect of the SNAP program has received public attention recently due to heightened awareness of the high prevalence of obesity; diabetes; high blood cholesterol; and other chronic, diet-related illnesses for which the public bears a sizeable cost. Suggestions that SNAP participants be prevented from using benefits to purchase certain foods perceived to contribute to poor dietary health—sugar-sweetened beverages, for example—highlight these concerns. Additionally, the FNS, aware that food assistance programs need to help address the high prevalence of obesity, is piloting a program that offers financial incentives for the purchase of healthy foods—the Healthy Incentives Pilot (HIP).[1] The Wholesome Wave Double Value Coupon Program, a privately funded program that offers SNAP participants incentives to buy from local farmers' markets, also seeks to improve diet quality through SNAP participation.[2]

Although public attention has only recently focused on the quality of SNAP participants' diets, this question has been the subject of much social science research over the last 30 years (Fox et al., 2004). Much of the literature has found no change in diet quality associated with SNAP (or Food Stamp Program) participation.[3] A few studies have found that the program is associated with improved nutritional intakes (Devaney and Moffitt, 1991; Wilde et al., 1999), and a few have found association with poorer intakes (Butler and Raymond, 1996; Yen, 2010).

The policy question is increasingly relevant, however. Recent research has consistently shown that SNAP participation reduces food insecurity. Changes to the basket of foods eligible for SNAP purchase— excluding sugar-sweetened beverages, for example—could change the mix of households who select into the program and alter its effectiveness at reducing food insecurity. At the same time, there is a legitimate question to be asked about whether SNAP does all it can to improve nutritional quality and access to calories. For example, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), which offers vouchers for a

[1]Information on the Healthy Incentives Pilot design, as well as plans for evaluation, is at http://www.fns.usda.gov/snap/hip/info.htm.

[2]Information on the Wholesome Wave Double Coupon Program is at http://wholesomewave.org/dvcp/.

[3]Throughout, we refer to the Supplemental Nutrition Assistance Program when discussing earlier studies, although almost all previous research refers to the Food Stamp Program.

narrow range of food products, has effected modest improvements in diet outcomes for children (Yen, 2010).

Getting an unbiased estimate of the effect of SNAP on diet quality has been difficult. It is reasonable to think that households that choose to participate in SNAP are systematically different from similar low-income households that do not. Researchers, however, do not observe these differences, and they may be correlated with diet quality. For example, households that participate in SNAP might value food and nutrition more than similar households that do not participate in the program. In this case, conventional methods for estimating the effect of SNAP on diet quality will overestimate the effects of SNAP because SNAP participants' diets are likely already better than similar nonparticipants' diets anyway. On the other hand, households that participate in SNAP may have lower quality diets due to unobserved preferences that are correlated with SNAP participation. In this situation, conventional methods would underestimate the effect of SNAP on diet quality.

This study uses new data to address this problem directly. It examines the effect of SNAP participation on adults' diet quality by using individual-level data on Healthy Eating Index (HEI) scores from the National Health and Nutrition Examination Survey (NHANES) matched to State-level policy data that capture variation in SNAP eligibility criteria. These policies change the eligibility criteria for, and cost of, enrolling in SNAP. In particular, we use indicators for whether States have adopted two policies: broad-based categorical eligibility, which generally makes any family that qualifies for Temporary Assistance to Needy Families (TANF) eligible for SNAP; and whether the State exempts one vehicle per household from SNAP asset tests. SNAP participation is strongly related to both these variables; moreover, it is unlikely that these variables are related to diet quality or HEI except through SNAP. The two variables offer the possibility of identifying SNAP participation independent of the unobserved household characteristics (unobservables) that also affect diet quality.

Background and Previous Research

Studies of the effect of SNAP on diet have examined a wide range of outcomes, including food expenditures, nutrient availability, adherence to USDA dietary guidance, food group servings, nutrients (macro and micro), body weight, source of food (at-home or away-from-home), and summary measures such as HEI. SNAP likely affects all of these outcomes because it increases income available for food-at-home (FAH) purchases by participants. Standard economic theory tells us that such increases in income ought to increase consumption of food, if food is a normal good and the amount of SNAP benefits does not exceed the household's regular food budget (i.e., what the household would usually spend on food without SNAP).[4]

Whether we should expect the nutritional quality of SNAP participants' diets to be improved with extra income depends on a host of assumptions about everything from the relative prices of "healthy" foods to the effect of SNAP on time spent on food acquisition and preparation. For example, if we assume that "healthy" foods are more expensive on a per-calorie basis than "unhealthy" ones, and that consumers buy and consume food on that basis (i.e., price-per-calorie), *and* that "healthy" foods are a normal good, then, all other things equal, SNAP should have an unequivocally positive effect on diet quality (Drewnowski and Specter, 2004; Drewnowski and Darmon, 2005). However, it is not clear that people consume food on this basis, nor is it clear that it is a meaningful way to characterize food prices (Burns et al., 2010; Carlson and Frazao, 2012). Some research has shown that increases in income effect very little change in consumption patterns up through the middle of the income distribution (Frazao et al., 2007). Moreover, market prices do not capture the time component of food price, which will be significant for SNAP households subject to work requirements[5] and for whom the time-cost of preparing foods consistent with dietary guidance is not trivial (Davis and You, 2010).[6]

A comprehensive review of the literature concerned with the effect of food and nutrition programs and SNAP, particularly on diet and health outcomes, has been completed by researchers in collaboration with the Economic Research Service (ERS) of the USDA (Fox et al., 2004). The authors of this study examined a wide range of diet-related outcomes and found that, for studies published between 1973 and 2002, there was little evidence of a significant association between SNAP and individual dietary intake. This was true for all of the outcomes they examined. Moreover, none of the studies reviewed addressed the selection problem (i.e., the

[4]However, research has consistently found that the marginal propensity to consume (MPC_f) food out of Supplemental Nutrition Assistance Program (SNAP) benefits is higher than out of ordinary income, so anomalies in spending and consumption patterns may be present. In other words, while theory suggests that people ought to spend SNAP benefits as cash, empirical work has found that they may spend more on food when extra income comes in the form of SNAP benefits than when it comes from a simple cash increase in their budget. For a discussion of the literature on MPC_f, see Meyerhoefer and Yang (2011).

[5]In general, able-bodied adults between 16 and 60 must register for work, accept suitable employment, or participate in job training in order to qualify for the Supplemental Nutrition Assistance Program.

[6]The Thrifty Food Plan, the least expensive of USDA-produced food plans, specifies types and amounts of foods that provide adequate nutrition for a family of four. However, the estimated cost of the Thrifty Food Plan does not include the time cost of preparation.

problem that unobservable characteristics probably influence both SNAP participation and diet choices).[7]

Two recent studies have tackled the selection problem for food assistance programs. Yen (2010) used multi-equation maximum likelihood to examine the effect of SNAP and WIC participation on five nutrition outcomes of children and found that SNAP had a small negative effect on the fiber intake of children. Deb and Waehrer (2012) used instrumental variables to identify the effect of SNAP participation on food intakes, particularly the mix of convenience foods and other foods consumed away from home, focusing on how SNAP might affect the time available for household food production. The study used data from the American Time Use Survey (ATUS) to estimate the amount of time that SNAP participants spent on food preparation and stratified the results by employment status. Additionally, the authors used NHANES data to examine intakes of convenience foods (at-home and away-from-home) and carbonated and sweetened beverages (CSB). Their results suggest that, for part-time workers, SNAP increased the amount of time available for household food production, but that these increases did not yield better diet quality. The study also found that part-time workers who participated in SNAP consumed significantly more calories from CSBs and fewer calories from fruits and vegetables but that this was not true for full-time workers.

This study differs from Yen (2010) in that we look at adult diet outcomes and use policy variables, rather than the choice of distribution for the unobservables alone, to identify the effects of SNAP; it differs from Deb and Waehrer (2012) because we look directly at nutrient composition as represented by the HEI score. We adopt a strategy that has been used in the recent literature (particularly, Yen et al., 2008; Ratcliffe et al., 2011; and Mykerezi and Mills, 2010) on the effect of SNAP on food insecurity—namely, using State variation in SNAP policies to better identify and isolate the effect of SNAP participation.[8] This study adds value by using exogenous State variables to examine the nutritional effects of SNAP on adults as measured by the HEI.

[7]The review does mention a few studies of cash-out experiments (wherein some Supplemental Nutrition Assistance Program participants receive cash for their benefits instead of a book of stamps or an Electronic Benefit Transfer card); these experiments examine aspects of food spending, rather than nutrient intake or other dietary outcomes.

[8]As in Shaefer and Gutierrez (2012), we also find that the functional form of our model helps to identify the effect of the Supplemental Nutrition Assistance Program.

Methods

In addition to describing the unconditional differences in food intakes for SNAP participants and nonparticipants, we estimate two econometric models. First, we show the results of a simple econometric model of the effect of SNAP on a given diet outcome, which looks like

$$y_i = X_i\beta + SNAP_i\delta_{OLS} + \varepsilon_i, \quad (1)$$

where *i* indexes an individual, *X* is a vector of individual- and household-level attributes, y is total HEI or HEI component, and *SNAP* is an indicator for whether or not a sample respondent participates in SNAP.[9] This is the ordinary least squares (OLS) model, which gives us conditional associations between SNAP receipt and diet outcomes. However, in the presence of unobservables correlated with SNAP receipt, estimates of the coefficient δ_{OLS} will be biased because they will include information not only on the effect of SNAP, but also on the effect of the unobservables correlated with both SNAP participation and diet quality. Because we believe that diets and SNAP participation are chosen together, we estimate the following model:

$$\begin{aligned} y_i &= X_i\beta + SNAP_i\delta_S + \varepsilon_i, \\ SNAP_i^* &= Z_i\gamma + X_i\theta + u_i, \quad (2) \end{aligned}$$

where *Z* are exogenous variables that identify SNAP participation, *SNAP** is a latent index for the probability of enrolling in SNAP (measured by a binary indicator), and δ_s is the marginal effect of SNAP, independent of the unobservables. Finally, ε and u, the unobservables in each equation, have a bivariate normal distribution with covariance matrix

$$\begin{matrix} \sigma^2 & p\sigma \\ p\sigma & 1 \end{matrix}$$

In this context, ρ is the estimate of the correlation between the unobservables in the two equations. We obtain estimates by using maximum likelihood.[10]

While this model is theoretically identified by the specification of functional form that characterizes the joint distribution of ε and u, we use State-level policy variables, *Z*, to identify variation in SNAP participation. In order for these variables to be valid instruments for SNAP participation, they should be correlated with SNAP receipt and uncorrelated with HEI scores. The first condition can be tested, and we show the results of the instrument tests in this report. The second is not subject to

[9]We focus on participation (the extensive margin) rather than the amount of the Supplemental Nutrition Assistance Program (the intensive margin) because the modeling problems are quite distinct. The unobservables problem, with respect to the amount of benefits, is more complicated because it involves more decisions, including labor force participation and household size.

[10]All models and estimates of standard errors take into account survey design information using Stata survey procedures. All models are weighted using the dietary day one sample weight (WTDRD1).

empirical verification; however, it seems unlikely that laws that change the cost to access SNAP would be correlated with individual HEI scores.

In the OLS model, δ_{OLS} estimates the effect of SNAP on HEI but also captures the effect of unobservables correlated with choosing SNAP. The selection model isolates the unobservables so that δ_S shows the marginal effect of SNAP on diet outcomes. The total expected difference in HEI scores in this model, also called the average treatment effect (ATE), is

$$\mu_i = \delta_S + \sigma\rho\left[\frac{\varphi(Z_i\gamma + X_i\theta)}{\Phi(Z_i\gamma + X_i\theta) * \left[1 - \Phi(Z_i\gamma + X_i\theta)\right]}\right], \quad (3)$$

where φ and Φ are the standard normal density function and cumulative distribution function, respectively. The intuition here is that, absent a selection effect—that is, if the correlation between unobservables in the two equations (ρ) is zero—the marginal effect could be read off of the coefficient δ_{OLS} in the OLS model; in much of the literature that uses participant/nonparticipant comparisons, this is what is estimated. But, if ρ is non-zero, δ_{OLS} will estimate the expected difference—including the selection *and* treatment effects. Here, in order to address the selection effect, we use the coefficient δ_S plus the expected difference in the value of the error terms, conditional on participation status, to estimate the expected differences in diet quality over SNAP participation status. The coefficient δ_S represents the difference that SNAP participation itself makes in diet quality for those who participate. (For a fuller treatment of this topic, see Greene (2011).) We calculate the standard errors of the ATE (as shown in equation 3) using the delta method.[11]

[11] Let $\alpha \equiv [\gamma, \theta]$; the standard error of the marginal effects is $v_\mu = \sqrt{\frac{\partial_u}{\partial_\alpha} V \frac{\partial_\mu{}'}{\partial_\alpha}}$, where V is a variance-covariance matrix of the treatment equation.

Data

National Health and Nutrition Examination Survey (NHANES)

We use data from four waves of the National Health and Nutrition Examination Survey (NHANES): 2001-02, 2003-04, 2005-06, and 2007-08. NHANES is a stratified, multistage probability sample of the civilian, non-institutionalized U.S. population. NHANES oversamples Blacks, Mexican-Americans (Hispanics after 2006), people over 60, and low-income people.[12] The survey consists of a series of initial interviews, usually conducted at the participants' homes, and a subsequent health examination completed at a Mobile Examination Center (MEC). We use the design information from the survey (primary sampling units and sample weights) to make unbiased population-level estimates.

Our primary outcome variable is HEI score. The HEI score was developed by researchers at the Center for Nutrition Policy and Promotion (CNPP) and the National Cancer Institute (NCI) (Guenther et al., 2007). The index measures an individual's adherence to the recommendations in the 2005 Dietary Guidelines for Americans, which translate into recommendations by MyPyramid (now MyPlate).[13] The HEI is the sum of the scores for 12 dietary elements: total fruit; whole fruit; total vegetables; dark green/orange vegetables and legumes; total grains; whole grains; milk; meat/beans; oils; saturated fat; sodium; and solid fats, alcohol, and added sugar (SoFAAS).

Scores for all of the food groups (i.e., total fruit, vegetables, etc.) and oils are based on intake adequacy on a per-1,000-calorie basis: people with no intakes receive a score of zero, while those with intakes that meet or exceed MyPlate recommendations get the maximum score. Intakes between zero and MyPlate recommendations receive scores prorated on a linear basis. For example, if someone eats half of the recommended daily amount of whole grains, that person receives half the maximum whole grains score—2.5. Scores for saturated fat, sodium, and SoFAAS are scaled according to the recommendations for limiting discretionary calories.[14] For example, for saturated fat, respondents get a score of 0 if they exceed 15 percent of calories from saturated fat, a score of 8 if they get less than 10 percent of their calories from saturated fat (which meets the 2005 dietary guidelines), and a score of 10 if they get less than 7 percent of their calories from saturated fat. The maximum score was assigned to those who had intakes below an amount recommended by relevant research. Therefore, for the total and all component scores, a high score indicates superior nutrient intake.

[12]Some changes to the sampling frame occurred between 2005-06 and 2007-08. The latter survey oversampled the entire Hispanic population, instead of just Mexican-Americans. In addition, the over-sample of pregnant women and adolescents during 2001-06 was discontinued. For more information, see http://www.cdc.gov/nchs/nhanes/nhanes2007-2008/generaldoc_e.htm.

[13]MyPlate is a USDA nutrition guide that displays the amounts and types of food an individual should consume per meal. More information on MyPlate is at http://www.choosemyplate.gov/.

[14]As there is no natural value for a zero score, researchers use the 85th percentile value of intakes from the dietary component of the National Health and Nutrition Examination Survey 2001-02.

The weighting of each component score for the final score is based on its importance to the overall view of the dietary recommendations. Total fruit, whole fruit, total vegetables, dark green/orange vegetables and legumes, total grains, and whole grains are all worth 5 points in the final scale; milk, meat/beans, oils, saturated fat, and sodium are worth 10 points; SoFAAS is worth 20 points. For more detail on the construction of the HEI scores, see Guenther et al. (2007).

Survey respondents in NHANES received an HEI score based on their 24-hour dietary recall data; separate scores were calculated for each of the 2 days. We use only the first day of the interview because the second day has a higher rate of nonresponse, and because people consistently report less consumption on the second day (which suggests under-reporting or survey fatigue). Each of the foods reported in the dietary recall is matched to nutrient and food group equivalents through the My Pyramid Equivalents Database (MPED), and HEI scores are constructed from that information.[15]

The independent variable is household SNAP participation. Since we wanted to measure the effect of SNAP on diet intake, and because the intake survey pertains to a single day's food consumption, we counted only those currently receiving SNAP as SNAP participants.[16] However, the SNAP participation variable is coded slightly differently across NHANES waves. In the 2001-02, 2003-04, and 2005-06 waves, the survey asks the respondent if the sample person is currently authorized to receive SNAP; we counted anyone who responded in the affirmative as a SNAP participant. In the 2007-08 wave, the survey initially asks the sample respondent whether anyone in the household has received SNAP benefits in the last 12 months, and then asks how long it has been since the household last received SNAP benefits. We counted as current participants anyone who responded that they (or someone in the household) had received their last benefits within the most recent 30 days. To check the robustness of our results, we also estimated models counting persons in households that received SNAP benefits in the last 12 months.

One difficult aspect of modeling the effect of SNAP on diet outcomes is the role of body weight and/or body mass index (BMI). It is difficult to argue against the idea that diet choices are informed by one's weight history; however, extant literature generally looks at the effect of SNAP on BMI, rather than BMI on SNAP. (For reviews of this literature, see Zagorsky and Smith (2009) and Ver Ploeg and Ralston (2008).) We have included self-reported weight lagged 1 year in the treatment and outcome equations, assuming that one's past weight affects current diet choices. Using current BMI alone, or with lagged weight, did not change the results.[17]

---

[15]It is an open question as to whether using the second day would introduce measurement error or bias into the results. It is possible that people are more likely to misreport their eating on the second day because the recall is taken over the phone. That might introduce measurement error, but not necessarily bias. On the other hand, it might be that people misreport in order to seem healthier on the second day, or that people actually do eat less on the second day to seem healthier. These would both introduce bias into the estimates, although it is not clear whether either is necessarily happening.

[16]The first day dietary recall survey is completed in the National Health and Nutrition Examination Survey Mobile Examination Center and is administered approximately 10 days after the household interview.

[17]Parameters for the treatment equation are shown in Appendix table A.1.

To address sample selection meaningfully, we need to include persons in households that are not automatically income eligible—that is, that have gross income below 130 percent of the Federal poverty line—but who might be on the margin of participating in SNAP. Because of the relaxation of eligibility requirements for SNAP in many States, and because persons in households with gross incomes above 130 percent of the Federal poverty line might qualify for SNAP, we include persons in households with slightly higher incomes here—up to 200% of the Federal poverty line.[18] These households help identify the effect of SNAP by representing both participating and potentially nonparticipating households in our sample.[19]

Exogenous Variables

One of the obstacles to getting good estimates of the effect of SNAP on diet outcomes is the selection issue. One method for addressing this issue is the treatment effects strategy. To identify the selection effects of interest, we need variables that are not correlated with HEI score, but are meaningfully correlated with SNAP participation. The exogenous variables that we use capture State-level policy variation in eligibility criteria for SNAP participation, but the policies are unlikely to be related to HEI scores except through SNAP participation. These data come from the database of SNAP eligibility rules compiled by researchers at ERS and linked to geo-coded NHANES data supplied by the National Center for Health Statistics (NCHS). We use indicator variables for whether or not the State used broad-based categorical eligibility rules to determine SNAP eligibility and whether or not the State exempted one vehicle from asset tests to determine SNAP eligibility. These two variables are positively associated with SNAP participation—in other words, if an individual lives in a State with broad-based categorical eligibility rules, or if the State exempts one vehicle from the SNAP asset tests, then there is a greater likelihood that this individual will participate in SNAP. At the same time, these policies are not likely to be related to individual food choices, except through their effect on SNAP participation.

There is considerable cross-State and cross-time variation in these policies. In 2001, Delaware, Maine, Maryland, Massachusetts, Michigan, North Dakota, Oregon, South Carolina, and Texas had broad-based categorical eligibility policies in place. Washington and Wisconsin added them in 2004; Minnesota and Arizona added them in 2006 and 2007, respectively; and Georgia and West Virginia added them in 2008. In 2001, Alaska, Arkansas, Colorado, Connecticut, Montana, Nevada, New York, Pennsylvania, and South Dakota had vehicle exemption policies in place. Virginia added this policy in 2002, Iowa in 2004. This study observed 34 unique States, 12 of which had one or the other of these policies

---

[18]We are aware that, between 2002 and 2008, 11 States raised gross income limits above the 130-percent cutoff (AZ, DE, MD, MA, NC, WA, WI-200 percent; ME, OR-185 percent; MN, TX-165 percent), using options under the broad-based eligibility rules. Nonetheless, there are few households over 200 percent of the Federal poverty line that report Supplemental Nutrition Assistance Program (SNAP) receipt in our sample; the majority of households are still subject to the 130-percent constraint in applying for SNAP. In addition to the income restriction, we restrict the sample to those at least 19 years old.

[19]It is important to include those who have annual incomes above the nominal income cutoff because there is considerable intra-year income volatility for low-income households. This volatility could render them eligible for part of a year. See Newman (2006) and Newman and Joliffe (2009).

during the time of the study.[20] We use the variation across States to identify SNAP participation, and we use time-varying State-level characteristics—unemployment rate, gross State product, State per capita income, and State spending on nutrition education—to adjust for time trends in State-level factors that may be correlated with SNAP participation.[21]

[20]Because of the confidential nature of the data, we cannot determine the actual State in which the respondent resides. We do, however, have masked State identifiers that allow us to count the number of States in the sample.

[21]In our sample, even though participants are matched to States by month and year, we do not observe the month or year that respondents are in the sample, so we cannot directly control for time effects. We have estimated all of the models using wave dummies to control for time variation; those estimates are identical to those we show, which control for State-level, time-varying economic characteristics.

Results

Sample Means for Supplemental Nutrition Assistance Program (SNAP) Participants and Nonparticipants

In our sample, SNAP households are more likely to be non-Hispanic Black (table 1). By many measures, SNAP households are significantly more disadvantaged than nonparticipant households. They have lower incomes, are more likely to be high school dropouts, and are less likely to have a college degree. Respondents from SNAP households are less likely to have been employed in the previous week and less likely to be married; they are younger, on average, and have higher self-reported weight a year before their interview. The States that SNAP participants live in are, on average, poorer, although they show no difference in unemployment rates. SNAP participants are more likely to live in States that have broad-based categorical eligibility policies.

Healthy Eating Index (HEI) Scores by SNAP Participation

The only HEI component scores on which SNAP participants do better are saturated fat and sodium, although only the latter is statistically significant (table 2). People in SNAP households have lower scores for total fruit; whole fruit; total vegetables; dark green/orange vegetables; total grain; whole grain; milk; and solid fats, alcohol, and added sugar (SoFAAS). Most of the differences are small—less than 1 point—although the difference in SoFAAS scores is 1.5 points, which is unsurprising as it is the largest component score of all.

Ordinary Least Squares (OLS) results

The coefficients (which represent δ_{OLS} from equation (1)) in table 3 are estimates of the association of HEI scores for respondents in SNAP households relative to those not in SNAP households, with all other observed determinants accounted for.[22] This coefficient captures both the effect of SNAP and the selection effect on diet quality. The model's determinants are ethnicity (Hispanic, non-Hispanic), race (White, Black, other), educational achievement (high school dropout, high school graduate, some college, college graduate), marital status (married/unmarried), age, annual household income, self-reported weight 1 year prior, employment status (employed/unemployed), household size, gross State product, State per capita income, State spending on nutrition education per poor person, current unemployment rate, 1-year lagged unemployment rate, and State fixed effects.[23]

[22]Although our main results pertain to adults in the Supplemental Nutrition Assistance Program households, we use individual-level (instead of household-level) weights (WTDRD1, the dietary day one sample weight) in all of the models, since the individual-level Healthy Eating Index score is the outcome of interest.

[23]We used the race/ethnicity recode variable in the National Health and Nutrition Examination Survey to assign racial/ethnic status. We have run all of the models with gender dummies and found no difference in the results, so we omit that from our empirical specification.

Table 1

Sample means for Supplemental Nutrition Assistance Program (SNAP) participants and nonparticipants

	Non-SNAP	SNAP
White	0.601	0.494
	0.020	0.054
Hispanic	0.204	0.199
	0.020	0.032
Black	0.126	0.293***
	0.012	0.028
Other race	0.046	0.030**
	0.006	0.005
High school dropout	0.330	0.434***
	0.014	0.018
Some college	0.280	0.245
	0.013	0.018
College graduate	0.097	0.036***
	0.008	0.005
Annual household income ($000’s)	19.929	14.478***
	0.322	0.388
Age	46.837	39.728***
	0.521	0.576
Married	0.536	0.412***
	0.014	0.025
Employed	0.507	0.383***
	0.012	0.019
Body weight, lagged	172.531	179.369***
	1.010	1.999
Household size	3.115	3.587***
	0.057	0.081
Gross State product ($Billions)	519.201	440.895***
	36.435	27.509
State per capita income ($000's)	33.966	34.199
	0.393	0.572
Nutrition education, $ per poor person	6.062	5.429*
	0.436	0.338
Current unemployment rate	5.258	5.291
	0.113	0.124
Lagged unemployment rate	5.068	5.080
	0.092	0.117
Broad-based categorical eligibility	0.172	0.202*
	0.032	0.037
One vehicle per SNAP unit exempt	0.103	0.133
	0.028	0.030
N	5,053	1,615

Note: 200 percent of Federal poverty line, estimation sample. *p<.10, **p<.05, ***p<.01 denote significance of differences in the sample means between SNAP participants and nonparticipants. Standard errors, adjusted for sample design, in parenthesis. These are means for the regression estimation sample, for which there are no missing values. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

Table 2
Healthy Eating Index (HEI) scores by Supplemental Nutrition Assistance Program (SNAP) participation

	Non-SNAP	SNAP	Difference
HEI total	51.297	47.220	-4.077***
	(0.444)	(0.530)	(0.799)
Total fruit	2.116	1.685	-0.431***
	(0.062)	(0.078)	(0.114)
Whole fruit	1.931	1.311	-0.620***
	(0.061)	(0.061)	(0.087)
Total veg	2.973	2.696	-0.277***
	(0.037)	(0.071)	(0.088)
Dark green/orange veg (DKGOrVeg)	1.190	0.925	-0.265***
	(0.047)	(0.059)	(0.088)
Total grain	4.262	4.080	-0.183***
	(0.027)	(0.045)	(0.048)
Whole grain	0.938	0.647	-0.291***
	(0.035)	(0.032)	(0.051)
Milk	4.778	4.201	-0.577***
	(0.096)	(0.135)	(0.166)
Meat/Beans	8.214	7.991	-0.224*
	(0.062)	(0.099)	(0.122)
Oils	5.360	5.267	-0.092
	(0.070)	(0.132)	(0.161)
Saturated fat	5.926	6.021	0.095
	(0.078)	(0.129)	(0.141)
Sodium	4.197	4.494	0.297**
	(0.070)	(0.101)	(0.127)
Solid fats, alcohol, and added sugar (SoFAAS)	9.412	7.902	-1.510***
	(0.199)	(0.227)	(0.366)
N		6,668	

Note: *** p<0.01, ** p<0.05, * p<0.1 denote significance of differences in the sample means between SNAP participants and nonparticipants. Standard errors, adjusted for complex survey design, in parenthesis. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

SNAP participants have lower HEI scores (on total and most component scores) than nonparticipants, as seen from the coefficients from an OLS regression of HEI score or component scores on determinants of HEI score. The total score—as well as the scores for whole fruit, total grains, milk, and meat/beans—are all significantly lower for participants than for nonparticipants. The differences in the other component scores are insignificant.

The results, however, do not address selection into SNAP; that is, they do not isolate the effect of those unobserved variables that correlate with both SNAP and HEI. We address this shortcoming in the results of our preferred models (shown in tables 4-10).

Table 3

Association of Supplemental Nutrition Assistance Program (SNAP) with Healthy Eating Index (HEI) scores: Ordinary Least Squares regression results

	HEI	Total fruit	Whole fruit	Total veg	Dark green/ orange veg	Total grain	Whole grain
SNAP	-1.280*	-0.111	-0.242**	-0.088	-0.096	-0.137*	-0.089
	(0.767)	(0.111)	(0.121)	(0.101)	(0.083)	(0.079)	(0.062)

	Milk	Meat/Beans	Oils	Saturated fat	Sodium	SoFAAS	N
SNAP	-0.323*	-0.402***	-0.042	0.256	0.264	-0.271	6,668
	(0.172)	(0.145)	(0.198)	(0.232)	(0.164)	(0.326)	

SoFAAS = Solid fats, alcohol, and added sugar

Note: *** p<0.01, ** p<0.05, * p<0.1. Standard errors, adjusted for complex survey design, in parenthesis. Dependent variable at the top of each column. Other regressors include race/ethnicity, education, annual income, age, marital status, lagged body weight, employment status, household size, gross State product, State per capita income, State unemployment rate, State unemployment rate lagged 1 year, State spending on nutrition education per poor person, and State fixed effects. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

Results From Model Accounting for Selection Into SNAP

Determinants of SNAP Participation

Table 4 shows coefficients from the second equation of model (2) outlined above, which estimates the probability of SNAP participation and measures the effect of person, household, and State characteristics on this probability. Because this is a probit equation[24], the coefficients let us know the direction of the effect on the probability of SNAP receipt, but the magnitude and significance cannot be read directly off of them or their standard errors. The results show that Blacks are more likely to be enrolled in SNAP than Whites (the reference group). Those with less education are more likely to participate in SNAP, respondents who were employed in the last week are less likely to be in SNAP households, and married persons are less likely to be enrolled in SNAP. Of the State-level variables, only lagged unemployment rate has a significant effect on the probability of SNAP enrollment. Having a higher self-reported weight 1 year prior to the interview increases the likelihood of SNAP participation by a small, but statistically significant, amount.

The policy variables are strongly correlated with observed participation: persons in States that have adopted expanded categorical eligibility and vehicle exemption policies are more likely to participate in SNAP. However, the correlation is not as strong as we might have assumed. We discuss this below.

Effect of SNAP on Diet Quality of Participants

For all but a few outcomes, SNAP has no discernible effect on consumption as measured by HEI scores, as shown in the estimates of δ_S displayed in table 5. This coefficient measures the effect of SNAP on HEI total and component scores for people who choose to participate in the program. The effect of SNAP on whole fruit consumption, however, is large, significant, and positive, and the effect on dark green/orange vegetable consumption is small, significant, and negative.

The values of the correlation parameter, ρ, (in table 5) estimate the association between the unobservables in the treatment and outcome equations. For most HEI components, this parameter is small, positive, and insignificant—that is, there is little correlation between selection into SNAP and diet quality "before"[25] adults in this low-income sample enroll in SNAP. This parameter is significant for the models that examine whole fruit and dark green/orange vegetables. It is large and negative for the whole fruit model, suggesting that adults who are likely to enroll in SNAP are less likely to eat whole fruit to begin with. The correlation coefficient is smaller

[24]A probit model is used to isolate the effect of factors on a variable that is a 0/1 outcome (such as Supplemental Nutrition Assistance Program participation). The magnitudes and, to a lesser extent, significances of the associations of the determinants of participation cannot be read off these coefficients because it is a non-linear model.

[25]Our model is not able to determine what Supplemental Nutrition Assistance Program (SNAP) participants consumed before they participated in SNAP. However, it does tell us something about the correlation between the unobservables—e.g., people most likely to participate in SNAP are less likely to consume a lot of whole fruit.

Table 4

Determinants of Supplemental Nutrition Assistance Program (SNAP) participation, main model

	HEI	Total fruit	Whole fruit	Total veg	DkGOrVeg	Total grain	Whole grain
Hispanic	-0.087	-0.091	-0.117	-0.072	-0.085	-0.087	-0.087
	(0.111)	(0.109)	(0.092)	(0.112)	(0.108)	(0.109)	(0.110)
Black	0.501***	0.498***	0.445***	0.513***	0.507***	0.501***	0.503***
	(0.088)	(0.086)	(0.081)	(0.089)	(0.085)	(0.087)	(0.087)
Other race	-0.195	-0.202	-0.233*	-0.166	-0.152	-0.195	-0.207
	(0.142)	(0.144)	(0.138)	(0.147)	(0.145)	(0.140)	(0.145)
High school dropout	0.221***	0.223***	0.180***	0.220***	0.219***	0.221***	0.229***
	(0.064)	(0.064)	(0.061)	(0.063)	(0.063)	(0.064)	(0.067)
Some college	-0.027	-0.018	0.021	-0.033	-0.030	-0.026	-0.021
	(0.091)	(0.093)	(0.086)	(0.091)	(0.090)	(0.090)	(0.091)
College graduate	-0.446***	-0.455***	-0.450***	-0.447***	-0.461***	-0.444***	-0.432***
	(0.144)	(0.140)	(0.122)	(0.144)	(0.148)	(0.142)	(0.143)
Annual household income ($000's)	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.015***	-0.015***	-0.014***	-0.015***	-0.015***	-0.015***	-0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Married	-0.396***	-0.398***	-0.359***	-0.396***	-0.399***	-0.399***	-0.395***
	(0.069)	(0.070)	(0.061)	(0.070)	(0.070)	(0.069)	(0.069)
Body weight, lagged	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Employed	-0.493***	-0.489***	-0.420***	-0.502***	-0.506***	-0.494***	-0.495***
	(0.062)	(0.062)	(0.055)	(0.061)	(0.062)	(0.062)	(0.062)
Household size	0.124***	0.124***	0.120***	0.124***	0.124***	0.124***	0.122***
	(0.025)	(0.025)	(0.024)	(0.025)	(0.025)	(0.025)	(0.025)
Gross State product ($Billions)	0.000*	0.000**	0.000	0.000*	0.000**	0.000*	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
State per capita income ($000's)	0.060***	0.061***	0.057***	0.063***	0.060***	0.060***	0.061***
	(0.020)	(0.019)	(0.020)	(0.020)	(0.020)	(0.019)	(0.019)
Nutrition education, $ per poor person	0.012	0.012	0.011	0.013	0.012	0.013	0.011
	(0.027)	(0.027)	(0.025)	(0.028)	(0.027)	(0.028)	(0.027)
Current unemployment rate	0.014	0.020	0.059	0.013	0.012	0.015	0.009
	(0.074)	(0.071)	(0.056)	(0.069)	(0.069)	(0.070)	(0.069)
Lagged unemployment rate	0.069	0.068	-0.005	0.078	0.071	0.068	0.075
	(0.051)	(0.051)	(0.048)	(0.052)	(0.049)	(0.050)	(0.050)
Broad-based categorical eligibility	0.294**	0.287*	0.289**	0.290**	0.286**	0.284**	0.276**
	(0.149)	(0.151)	(0.126)	(0.136)	(0.146)	(0.144)	(0.141)
Vehicle exempt	0.340	0.319	0.281	0.364	0.360	0.317	0.393
	(0.291)	(0.294)	(0.209)	(0.296)	(0.276)	(0.275)	(0.299)
N				6,667			

—continued

Table 4

Determinants of Supplemental Nutrition Assistance Program (SNAP) participation, main model—Continued

	Milk	Meat/Beans	Oils	SatFat	Sodium	SoFAAS
Hispanic	-0.086	-0.088	-0.084	-0.085	-0.086	-0.085
	(0.109)	(0.109)	(0.109)	(0.111)	(0.109)	(0.110)
Black	0.500***	0.501***	0.501***	0.501***	0.501***	0.503***
	(0.087)	(0.087)	(0.087)	(0.086)	(0.087)	(0.087)
Other race	-0.191	-0.196	-0.187	-0.200	-0.198	-0.187
	(0.142)	(0.141)	(0.146)	(0.139)	(0.138)	(0.143)
High school dropout	0.222***	0.220***	0.222***	0.221***	0.221***	0.221***
	(0.064)	(0.064)	(0.065)	(0.064)	(0.064)	(0.064)
Some college	-0.028	-0.027	-0.025	-0.029	-0.026	-0.029
	(0.090)	(0.090)	(0.090)	(0.090)	(0.090)	(0.090)
College graduate	-0.443***	-0.442***	-0.442***	-0.431***	-0.447***	-0.443***
	(0.144)	(0.143)	(0.141)	(0.156)	(0.142)	(0.145)
Annual household income ($000's)	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.015***	-0.015***	-0.015***	-0.015***	-0.015***	-0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Married	-0.397***	-0.395***	-0.394***	-0.396***	-0.397***	-0.395***
	(0.069)	(0.069)	(0.069)	(0.069)	(0.069)	(0.069)
Body weight, lagged	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Employed	-0.493***	-0.493***	-0.496***	-0.495***	-0.493***	-0.494***
	(0.062)	(0.062)	(0.062)	(0.062)	(0.063)	(0.062)
Household size	0.124***	0.124***	0.124***	0.124***	0.125***	0.123***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.026)	(0.025)
Gross State product ($Billions)	0.000*	0.000*	0.000**	0.000**	0.000*	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
State per capita income ($000's)	0.060***	0.060***	0.060***	0.060***	0.060***	0.060***
	(0.019)	(0.019)	(0.020)	(0.019)	(0.019)	(0.020)
Nutrition education, $ per poor person	0.012	0.012	0.013	0.012	0.013	0.011
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Current unemployment rate	0.014	0.014	0.018	0.012	0.015	0.012
	(0.069)	(0.070)	(0.070)	(0.070)	(0.070)	(0.071)

—continued

Table 4

Determinants of Supplemental Nutrition Assistance Program (SNAP) participation, main model—Continued

	Milk	Meat/Beans	Oils	SatFat	Sodium	SoFAAS
Lagged unemployment rate	0.069 (0.050)	0.069 (0.050)	0.067 (0.050)	0.070 (0.050)	0.068 (0.050)	0.070 (0.050)
Broad-based categorical eligibility	0.299** (0.144)	0.297** (0.143)	0.313** (0.157)	0.293** (0.142)	0.287* (0.147)	0.299** (0.139)
Vehicle exempt	0.334 (0.278)	0.341 (0.282)	0.326 (0.279)	0.326 (0.281)	0.330 (0.279)	0.347 (0.288)
N	6,668					

HEI = Healthy Eating Index; DkGOrVeg = Dark green/orange vegetables.; SoFAAS = Solid fats, alcohol, and added sugar

Note: *p<.10, **p<.05, ***p<.01. Standard errors, adjusted for complex survey design, in parenthesis. State fixed effects not shown. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

Table 5

Effect of Supplemental Nutrition Assistance Program (SNAP) on Healthy Eating Index (HEI) scores

	HEI	Total fruit	Whole fruit	Total veg	DkGOrVeg	Total grain	Whole grain
δ_S	-1.441 (4.503)	0.270 (0.710)	2.795*** (0.209)	-0.660 (0.592)	-0.735*** (0.187)	-0.039 (0.147)	-0.383 (0.233)
ρ	0.007 (0.195)	-0.112 (0.201)	-0.979*** (0.084)	0.199 (0.203)	0.216*** (0.052)	-0.049 (0.051)	0.125 (0.092)
$F\ (IV)$	2.955	2.293	3.468	3.291	2.946	2.639	3.172

	Milk	Meat/Beans	Oils	Saturated fat	Sodium	SoFAAS	N
δ_S	-0.054 (0.590)	-0.248 (0.310)	0.372 (0.741)	-0.193 (0.987)	-0.046 (0.740)	-0.820 (1.423)	
ρ	-0.046 (0.093)	-0.033 (0.067)	-0.068 (0.115)	0.073 (0.145)	0.057 (0.136)	0.050 (0.121)	6,668
$F\ (IV)$	3.042	2.975	2.878	2.915	2.628	3.178	

DkGOrVeg = Dark green/orange vegetables; SoFAAS = Solid fats, alcohol, and added sugar

Note: *p<.10, **p<.05, ***p<.01. Marginal effect of SNAP from two-equation maximum likelihood model, as described in text. Selection and outcome models include race/ethnicity, education, annual income, age, marital status, lagged body weight, employment status, household size, gross State product, State per capita income, State unemployment rate, State unemployment rate lagged 1 year, State spending on nutrition education per poor person, and State fixed effects. Selection equation includes indicators for State SNAP policies: broad-based categorical eligibility and one vehicle per SNAP unit exemption. Standard errors, adjusted for complex survey design, in parenthesis. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

and positive for the dark green/orange vegetables model, suggesting that people who are more likely to enroll in SNAP tend to eat more dark green/orange vegetables.

The results for the whole fruit model are particularly curious because they suggest that SNAP induces a very large increase in whole fruit consumption for SNAP participants. Although this seems possible, especially for those consuming small amounts of whole fruit, it might also be an artifact of the distributional assumptions of the model. Table 6 confirms this suspicion. It shows the frequencies with which respondents in the sample have whole fruit scores that are zero, more than zero but less than five, and five (a perfect score for this component). Sixty percent of SNAP participants have scores that are zero, and more than 80 percent have scores that are zero or five. These distributions suggest not only that the joint distribution is not bivariate normal, but that SNAP might not affect HEI score linearly. It seems more likely that SNAP might induce a change in the "type" of whole fruit consumer when he or she enrolls; that is, it induces those who consume no whole fruit to consume some, or those who consume some fruit to consume the recommended amount.

To examine this possibility, we estimated bivariate probit models where the two outcomes were SNAP participation and the whole fruit component score above zero.[26] As suspected, the marginal effect of SNAP participation on consuming some whole fruit is positive, and the parameter value for SNAP participation is significant (table 7). SNAP participation increases the probability that participants will eat some whole fruit by about 23 percentage points.

Table 6

Frequencies of whole fruit score

	No SNAP	SNAP
0	2,622	623
0<score<5	1,261	199
5	1,737	226
N	6,668	

N denotes sample size.

Table 7

Effect of Supplemental Nutrition Assistance Program (SNAP) on probability of eating more fruit

	Parameter	Effect on probability of eating some fruit
SNAP	0.548* (0.32)	0.238
N	6,668	

Note: *p<.10, **p<.05, ***p<.01. Parameters and marginal effects from bivariate probit model in which outcome variables are SNAP participation and having above a zero score on HEI whole fruit score. Both equations include race/ethnicity, education, annual income, age, marital status, lagged body weight, employment status, household size, gross State product, State per capita income, State unemployment rate, State unemployment rate lagged 1 year, State spending on nutrition education per poor person, and State fixed effects. SNAP equation includes indicators for State SNAP policies: broad-based categorical eligibility and one vehicle exemption per SNAP unit. Standard errors, adjusted for complex survey design, in parenthesis. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

[26]To check the robustness of all the results, we also estimated Instrumental Variables (2 Stage Least Squares) and Generalized Method of Moments models for all outcomes, with the idea that these specifications would relax the bivariate normality assumption. These models yielded similar results in terms of the significance reported, but with even larger and more implausible marginal effects in some cases.

Expected Differences in Diet Quality Between SNAP Participants and Nonparticipants

After program effects, observed characteristics, and unobservables are accounted for, SNAP participants do marginally worse on total HEI than comparable nonparticipants: about 1.25 points lower, or about 2.5 percent of the mean for this group (figure 1 and table 8). Scores for all of the HEI components (except saturated fat and sodium) are lower for SNAP participants than nonparticipants, although most by small fractions of a point. Those components that are higher are also higher by only a fraction of a point.

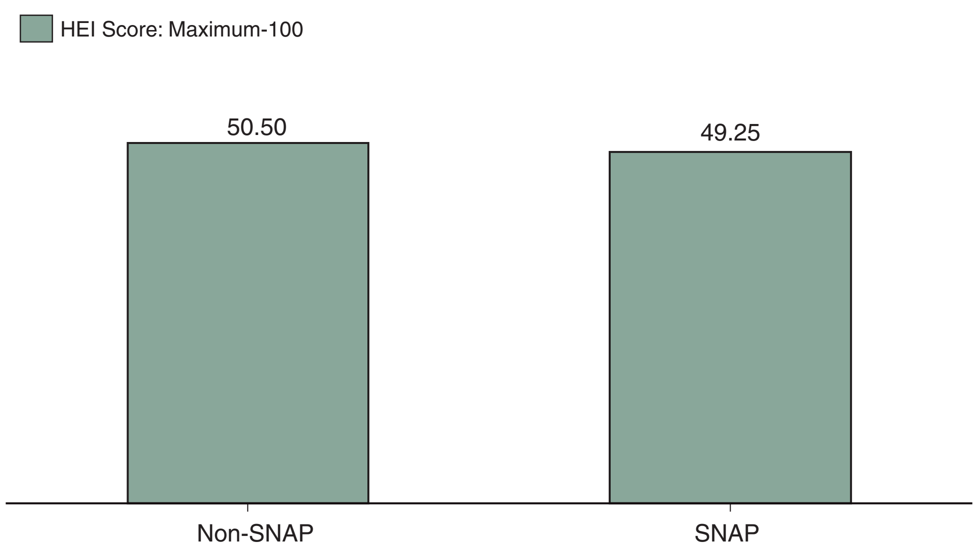
The results also show that one of the benefits of using maximum likelihood to estimate the parameters of this model—even though it is more complex than OLS—is that it is more efficient, which is reflected in the more precise estimates of the differences in total HEI and HEI components for participants and nonparticipants.

Robustness

The F-test of the correlation of the exogenous variables with SNAP participation is in table 5. While these policies are positively correlated with SNAP participation, they fail to meet the rule-of-thumb value for strong instruments (10) that has been established in the literature (Bound et al., 1995).[27] This is something of a concern,

Figure 1

Supplemental Nutrition Assistance Program (SNAP) participants' Healthy Eating Index (HEI) scores are comparable to nonparticipants' scores



Source: Calculations based on National Health and Nutrition Examination Survey (NHANES) data and the treatment effects models described in this report.

[27]The work of Bound et al. (1995) remains a touchstone for non-linear models despite the fact that it was developed for linear models—primarily 2 Stage Least Squares. For more on this, see Greene (2011).

Table 8

Expected differences in Healthy Eating Index (HEI) scores by participation in the Supplemental Nutrition Assistance Program (SNAP)

	HEI	Total fruit	Whole fruit	Total veg	DkGOrVeg	Total grain	Whole grain
ATE_{SNAP}	-1.249***	-0.186***	-0.678***	0.023	0.030	-0.157***	-0.031***
	(0.006)	(0.013)	(0.105)	(0.021)	(0.023)	(0.003)	(0.011)

	Milk	Meat/Beans	Oils	Saturated fat	Sodium	SoFAAS	N
ATE_{SNAP}	-0.376***	-0.431***	-0.123***	0.344***	0.325***	-0.163***	6,668
	(0.010)	(0.005)	(0.015)	(0.016)	(0.011)	(0.020)	

DkGOrVeg = Dark green/orange vegetables; SoFAAS = Solid fats, alcohol, and added sugar

Note: *p<.10, **p<.05, ***p<.01. Total effects of SNAP on HEI and HEI component scores from two-equation maximum likelihood model, calculated as described in text. Selection and outcome models include race/ethnicity, education, annual income, age, marital status, lagged body weight, employment status, household size, gross State product, State per capita income, State unemployment rate, State unemployment rate lagged 1 year, State spending on nutrition education per poor person, and State fixed effects. Selection equation includes indicators for State SNAP policies: broad-based categorical eligibility and one vehicle exemption per SNAP unit. Standard errors, calculated by the delta method and adjusted for complex survey design, in parenthesis. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

because it indicates that we may not have identified SNAP participation independent of individual-level unobserved characteristics as well as we had assumed. However, while we count only those enrolled in SNAP in the current month as participating in SNAP in the applicable models for the tests in table 5, it is reasonable to think that SNAP policies do not affect whether one enrolls in a particular month, but whether one enrolls in SNAP at all. To address this, and to check the robustness of these results in general, we re-estimated the main model above but with SNAP participation redefined: we count as SNAP participants anyone who reports that they have participated in SNAP in the last 12 months.[28]

There are several noteworthy aspects of these results (table 9). First, the State policy variables have F-test values that are generally above the threshold value for strong instruments (10). Second, these results mirror those of table 5 in suggesting large increases in whole fruit consumption and small decreases in dark green/orange vegetable consumption among SNAP participants. Third, these results indicate small negative effects of SNAP on whole grain consumption and large negative effects on the solid fats, alcohol, and added sugar (SoFAAS) score. Since larger scores are better for all components, this indicates that SNAP participants—defined as those who have been on SNAP at any time in the last 12 months—eat too much solid fat and added sugar, and not enough whole grains. Finally, we note that total HEI scores are about 10 percent lower for persons in SNAP households. As in the main sample results, the parameter ρ is mostly insignificant; here, as in table 5, it is significant and negative in

[28]In the 2003-04 and 2005-06 surveys, two questions pertain to household Supplemental Nutrition Assistance Program (SNAP) receipt: the number of persons in the household authorized to receive SNAP, and whether the household received SNAP. Both variables pertain to the previous 12 months. The 2007-08 survey asks only if SNAP receipt occurred in the previous 12 months. We tested to make sure that, using either the number of persons or the indicator in the earlier iterations, we had the same number of (unweighted) food stamp households. There are small differences in the number of cases using these variables, but our results are not sensitive to these differences.

the whole fruit model, and significant and positive in the dark green/orange vegetable model. It is also significant and positive in the SoFAAS model.

The expected differences in diet quality for SNAP participants and nonparticipants for these models are shown in table 10. As in the main results, SNAP participants do worse than their counterparts in terms of total HEI and many component scores. However, SNAP participants do slightly better on the score for saturated fat. The magnitudes of all of the effects are quite small: the largest effect, 1.28 points for total HEI, amounts to about 2.5 percent of the unconditional average for this income group.

Table 9

Effects of Supplemental Nutrition Assistance Program (SNAP) on Healthy Eating Index (HEI) scores, SNAP participation any time in last 12 months

	HEI	Total fruit	Whole fruit	Total veg	DkGOrVeg	Total grain	Whole grain
δ_S	-5.138*	-0.212	2.100***	-0.620	-0.718***	-0.058	-0.460*
	(3.004)	(0.511)	(0.595)	(0.561)	(0.153)	(0.139)	(0.251)
ρ	0.157	0.010	-0.717***	0.196	0.214***	-0.018	0.160
	(0.133)	(0.151)	(0.200)	(0.198)	(0.048)	(0.049)	(0.102)
F (IV)	11.178	11.000	7.296	9.934	10.962	10.734	11.934

	Milk	Meat/Beans	Oils	Saturated fat	Sodium	SoFAAS	N
δ_S	0.112	-0.382	-0.205	-0.431	1.275	-2.970***	
	(0.748)	(0.608)	(0.639)	(1.139)	(0.814)	(1.086)	
ρ	-0.045	0.020	0.025	0.079	-0.210	0.219**	6,668
	(0.115)	(0.129)	(0.099)	(0.172)	(0.150)	(0.098)	
F (IV)	12.213	11.502	11.520	11.323	12.598	11.749	

DkGOrVeg = Dark green/orange vegetables; SoFAAS = Solid fats, alcohol, and added sugar

Note: *p<.10, **p<.05, ***p<.01. Marginal effect of SNAP from two-equation maximum likelihood model, as described in text. Selection and outcome models include race/ethnicity, education, annual income, age, marital status, lagged body weight, employment status, household size, gross State product, State per capita income, State unemployment rate, State unemployment rate lagged 1 year, State spending on nutrition education per poor person, and State fixed effects. Selection equation includes indicators for State SNAP policies: broad-based categorical eligibility and one vehicle per SNAP unit exemption. Standard errors, adjusted for complex survey design, in parenthesis. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

Table 10

Expected differences in Healthy Eating Index (HEI) scores by Supplemental Nutrition Assistance Program (SNAP) participation any time in last 12 months

	HEI	Total fruit	Whole fruit	Total veg	DkGOrVeg	Total grain	Whole grain
ATE_{SNAP}	-1.280***	-0.176***	-0.511***	-0.002	-0.021	-0.097***	-0.047***
	(0.108)	(0.001)	(0.072)	(0.017)	(0.020)	(0.001)	(0.012)

	Milk	Meat/Beans	Oils	Saturated fat	Sodium	SoFAAS	N
ATE_{SNAP}	-0.178***	-0.277***	-0.036***	0.103***	0.029	-0.327***	6,668
	(0.008)	(0.003)	(0.005)	(0.015)	(0.036)	(0.074)	

DkGOrVeg = Dark green/orange vegetables; SoFAAS = Solid fats, alcohol, and added sugar

Note: *p<.10, **p<.05, ***p<.01. Total effects of SNAP on HEI and HEI component scores from two-equation maximum likelihood model, calculated as described in text. Selection and outcome models include race/ethnicity, education, annual income, age, marital status, lagged body weight, employment status, household size, gross State product, State per capita income, State unemployment rate, State unemployment rate lagged 1 year, State spending on nutrition education per poor person, and State fixed effects. Selection equation includes indicators for State SNAP policies: broad-based categorical eligibility and one vehicle exemption per SNAP unit. Standard errors, calculated by the delta method and adjusted for complex survey design, in parenthesis. Estimates weighted by dietary day one sample weight (WTDRD1). N denotes sample size.

Conclusion

For most components of diet measured by the HEI score, SNAP participants are at a small, statistically significant disadvantage in terms of diet quality relative to comparable nonparticipants. At the same time, there are aspects of diet quality on which SNAP participants do better; in particular, they consume less sodium and saturated fat than their counterparts. Additionally, we find that SNAP induces participants to increase their whole fruit consumption, possibly by relatively large amounts; at the very least, it increases the likelihood that SNAP participants will change from eating no whole fruit to eating some. We also find that SNAP induces participants to decrease their intake of dark green/orange vegetables by a modest amount. This effect could be the result of both time constraints associated with SNAP work requirements and extra income: people on SNAP may see whole fruit as more affordable with a little extra income, and consume more of it because it requires no preparation time. At the same time, dark green/orange vegetables may be less attractive to SNAP participants because they may require more preparation time. This could also be due to the substitution of one convenient snack food for another—apples or bananas for baby carrots, for example. The correlation coefficient in many of our models is small, positive, and not often significant, which means that we find inconclusive evidence as to whether selection into SNAP is beneficial or adverse.

Our exogenous variables do not meet the values determined in the literature to measure strong correlation for the purposes of identification. However, we think that this is due to two possible data challenges—the choice of whether to use a current or 12-month SNAP participation variable, and the fact that NHANES surveys are conducted in only a subset of States each year. When we examine models that use any SNAP receipt in the last 12 months, the instruments are strong for nearly all of our models. Moreover, the two main results from our preferred models—regarding whole fruit and dark green/orange vegetable intake—are mirrored in these latter models. We think this suggests that the evidence for our preferred results is strong, although identification of the effects of SNAP is partly from our exogenous variables and partly from the distributional assumptions that we make about the unobservables. Moreover, we only have observations from a subset of States in each NHANES wave, and the strength of the instruments may depend on how different policies change in the subset over successive NHANES waves. This could explain why instruments used in previous studies concerning food security are not as strong in our data.

Our results give mixed evidence concerning policy proposals to limit foods that SNAP participants can purchase. Taking selection effects into account, SNAP participants have slightly lower HEI scores than comparable nonparticipants. However, SNAP itself induces a large improvement in the likelihood of consuming whole fruit, but a slight decline in the consumption of dark green/orange vegetables. While the program could do more to improve participants' diets in that context, the question is how to alter the program without reducing its effectiveness in improving other diet outcomes and combating food insecurity. For example, it may be possible to reduce food insecurity while incentivizing the purchase of healthier foods, rather than restricting purchases of unhealthy foods. This approach is also supported by empirical evidence that subsidies for healthy foods (rather than taxes of unhealthy ones) would help reduce the costs of cardiovascular disease (Rahkovsky and Gregory, 2013). Addressing this question—how to strike a programmatic balance between reducing food insecurity and mandating healthy food purchases— is an avenue for further research.

References

Bound, J., D. A. Jaeger, and R. M. Baker. (1995). "Problems with Instrumental Variables Estimation When the Correlation between the Instruments and the Endogenous Explanatory Variable Is Weak." *Journal of the American Statistical Association* 90(430): 443-450.

Burns, C., G. Sacks, M. Rayner, G. Bilenkij, and B. Swinburn. (2010). "Correctly Calculating the Cost of Food." *Nutrition Reviews* 68(3): 182-183.

Butler, J. S. and J. E. Raymond. (1996). "The Effect of the Food Stamp Program on Nutrient Intake." *Economic Inquiry* 34(4): 781-798.

Carlson, A. and E. Frazao. (2012). *Are Healthy Foods Really More Expensive? It Depends on How You Measure the Price.* EIB-96, USDA, Economic Research Service. http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib96.aspx

Davis, G. C. and W. You. (2010). "The Thrifty Food Plan Is Not Thrifty When Labor Cost Is Considered." *The Journal of Nutrition* 140(4): 854-857.

Deb, P. and G. Waehrer. (2012). *Food Stamp Effects on Food Preparation and Consumption Patterns.* Contractor and Cooperator Report No. 75, USDA, Food and Nutrition Assistance Research Program. http://naldc.nal.usda.gov/catalog/50616

DePolt, R. A., R. A. Moffitt, and D.C. Ribar. (2009). "Food Stamps, Temporary Assistance For Needy Families and Food Hardships in Three American Cities." *Pacific Economic Review* 14(4): 445-473.

Devaney, B. and R. Moffitt. (1991). "Dietary Effects of the Food Stamp Program." *American Journal of Agricultural Economics* 73(1): 202-211.

Drewnowski, A. and N. Darmon. (2005). "Food Choices and Diet Costs: An Economic Analysis." *The Journal of Nutrition* 135(4): 900-904.

Drewnowski, A. and S.E. Specter. (2004). "Poverty and Obesity: The Role of Energy Density and Energy Costs." *The American Journal of Clinical Nutrition* 79(1): 6-16.

Fox, M. K., W. Hamilton, and B. Lin. (2004). *Effects of Food Assistance and Nutrition Programs on Nutrition and Health: Volume 4, Executive Summary of the Literature Review.* Food Assistance and Nutrition Research Reports No. 19-4, USDA, Economic Research Service. http://webarchives.cdlib.org/sw1tx36512/http://www.ers.usda.gov/Publications/FANRR19-4/

Frazao, E., M. Andrews, D. Smallwood, and M. Prell. (2007). *Can Food Stamps Do More To Improve Food Choices? An Economic Perspective—Food Spending Patterns of Low-Income Households: Will Increasing Purchasing Power Result in Healthier Food Choices?* EIB-29-4, USDA, Economic Research Service. http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib29-4.aspx

Greene, W. (2011). *Econometric Analysis.* New York, Prentice Hall.

Guenther, P. M., J. Reedy, S. M. Krebs-Smith, B.B. Reeve, and P.P. Basiotis. (2007). *Development and Evaluation of the Healthy Eating Index-2005:Technical Report.* USDA, Center for Nutrition Policy and Promotion. http://www.cnpp.usda.gov/Publications/HEI/HEI-2005/HEI-2005TechnicalReport.pdf

Meyerhoefer, C. and M. Yang. (2011). "The Relationship between Food Assistance and Health: A Review of the Literature and Empirical Strategies for Identifying Program Effects." *Applied Economic Policy and Perspectives* 33(3): 304-344.

Mykerezi, E. and B. Mills. (2010). "The Impact of Food Stamp Program Participation on Household Food Insecurity." *American Journal of Agricultural Economics* 92(5): 1379-1391.

Newman, C. (2006). "Income Volatility Complicates Food Assistance." *Amber Waves* 4(4), USDA, Economic Research Service.

Newman, C. and D. Joliffe. (2009). "Income Volatility Is Rising, With Mixed Effects on Nutrition Assistance Participation." *Amber Waves* 7(4), USDA, Economic Research Service.

Nord, M. and A. M. Golla. (2009). *Does SNAP Decrease Food Insecurity? Untangling the Self-Selection Effect*. ERR-85, USDA, Economic Research Service. http://www.ers.usda.gov/publications/err-economic-research-report/err85.aspx

Nord, M. and M. Prell. (2011). *Food Security Improved Following the 2009 ARRA Increase in SNAP Benefits.* ERR-116, USDA, Economic Research Service. http://www.ers.usda.gov/publications/err-economic-research-report/err116.aspx

Rahkovsky, I. and C. A. Gregory. (2013). "Food Prices and Blood Cholesterol." *Economics & Human Biology* 11(1): 95-107.

Ratcliffe, C., S. M. McKernan, and S. Zhang. (2011). "How Much Does the Supplemental Nutrition Assistance Program Reduce Food Insecurity?" *American Journal of Agricultural Economics* 93(4): 1082-1098.

Shaefer, H. L. and I. Gutierrez. (2012). *The Effects of Participation in the Supplemental Nutrition Assistance Program on the Material Hardship of Low-Income Families with Children*. National Poverty Center Working Paper Series No. 11-18. University of Michigan: National Poverty Center. http://npc.umich.edu/publications/u/2011-18-npc-working-paper-revised.pdf

Ver Ploeg, M. and K. Ralston. (2008). *Food Stamps and Obesity: What Do We Know?* EIB-34, USDA, Economic Research Service. http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib34.aspx

Wilde, P. E., P.E. McNamara, and C.K. Ranney. (1999). "The Effect of Income and Food Programs on Dietary Quality: A Seemingly Unrelated Regression Analysis with Error Components." *American Journal of Agricultural Economics* 81(4): 959-971.

Yen, S. T. (2010). "The Effects of SNAP and WIC Programs on Nutrient Intakes of Children." *Food Policy* 35(6): 576-583.

Yen, S. T., M. Andrews, Z. Chen, and D.B. Eastwood. (2008). "Food Stamp Program Participation and Food Insecurity: An Instrumental Variables Approach." *American Journal of Agricultural Economics* 90(1): 117-132.

Zagorsky, J. L. and P.K. Smith. (2009). "Does the U.S. Food Stamp Program Contribute to Adult Weight Gain?" *Economics & Human Biology* 7(2): 246 -258.

Appendix table A.1

Parameter Estimates of Outcome Equation

	HEI	Total fruit	Whole fruit	Total veg	DkGOrVeg	Total grain	Whole grain
SNAP	-1.441	0.270	2.795***	-0.660	-0.735***	-0.039	-0.383
	(4.503)	(0.710)	(0.209)	(0.592)	(0.187)	(0.147)	(0.233)
Hispanic	5.631***	0.744***	0.661***	0.222**	0.335***	0.263***	-0.166**
	(0.979)	(0.118)	(0.127)	(0.100)	(0.103)	(0.060)	(0.076)
Black	-1.290	0.182	-0.551***	-0.145	0.113	-0.081	-0.076
	(0.843)	(0.122)	(0.141)	(0.119)	(0.093)	(0.066)	(0.069)
Other race	3.331***	0.430**	0.526***	0.407***	0.252	0.312***	-0.141
	(1.156)	(0.182)	(0.180)	(0.137)	(0.171)	(0.089)	(0.144)
High school dropout	-1.097*	-0.175**	-0.263***	-0.145*	0.145**	0.032	-0.107*
	(0.571)	(0.080)	(0.100)	(0.078)	(0.071)	(0.062)	(0.060)
Some college	0.646	0.093	0.175	-0.104	0.076	0.041	0.188***
	(0.582)	(0.076)	(0.121)	(0.077)	(0.068)	(0.061)	(0.064)
College graduate	5.712***	0.689***	0.961***	0.324**	0.564***	0.121	0.339***
	(1.314)	(0.148)	(0.171)	(0.144)	(0.170)	(0.078)	(0.112)
Annual household income ($000's)	-0.000	0.000	0.000***	-0.000	-0.000*	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	0.139***	0.024***	0.037***	0.011***	0.010***	0.003***	0.011***
	(0.020)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)
Married	1.194*	0.056	0.140	0.056	0.058	0.024	-0.020
	(0.616)	(0.104)	(0.108)	(0.086)	(0.070)	(0.043)	(0.053)
Body weight, lagged	-0.009*	-0.002***	-0.003***	-0.000	-0.000	-0.000	-0.000
	(0.006)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Employed	-1.201*	-0.092	0.192**	-0.059	0.034	0.008	-0.248***
	(0.632)	(0.100)	(0.083)	(0.106)	(0.058)	(0.065)	(0.057)
Household size	-0.274	-0.043	-0.120***	0.038	0.041	0.002	-0.058***
	(0.255)	(0.035)	(0.032)	(0.030)	(0.026)	(0.017)	(0.019)
Gross State product ($Billions)	-0.000	0.000	-0.000	0.000**	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
State per capita income ($000's)	0.420**	0.024	-0.012	-0.008	0.019	0.010	0.025*
	(0.186)	(0.034)	(0.036)	(0.016)	(0.014)	(0.010)	(0.014)
Nutrition education, $ per poor person	-0.171	-0.024	-0.027	-0.013	-0.021	-0.003	0.012
	(0.166)	(0.021)	(0.032)	(0.022)	(0.017)	(0.011)	(0.018)
Current unemployment rate	-0.563	-0.049	-0.081	-0.150***	-0.074	-0.061**	0.034
	(0.495)	(0.079)	(0.098)	(0.054)	(0.069)	(0.030)	(0.058)
Lagged unemployment rate	0.467	0.101	0.102	0.101**	0.007	0.021	0.072
	(0.446)	(0.075)	(0.084)	(0.047)	(0.057)	(0.034)	(0.052)

—continued

Appendix table A.1

Parameter Estimates of Outcome Equation—Continued

	Milk	Meat/Beans	Oils	Saturated fat	Sodium	SoFAAS
SNAP	-0.054	-0.248	0.372	-0.193	-0.046	-0.820
	(0.590)	(0.310)	(0.741)	(0.987)	(0.740)	(1.423)
Hispanic	-0.370**	0.401***	-0.584***	1.257***	0.430**	2.458***
	(0.185)	(0.151)	(0.152)	(0.161)	(0.182)	(0.486)
Black	-1.658***	0.444***	0.001	0.450**	0.220	-0.395
	(0.172)	(0.135)	(0.211)	(0.198)	(0.166)	(0.439)
Other race	-1.435***	0.419	-0.526*	1.084***	-0.763**	2.823***
	(0.347)	(0.267)	(0.311)	(0.324)	(0.371)	(0.661)
High school dropout	-0.116	0.177	-0.662***	0.235	-0.037	-0.268
	(0.164)	(0.147)	(0.165)	(0.167)	(0.144)	(0.268)
Some college	0.385***	-0.106	0.073	0.073	-0.026	-0.213
	(0.146)	(0.176)	(0.156)	(0.170)	(0.147)	(0.300)
College graduate	0.544**	0.239	0.034	0.369	-0.431**	2.060***
	(0.252)	(0.206)	(0.281)	(0.302)	(0.202)	(0.521)
Annual household income ($000's)	0.000*	0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.007	0.007**	0.006	-0.005	-0.010*	0.058***
	(0.004)	(0.003)	(0.005)	(0.005)	(0.006)	(0.008)
Married	-0.149	0.259**	0.246	0.214	-0.103	0.539*
	(0.172)	(0.131)	(0.151)	(0.212)	(0.136)	(0.276)
Body weight, lagged	-0.002*	0.006***	-0.000	-0.003**	-0.004***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Employed	-0.282**	0.087	0.083	-0.014	-0.032	-0.695**
	(0.143)	(0.117)	(0.152)	(0.163)	(0.159)	(0.279)
Household size	-0.100**	0.028	-0.009	-0.036	0.027	-0.093
	(0.047)	(0.027)	(0.054)	(0.048)	(0.040)	(0.111)
Gross State product ($Billions)	0.000	-0.000***	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
State per capita income ($000's)	0.091***	0.096***	0.011	-0.045	-0.060**	0.238***
	(0.035)	(0.028)	(0.031)	(0.033)	(0.030)	(0.067)
Nutrition education, $ per poor person	-0.107***	0.010	0.021	0.004	0.019	-0.048
	(0.041)	(0.024)	(0.031)	(0.047)	(0.033)	(0.065)
Current unemployment rate	0.051	-0.131*	-0.230**	0.103	0.380***	-0.367*
	(0.104)	(0.068)	(0.109)	(0.107)	(0.101)	(0.206)
Lagged unemployment rate	0.155	0.081	0.165*	-0.400***	-0.073	0.127
	(0.116)	(0.094)	(0.100)	(0.075)	(0.113)	(0.196)
N			**6,668**			

SNAP = Supplemental Nutrition Assistance Program; HEI = Healthy Eating Index; DkGOrVeg = Dark green/orange vegetables; SoFAAS = Solid fats, alcohol, and added sugar

Note: *p<.10, **p<.05, ***p<.01. State fixed effects not shown. N denotes sample size.