

# **The Effects of the Food Stamp Program on Energy Balance and Obesity**

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## **Abstract**

Between 2001 and 2006, women participating in the U.S. Food Stamp program (FSP) weighed 15.5 pounds more than eligible nonparticipants on average. We make three contributions to the large and growing literature that addresses this weight difference. First, we use a dataset (NHANES) that contains detailed information on a wide variety of demographic, socioeconomic, health and behavioral characteristics and are thus not limited to sparse reduced-form regression models. Second, we specify a physiological model of weight gain with which we show that average differences in caloric intake and physical activity are much too small to explain the weight difference. Third, we use an instrumental variables framework to show that individuals with a genetic predisposition to obesity are more likely to participate in the FSP and that the magnitude of this effect is large enough to explain the weight difference. We conclude that participation in the FSP does not cause weight gain.

**JEL Codes:** Q18, H53, I12, I18, I38

**Key Words:** Food Stamp Program (FSP), Supplemental Nutrition Assistance Program (SNAP), obesity, food assistance, nutrition assistance.

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## **Highlights:**

- We model weight gain as a function of food stamp participation, physical activity, and food consumption.
- We examine the effect of food stamp participation on food consumption and physical activity.
- Food stamp participation is not associated with a significant difference in weight gain, food consumption, or physical activity.
- Unobserved differences in the propensity for obesity may affect the decision to participate in the Food Stamp Program.

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The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the Research Data Center, the National Center for Health Statistics, the Centers for Disease Control and Prevention, or the U.S. Department of Agriculture Economic Research Service. Data collection for NHANES was approved by the NCHS Research Ethics Review Board. Analysis of deidentified data from the survey is exempt from the federal regulations for the protection of human research participants. Analysis of restricted data through the NCHS Research Data Center is also approved by the NCHS ERB.

## 1. Introduction

Over recent decades, the prevalence of obesity has increased markedly in the United States. Between 1960 and 2009 the percentage of adults in the United States classified as overweight or obese (having a body mass index (BMI) greater than 25) increased from 41 percent to 68 percent (Flegal 1998; Levi et al. 2010).<sup>1</sup> Many possible causes for the dramatic increase in obesity have been proposed, including the decline in energy expended during work, the decline in smoking rates, agricultural subsidies, the National School Lunch Program, and the Food Stamp Program (Lakdawalla and Philipson 2002; Gibson 2003; Nonnemaker et al. 2009; Schanzenbach 2009; Okrent and Alston 2011; Meyerhoefer and Pylypchuk 2008). This paper concerns that last possibility.

The Food Stamp Program (FSP) administered by U.S. Department of Agriculture (USDA) has functioned as the mainstay of U.S. food assistance programs for over 40 years.<sup>2</sup> In 2011, 44.7 million Americans (14 percent of the population) participated, receiving an average of \$134 per person per month of enrollment. In that year, 73 percent of the \$102.9 billion spent on food assistance was delivered through Food Stamp benefits.<sup>3</sup> Given the scale of the FSP, and the national spotlight on obesity, the economic and nutritional consequences of the FSP have been the subject of many studies (Jensen and Wilde 2010). Prior studies have documented a statistical association between FSP participation and obesity. For instance, Gibson (2003) demonstrated that female FSP participants are more likely to be overweight or obese than eligible nonparticipants. This observation raises the question: Is the additional income provided

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<sup>1</sup> BMI is calculated as the ratio of weight (kg) to height squared (m<sup>2</sup>).

<sup>2</sup> The Food Stamp Program was renamed the Supplemental Nutrition Assistance Program in October, 2008.

<sup>3</sup> Food Stamp Program and total USDA expenditures are taken from Food and Nutrition Services program data, available at: <http://www.fns.usda.gov/pd/SNAPsummary.htm> and <http://www.fns.usda.gov/pd/annual.htm>.

through FSP benefits inducing participants to eat significantly more than they would otherwise, and thus making participants fatter? Previous studies that addressed this question applied a wide variety of methods and yielded mixed results, and the question remains unanswered; researchers have not established conclusively that FSP participation causes obesity (e.g., Devaney and Moffitt 1991; Townsend et al. 2001; Gibson 2003; Chen, Yen, and Eastwood 2005; Baum 2007; Ver Ploeg et al. 2007; Meyerhoefer and Pylypchuk 2008; Ver Ploeg and Ralston 2008; Fan 2010). More definitive answers to this important question require better models, better methods, better data, or all three. We have sought to improve upon previous work in all three dimensions.

The previous work typically modeled the cross-sectional relationship between body weight or body mass index (BMI) and participation in the FSP. However, a consideration of the structural relationships suggests that we should be modeling the relationship between *changes in weight* and participation in the FSP. We adopt that approach here. We specify a physiological model of weight gain using the energy balance equation (Frankenfield, Roth-Yousey, and Compher 2005; Gropper, Smith, and Groff 2009). We show that the average FSP participant in our dataset weighed 15.5 pounds more than the average eligible nonparticipant. The energy balance model reveals that differences in average food consumption and physical activity are much too small to explain this weight difference. Moreover, after controlling for a set of observables we find that FSP participation is not even positively related to caloric intake.

Because our dataset provides information on a wide variety of demographic, socioeconomic, health and behavioral characteristics we also estimate reduced-form regression models of weight gain. In theory, these models and the energy balance model could yield different results because the energy balance model we use is a linearized approximation to nonlinear dynamic function, parameterized using values for a woman with normal weight and

normal activity level. Moreover, the causal effects of the FSP on energy balance could be obscured by systematic measurement error in our food intake and physical activity variables. Alternatively, FSP participation may change diet composition in ways that do not affect energy balance, but in ways that change other parameters of the model (e.g., if the FSP leads people to a diet high in refined carbohydrates). In spite of these theoretical possibilities, our reduced-form model of weight gain shows no evidence of significant additional weight gain by FSP participants.

The observed correlation between weight and FSP participation could be explained, alternatively, if obesity influences the FSP participation decision or if weight and participation are jointly determined by other causes. To address these possibilities, we develop a model of program participation in which body weight can influence the choice to participate in the FSP. To our knowledge, no-one else has investigated whether individual propensities for obesity influence the decision to participate in the FSP. To allow for the possible endogeneity of body weight to FSP participation, we use a family history of type 2 diabetes as an instrumental variable. Such a family history strongly predicts weight, and we assume that it does not affect FSP participation except through its effect on weight. Our estimates show a strong and significant effect of obesity on propensity to participate in the FSP. Moreover, a Hausman test provides no evidence that weight is endogenous to participation.

## **2. Background and Motivation**

Obesity is a complex health condition, and much about the causes, consequences, and underlying mechanisms remains unknown. The gross correlation between body weight (or BMI) and participation in the FSP is apparent in the data. Figure 1 plots body weight as a

nonparametric function of age for FSP participants<sup>4</sup> and separately for nonparticipants, based on pooled data from the 2001–2002, 2003–2004, and 2005–2006 National Health and Nutrition Examination Surveys (NHANESs).<sup>5</sup> Food stamp participants were almost 20 pounds heavier than eligible nonparticipants among 18–40 year-old women during this period. The gap is smaller for older women than for young women; it averages less than 10 pounds for women over 50. Figure 1 also shows that women with household income greater than 185 percent of the poverty line had similar body weight to eligible nonparticipants.

**[Figure 1. Weight and Age for Women by Food Stamp Program Status]**

Given that taxpayers fund the FSP, a Federally administered entitlement program, the suggestion that Food Stamps may have contributed to the obesity problem concerns program administrators and researchers alike. Furthermore, if the FSP promotes obesity, it may also contribute to the development of other costly health conditions associated with obesity (e.g., type 2 diabetes, heart disease, and some cancers; see Colditz 1992; Flegal et al. 2007; American Diabetes Association 2008; Huang et al. 2009). However, the obesity issue is very complex, with multiple potential contributing factors such that simple correlation does not establish causation (see Smith, 2009, for a review of the literature and evidence on the links between poverty, income assistance, and obesity in the United States).

Using both longitudinal and cross-sectional data, numerous investigations have documented the connection between FSP participation or poverty and obesity, reporting mixed results as to the direction of causation and the magnitude of the effect (see Drewnowski and Specter 2004, and Smith 2009 for reviews of the literature). Townsend et al. (2001) found that

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<sup>4</sup> We define a participant as a female respondent who reported living in a household that received FSP benefits in at least one of the past 12 months.

<sup>5</sup> See Section 3 for more information about the data.

low-income women on food stamps had a 38 percent greater probability of being overweight (defined as having a BMI > 27.3). Similarly, Gibson (2003) found a significantly increased risk of obesity (defined as having a BMI  $\geq$  30) for low-income women currently participating in the FSP, and an even larger effect for long-term female FSP participants. In agreement with Gibson (2003), Chen, Yen, and Eastwood (2005) and Baum (2007) also found that FSP participation had a positive and significant relationship with BMI and obesity for women, but not for men. Similarly, Meyerhoefer and Pylypchuk (2008) found that female FSP participants had a 2.5 percent lower chance of being categorized as normal or underweight (BMI < 25). Their estimate has the same sign, but a much smaller magnitude than those of similar and earlier studies (i.e., Townsend et al. 2001; Gibson 2003; Chen, Yen and Eastwood 2005).

Employing the data from the NHANES II (1976–80), III (1988–94), and 1999–2002 continuing survey, Ver Ploeg et al. (2007) demonstrated that, in more current rounds of the NHANES survey, there was no longer a “BMI gap” between white female participants and nonparticipants. However, this analysis controlled only for a quadratic function of age, and included women ineligible for the FSP. Kaushal (2007) used data from the National Health Interview Survey to exploit the natural experiment that resulted from foreign-born immigrants in some states losing FSP eligibility after the enactment of the Personal Responsibility and Work Opportunity Reconciliation Act in 1996. Kaushal (2007) found no evidence that FSP participation significantly increased the BMIs of low-income immigrant mothers.

Zagorsky and Smith (2009) used the NLSY79 to evaluate the BMIs of individuals who had participated in the FSP during a given year, and found that the BMIs of female FSP participants were 1.24 units greater than the BMIs of nonparticipants. Also using the NLSY79, but applying propensity-score matching techniques to control for pre-participation weight and

other socio-economic and demographic factors, Fan (2010) found that participation in the FSP had no significant effect on BMI or obesity among low-income women. Both Zagorsky and Smith (2009) and Fan (2010) controlled for individual characteristics such as race, education, gender, marital status, homeownership, state of residence, and household income.

Three pieces of evidence from outside this literature cast doubt on the hypothesis that FSP participation causes obesity. First, the direction of causation could run from obesity to poverty, and thus, from obesity to welfare participation. For instance, Cawley (2004) found that having a high body weight is associated with significantly lower wage rates for white women. Even holding income constant, characteristics that make individuals more susceptible to weight gain may be associated with other characteristics that cause people to be less economically secure and more likely to participate in the FSP. This possibility underlies the importance of accounting for selection bias in cross-sectional regressions of weight or BMI on FSP participation. Notably, Fan (2010), who used propensity score matching, and Kaushal (2007), who exploited a natural experiment, found no causal effect of FSP participation on obesity once they accounted for selection bias. We explore this issue further in Section 6.

Second, the hypothesis that increasing the purchasing power of a low-income household would result in negative health outcomes contradicts the much-studied and well-documented “health-wealth gradient,” that is, the positive association between measures of socio-economic status and good health.<sup>6</sup> For instance, one popular hypothesis is that the extra income for food afforded by participation in the FSP induces increases in caloric intake, which explains the higher prevalence of obesity among women who participate in the FSP. In this scenario, we might expect the poorest households, for whom FSP benefits comprise a larger fraction of total

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<sup>6</sup> For more on the relationship between socio-economic status and various health outcomes see Adler and Rehkopf (2008), Adler et al. (1994), Deaton (2001), Herd (2010), Matthews and Gallo (2011), and Wilkinson (1996).

income, to have the greatest increase in food consumption (Wilde, Troy, and Rogers 2009). However, as Figure 2 demonstrates, the difference in weight between participants and nonparticipants is not greater for poorer women than women near the gross income cutoff (income-to-poverty ratio = 1.85).

**[Figure 2. Weight by Income-to-Poverty Ratio for Women by Food Stamp Program Status]**

Third, in the 1990s and early 2000s over half of participating households exited the FSP within eight to ten months of beginning a new FSP participation spell (Cody et al. 2005; Cody et al. 2007). Between 2004 and 2006, 60 percent of participating households had multiple participation spells, with a median total spell length of 18 months and a median time-off between spells of 20 months. For the same time period, 65 percent of participating households had a total participation spell length of 24 months or less, suggesting that if FSP participation increases food consumption and causes weight gain, it has a window of at most 2 years time in which to do so for most households (Mabli et al. 2011). Moreover, as Figure 1 shows, a large weight gap exists even for women as young as 18, who must have participated in the FSP as adults for only a short time, although they may have participated as children. These arguments raise doubts about the potential magnitude of any effect of FSP participation on aggregate obesity rates.

### **3. Data**

We use data from the 2001–2002, 2003–2004, and 2005–2006 public-use NHANES. The NHANES contains details on characteristics of households and individuals, dietary recall information, lab test results, and physical exam measurements. These detailed data enable us to estimate the effect of FSP participation on energy balance and to control for a wide variety of

behavioral and health characteristics, including alcohol consumption, smoking, thyroid condition, breastfeeding, food-away-from-home frequency, and depression. Moreover, unlike some previous studies, we use data on measured weight in addition to self-reported weight.

The National Center for Health Statistics (NCHS) and the Centers for Disease Control and Prevention (CDC) conduct the NHANES. Starting in 1999 the NHANES became a continuous annual survey with publicly available data released in two-year increments. The NHANES has a complex survey design and is intended to represent civilian non-institutionalized individuals of all ages living in the United States. Of the 38,779 individuals screened for participation in the 2001–2006 NHANES, 31,509 completed interviews, and 30,070 underwent a physical exam in the mobile examination center.

We use the sampling weights, masked variance units, and strata provided in the publicly available 2001–2006 NHANES data, and perform all analysis in STATA-MP 10.0 for Windows. We restrict the data to non-pregnant women at least age 18 and no older than 70 with non-missing values for the variables used in our analysis and household income no more than 185 percent of the federal poverty threshold. We choose women with reported household income at or below 185 percent of the federal poverty threshold because this is the gross income cutoff for the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and women who participate in WIC automatically qualify to receive FSP benefits as well. This makes women at or below this cutoff reasonably representative of the eligible female population.

We have data on 2,592 women aged between 18 and 70 with household income no more than 185 percent of the federal poverty threshold. After dropping missing observations, we are left with observations on 2,018 women, 514 of whom participated in the FSP.<sup>7</sup> Using the

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<sup>7</sup> For the 574 observations with missing data, the average weight difference between participants and nonparticipants was 14.1 pounds, compared to 15.5 pounds in our estimation sample.

“WTMEC2YR” survey weights we construct the appropriate weights for the six years of combined data with the formula ( $MEC6YR = 1/3 * WTMEC2YR$ ) and the tutorial provided by the National Center for Health Statistics (NCHS).

**[Table 1. Summary Statistics for Low-Income Women—Public-Use NHANES Data]**

Table 1 displays summary statistics for the public-use NHANES data described above. Consistent with Figure 1, FSP participants weighed an average of 15.5 lb more than eligible nonparticipants. Body weight is measured as part of the medical examination; unlike many other surveys, here it is not self-reported. In addition to measuring current weight, NHANES asks participants to estimate how much they weighed one year earlier. We use this reported past weight to estimate the change in weight, and find that participants gained 6.7 lb on average compared to 4.9 lb for nonparticipants. This difference is statistically insignificant at the ten percent level.

Women tend to underestimate their current and past weight and the severity of their underestimation increases with current BMI (Rowland 1990; Perry et al. 1995), so it is possible that this weight change (the difference between current measured weight and self-reported past weight) overestimates the actual weight gain. In addition, both men and women who have lost weight tend to underreport their past weight more than those who had maintained their weight or gained weight, implying that individuals underestimate losses more than they overestimate gains (Perry et al. 1995). The underreporting bias may be mitigated in this case because survey respondents answered the question about past weight after having been weighed. Black, Taylor, and Coster (1998) found that the accuracy of self-reported weight did not decrease as weight increased for individuals who knew they would have their weight measured following the weight survey. Moreover, as long as FSP participants are no more or less likely than nonparticipants to

underreport past weight, we can still consistently estimate the difference in weight gain between the two groups.

Participants consume an estimated 40.2 more kilocalories (kcal) per day than nonparticipants. NHANES estimated food consumption (dietary intake) using the 24-hour diet recall measurements. The survey includes two separate diet recall questionnaires conducted on different days. We use the average across the two days. Dietary recall data are notorious for underreporting total energy intake (Briefel et al. 1997; Livingstone and Black 2003), but the difference in calorie consumption by participants and nonparticipants is not biased unless FSP participants systematically underreport food consumption more or less than nonparticipants do.

Compared with nonparticipants, participants were significantly less likely to engage in vigorous physical activity and expended an estimated 34.6 fewer calories in leisure time physical activity per day. NHANES collected information on the frequency, duration, and intensity of several physical activities including walking, running, and biking during the past month. The intensity variable is reported in metabolic equivalents (METS), where a MET corresponds approximately to 0.9 kcal per kilogram of bodyweight per hour for the average woman (Gropner, Smith and Groff, 2009, pg 296).<sup>8</sup> We combine this information to estimate daily calories expended in leisure time physical activity.<sup>9</sup> We assume zero activity for any missing entries for leisure time physical activity. Troiano et al. (2008) found that self reported measures of physical activity in NHANES 2003–2004 were qualitatively compatible with objective measures of activity gathered from accelerometers in that women and older individuals engaged in less

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<sup>8</sup> See the Physical Activity Individual Activities file, part of the NHANES questionnaire file.

<sup>9</sup> Specifically, we estimate the daily energy expenditure in leisure time physical activity using the formula:  $ACT = (9.8W) \sum_j (METS_j \cdot (t_j / 24) \cdot (f_j / 30))$ , where the subscript  $j$  indicates the activity type,  $t$  represents the length of time spent in the activity (in hours per event),  $f$  measures the frequency of the activity over the previous month, and  $W$  is weight in pounds. The constant 7.8 is the kcal/lb/day equivalent of 0.9 kcal/kg/hour.

physical activity, but that individual reports significantly overstated the percent of individuals who completed the recommended 30 minutes per day of moderate intensity physical activity.

Table 1 shows numerous other differences between female participants and nonparticipants. Compared with nonparticipants, participants in our sample are less likely to have a college education and less likely to be married, although they are of similar age and are more likely to have young children. Black respondents make up 35 percent of participants but only 14 percent of nonparticipants. In contrast Mexican-American respondents comprise only 9 percent of participants but 15 percent of nonparticipants. Participants are 9 percent more likely to be U.S. citizens. Participants are poorer on average; they have 27 percent lower average household incomes, are 51 percent more likely to rent their home, and eat 0.8 fewer meals per week away from home. These demographic and socioeconomic differences reveal that participants differ from nonparticipants in more than just weight and therefore that controlling for these characteristics is important in discerning the effect of participation on weight and weight gain.

Participating women also differ in their behavioral and health characteristics. Participants report having experienced approximately four more days of feeling depressed in the previous month, have a 20 percent greater probability of meeting the criteria for metabolic syndrome, consume nearly 10 more grams of sugar a day, drink 0.3 more alcoholic drinks per day, and have almost twice the propensity to smoke.<sup>10</sup> Also, participants have a greater probability of sitting for most of the day and a lower probability of doing light lifting or climbing

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<sup>10</sup> The National Cholesterol Education Program identifies individuals as having metabolic syndrome if they display three or more of the following five risk factors: (i) abdominal obesity (waist circumference > 102 cm for men or > 88cm for women); (ii) elevated blood triglycerides ( $\geq 150$ mg/dL); (iii) low HDL cholesterol (< 40 mg/dL for men and < 50 mg/dL for women); (iv) hypertension (>130/85 mmHg); and (v) hyperglycemia (fasting blood glucose  $\geq 110$ mg/dL).

stairs on a daily basis. These differences all suggest that participants have less-healthy lifestyles and poorer health than nonparticipants and may explain both their participation in the FSP and their heavier weight. We explore these issues further in Section 6.

## 4. Physiological Models of Weight Gain

### 4.1. Background

On a day-to-day basis the amount of energy stored ( $ES$ ) or weight gained depends on the amount energy consumed ( $EC$ ) relative to energy expended ( $EE$ ),

$$ES = EC - EE \quad (1)$$

This equation is known as the energy balance equation. Total energy expended has two main elements, (i) the resting metabolic rate (RMR), which is the amount of energy needed to sustain life for a human at rest, and (ii) energy expended during physical activities ( $ACT$ ).<sup>11</sup> In addition to these main elements, humans also expend energy during digestion and maintaining a normal body temperature (see, for example, Mifflin 1990; Frankenfield, Roth-Yousey, and Compher 2005; Henry 2005; Sherwood 2007; Gropper, Smith, and Groff 2009).

Energy expended from RMR depends on body weight; heavier people require more energy to sustain life. If a woman increases her food consumption permanently by a constant amount of calories from the steady-state, then her weight begins to increase, which causes  $RMR$  to increase. If her energy balance remains positive ( $ES > 0$ ), then weight increases further. This process continues until she reaches a new steady-state weight. Based on a dynamic model of energy balance, Hall et al. (2011) estimate that a permanent increase in energy intake of 10 kcal per day causes a 1 pound gain in steady-state weight. They estimate that weight increases by 0.5

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<sup>11</sup> Basal metabolic rate (BMR), resting metabolic rate (RMR), and resting energy expenditure (REE) are often used interchangeably, but BMR has specific measurement criteria. BMR is the amount of energy expended when a person is lying down in a thermo-neutral environment, not moving, has not eaten in 12 hours (i.e., “post absorptive”), and has recently awoken from a full-night sleep (Gropper, Smith and Groff 2009).

pounds in the first year and reaches the steady-state after approximately three years. Similarly, the parameterization in Christiansen et al. (2005) implies a steady state increase of 1.28 lb and a one-year increase of 0.77 lb for each 10 kcal/day increase in food consumption. A detailed description of dynamic energy-balance models is provided in the Appendix.

This dynamic process differs substantially from the popular notion that the change in weight is proportional to calorie intake and therefore that a permanent increase in the rate of caloric intake causes a permanent increase in the rate of weight gain. A commonly used rule of thumb of this type posits that body weight increases by one pound for every 3,500 additional kcal consumed. In contrast, the energy balance equation implies diminishing returns—the effect of 3,500 additional kcal (or about 10 kcal per day) diminishes over time as weight increases. Thus, the rule of thumb implies that a permanent increase in consumption of 10 kcal per day increases weight by one pound per year in perpetuity, while a dynamic model implies a steady-state increase of just one pound.

Table 1 shows that food stamp participants weighed 15.5 pounds more than eligible nonparticipants during our 2001–06 sample period (see also Figure 1). If this difference reflects a difference in steady-state weight, then the Christiansen et al. (2005) energy balance model implies that food stamp participants were consuming about 121 kcal per day more than participants, holding physical activity constant (see the Appendix for details). If FSP participation causes weight gain and participants had not yet reached their steady-state weight, then participants should have been consuming an amount greater than 121 kcal more than eligible nonparticipants. Moreover, the model of Hall et al. (2011) requires an even greater food-intake difference of 155 kcal to generate 15.5 additional pounds of weight. By focusing on the Christiansen et al. (2005) model we set a lower threshold for the energy differences require to

explain the weight gap. Table 1 shows that participants consumed 40 kcal more and expended 35 kcal less energy per day than nonparticipants. This net difference of 75 kcal is too small to explain the observed average weight difference.

Most food stamp spells are less than one year (Cody et al. 2005; Cody et al. 2007; Mabli et al. 2011). In our data, we categorize FSP participants as those who participated for at least one month during the past year. These participants make use of the program for 7.6 months on average, which is very similar to the 8 month median participation spell reported by Cody et al. (2007). If participation leads to increased food consumption only in the months in which a person participates, then the additional calorie consumption for current participants would need to be substantially greater than 121 kcal per day. The above models suggest that the expected weight gain would be a little over half of the steady-state gain after one year of increased food consumption, and less than half of the steady-state gain after only 7.6 months of increased food consumption. These arguments suggest that the additional food consumption of participants would need to be substantially more than 121 kcal per day before increased food consumption caused by FSP participation could explain the weight gap. Even if some of the participants in our sample were repeat FSP participants, with a total spell length of 18 months or more and a sustained increase in food consumption of 75 kcals per day, we would only expect a 9.6 pound difference in their steady-state weight.

This analysis shows that average differences in food consumption and physical activity are insufficient to explain the average weight difference between FSP participants and nonparticipants. However, these averages may obscure important heterogeneity. In the next section, we use regression models to ask whether FSP participation is associated with increased

calorie consumption and reduced physical activity after controlling for demographic, socioeconomic, behavioral, and health characteristics.

#### 4.2 Does FSP Participation Affect Energy Imbalance?

The natural channel for FSP participation to affect weight is through food consumption (*EC*) or physical activity (*ACT*). It is also possible that FSP participation could change the composition of diet and therefore affect the reference value of *RMR*. In this section we focus on effects through *EC* and *ACT*. We explore other mechanisms in Section 5.

We estimate the following regression equations

$$EC = \delta_0 + \delta_1 FSP + \delta_2 Z + \varepsilon_{EC}, \quad (2)$$

$$ACT = \beta_0 + \beta_1 FSP + \beta_2 Z + \varepsilon_{ACT}. \quad (3)$$

The vector  $Z$  includes information on genetic variation (age and race), socio-economic status (marital status, income-to-poverty ratio, and educational attainment), health behaviors and conditions (smoking, alcohol, thyroid conditions, depression, serum C-reactive protein, television and computer viewing time, and the number of meals at restaurants), and employment characteristics (indicators for being employed, ever-worked, and working full-time).

If the coefficients  $\delta_1$  and  $\beta_1$  were found to be significant in the regressions (2) and (3), one valid interpretation could be that the causality runs from the energy balance variables to participation. For example, a taste for high calorie food could entice people to participate in the program to enable them to buy more of that food. In this section, we estimate the regressions (2) and (3) by ordinary least squares (OLS) and ask whether the resulting coefficients could explain an energy imbalance under the assumption that participation is exogenous to preferences for food and exercise. If the answer to this question is “no,” then the direction of causation is moot. In

Section 6, we use instrumental variables estimation to investigate the FSP participation decision and whether it is affected by exogenous variables that affect body weight.

Tables 2 and 3 contain the results from estimation of the models described by equations (2) and (3). The results imply that FSP participation has no significant effect on energy consumed or energy expended in leisure time physical activity. Column 1 in Table 2 shows that FSP participants consume 40.2 calories per day more than eligible nonparticipants do, although this difference is statistically insignificant. After controlling for age and race, the coefficient becomes  $-7.9$ ; this value is small, negative, and statistically insignificant. The magnitude remains similar when we introduce other controls. Thus, not only is average calorie consumption too small to explain the weight gap, but the average calorie difference is better explained by demographic differences than by FSP participation. In particular, black women report consuming 117 more calories than white women; as Table 1 shows, a relatively high proportion of black women are FSP participants and a comparatively high proportion of FSP participants are black. The results are similar if we measure participation by the number months participating during the past year rather than a dummy variable indicating participation at some point during the year. The negative coefficient on the number of months participating in columns 4, 6, and 8 contradicts the expectation that a relatively longer FSP participation spell would result in greater weight gain, and lends further evidence to the claim that FSP participation does not cause weight gain by increasing consumption.

Few of the control variables are statistically significant in the calories regression. Calorie consumption decreases with age. All else equal, a 40 year old is predicted to consume about 130 fewer kcal per day than a 20 year old and about 200 more than a 60 year old. These declines reflect declines in the RMR as people age. Estimated weight one year prior is negatively related

to calories consumed, although the coefficient is insignificant. One possible explanation for the negative coefficient on past weight is that heavier individuals may have made attempts to lose weight by decreasing energy consumption (Briefel et al. 1997).

As discussed in Section 3, the propensity to underreport energy consumption increases with weight. Black (2000) and Livingstone and Black (2003) suggest estimating the propensity to misreport food intake by classifying individuals who report low energy consumption relative to their resting metabolic rate (EC/RMR) as under-reporters. Based on this method, a greater propensity to report low EC/RMR by FSP participants would indicate that they are more likely to underreport food consumption. However, a low reported ratio could be accurate if the woman was losing weight, or was sedentary, or if the survey was taken on a day when she ate much less than usual. From appendix equation (A2), women with normal activity levels have EC/RMR approximately equal to 1.5. We categorize women who have EC/RMR below their self-reported average amount of daily physical activity as under-reporters, and check whether FSP participants are more likely than nonparticipants to be under-reporters. We do not find a significant difference in underreporting for participants versus nonparticipants (61% versus 56% probability, respectively). Thus, we have some evidence to suggest that systematic bias in the dietary recall data for FSP participants do not account for the observed differences in weight and energy consumption.

Table 3 shows that FSP participation is associated with a reduced amount of energy expended in leisure time physical activity (17 fewer kcal a day in the full specification), but the difference becomes smaller in magnitude and insignificant after introducing controls such as smoking and having a child under one year of age, both of which are positively associated with FSP participation (see Table 1). Table 3 also shows that the amount of energy expended in

leisure time physical activity declines as women age. Women who smoke or are married expend about 43 and 61 fewer kcal a day, respectively, but heavy television watchers do expend significantly less energy. The results are similar if we measure participation by the number of months of participating during the past year rather than a dummy variable indicating participation at some point during the year, where each additional month of participation is associated with a statistically insignificant 2.4 kcal decrease in energy expenditure.

[**Table 2.** OLS Regression of Calorie Intake on FSP Participation]

[**Table 3.** OLS Regression of Energy Expended in Physical Activity on FSP Participation]

The results in Tables 2 and 3 show that differences in energy balance are insufficient to explain more than a small fraction of the greater weight of FSP participants compared with nonparticipants. These results leave three possibilities that we explore in the remainder of the paper. First, FSP participation may cause a small energy imbalance that is obscured by systematic measurement error in our measures of food intake and physical activity. It would stretch credibility to claim that measurement error differences between participants and nonparticipants could be large enough to explain the entire 15.5 lb weight difference, but the above analysis does not rule out the possibility that FSP participation causes some weight gain.

Second, FSP participation may change diet composition in ways that do not affect energy balance, but which change RMR or physical activity. For example, if the FSP leads people to a diet high in refined carbohydrates (e.g., white sugar and flour), resulting in a chronic state of hyperinsulinemia (high blood insulin), increased fat deposition and decreased physical activity, then RMR may decline and weight would increase even if energy consumption had not changed (Kahn and Flier 2000; Taubes 2008; Wells and Siervo 2011). Finally, differences in RMR across individuals may be correlated both with the propensity to be heavy and the propensity to

participate in the food stamp program. In other words, the association between being heavy and participating in the FSP is an example of omitted variables bias. We address the first two possibilities in Section 5 and the third possibility in Section 6.

## 5. Regression Models of Weight Gain

We begin with the reduced-form regression model

$$\Delta W = \alpha_0 + \alpha_1 FSP + \alpha_2 Z + \varepsilon_{\Delta W}, \quad (3)$$

where the control variables,  $Z$  control for heterogeneity in base energy expenditure ( $\overline{RMR}$ ). We include in  $Z$  individual characteristics that reflect genetic (e.g., race), physiological (e.g., having a thyroid condition), and behavioral (e.g., television viewing time) determinants of body weight, in addition to several measures of socio-economic status suggested in the literature (Feinman and Lieber 1998; Rooney and Schauberg 2002; Chioloro et al. 2008; Kim 2008; Clark and Dillon 2011; Fraser et al. 2011). Many of these individual characteristics have not been controlled for in previous papers on this topic. We use the same two measures of FSP participation as in the models reported in Tables 2 and 3.

The regression in (3) asks whether FSP participation is associated with weight gain, after controlling for variables that may affect the base RMR or behavior. In addition, we estimate a model based on the energy balance equation:

$$\Delta W = \alpha_0 + \alpha_1 FSP + \alpha_2 Z + \alpha_3 CS + \alpha_4 ACT + \varepsilon_{\Delta W}, \quad (4)$$

where  $CS = EC - \left(\frac{0.9 \cdot 24}{2.204}\right) W_0 = EC - 9.8 W_0$  denotes the calorie surplus, essentially the calories consumed in excess of those required to maintain current weight (see Gropper, Smith and Groff

2009).<sup>12</sup> In the context of equation (4), which follows directly from the appendix equation (A2) under the assumption of constant food intake and physical activity throughout the year,  $CS$  measures the calories consumed in excess of those required to maintain current weight for no leisure time physical activity ( $ACT = 0$ ) and at the benchmark resting metabolic rate  $\overline{RMR}$ .  $ACT$  measures the energy expended in leisure time physical activities (e.g., jogging, gardening, or taking an aerobics class).

In (4), the coefficient  $\alpha_1$  measures any effect of  $FSP$  on weight gain in addition to that which is attributed to measured activity and calorie surplus. A growing vein of medical literature suggests that the simple energy balance equation (i.e., comparing energy intake and expenditure) does not entirely explain why some people continuously gain weight and never reach a weight plateau. Recent research proposes that the metabolic dysfunction caused by consuming a diet high in refined carbohydrates promotes sedentary behavior and food-seeking behavior (hunger), promoting continued weight gain and insulin resistance (Wells and Siervo 2011). If  $FSP$  participation generates such an effect in our data, then  $\alpha_1$  in (4) captures it.

Table 4 displays the results from estimation of the model described by equations (3) and (4) for low-income women. As column 1 demonstrates, when we do not control for any individual characteristics, we find a positive but statistically insignificant association between  $FSP$  participation and weight gain over the previous year. Columns 1, 3, 5, and 7 display the results of the model, adding progressively more individual characteristics. Focusing on column

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<sup>12</sup> We also tried several other RMR prediction equations including the Mifflin St. Jeor, Oxford, and WHO/FAO/UNU/Schofield prediction equations. The results were qualitatively the same and are available from the authors upon request. We did not use RMR prediction equations based on FFM and FM because we observe these variables only for a subset of our sample. Frankenfield, Roth-Yousy, and Compher (2005) found that the Mifflin St. Jeor equation predicted RMR with less error than the Harris-Benedict, WHO/FAO/UNU/Schofield, or Owen RMR prediction equations. Henry (2005) found that the WHO/FAO/UNU/Schofield often over-estimates RMR, and presented the new Oxford RMR equations.

7, our results suggest that, all else equal, women who participated in the FSP gained about 0.97 more pounds in the past year compared with low-income women who did not participate. This estimate is not statistically significant and has a 95 percent confidence interval of  $(-2.01, 3.95)$ . Compared to the model with no controls (column 1), the coefficient on FSP participation is halved when we control for race and age (column 3). Adding further controls makes little difference to the coefficient estimate or standard error.

The activity and calorie surplus variables have little effect on the estimated coefficient on FSP participation (columns 5 and 7). Thus, even when we hold physical activity and consumption constant and interpret the coefficient on FSP participation as the causal effect on weight gain, we can conclude that the one pound greater weight gain of FSP participants does not result from their increased food consumption or reduced activity. This result is consistent with the regressions in Tables 2 and 3.

We find even weaker evidence that the FSP causes obesity when we focus on FSP spell length (measured in months). Without any controls, we obtain an insignificant coefficient estimate of 0.085 pounds per month of participation in the FSP; this estimate becomes negative when we add controls to the model, but it remains statistically insignificant with a 95 percent confidence interval of  $(-0.37, 0.26)$  in column 8. Thus, controlling for age and race and taking the point estimates at face value, additional months on food stamps are associated with a small weight loss.<sup>13</sup>

As we would expect, a significant positive relationship exists between calorie surplus and weight gain. The coefficients on calorie surplus equal about 0.0037, which suggests that a

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<sup>13</sup> When we restrict the data set to include only women for whom we have information on occupation and employment, and include indicators for occupation class and whether they worked outside the home, the coefficient on FSP participation decreases to 0.33 (results not shown). Women with a job categorized as “manufacturing,” which likely entails more strenuous activity than occupations in the retail, healthcare, or transportation categories, gained less weight.

calorie surplus of 100 kcal per day is associated with a 0.37 pound increase in body weight over the past year, much less than the 7 pounds implied by the physiological model in equation (A6) or the 5 pounds implied by the model in Hall et al. (2011). However, these models hold activity level constant. Hall et al. (2009) suggest the formula  $\Delta W_{\text{lbs}} = [CS_{\text{kcal/day}}/103.466]$  which would imply a coefficient of 0.0097. Our smaller estimate may be caused in part by measurement error in our calorie intake and leisure time physical activity variables, or other factors and individual characteristics that we do not observe and omit from the regression.<sup>14</sup>

Few of the coefficients on control variables in Table 4 are statistically significant. Women who reported that they were breastfeeding gained almost seven more pounds in the past year than women who did not breastfeed at the time of the survey. Being married, having a thyroid condition, higher amounts of C-reactive protein in the blood, and spending more than three hours a day on the computer are also associated with having gained more weight over the past year.

[**Table 5.** OLS Regression of Change in Weight on Food Stamp Program Participation]

We conducted several robustness checks of our results. Following Shapiro (2005) and using data from the 2007–2008 NHANES we also investigated whether the timing of the disbursement of FSP benefits had any effect on caloric intake, and found no effect.<sup>15</sup> In addition, the qualitative results were unchanged when we conducted the analysis without survey weights, or dropped observations with extreme values for calorie intake.

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<sup>14</sup> Classical measurement error would bias the coefficient on *CS* towards zero, but would not bias the regressions in Table 3, in which calorie consumption is the dependent variable.

<sup>15</sup> These results are omitted for brevity, but are available from the authors upon request.

## 6. Models of Participation in the Food Stamp Program

The results presented in Sections 4 and 5 do not support the claim that participation in the FSP causes obesity or weight gain through the physiological or behavioral channels we explored. Other variables that have been omitted from previous analysis may make some people both more likely to be overweight and more likely participate in the FSP. For example, if some individuals derive greater utility from consuming food, then they may be more likely to be obese and will have greater net benefits from participating in the FSP.

Similar to Wilde, Troy and Rogers (2009), Table 1 shows that, relative to nonparticipants, FSP participants tend to have relatively stronger preferences for food at home FAH. Moreover, if, when compared with non-obese individuals, obese individuals have a greater willingness-to-pay for food because they find it more rewarding or enjoyable, they may also have greater willingness to pay the stigma and transactions costs of applying for and using FSP benefits (Saelens and Epstein 1996). Further, living in the “culture of poverty” could promote both obesity and FSP participation. If poor individuals have myopic or present-biased preferences they will be less willing to forgo pleasure in the current period (e.g., cutting back on ice cream) to ensure benefits in later periods (e.g., maintaining healthy body weight). The culture of poverty may also affect participation in the FSP because relatively disadvantaged people have greater potential benefits from, and possibly willingness to use, social assistance programs.

Following Moffitt (1983) and Meyerhoefer and Pylypchuk (2008), we model the decision to participate in the FSP by an income eligible household as the result of a household utility maximization process. The household decision-maker maximizes utility with respect to food,  $U(\cdot)$ , (which can be transformed into energy consumption and thus, surplus calories) ( $CS$ ), non-

food ( $NF$ ), and their current weight status ( $W$ ) net of (i) the disutility of unhealthiness or obesity,  $C(\cdot)$ , and (ii) for participants, the stigma of welfare receipt, given constraints on total household money income ( $Y$ ) and time ( $H$ ),  $C^P(\cdot)$ . Specifically, the household decision-maker maximizes the net-utility function given by equation (5), subject to the budget constraint given by equation (6), and the time constraint given by (7).

$$\max_{F, NF, W} U(L, CS, NF, W) - C(W - W^{desired}) - P \cdot C^P(S, T; Z) \quad (5)$$

$$Y = EI + P \cdot FSB \quad (6)$$

$$H = J + L + ACT \quad (7)$$

where  $EI$  denotes earned income, and  $J$ ,  $L$ , and  $ACT$  measure the amount of time spent at work, leisure (e.g., sleeping, cooking meals, or watching television), and doing physical activity, respectively. In this framework  $P = 1$  if the household participates, 0 if not; household and individual characteristics affect  $C^P(S, T; Z)$ , which describes the (fixed) disutility of the stigma ( $S$ ) and transaction costs ( $T$ ) associated with participating in the FSP;  $C(W - W^{desired})$  represents the disutility associated with feeling overweight (e.g., social stigma or feeling like an outcast). For simplicity, total income ( $Y$ ) is comprised of earned income ( $EI$ ) and the FSP benefit ( $FSB$ ).<sup>16</sup> The vector  $Z$  includes personal characteristics that influence health and participation.

When the household maximizes utility it jointly determines body weight, physical activity, and food demand. Utility maximization yields functions describing household demand for food, non-food, labor, and physical activity, as functions of exogenous prices, income, and other household characteristics, which also determine the FSP participation choice.

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<sup>16</sup> Some evidence suggests that being obese carries a significant stigma and that this stigma has a lasting effect on education and earnings, especially for women (Gortmaker et al., 1993; Puhl and Brownell, 2001; Baum and Ford, 2004).

The decision to participate in the FSP hinges on whether the utility of the eligible household, when it participates, is greater than its utility when it does not participate. That is, if  $P^*$  in (8) signifies the net utility from participation,

$$P^* = U(CS^P, NF^P, W^P, EI, FSB) - U(CS^{NP}, NF^{NP}, W^{NP}, EI) - C^P(S, T; Z) + C(EW^{NP}) - C(EW^P) \quad (8)$$

then the household participates if  $P^* > 0$  and does not participate otherwise. The superscript  $j = P, NP$  indicates whether the household participates in the FSP. Based on equation (8), changes in earned income ( $EI$ ), welfare stigma ( $S$ ), transaction costs ( $T$ ), information, and body image will influence the likelihood of participating in the FSP. That is, reducing  $EI$ ,  $S$ , or  $T$  would increase the probability that the household participates.

Equation (9) represents the empirical counterpart of the conceptual model of FSP participation described by equation (8).

$$FSP = \phi_0 + \phi_1 W + \phi_2 Z + \varepsilon_{FSP} \quad (9)$$

In addition to the variables used as controls in Tables 3–5, the vector  $Z$  also includes an indicator for U.S. citizenship, the number of months at the current job, and homeownership status.

Because access to the FSP varies geographically, we also use restricted-use data, available only through a National Center for Health Statistics or Census Research Data Center, on the state and county where the survey respondent resides.<sup>17</sup> This geographic information allows us to add additional variables to the analysis. We use county unemployment rates for years 1999 through

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<sup>17</sup> We applied the sampling weights, masked variance units, and strata provided in the publicly available 2001–2006 NHANES data, and performed all analysis in STATA-MP 12.0 at the Census Research Data Center in Berkeley, CA. Using the same criteria outlined above to limit the NHANES data and dropping observations with missing county characteristics, FSP characteristics, or geographic identifiers, 2,375 observations remained (497 participants and 1,878 nonparticipants). The 2,375 observations in the sample have a survey-weighted mean body weight of 178.5 pounds (with a standard error of 2.6) for FSP participants and 163.9 pounds (with a standard error of 1.2) for nonparticipants.

2006 from the US Bureau of Labor Statistics.<sup>18</sup> We also extracted from the US Census Bureau's Local Area Unemployment Statistics series, data on (i) the percentage of the total population living at or below the federal poverty line, (ii) the percentage of the population 0 to 17 years old living at or below the poverty line, and (iii) median family income by county.<sup>19</sup> From the USDA ERS we use information and variables from the Food Environment Atlas and the Rural-Urban Continuum Codes.<sup>20</sup> The USDA FNS provided us with an unreleased and updated version of the Food Stamp Program Rules Database, which contains information on state FSP rules governing asset limits, recertification period length, immigrant eligibility, issuance methods, reporting requirements, and outreach activities.

Under the hypothesis that FSP participation causes obesity, the contemporaneous weight variable in (9) is endogenous to *FSP*. Our results in Sections 4 and 5 imply that such endogeneity is not empirically relevant. However, as a further check on those results, we also estimate (9) using instrumental variables (IV). We use a binary indicator variable for having a family history of type 2 diabetes to instrument for weight. Individuals cannot control the traits and genetic material they inherit, thus, they take their having a family history of type 2 diabetes as given when making decisions that affect their weight. We assume that having inherited a predisposition to type 2 diabetes and obesity can affect the decision to participate in the FSP only by affecting body weight. In other words, we assume that the instrument meets the exclusion restriction of IV because it does not belong as a regressor in equation (9). This instrument captures inherited predisposition both through a genetic predisposition and a predisposition that individuals learn or develop through their exposure to obesogenic environments during

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<sup>18</sup> Available at: <http://www.bls.gov/lau/#tables>

<sup>19</sup> Available at: <http://www.census.gov/did/www/saige/data/statecounty/data/index.html> and <http://www.census.gov/popest/eval-estimates/eval-est2010.html>

<sup>20</sup> Available at: <http://www.ers.usda.gov/foodatlas/> and <http://www.ers.usda.gov/data/ruralurbancontinuumcodes/>

childhood and adolescence. We perform the IV estimation in STATA 12 using the survey commands for instrumental variables with the two-stage-least-squares (2SLS) estimator.<sup>21</sup>

**[Table 5. OLS and IV Models of Food Stamp Program Participation]**

Table 5 contains the results for the model described by equation (9) estimated by OLS (columns 1–4) and IV (columns 5–8). Column 1 shows that the probability of FSP participation increases by 0.001 for every pound of body weight. This coefficient provides another way to view the differences in body weight shown in Figure 1. If this significant coefficient reflects omitted-variables bias, then including those omitted variables in the model would reduce the coefficient on body weight to zero. When we control for age and race, the coefficient drops by 10% to 0.0009, and its value remains nearly the same when we add control variables. In column 4, we include a long list of individual, county, and state characteristics, and state fixed effects, the coefficient on weight stays stable and statistically significant.

Consistent with the previous literature, we find that more-educated women and married women were less likely to participate in the FSP. We also find that women who ate more meals at restaurants were significantly less likely to participate in the FSP, perhaps because they had strong preferences for food-away-from-home, which cannot be purchased with food stamps. Black women, women who smoked, and women who rented their place of residence were 11.9, 10.6, and 13.9 percentage points more likely to participate, respectively (column 4 of Table 5). Women with children less than five years of age had a 17 percentage point higher probability of participating.

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<sup>21</sup> We use STATA 12 to estimate the models that include state and county characteristics, and STATA 10 to estimate the models that exclude state and county characteristics.

However, the inclusion of additional determinants of FSP participation does not make the relationship between current weight and participation insignificant. The coefficient in column 4 implies that for two women with a 20 pound difference in body weight, the heavier woman has a 1.6 percentage point (or 7.6 percent) greater likelihood of choosing to participate in the FSP than the lighter woman, all else equal.

The IV estimates of the weight coefficient imply that an additional 20 pounds of body weight would increase the probability of participating in the FSP by approximately 5 percentage points ( $0.06 = 20 * 0.003$ ) for women who might have a lower body weight if they did not have a family history of type 2 diabetes. Relative to the women with comparatively lower propensities for obesity, women with a greater propensity for obesity may have larger perceived benefits or smaller perceived costs of FSP participation, and thus a greater probability of participating in the FSP. The point estimate changes little when we add controls, although it loses statistical significance when we add the large set of controls.

We evaluate the strength of our instrument using the first-stage F-statistic; the instrument would be deemed weak if the F-statistic for the test of the significance of the IV in the first stage of the 2SLS IV estimation were to fall below 10 (Staiger and Stock 1997). The first stage regression shows that having a family history of type 2 diabetes significantly increases body weight, by approximately 12.3 pounds in the full specification. The smallest first-stage F-statistic across our specifications is 28, so we do not have a weak instrument.

We use a Hausman test to compare the OLS and IV estimators and test whether body weight is an endogenous regressor in the FSP participation equation (Cameron and Trivedi 2005, p. 276). We fail to reject the null hypothesis of the Hausman test that body weight is an

endogenous regressor in the FSP participation equation for all specifications. This result provides further evidence that FSP participation does not cause weight gain.

The IV estimates of the weight coefficient exceed the OLS estimates. In the full specification (column 8) the IV estimate of the effect of weight on FSP participation remains approximately 3 times larger ( $3 = 0.003/0.001$ ) than the OLS estimate (see columns 4 and 8). If OLS were biased due to reverse causality from FSP to weight, then we would expect the OLS coefficient to be biased upward. In contrast, the IV estimates presented here suggest a downward-biased OLS estimate and, therefore, that reverse causality is not important. The Hausman test indicates that the IV estimate is not statistically significantly greater than the OLS estimate. To the extent that the IV coefficient is greater, it reflects unobserved heterogeneity and a local average treatment effect (LATE, Imbens and Angrist 2004). Specifically, IV estimates the effect of weight on participation for the particular group of women who might have a lower body weight if they did not have a family history of type 2 diabetes. The fact that these women display a greater than average association between weight and FSP participation adds evidence to the argument that unobserved factors that cause both high body weight and FSP participation underlie the observed correlation between these variables.

The full specification in column 4 of Table 5 provides further insight into the many individual and household characteristics that affect the decision to participate in the FSP. As in previous studies, we find that older, married, educated, and relatively higher-income women have a lower probability of participating in the FSP. Conversely, we find that minorities, women who rent their homes, women who smoke cigarettes, and women with infants and young children (between one and five years old) have a higher probability of participating in the FSP, all else equal. Interestingly, women currently breastfeeding their infants have a significantly lower

probability of participating in the FSP. One possible explanation for these seemingly contradictory results is that women who do not breastfeed their infants may prefer to use only FSP benefits (which you can also use to buy infant formula), rather than WIC benefits or both WIC and FSP benefits, because the FSP offers greater flexibility in shopping choices and more anonymity than WIC benefits.<sup>22</sup>

As did Wilde, Troy, and Rogers (2009) and Pan and Jensen (2008), we also found evidence that individuals who eat a greater number of meals away from home—which may signify a stronger preference for food away from home—have a lower probability of participating in the FSP. All else equal, and as we might expect, women who lived in states that applied a sales tax to food items (i.e., had relatively higher food costs) had a higher probability of participating in the FSP. Lastly, several state fixed effects significantly increased or decreased the likelihood that women participated in the FSP.

## **7. Conclusion**

Many commentators and some policymakers have suggested that the FSP may have contributed to the “obesity epidemic” by facilitating the overconsumption of food and calories. In response to these concerns, researchers have attempted to model and measure the effects of FSP participation on obesity in the United States. However, it has proved very difficult to identify a causal relationship between FSP participation and obesity. Much of the previously published work on the subject has failed to: (i) adequately control for the systematic differences between FSP participants and nonparticipants (i.e., selection bias), (ii) test whether FSP

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<sup>22</sup> Participants in the FSP use an EBT card to pay for food items whereas WIC participants purchase “WIC Foods” with vouchers or coupons for the specific foods on the WIC list. Women may feel less stigma from using the EBT cards provided by the FSP than the coupons provided by WIC. In addition, participants may prefer the much less restricted FSP approved foods list over the WIC approved foods list. Pregnant or breastfeeding women and their children are automatically eligible for WIC if they are eligible for the FSP.

participation leads to weight gain, and (iii) consider the possibility that, along with many other individual and household characteristics, body weight also affects the decision to participate in the FSP. These gaps in the literature motivated this study.

This study makes several contributions to the existing literature on the links between participation in the FSP, the health of FSP participants, and obesity. Specifically, first, we develop a physiologically consistent model that relates *changes in weight* to FSP participation while controlling for many of the individual and environmental characteristics and factors that influence the body weight of an individual. To conduct this analysis, we use the NHANES data, which contains information on a wide range of individual health characteristics and behaviors, as well as household characteristics. Furthermore, having obtained access to the restricted-use NHANES variables (the state and county of residence) we merged these detailed health data with socio-economic, macroeconomic, and FSP program characteristics by county and state. Second, we construct a model that allows body weight to influence the choice to participate in the FSP and use IV techniques to identify the effect of body weight on the probability of FSP participation. This model contributes new insights into the personal and household characteristics that influence the decision to participate in the FSP (e.g., women with formula-fed infants may participate in the FSP instead of WIC), and corroborates the findings in previous studies (e.g., that older and more educated people have lower participation rates).

The FSP provides a valuable safety net against hunger and malnutrition for millions of low-income Americans, and the existing literature has shown that the FSP achieves the goal of reducing food insecurity and preventing hunger (Gundersen, Kreider, and Pepper 2011). Our research contributes to the literature on the determinants of FSP participation and the effects of FSP participation on health and obesity. It demonstrates the difficulty of identifying a causal

link between FSP participation and obesity, in part because the decision to participate in the FSP is likely to depend on many factors that the econometrician will never observe. Identification problems of this type are encountered often in analysis of public health policy questions, and they call for creative approaches. We outline a framework for modeling the links between a public policy (in this case a subsidy for food) and health outcomes, paying specific attention to capturing the fundamental mechanisms—both economic and physiological—involved in the process. We explore the various links that might account for the observed correlation between obesity and FSP participation. The separate elements provide reinforcing evidence. We find no justification for making changes to the FSP on the grounds that FSP participation causes weight gain.

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## Appendix: Dynamic Energy Balance Models

Christiansen et al. (2005) model energy expenditure multiplicatively as  $EE=PAF \times RMR$ , where  $PAF$  represents the physical activity factor, or the ratio of total daily energy expenditure to resting metabolic rate. For example,  $PAF$  would equal one for a person who did nothing more than lie in bed all day. Based on the amount of average daily physical activity individuals reported and the corresponding metabolic equivalents (METs) provided in NHANES we assume a  $PAF$  of 1.5, the average for women in our sample.<sup>23</sup> Sherwood (2007) use a functional form that is additive in RMR and energy expended in physical activity.

Combining ideas from these studies, and the daily physical activity reported in NHANES, we choose the formulation

$$EE = 1.5RMR + ACT \quad (A1)$$

where  $ACT$  denotes physical activity in excess of the normal amount of 1.5. The  $ACT$  term could be negative for a person whose activity level is less than normal. We choose this formulation because we see  $ACT$  as a choice variable that may be an unspecified function of weight. For example, an overweight woman may have below-normal activity levels because she lacks energy or she may expend more energy in physical activity than a normal-weight person because it takes more energy for her to perform a given exercise. In contrast, the term  $1.5 RMR$  captures energy required by biophysical mechanisms to live assuming a typical amount of physical activity.

Chow and Hall (2008), Christiansen et al. (2005), Frankenfield, Roth-Yousy and Compher (2005), Henry (2005), and Gropper, Smith and Groff (2009) show that the relationship

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<sup>23</sup> The NHANES questionnaire asked whether the respondent which of the four sentences best described their usual daily activities: (i) sits most of the day and does not walk about very much, (ii) stands or walks about a lot during the day, but does not have to carry or lift things very often, (iii) lift(s) light load or has to climb stairs or hills often, or (iv) does heavy work or carries heavy loads. Each activity level had a corresponding MET score, i.e., the amount of energy relative to RMR needed to complete the reported average daily physical activity.

between RMR and bodyweight is approximately linear. Using this relationship and combining equations (1) and (2), we write the energy balance equation as

$$ES = EC - ACT - 1.5(\overline{RMR} - \alpha(W - \bar{W})) \quad (A2)$$

where  $W$  denotes weight,  $\bar{W}$  denotes a reference weight,  $\overline{RMR}$  denotes a reference value of  $RMR$ , and  $\alpha$  is a parameter that captures the energy content of the difference between weight  $W$  and the reference weight  $\bar{W}$ . It follows that weight dynamics can be approximated well by the differential equation

$$\frac{dW}{dt} = \rho(EC - ACT - 1.5\overline{RMR} + 1.5\alpha(W - \bar{W})) \quad (A3)$$

where  $\rho$  is an energy conversion parameter. Chow and Hall (2008) argue that this linearized equation represents weight dynamics well, conditional on body composition and a fixed amount of physical activity. In other words, base energy expenditure ( $\overline{RMR}$ ) varies across individuals and is driven by factors such as age, gender, physical activity, diet, existing health conditions (e.g., diabetes or asthma), and the relative amounts of fat and fat-free mass (Sherwood 2007; Gropper, Smith and Groff 2009). The solution to the differential equation in (A3) is

$$\begin{aligned} W(t) &= e^{-1.5\rho\alpha t}W(0) + \rho \int_0^t e^{-1.5\rho\alpha(t-s)} (EC(s) - ACT(s) + 1.5(\alpha\bar{W} - \overline{RMR})) ds \\ &= e^{-1.5\rho\alpha t}W(0) + \rho \int_0^t e^{-1.5\rho\alpha(t-s)} (EC(s) - ACT(s)) ds + \frac{\alpha\bar{W} - \overline{RMR}}{\alpha} (1 - e^{-\rho\alpha t}) \end{aligned} \quad (A4)$$

Christiansen et al. (2005) estimate that, for a typical woman, the  $\alpha$  parameter in (A4), which measures the energy content of a one unit change in body mass or the energy needed to maintain the additional body weight, equals 0.048 MJ per kilogram of bodyweight per day, or 5.21 kcal/lb/day. This estimate derives from body fat percentage and the relative energy expenditures of lean tissue and fat. When a person gains weight, the additional tissue contains a

greater proportion of body fat than the existing tissue, which affects RMR because fat is less metabolically active than muscle. Based on experimental data, Christiansen et al. (2005) estimate RMR in kcal per pound of body weight per day using the equation

$$RMR = 12.6W - 9.7FM, \quad (A5)$$

where  $FM$  represents fat-mass in pounds.<sup>24</sup> Then, based on experimental data showing that the marginal increase in fat mass per pound of body weight gain is similar for women across a wide range of body mass, they set  $\partial FM / \partial W = 0.76$ . It follows that  $\alpha = 12.6 - 0.76 \cdot 9.7 = 5.2$ . This estimate is slightly larger than the value of 4.3 that is commonly applied in clinical settings and was derived in 1919 from indirect calorimetry by Harris and Benedict.<sup>25</sup>

Based on experimental evidence, Christiansen et al. (2005) estimate that the parameter  $\rho$  equals  $1/28.6 = 0.035$  kg/MJ or 0.00032 lb/kcal. Substituting these parameters into (A4) implies that the change in weight over a year ( $t = 365$ ) can be expressed as

$$\Delta W = 0.00032 \int_0^{365} e^{-0.0025(365-s)} (EC(s) - ACT(s)) ds - 0.67W_0 + \mu \quad (A6)$$

where  $\mu = 0.058(\alpha \bar{W} - \overline{RMR})$  and  $W_0$  equals weight one year prior.<sup>26</sup> This model implies that the effect on weight after one year of an increase of 10 kcal per day is

$$10\rho \int_0^{365} e^{-1.5\rho\alpha(365-s)} ds = \frac{10}{1.5\alpha} (1 - e^{-1.5\rho\alpha(365)}) = 0.77 \text{ lb.} \quad (A7)$$

This number is slightly larger than the numbers implied by Hall et al. (2011), who predict a 0.5 lb (0.23 kg) increase in body weight after one year of consuming an additional 10 kcal per day.

<sup>24</sup> The equations in Christiansen et al. (2005) are given in kg/MJ but we convert to lb/kcal to be consistent with the rest of our analysis.

<sup>25</sup> Gropper, Smith, and Groff (2009) report the Harris-Benedict equation for women as  $RMR = 655.1 + 9.56W + 1.85H - 4.7A$ , where  $W$  denotes weight in kilograms,  $H$  denotes height in centimeters, and  $A$  is age in years. We convert the coefficient on  $W$  to pounds by dividing by 2.2.

<sup>26</sup> The exponent term follows from  $-1.5\rho\alpha(365-s) = -1.5(0.00032)(5.21)(365-s) = -0.0025(365-s)$ .

The steady-state weight increase in the Christiansen et al. (2005) model equals  $10/1.5\alpha = 1.28$  lb (0.58 kg). Thus, the Hall et al. (2011) model has similar steady-state implications to those of Christiansen et al. (2005), but the adjustment occurs more quickly in the latter. In general, after one year we would expect

$$\Delta W = \Delta EC \left( \rho \int_0^{365} e^{-1.5\rho\alpha(365-s)} ds \right) = \frac{\Delta EC}{1.5\alpha} \left( 1 - e^{-1.5\rho\alpha(365)} \right), \quad (\text{A8})$$

and a change in the steady-state weight of

$$\Delta W = \frac{\Delta EC}{1.5\alpha}. \quad (\text{A9})$$

Next, we place these models in the context of the effects of FSP participation on weight. Table A1 complements Table 1 by showing that food stamp participants weighed 18.4 pounds more than eligible nonparticipants among 18–40 year-old women during our 2001–06 sample period (see also Figure 1). If this difference reflects a difference in steady-state weight, then the energy balance model in (A9) implies that food stamp participants would consume about  $18.4 \times 1.5 \times \alpha = 144$  kcal per day more than participants, holding physical activity constant. If FSP participation causes weight gain and participants had not yet reached their steady-state weight, then participants should consume an amount greater than 144 kcal more than eligible nonparticipants. For example, to gain 20 lb in one year would require consuming an additional 261 kcal per day.

**[Table A2. Summary Statistics by Age Group]**

We examined the differences in energy consumption between participants and eligible nonparticipants against this reference point, by age category. For 18–40 year olds, the average energy consumed in the food recall survey was 40 kcal more for FSP participants than eligible

nonparticipants. This additional consumption is insignificantly different from zero and substantially smaller in magnitude than 144 kcal. However, a test of the null hypothesis that the food consumption difference equals 144 kcal has a p-value of 0.063, so it is not significantly different from 144 kcal. For 40–60 year olds the average weight difference was 14 lbs, and the average difference in calorie consumption was –44 kcal. This calorie difference implies women 40–65 years of age who participate in the FSP should have a 5.6 lb *lower* steady-state weight than non-participating women in this age group.

Dietary recall data are notorious for underreporting in total energy intake, and some *RMR* prediction equations overstate energy requirements, implying that the calculated calorie consumption could be biased down (Briefel et al. 1997; Henry 2005). For dietary recall bias to account for the observed differences in their weight and calories, the bias would need to be substantially greater for participants than nonparticipants. The probability of misreporting energy consumption increases with weight, age, gender, recent weight loss attempts, and self-perception of weight status (i.e., feeling the need to lose weight); and cultural norms may also influence the propensity for an individual to misreport their consumption habits.

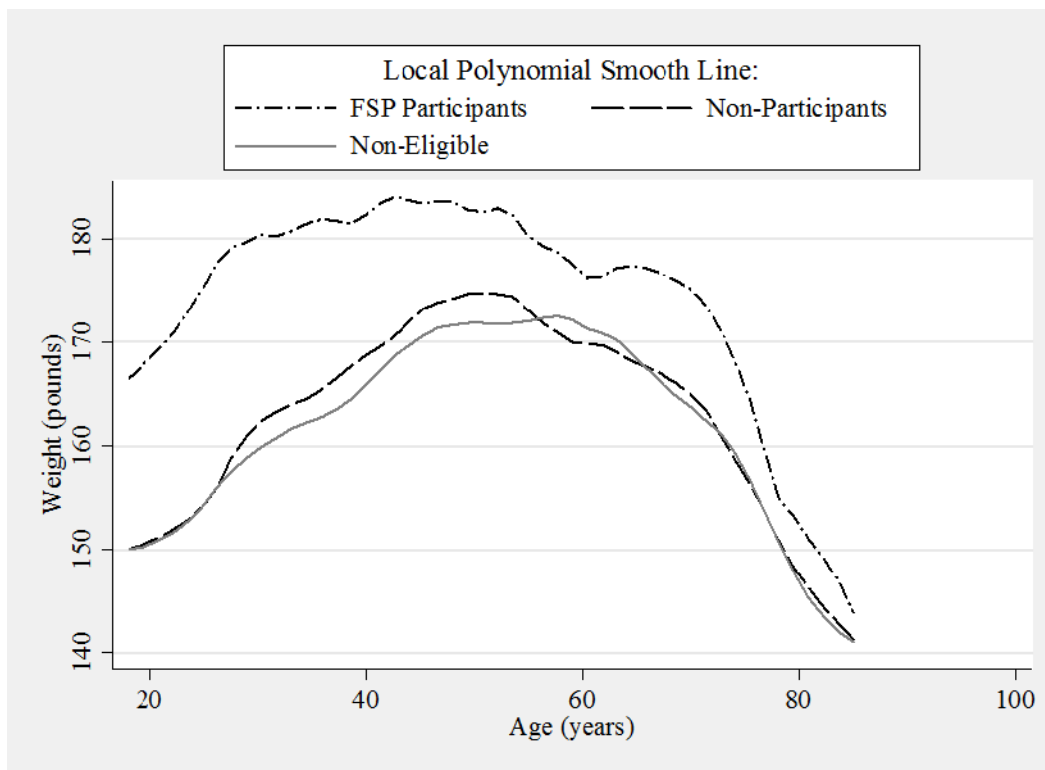
We only observe consumption at the end of the year rather than an average throughout the year. Although this quantity is a noisy estimate of average food consumption throughout the year, it not a biased estimate of the calorie difference between participants and nonparticipants unless participants reduce their consumption at the end of the year relative to nonparticipants. Such a result could arise if participants increase food intake while on food stamps and then reduce intake after they stop participating. To check this, we estimated the difference in calorie consumption between nonparticipants and those who participated only in the past month rather than at some point in the past year. We found that women who participated only in the previous

month consumed 143 fewer calories (a statistically insignificant difference) per day than nonparticipants.

Apart from food intake, energy imbalance can also arise from a change in physical activity. Compared to nonparticipants, FSP participants in our sample expended 35 fewer kcal per day in leisure time physical activity. However, the 75 kcal net difference (i.e., 35 fewer kcal expended and 40 additional kcal consumed) accounts for about half of the 144 excess kcal needed to account for the 18 pound difference (for women aged 18–40 years) in body weight between participants and nonparticipants (we would expect a 5.7 lb weight gain after 1 year and a 9.6 lb increase in steady-state weight for a increase of 75 kcal).

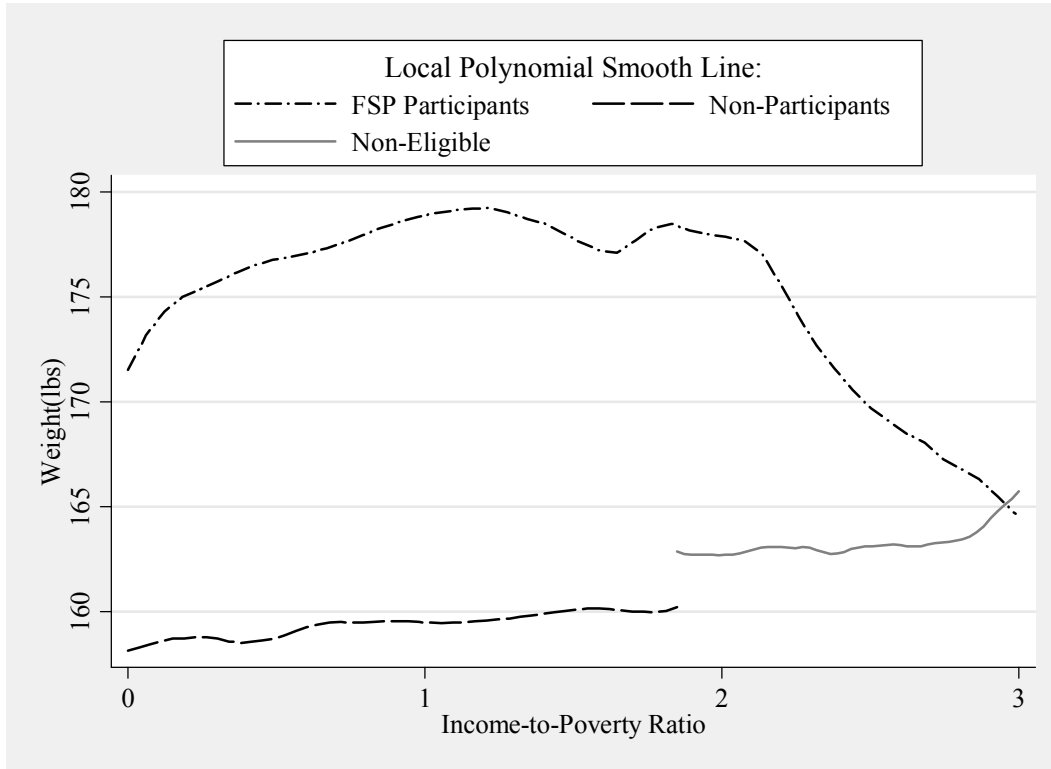
Equations (A4) and (A6) are linearized approximations to a nonlinear dynamic energy balance function parameterized using values for a normal weight woman with normal activity level. For obese individuals, a relatively greater proportion of any gains in body weight go to fat rather than to lean tissue (Christiansen et al. 2005). This difference has the effect of decreasing the values of  $\rho$  and  $\alpha$ , implying a greater steady-state weight increase for a given increase in calories per day, and a slower adaptation to that steady state. Table 4 in Christiansen et al. (2005) implies that for a morbidly obese person,  $\alpha = 2.93$  kcal/lb/day and  $\rho = 0.00026$  lb/kcal. With these parameters, the steady state weight increase from a permanent 10 kcal/day increase in food consumption equals  $10/1.5\alpha = 2.28$  lb with an increase of 0.78 lb after the first year. Thus, to gain 20 lb in one year would require consuming an additional 258 kcal per day; a 20 lb steady-state weight increase could be achieved with a permanent 87.9 kcal per day increase in food intake. However, these parameters apply to only a few observations in our sample, so they cannot be used to explain the average differences in weight between participants and nonparticipants.

## Tables and Figures



**Figure 1.** *Weight and Age for Women by Food Stamp Program Status*

**Notes:** Data pooled from the 2001–2001, 2003–2004, and 2005–2006 NHANES. Women who reported having a household income at or below 185 percent of the federal poverty threshold were considered eligible and women above this threshold were considered ineligible. We use the “twoway lpoly” STATA command with epanechnikov kernel functions, local mean smoothing, and the rule-of-thumb bandwidth estimator (the default options).



**Figure 2.** *Weight by Income-to-Poverty Ratio for Women by Food Stamp Program Status*  
**Notes:** See Figure 1.

**Table 1.** Summary Statistics for Low-Income Women Ages 18-70

	Participants	Nonparticipants	Difference in Means
FSP participation spell length (months)	7.61 (0.27)		
Weight (lbs)	179.18 (2.50)	163.69 (1.47)	15.49** (2.56)
Age (years)	37.17 (0.58)	39.33 (0.72)	-2.16* (0.82)
Change in weight in past year (lbs)	6.73 (1.34)	4.85 (0.66)	1.88 (1.43)
Vigorous physical activity	0.21 (0.02)	0.30 (0.02)	-0.09** (0.03)
Moderate physical activity	0.46 (0.04)	0.52 (0.02)	-0.06 (0.04)
No physical activity	0.48 (0.03)	0.40 (0.02)	0.08 (0.04)
Total daily calories (kcal)	1,849.55 (36.42)	1,809.39 (29.83)	40.16 (54.38)
Energy expended in daily leisure time physical activity (kcal)	121.13 (12.27)	155.69 (19.04)	34.57 (20.15)
Daily physical activity level (METS)	1.49 (0.004)	1.51 (0.003)	0.02** (0.005)
Type 2 diabetes	0.09 (0.01)	0.08 (0.01)	0.01 (0.01)
The Metabolic Syndrome <sup>a</sup>	0.59 (0.03)	0.49 (0.02)	0.10** (0.03)
Elevated waist circumference (> 88cm)	0.70 (0.02)	0.59 (0.02)	0.11** (0.03)
Family history of type 2 diabetes	0.41 (0.02)	0.38 (0.02)	0.03 (0.03)
Non-Hispanic black	0.35 (0.04)	0.14 (0.02)	0.20** (0.03)
Mexican American	0.09 (0.02)	0.15 (0.02)	-0.06** (0.01)
Other race	0.12 (0.03)	0.14 (0.2)	-0.01 (0.02)

**Table 1 (continued).** Summary Statistics for Low-Income Women Ages 18-70

	Participants	Nonparticipants	Difference in Means
Income-to-poverty ratio	0.80 (0.03)	1.09 (0.02)	-0.29** (0.03)
High school graduate	0.29 (0.03)	0.28 (0.02)	0.01 (0.03)
College graduate	0.04 (0.01)	0.11 (0.01)	-0.07** (0.02)
Married	0.35 (0.03)	0.48 (0.02)	-0.14** (0.04)
US citizen	0.92 (0.01)	0.84 (0.02)	0.08 (0.02)
Renter	0.71 (0.03)	0.47 (0.02)	0.24** (0.03)
Don't rent or own home	0.02 (0.01)	0.05 (0.01)	-0.03* (0.01)
Current smoker	0.47 (0.03)	0.27 (0.02)	0.20** (0.03)
Alcoholic drinks per day	1.70 (0.10)	1.37 (0.08)	0.33** (0.10)
# meals per week away-from-home	1.55 (0.09)	2.34 (0.19)	-0.80** (0.24)
> 3 hours TV/day	0.67 (0.02)	0.62 (0.02)	0.04 (0.03)
> 3 hours computer/day	0.72 (0.03)	0.70 (0.03)	0.02 (0.04)
Youngest child $\leq$ 1year old	0.12 (0.02)	0.07 (0.01)	0.04 (0.02)
Youngest child 1–5 years old	0.24 (0.02)	0.12 (0.01)	0.13** (0.03)
Currently breastfeeding	0.03 (0.01)	0.03 (0.01)	0.01 (0.01)
Days in the last month felt depressed	9.34 (0.60)	5.44 (0.24)	3.90** (0.61)
Thyroid condition	0.09 (0.02)	0.07 (0.01)	0.01 (0.02)
Observations	514	1,504	

Notes: All means estimated using the survey settings in STATA 10. Standard errors in parentheses, \*\* p<0.01, \* p<0.05.

(a) We were only able to identify individuals from the 2003-2004 and 2005-2006 NHANES (1,368 observations) who met the National Cholesterol Education Program ATP III guidelines criteria for the Metabolic Syndrome.

**Table 2.** Regression of Total Daily Calories on FSP Participation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FSP last year	40.16 (54.38)		-7.933 (58.84)		-0.805 (62.70)		21.51 (59.46)	
FSP spell length		2.325 (4.885)		-1.924 (5.153)		-1.872 (5.500)		-0.297 (5.335)
Weight one year ago ( $W_0$ )							-0.495 (0.414)	-0.478 (0.416)
Age			-7.841** (1.486)	-7.832** (1.483)	-5.591** (1.823)	-5.543** (1.791)	-4.743* (1.849)	-4.733* (1.816)
[Age - mean(Age)] <sup>2</sup>			-0.0924 (0.0862)	-0.0949 (0.0885)	-0.117 (0.0981)	-0.121 (0.0992)	-0.111 (0.0961)	-0.116 (0.0968)
Non-Hispanic black			117.3* (56.23)	118.6* (52.77)	135.8* (56.86)	137.9* (52.44)	151.4* (56.73)	155.5** (53.11)
Mexican American			21.74 (45.97)	20.40 (46.75)	69.79 (44.82)	68.25 (45.68)	83.23 (45.64)	82.14 (46.07)
Other race			-114.4 (64.91)	-115.5 (65.95)	-91.70 (64.84)	-92.32 (65.84)	-95.98 (65.32)	-94.63 (66.05)
Income-to-poverty ratio					36.05 (44.23)	32.60 (43.11)	42.96 (44.09)	38.83 (43.20)
High school graduate					23.63 (43.46)	22.63 (43.43)	29.45 (43.62)	28.42 (43.72)
College graduate					41.57 (78.97)	40.55 (78.58)	32.38 (77.59)	30.58 (77.18)
Married					-35.82 (45.13)	-37.96 (44.76)	-37.46 (45.06)	-39.72 (44.54)
Current smoker					19.62 (68.58)	21.19 (70.31)	16.18 (65.60)	19.10 (67.24)
Alcoholic drinks per day					22.93 (16.61)	22.98 (16.63)	23.63 (16.53)	23.60 (16.57)
# meals per week away-from-home					19.11* (7.502)	18.87* (7.755)	20.37* (7.595)	19.98* (7.834)

**Table 2 (continued).** Regression of Total Daily Calories on FSP Participation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
> 3 hours TV/day					64.13 (45.75)	64.16 (45.83)	7.591 (53.07)	8.926 (53.40)
> 3 hours computer/day					-19.07 (47.47)	-19.58 (47.75)	-67.72 (44.76)	-67.13 (44.79)
Youngest child $\leq$ 1 year old					77.23 (82.39)	82.37 (81.12)	73.51 (79.37)	79.54 (77.31)
Youngest child 1–5 years old					53.04 (57.57)	56.23 (57.19)	55.09 (57.57)	59.37 (57.26)
Currently breastfeeding					139.6 (124.0)	136.7 (123.1)	142.8 (127.0)	138.4 (125.9)
Needed more emotional support in past year					19.29 (56.62)	19.49 (56.78)	38.87 (55.71)	38.92 (55.71)
C-reactive protein (biomarker for inflammation)					-61.09* (26.48)	-60.39* (26.47)	-53.45 (27.20)	-52.83 (27.12)
Thyroid condition					28.26 (88.08)	28.61 (89.30)	24.62 (86.89)	25.71 (87.89)
Days in the last month felt depressed					2.092 (3.292)	2.164 (3.227)	2.309 (3.333)	2.417 (3.272)
Year fixed effect (2003-2004)							68.19 (39.32)	69.07 (38.64)
Year fixed effect (2001-2002)							179.4** (58.73)	176.1** (61.10)
Constant	1,809** (29.83)	1,815** (24.83)	2,136** (69.40)	2,138** (66.66)	1,896** (88.89)	1,902** (93.79)	1,901** (91.17)	1,908** (94.64)
Observations	2,018	2,018	2,018	2,018	2,018	2,018	2,018	2,018
R <sup>2</sup>	0.001	0.000	0.038	0.038	0.058	0.058	0.065	0.065

Notes: Standard errors in parentheses, \*\* p&lt;0.01, \* p&lt;0.05.

**Table 3.** Regression of Energy Expended in Physical Activity on FSP Participation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FSP last year	-34.57 (20.15)		-40.47* (17.00)		-22.14 (18.47)		-17.07 (17.76)	
FSP spell length		-4.246* (1.936)		-4.387* (1.757)		-2.846 (2.052)		-2.424 (2.087)
Age			-4.459** (1.328)	-4.438** (1.335)	-4.717* (1.812)	-4.667* (1.832)	-4.648* (1.773)	-4.603* (1.796)
[Age - mean(Age)] <sup>2</sup>			0.175** (0.0609)	0.174** (0.0614)	0.128** (0.0463)	0.127** (0.0469)	0.130** (0.0480)	0.128* (0.0484)
Non-Hispanic black			38.33 (27.19)	36.18 (27.39)	16.92 (26.55)	15.83 (26.72)	17.96 (25.72)	17.39 (25.64)
Mexican American			-53.71* (24.66)	-55.63* (24.83)	-43.14 (22.83)	-44.82 (22.45)	-40.99 (21.04)	-42.46* (20.63)
Other race			68.71 (39.12)	65.84 (38.68)	61.32 (39.21)	59.39 (38.14)	58.36 (38.34)	56.85 (37.34)
Income-to-poverty ratio					-7.691 (33.75)	-9.437 (34.37)	-7.731 (33.73)	-9.498 (34.36)
High school graduate					35.55 (34.46)	34.67 (34.74)	37.46 (35.78)	36.64 (36.08)
College graduate					26.43 (29.98)	26.67 (29.81)	25.89 (30.11)	25.92 (29.99)
Married					-59.17* (22.95)	-60.43* (22.65)	-59.73* (23.06)	-60.96* (22.76)
Current smoker					-43.53* (21.46)	-43.68* (21.54)	-42.98* (20.92)	-42.90* (20.87)
Alcoholic drinks per day					-2.507 (4.239)	-2.406 (4.266)	-2.420 (4.157)	-2.335 (4.189)
# meals per week away-from-home					-0.316 (3.706)	-0.324 (3.674)	-0.427 (3.643)	-0.459 (3.620)

**Table 3 (continued).** Regression of Energy Expended in Physical Activity on FSP Participation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
> 3 hours TV/day					14.48 (25.29)	14.67 (25.36)	1.151 (21.80)	1.317 (21.78)
> 3 hours computer/day					-24.45 (21.28)	-24.70 (21.36)	-34.88 (17.81)	-35.14 (17.86)
Youngest child $\leq$ 1 year old					-65.65 (55.48)	-62.46 (56.78)	-72.10 (56.61)	-68.91 (58.04)
Youngest child 1–5 years old					-51.67 (26.97)	-50.62 (27.01)	-51.57 (26.45)	-50.35 (26.46)
Currently breastfeeding					-98.92** (35.98)	-99.86** (36.12)	-92.21** (33.81)	-93.37** (34.17)
Needed more emotional support in past year					18.37 (22.94)	23.03 (22.90)	22.93 (26.44)	26.88 (26.50)
C-reactive protein (biomarker for inflammation)					-2.963 (5.153)	-2.724 (5.144)	-3.715 (5.254)	-3.415 (5.233)
Thyroid condition					-65.81** (21.71)	-66.21** (21.91)	-67.94** (23.36)	-68.20** (23.51)
Days in the last month felt depressed					-1.441* (0.797)	-1.807* (0.815)	-1.802* (0.776)	-1.762* (0.786)
Year fixed effect (2003-2004)							-17.75 (17.91)	-17.35 (17.93)
Year fixed effect (2001-2002)							21.81 (40.53)	22.00 (40.82)
Constant	155.7** (19.03)	155.1** (17.87)	281.3** (58.30)	279.8** (58.67)	381.6** (61.31)	382.6** (60.42)	391.4** (61.97)	392.6** (61.44)
Observations	2,018	2,018	2,018	2,018	2,018	2,018	2,018	2,018
R <sup>2</sup>	0.002	0.003	0.040	0.040	0.069	0.069	0.070	0.070

Notes: Standard errors in parentheses, \*\* p<0.01, \* p<0.05.

**Table 4.** Regression of Change in Weight on FSP Participation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FSP last year	1.880 (1.426)		0.939 (1.359)		0.895 (1.416)		0.970 (1.477)	
FSP spell length		0.0853 (0.150)		-0.0125 (0.147)		-0.0653 (0.153)		-0.0579 (0.156)
ACT					-0.00733 (0.00375)	-0.00738 (0.00377)	-0.00737 (0.00374)	-0.00741 (0.00375)
Calorie surplus					0.00367** (0.00132)	0.00364** (0.00132)	0.00372** (0.00132)	0.00370** (0.00132)
Age			-0.126* (0.0472)	-0.126* (0.0474)	-0.139* (0.0654)	-0.137* (0.0657)	-0.141* (0.0658)	-0.140* (0.0661)
[Age - mean(Age)] <sup>2</sup>			-0.00234 (0.00242)	-0.00260 (0.00241)	0.000107 (0.00271)	-0.000208 (0.00267)	-4.20e-05 (0.00267)	-0.000367 (0.00264)
Non-Hispanic black			1.615 (1.486)	1.854 (1.518)	1.526 (1.520)	1.784 (1.559)	1.463 (1.497)	1.711 (1.527)
Mexican American			-2.189 (1.306)	-2.248 (1.324)	-4.800** (1.522)	-4.880** (1.521)	-4.929** (1.495)	-5.024** (1.494)
Other race			-2.767 (1.891)	-2.749 (1.872)	-3.494 (1.898)	-3.468 (1.882)	-3.737 (1.909)	-3.695 (1.889)
Income-to-poverty ratio					-1.772 (1.515)	-2.046 (1.522)	-1.860 (1.526)	-2.130 (1.534)
High school graduate					-0.217 (1.393)	-0.279 (1.395)	-0.165 (1.380)	-0.236 (1.381)
College graduate					4.000 (2.415)	3.888 (2.387)	4.074 (2.464)	3.969 (2.439)
Married					2.740 (1.534)	2.574 (1.547)	2.716 (1.539)	2.559 (1.552)
Current smoker					-3.421 (2.263)	-3.254 (2.244)	-3.432 (2.242)	-3.270 (2.219)
Alcoholic drinks per day					0.125 (0.604)	0.126 (0.599)	0.121 (0.595)	0.121 (0.591)

**Table 4 (continued).** Regression of Change in Weight on FSP Participation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# meals per week away-from-home					-0.209 (0.157)	-0.231 (0.156)	-0.234 (0.157)	-0.257 (0.156)
> 3 hours TV/day					-0.867 (0.867)	-0.872 (0.868)	-0.878 (0.948)	-0.790 (0.946)
> 3 hours computer/day					2.195 (1.414)	2.151 (1.417)	2.250 (1.533)	2.283 (1.518)
Youngest child $\leq$ 1 year old					-0.726 (2.208)	-0.343 (2.172)	-1.122 (2.185)	-0.719 (2.140)
Youngest child 1–5 years old					-0.647 (1.947)	-0.369 (1.953)	-0.678 (1.967)	-0.408 (1.972)
Currently breastfeeding					6.589** (2.292)	6.338** (2.263)	6.899** (2.294)	6.616** (2.259)
Needed more emotional support in past year					-0.111 (2.211)	-0.127 (2.197)	-0.0984 (2.256)	-0.208 (2.245)
C-reactive protein (biomarker for inflammation)					4.208** (0.910)	4.242** (0.909)	4.294** (0.915)	4.252** (0.914)
Thyroid condition					1.130 (2.613)	1.179 (2.599)	1.102 (2.615)	1.166 (2.599)
Days in the last month felt depressed					0.0106 (0.0727)	0.0176 (0.0734)	0.0109 (0.0726)	0.0175 (0.0734)
Year fixed effect (2003-2004)							-2.138 (1.385)	-2.082 (1.376)
Year fixed effect (2001-2002)							-1.169 (1.765)	-1.358 (1.750)
Constant	4.854** (0.657)	5.166** (0.602)	10.84** (2.133)	11.12** (2.182)	9.730** (2.385)	10.31** (2.412)	11.19** (2.741)	11.73** (2.775)
Observations	2,018	2,018	2,018	2,018	2,018	2,018	2,018	2,018
R <sup>2</sup>	0.001	0.000	0.014	0.014	0.082	0.082	0.083	0.083

Notes: Standard errors in parentheses, \*\* p&lt;0.01, \* p&lt;0.05.

**Table 5.** OLS and IV Models of FSP Participation

	<i>Ordinary least squares (OLS)</i>				<i>Instrumental variables (IV)</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Weight (lbs)	0.001** (0.0002)	0.0009** (0.0002)	0.0008** (0.0002)	0.0008** (0.0002)	0.0034* (0.0012)	0.0021 (0.0017)	0.0017 (0.0017)	0.0027 (0.0016)
Age		-0.00002 (0.0008)	-0.0001 (0.0008)	-0.0003 (0.0008)		-0.0002 (0.0009)	-0.0002 (0.0009)	-0.0005 (0.0009)
[Age - mean(Age)] <sup>2</sup>		-0.0002** (0.00004)	-0.0002** (0.00004)	-0.0002** (0.00004)		-0.0002** (0.0001)	-0.0002 (0.0001)	-0.0001 (0.0001)
Non-Hispanic black		0.104** (0.032)	0.111** (0.032)	0.119** (0.04)		0.0817 (0.0485)	0.0910 (0.0464)	0.0798 (0.0479)
Mexican American		0.007 (0.026)	0.020 (0.024)	0.04 (0.03)		0.0093 (0.0256)	0.0190 (0.0236)	0.0416 (0.0286)
Other race		0.058* (0.027)	0.064* (0.03)	0.07* (0.03)		0.0743 (0.0379)	0.0749 (0.0394)	0.0866 (0.0372)
Income-to-poverty ratio		-0.166** (0.022)	-0.161** (0.021)	-0.17 (0.02)		-0.1637** (0.0227)	-0.1594 (0.0219)	-0.1642 (0.0222)
High school graduate		-0.028 (0.019)	-0.029 (0.018)	-0.03 (0.02)		-0.0299 (0.0215)	-0.0302 (0.0203)	-0.0322 (0.0223)
College graduate		-0.081* (0.037)	-0.068 (0.035)	-0.06 (0.04)		-0.0834* (0.0399)	-0.0708 (0.0383)	-0.0690 (0.0421)
Married		-0.072** (0.025)	-0.078** (0.026)	-0.078** (0.03)		-0.0746** (0.026)	-0.0794 (0.0267)	-0.0811 (0.027)
US Citizen		0.162** (0.029)	0.142** (0.03)	0.139** (0.03)		0.1401** (0.0442)	0.1256 (0.0431)	0.1070 (0.0417)
Renter		0.131** (0.021)	0.140** (0.021)	0.139** (0.02)		0.1331** (0.0234)	0.1416 (0.0226)	0.1414 (0.0255)
Don't rent or own home		-0.029 (0.034)	-0.017 (0.034)	-0.04 (0.04)		-0.0306 (0.036)	-0.0186 (0.035)	-0.0447 (0.0419)
Current smoker		0.112** (0.025)	0.110** (0.024)	0.106** (0.02)		0.1275** (0.0338)	0.1216 (0.0336)	0.1293 (0.0343)
Alcoholic drinks per day		-0.006 (0.006)	-0.006 (0.006)	-0.01 (0.01)		-0.0067 (0.0061)	-0.0070 (0.0062)	-0.0088 (0.0066)
# meals per week away-from-home		-0.014** (0.004)	-0.015** (0.004)	-0.014** (0.003)		-0.0141** (0.0036)	-0.0151 (0.0036)	-0.0132 (0.0036)

**Table 5 (continued).** OLS and IV Models of FSP Participation

	<i>Ordinary least squares (OLS)</i>				<i>Instrumental variables (IV)</i>			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
> 3 hours TV/day		0.000 (0.02)	-0.001 (0.02)	0.01 (0.02)		-0.0056 (0.0194)	-0.0060 (0.0201)	0.0042 (0.0212)
> 3 hours computer/day		-0.015 (0.02)	-0.020 (0.02)	-0.01 (0.02)		-0.0247 (0.0233)	-0.0272 (0.0238)	-0.0231 (0.0245)
Youngest child $\leq$ 1year old		0.268** (0.041)	0.262** (0.042)	0.262** (0.04)		0.2717** (0.0393)	0.2653 (0.0396)	0.2674 (0.041)
Youngest child 1–5 years old		0.177** (0.039)	0.177** (0.038)	0.170** (0.04)		0.1742** (0.0383)	0.1749 (0.0372)	0.1667 (0.037)
Currently breastfeeding		-0.192** (0.058)	-0.187** (0.058)	-0.171** (0.06)		-0.1913** (0.0575)	-0.1861 (0.0576)	-0.1671 (0.0571)
Metropolitan area indicator			-0.034 (0.028)	-0.01 (0.03)			-0.0264 (0.027)	-0.0046 (0.0238)
County child poverty rate			0.00009 (0.003)	0.005 (0.003)			0.0003 (0.0024)	0.0046 (0.0032)
County median household income			-0.000002 (0.000001)	-0.000001 (0.000002)			-0.000002 (0.000002)	-0.000001 (0.000001)
County unemployment rate			0.006 (0.008)	-0.01 (0.01)			0.0038 (0.0085)	-0.0099 (0.0099)
# Food Stamp authorized stores in county			-0.00002** (0.00001)	-0.00002** (0.00001)			-0.00002 (0.00001)	-0.00002 (0.00001)
State food sales tax indicator			-0.002 (0.025)	0.09 (0.05)			-0.0085 (0.0249)	0.1025 (0.0488)
State fixed effects?	No	No	No	Yes	No	No	No	Yes
Family history type 2 diabetes (first-stage)					16.65** (2.15)	12.21** (2.22)	11.58** (2.19)	12.31** (2.13)
Constant	0.020 (0.0392)	0.09 (0.054)	0.185 (0.125)	0.06 (0.12)	-0.3561 (0.1946)	-0.0903 (0.2381)	0.0587 (0.2035)	-0.2145 (0.2465)
Observations	2,375	2,375	2,375	2,375	2,375	2,375	2,375	2,375
R <sup>2</sup>	0.02	0.23	0.24	0.26				0.224
F-statistic test of model significance					8.26	26.18	18.92	
First stage F-statistic					59.75	30.14	28.09	33.52

**Table A1.** Summary Statistics by Age Group

	<i>Panel A: 18–40 years of age</i>		
	Participants	Nonparticipants	Difference in Means
FSP participation spell length (months)	7.57 (0.38)	- -	- -
Weight (lbs)	175.77 (3.13)	157.40 (1.95)	18.37** (3.37)
Change in weight in past year (lbs)	8.83 (1.49)	5.82 (0.91)	3.01 (1.65)
Vigorous physical activity	0.24 (0.03)	0.39 (0.03)	-0.15** (0.04)
Moderate physical activity	0.47 (0.05)	0.56 (0.03)	-0.10 (0.05)
Total daily calories (kcal)	1,956.44 (39.64)	1,916.71 (46.23)	39.73 (72.78)
Observations	318	839	
	<i>Panel B: 41 - 60 years of age</i>		
FSP participation spell length (months)	7.66 (0.55)	- -	- -
Weight (lbs)	186.71 (3.92)	172.72 (3.28)	13.99** (4.87)
Change in weight in past year (lbs)	3.12 (2.54)	4.79 (1.67)	-1.67 (3.21)
Vigorous physical activity	0.19 (0.04)	0.21 (0.03)	-0.03 (0.04)
Moderate physical activity	0.45 (0.05)	0.49 (0.04)	-0.04 (0.07)
Total daily calories (kcal)	1,681.16 (66.35)	1,725.18 (26.36)	-44.02 (77.25)
Observations	142	391	

Notes: Standard errors in parentheses, \*\* p<0.01, \* p<0.05.