Food Stamp Program Participation is Positively Related to Obesity in Low Income Women\textsuperscript{1,2}

Diane Gibson\textsuperscript{3}

School of Public Affairs, Baruch College, City University of New York, NY 10010

ABSTRACT This study examined the relationship between Food Stamp Program (FSP) participation and the obesity of low income individuals using data from the National Longitudinal Survey of Youth 1979. Obesity was defined as body mass index $\geq 30$ kg/m\textsuperscript{2}. The data were arranged as a panel with multiple observations per individual, and the models of obesity included current and long-term FSP participation, additional demographic, socioeconomic and environment characteristics and individual fixed effects. Individual fixed effects were used to take into account unobserved differences across individuals that did not vary over time. In ordinary least squares models, current and long-term FSP participation were significantly related to the obesity of low income women ($P < 0.05$), but not of low income men. For low income women, current participation in the FSP was associated with a 9.1% increase in the predicted probability of current obesity. Participation in the FSP in each of the previous five years compared to no participation over that time period was associated with approximately a 20.5% increase in the predicted probability of current obesity. These models did not control for food insecurity, and this omission potentially complicates the interpretation of the FSP participation variables. J. Nutr. 133: 2225–2231, 2003.

KEY WORDS: • obesity • food stamps • economic disadvantage • women

In 2001 the Food Stamp Program (FSP)\textsuperscript{4} provided vouchers worth $15.5 billion to participants in the program and served an average of 17.3 million people per month. During 2001, nonelderly adults over age 18 made up 39% of participants in the FSP (1). The goal of the FSP and other nutrition assistance programs is to fight hunger, food insecurity and related health problems (2). One measure of health directly linked to food consumption is obesity. Obesity has become a primary public health concern in the United States, and this study examined the relationship between FSP participation and obesity.

A large body of research has addressed the serious health consequences of obesity. Obesity has been found to increase the likelihood of heart disease, high blood pressure, cancer and diabetes (3–5). It has been estimated that 300,000 premature deaths occur per year in the United States because of obesity and sedentary lifestyles (5). In comparison tobacco, alcohol and illegal drugs have been associated with $\sim$400,000, 100,000 and 20,000 deaths per year, respectively (6).

FSP participation may be associated with obesity if it is related to food insecurity or health behaviors that influence obesity. Previous research has found that FSP participation is associated with a reduction in the food insecurity of participants (7), but individuals who participated in the FSP are still more likely to be food insecure than nonparticipants (7,8). Previous research has also found that mild food insecurity is positively related to being overweight for women (9,10). Therefore FSP participation may be positively associated with obesity as a result of the association between FSP participation and food insecurity. Alternatively, FSP participation could have an effect on obesity if it directly influences health behaviors related to obesity such as the quantity, quality or timing of food consumption (11–14).

Townsend et al. (9) examined the determinants of overweight with a sample of 9,451 women and men from the 1994–1996 Continuing Study of Food Intake of Individuals (CSFII). This is the only previous study that has examined the relationship between FSP participation and the weight of adults. Townsend et al. classified men with a BMI $> 27.8$ kg/m\textsuperscript{2} and women with a BMI $> 27.3$ kg/m\textsuperscript{2} as overweight. BMI was calculated as weight in kilograms divided by height in meters squared. In logistic regression models that also controlled for current food insecurity, age, ethnicity, education, income, occupation, welfare receipt, household size, urbanization and lifestyle variables, they found a positive and significant association between FSP participation and overweight for

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\textsuperscript{3} To whom correspondence should be addressed.

E-mail: diane_gibson@baruch.cuny.edu

\textsuperscript{4} Abbreviations used: AFDC, Aid to Families with Dependent Children; AFQT, Armed Forces Qualifying Test; CSFII, Continuing Survey of Food Intakes by Individuals; FS, food stamps; FSP, Food Stamp Program; NEP, Nutrition Education Plan; NLSY79, National Longitudinal Survey of Youth 1979; OLS, Ordinary Least Squares; WIC, Special Supplemental Nutrition Program for Women, Infants and Children.

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women, but not for men. Holding all else constant, participation in the FSP was associated with a 38% increase in the likelihood that a woman was overweight. Their analysis was limited by the CSFII because of its cross-sectional design as well as the absence of potentially relevant variables such as an individual’s history of poverty, social program participation and food insecurity.

The empirical analyses in this study attempted to address both of these limitations. A panel data set was used that allowed individual fixed effects to be included in the empirical models of obesity. Individual fixed effects took into account unobserved differences across individuals that did not change over time. Additionally, the data were extensive enough so that an individual’s long-term FSP participation and other long-term resources could be determined and included in the models of obesity.

**SUBJECTS AND METHODS**

**Sample.** Data from the National Longitudinal Survey of Youth 1979 (NLSY79) were used to examine the relationship between FSP participation and obesity for low income individuals. The initial wave of the survey was administered in 1979 to 6,283 females and 6,403 males aged 14–22 y in 8,770 households. The NLSY79 over-sampled black, Hispanic and economically disadvantaged nonblack, non-Hispanic individuals. Follow-up interviews were conducted annually until 1994 and biennially thereafter.

The data were arranged as a panel so that there were multiple observations per individual and the unit of analysis was a person-year. The sample used in the empirical analyses included observations from the 1985 through the 1996 waves of the survey, although data from earlier years of the survey were used to create variables that measured long-term family resources. An observation on a respondent was included in the sample every survey year in which the respondent was 20 y or older, had a total family income-to-needs ratio less than two, was independent and information was available on the respondent’s current weight, height and FSP participation status. The total family income-to-needs ratio was set equal to two so that the panel would include observations on 3,574 women and 8,957 observations on 3,157 men.

**Conceptual model.** The conceptual model of obesity (Fig. 1) that guided the empirical analyses differs from the conceptual models used in recent empirical studies of overweight (9,10,16,17) in that it follows Grossman (18) and assumes that a person’s obesity status at a point in time is a consequence of the person’s current and past personal characteristics rather than just current characteristics.

Demographic, socioeconomic and environment characteristics such as FSP participation, non-FSP family resources, education, occupation, hours of work, family composition, pregnancy status, region and urban residence, age, race or ethnicity, gender and underlying genetic factors may affect obesity directly or indirectly through influence on health behaviors related to obesity or food insecurity. Some of these personal characteristics may vary over time and some may not.

It is assumed that both current and past health behaviors and current and past food insecurity contribute to an individual’s current obesity status. Examples of health behaviors related to obesity are the amount and timing of nutrient consumption, the amount and intensity of physical activity, and the amount of smoking and drinking (11–14). Other conceptual models of obesity have assumed that food insecurity may influence obesity through health behaviors or other pathways (9,10,16,17).

The empirical models of obesity that were estimated included a set of individual demographic, socioeconomic and environment characteristics as independent variables. Food insecurity and health behaviors such as nutrient consumption and activity levels were excluded from these models. A benefit of this approach is that it allowed an estimate of the overall relationship between obesity and these personal characteristics. A disadvantage of this approach is that it did not provide insight into the mechanism for the relationship between these variables and obesity. Additionally, the interpretation of the FSP participation variables is complicated if food insecurity influenced both FSP participation and obesity. This issue is discussed in detail later in this article.

**Dependent variable.** Self-reported height information from 1985 (when respondents were between 20 and 28 y old) was combined with the self-reported weight of respondents from the 1985, 1986, 1988–1990, 1992–1994 and 1996 interviews to calculate a respondent’s BMI in each of these survey years. A respondent was categorized as obese if his or her BMI was $\geq 30$ kg/m\(^2\) (19).

**Independent variables.** The empirical models of obesity included current and long-term FSP participation. Two main variables were used to assess current FSP participation. One was an indicator variable for FSP participation in the previous calendar year. The other was a continuous variable measuring the amount of Food Stamp (FS) benefits a household received in the previous calendar year (defined in thousands of dollars). In this study, values of variables from the same survey year as the outcome variable are referred to as “current” values of these variables. The models also included the number of years a respondent participated in the FSP in the previous five survey years (hereafter referred to as the “previous five years”).

The models also included controls for other current and long-term family resources. In every year of the NLSY79, information was collected on the total family income of a respondent in the calendar year preceding the survey year. This variable included income from possible sources such as wages, spouse’s wages, income from a business and income from social programs such as Aid to Families with Dependent Children (AFDC), FS and other public assistance (20). A number of alternative specifications of this variable was used in the empirical models. All income variables were annual values defined in thousands of dollars.

Following previous research, a respondent was assumed to be eligible for the FSP in survey years where the respondent’s total family income net of FS benefits (hereafter referred to as “FS eligibility income”) corresponded to a FS eligibility income-to-needs ratio that was $<1.3$ (21–23). Long-term family resources other than long-term FSP participation were measured with two variables. The mean long-term level of other resources was approximated with the mean of the respondent’s FS eligibility income-to-needs ratios over the previous five years. The variance in other long-term resources was approximated by the number of years in the previous five a respondent’s family was eligible for the FSP.

Missing information for the long-term variables was quite common (67% of observations were missing data on one or more of the long-term variables). The NLSY79 assessed the FSP participation of

**FIGURE 1** Conceptual framework for the relationship between current obesity and current and past demographic, socioeconomic and environment characteristics.
dependent respondents inconsistently across survey years and as a result it was not possible to calculate the long-term FSP participation for respondents who were dependent in the previous five survey years. This accounted for 38.4% of the observations with missing long-term variables. The remainder of the missing long-term variables was due to nonresponse to the income questions or because individuals returned to the NLSY79 sample after missing interviews.

In order to include observations with missing long-term family resources in the sample, a long-term variable was set equal to zero if an observation was missing information on that variable. The empirical models also included separate indicator variables for missing data for each long-term variable. This allowed nonmissing information on these observations to be used in estimating the empirical models. However, the estimates may be biased if observations with missing data differed systematically from observations without missing data. This is potentially a concern as the incidence of obesity was significantly higher for observations with missing long-term variables than for observations without missing long-term variables (22.3% vs. 20.1%, Pearson chi-squared = 16.07, P = 0.00).

In the models of obesity without individual fixed effects, other control variables included a respondent's highest grade completed, percent of the Armed Forces Qualifying Test (AFQT), the highest grade completed by each of the respondent's parents, family size, marital status, race or ethnicity, age, age-squared, urban residence, region, occupation, mean hours worked per week and pregnancy status. Additionally, whether a respondent was currently enrolled in college was included as a control because college students are categorically ineligible for the FSP (1). As in Chou et al. (6), the models also included time-trends, specifically the number of years between the year of the obesity observation and 1985, and the square of this number.

FS recipients may differ from nonrecipients even when individuals with the same measurable characteristics are compared. For example, unmeasured genetic characteristics may be related to the likelihood that a person receives FS as well as to the person’s obesity status. If unobserved differences between people are correlated with both obesity and FS receipt, the estimated relationship between FSP and obesity will be biased. If these unobserved characteristics do not vary over time, including individual fixed effects in models of obesity solves this problem. With the inclusion of individual fixed effects, within-person variation in personal characteristics is used to explain within-person variation in obesity. Therefore personal characteristics that do not vary over time, such as the initial health endowment of the individual, can be omitted from these models (24).

The time-invariant controls excluded from the empirical models of obesity that included individual fixed effects were the respondent's percentile on the AFQT, the highest grade completed by each of the respondent’s parents, and the respondent’s race or ethnicity. As in Lakdawalla and Philipson (14), the age and age-squared variables were also excluded from the fixed effects models because they could not be identified separately from the time and time-squared variables. Therefore in the fixed effects models the coefficients on the time and time-squared variables captured the effect of both age and the time period.

Statistical analysis. As in Townsend et al. (9), men and women were analyzed separately. Differences in the unweighted prevalence of obesity, overweight and underweight among FSP participation and FS eligibility categories were examined with Pearson chi-squared tests using a significance level of P < 0.05. Overweight was defined as a BMI ≥ 25 kg/m² and underweight was defined as a BMI < 18 kg/m² (19). Differences in the mean weight among FSP participation and FS eligibility categories were examined with two-sample t-tests with the assumption of unequal variance using a significance level of P < 0.05.

Four main specifications were used in ordinary least squares (OLS) and logistic regression models of obesity. The first specification was estimated with and without the inclusion of individual-fixed effects. The latter three specifications all included individual-fixed effects. The first main specification tested whether there was a difference in the dose-response relationship to obesity of FS resources and other resources. In this model a variable for the current amount of FS benefits was included in addition to the indicator for current FSP participation (model [3]). Finally, model [4] removed all current indicators of resources and FSP participation to examine whether models were over-specified with their inclusion. Following the NLSY79 study recommendations, the regression models did not use sample weights but instead used indicator variables to specify group membership (20). Huber-White standard errors were calculated in the OLS models with and without individual fixed effects, with clustering on the individual in the models without fixed effects and on the household in the models with individual-fixed effects. This method assumed that observations within a cluster were not independent. The standard errors were not adjusted further to account for design effects; however, the design effects in longitudinal data are large and the coefficients on current FS eligibility income and the long-term income-to-needs ratio were much smaller and lost their significance when individual-fixed effects were added to the models of obesity. This suggests that even including a large set of independent variables may not prevent biased estimates of the association between the included independent variables and an individual’s obesity status in models of obesity without individual-fixed effects.

Moving from model [1A] to a model with only individual-fixed effects increased the R-squared from 0.077 to 0.736 (results not shown). The R-squared was 0.759 in model [1B]. In model [1B] current participation in the FSP was related to a 0.90 percentage point increase in the probability of obesity (P = 0.00). Overweight was defined as a BMI ≥ 25 kg/m² and underweight was defined as a BMI < 18 kg/m² (19). Differences in the mean weight among FSP participation and FS eligibility categories were examined with two-sample t-tests with the assumption of unequal variance using a significance level of P < 0.05.

In the sample 23.5% of woman-year observations and 18.6% of man-year observations were obese, and 39.0% of woman-year observations and 15.8% of man-year observations were current FSP participants. In bivariate analyses, current FSP participation was significantly related to obesity status among woman-year observations (Pearson chi-squared = 172.1, P = 0.00) and among man-year observations (Pearson chi-squared = 33.5, P = 0.00) (Table 1).

The discussion of the results of the multivariate models focuses on the OLS models rather than the logistic regression models because of the ease of interpreting linear probability models. The patterns of signs and significance in the logistic regression models were the same as in the equivalent OLS models (logistic regression results not shown).

Consistent with the results of Townsend et al. (9), current and long-term FSP participation were nonsignificantly related to the obesity of low income men in all of the multivariate model specifications (P = 0.143 and P = 0.506 respectively; results not shown). Since this was not the case for low income women, the results for women are examined in detail (Table 2).

The decline in magnitude and significance of the coefficients on many of the variables from model [1A] (without individual fixed effects) to model [1B] (with individual fixed effects) indicates that models of obesity without individual-fixed effects were subject to omitted variable bias. For example, the coefficient on current FSP participation was less than half as large and the coefficients on current FS eligibility income and the long-term income-to-needs ratio were much smaller and lost their significance when individual-fixed effects were added to the models of obesity. This suggests that even including a large set of independent variables may not prevent biased estimates of the association between the included independent variables and an individual’s obesity status in models of obesity without individual-fixed effects.
TABLE 1
Prevalence of obesity, overweight and underweight and mean weight among low income women by Food Stamp Program (FSP) participation and FSP eligibility category: National Longitudinal Survey of Youth 1979 pooled sample

<table>
<thead>
<tr>
<th></th>
<th>Obese</th>
<th>Overweight but not obese</th>
<th>Underweight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td></td>
<td>kg/m²</td>
</tr>
<tr>
<td>Full sample (n = 13,390)</td>
<td>23.5</td>
<td>26.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Current FSP participant:</td>
<td>29.7*</td>
<td>26.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Yes (n = 5,111)</td>
<td>21.6</td>
<td>25.6</td>
<td>2.8</td>
</tr>
<tr>
<td>No (n = 8,279)</td>
<td>19.8</td>
<td>22.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Currently eligible for the FSP:</td>
<td>24.5*</td>
<td>26.0</td>
<td>2.9*</td>
</tr>
<tr>
<td>Yes (n = 8,801)</td>
<td>21.6</td>
<td>26.2</td>
<td>2.3</td>
</tr>
<tr>
<td>No (n = 4,589)</td>
<td>19.8</td>
<td>24.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Long-term FSP eligibility income-to-needs ratio:</td>
<td>26.5*</td>
<td>27.6*</td>
<td>2.9</td>
</tr>
<tr>
<td>≤1.3 (n = 7,478)</td>
<td>21.6</td>
<td>26.2</td>
<td>2.3</td>
</tr>
<tr>
<td>&gt;1.3 (n = 5,828)</td>
<td>19.8</td>
<td>24.3</td>
<td>2.4</td>
</tr>
</tbody>
</table>

1 Every year that an individual was included in the sample was a separate observation. Therefore the percentages and means in the pooled sample refer to woman-year observations. Overweight = BMI ≥ 25 kg/m²; Underweight = BMI < 18 kg/m².

The estimates from model [2] can provide further insight into this issue. This model replaced FS eligibility income with the amount of FS benefits. The correlation between FS eligibility income and the amount of FS benefits was only −0.34. The coefficients on the variables that measured current FSP participation and the amount of benefits from each other. In model [2] the coefficient was essentially unchanged and was still significantly different from zero (P = 0.042). This provides further support for the conclusion that FS resources and other income had a different relationship to obesity. The size of the coefficient on the long-term FSP participation variable did not change from model [1B] to [2].

Model [3] included separate controls for the amount of FS eligibility income and the amount of FS benefits. The correlation between FS eligibility income and the amount of FS benefits was only −0.34. The coefficients on the variables that measured current FSP participation and the amount of benefits

TABLE 2
Ordinary least squares regression models predicting obesity in low income women (n = 13,390)1,2

<table>
<thead>
<tr>
<th></th>
<th>[1A]</th>
<th>[1B] with individual fixed effects</th>
<th>[2] with individual fixed effects</th>
<th>[3] with individual fixed effects</th>
<th>[4] with individual fixed effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Robust SE</td>
<td>Coefficient</td>
<td>Robust SE</td>
<td>Coefficient</td>
</tr>
<tr>
<td>Current resources</td>
<td>FS eligibility income</td>
<td>0.0025**</td>
<td>0.0007</td>
<td>0.00032</td>
<td>0.00052</td>
</tr>
<tr>
<td></td>
<td>Total family income</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>FSP participant</td>
<td>0.0491**</td>
<td>0.0119</td>
<td>0.0200**</td>
<td>0.0097</td>
</tr>
<tr>
<td></td>
<td>FS benefit amount</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Long-term resources</td>
<td>Years of FSP participation in previous 5 y</td>
<td>0.0164**</td>
<td>0.0048</td>
<td>0.0090**</td>
<td>0.0040</td>
</tr>
<tr>
<td></td>
<td>Long-term FSP eligibility income-to-needs ratio</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>Years of FSP eligibility in previous 5 y</td>
<td>0.0005</td>
<td>0.0048</td>
<td>0.0046</td>
<td>0.0042</td>
</tr>
<tr>
<td></td>
<td>R-Squared</td>
<td>0.779</td>
<td>0.759</td>
<td>0.759</td>
<td>0.759</td>
</tr>
</tbody>
</table>

1 All dollar values are in $1998 and all income variables are annual values in thousands of dollars.

2 Controls in model [1A] included mean hours worked per week, age, age-squared, race and ethnicity, marital status, family size, pregnancy status, highest grade completed, college enrollment status, AFQT score, mother’s and father’s highest grade completed, region, urban residence, occupation, time, time-squared and separate indicators for missing information on long-term FSP participation, long-term income-to-needs and long-term FSP eligibility. Models [1B]–[4] included individual fixed effects and excluded age, age-squared, race and ethnicity, AFQT score and mother's and father's highest grade completed.

** Double asterisks indicate statistically significant at the 0.05 level. Abbreviations: AFQT, Armed Forces Qualifying Test; FS, food stamps; FSP, Food Stamp Program.
were not significantly different from zero. The coefficient on long-term FSP participation was still positive and significant in this specification.

Model [4] excluded current family resources. When these variables were removed, the size and significance of the coefficients on the other variables in the model minimally changed. Long-term FSP participation was still positively and significantly related to obesity. As in the other models with individual-fixed effects, the coefficients on the variables that measure other long-term resources were not significant.

To test the sensitivity of the estimates to the method of constructing the sample, models [1–4] were reestimated using two alternative samples. The first excluded pregnant women or women who had recently given birth, and the estimates were similar in magnitude and significance to those presented in Table 2 (results not shown). The second dropped the income-to-needs restriction and instead used all available years of observations on women who had less than a high school education as of the 1st mean AFDC benefit. The estimates were also similar in magnitude and significance to those presented in Table 2 (results not shown).

The results of these models provide strong support for the conclusion that FSP participation was positively and significantly related to the obesity of low income women. Additionally, the results also support the conclusion that FS benefits and other monetary resources had a different relationship to obesity. A question that remains to be explored was whether social program participation in general, instead of FSP participation in particular, was responsible for these results. This possibility was investigated by including AFDC participation and benefits in models of obesity. Unfortunately the NLSY79 contains information on benefits from the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) program that is too limited to use for considering the relationship between WIC participation and obesity.

Neither current AFDC participation nor long-term AFDC participation was significantly related to obesity in a model excluding current and long-term FSP participation (results not shown). If in fact AFDC participation was strongly and positively related to obesity, the size and significance of the relationship between AFDC participation and obesity would be expected to be particularly strong in this model.

Neither current nor long-term AFDC participation was significantly related to obesity in a model including current and long-term FSP participation. However, current and long-term FSP participation were positively and significantly related to obesity (results not shown). It is not possible to reject the hypothesis that the coefficients on current FSP participation and current AFDC participation were equal (F-statistic = 2.08, P > F = 0.149). However, the mean FS benefit was $2393 per year and the mean AFDC benefit was $395 per year for current FSP participants (both amounts unweighted). This suggests that even if the coefficients on the indicators for participation were the same, the relationship to obesity per dollar of benefits was larger for the FSP. The F-statistic was also 2.08 (P > F = 0.149) for the test of the hypothesis that the coefficients on long-term FSP participation and long-term AFDC participation were equal. On average, long-term FSP participants in the sample received a smaller amount of benefits from the FSP than from AFDC. These supplemental analyses offer qualified support for the conclusion that benefits from FS and AFDC had a different relationship to obesity.

Gleason et al. (25) found that events such as recent changes in income, household composition or the receipt of other public assistance are more likely among individuals who decided to start participating in the FSP than among those who remained nonparticipants. To take into account the possibility that these types of events also influence a woman's obesity status, models [1–4] were also estimated including controls for the change in a woman's income eligibility for the FSP and marital status in the previous calendar year and the timing of recent pregnancies. Current and long-term FSP participation remained positively and significantly related to a woman's obesity status in these models, with magnitudes very similar to the results in Table 2 (results not shown).

From a policy point of view, a key question is the magnitude of the relationship between FSP participation and obesity and how it compares to the magnitude of other coefficients in the models. Using the estimates from model [1b], a woman who was not a current or former FSP participant whose other characteristics were equal to the sample averages (unweighted) had a predicted probability of obesity of 21.9%. All other variables constant, current participation in the FSP increased the predicted probability of current obesity by 2.00 percentage points, or by 9.1%. Participation in the FSP in all of the five previous years increased the predicted probability of current obesity by 4.50 percentage points, or by 20.5%.

Again using the estimates from model [1b], the probability of obesity was also strongly influenced by marital status (+2.3 percentage points if married), family size (+1.3 percentage points per additional family member) and region of residence (−7.1 percentage points if currently living in the South; these coefficients are not shown in Table 2).

DISCUSSION

The empirical models of obesity examine the relationship between an individual's demographic, socioeconomic and environment characteristics and obesity status. Under a wide variety of empirical specifications, current and long-term FSP participation were positively and significantly related to obesity for low income women. Additionally, FSP participation remained significant in models of obesity that included events that might have triggered participation in the FSP such as recent pregnancies and recent changes in income or marital status. These results are consistent with Townsend et al. (9), who also found a positive and significant relationship between FSP participation and weight for women. The estimates also suggest that for low income women, benefits provided by the FSP had a larger positive relationship to obesity per dollar than cash income. The results also provide qualified support for the conclusion that benefits provided by the FSP had a larger positive relationship to obesity per dollar than benefits provided by AFDC.

The empirical models of obesity controlled for a large set of demographic, socioeconomic and environmental characteristics, including individual fixed effects, to take into account unobserved characteristics of individuals that did not vary over time. However, the estimates of the relationship between FSP participation and obesity may be biased as a result of reverse causality from obesity to FSP participation or selection bias. Selection bias remains a possibility if there were unobserved demographic, socioeconomic or environment characteristics of individuals that varied over time and were related to both obesity and FSP participation.

One potentially important excluded variable is depression, and information on depression in the NLSY79 is too limited to include in the models of obesity. The direction of the potential bias is unclear because the link between depression and FSP participation has not been explored previously. Additionally, depression has been found to be positively, negatively or nonsignificantly related to obesity, depending on the popula-
tion under study and the measure of depression considered (26,27).

The conceptual model assumes that the direction of influence is from individual demographic, socioeconomic and environmental characteristics to intermediate variables such as food insecurity and health behaviors. Another potential source of bias arises if the intermediate variables also influence an individual’s FSP participation.

As mentioned earlier, previous research has found that FSP participants were more likely to be food insecure than non-participants (7,8), and that there was a positive relationship between mild food insecurity and overweight (9,10,28). Therefore, excluding food insecurity from models of obesity may overstate the relationship between FSP participation and obesity. Unfortunately, this issue cannot be examined empirically using the NLSY79 because it does not contain data on the food security status of respondents.

A criticism of the previous research on food insecurity and overweight is that even with the inclusion of these variables, models of long-term resources were important for explaining current obesity (28), which included variables for long-term poverty in models with the exception of the study of Sarlio-Lahteenkorva et al. (28), which included variables for long-term poverty in models predicting food insecurity and that it was limited to cross-sectional data. The research in this paper suggests that long-term resources were important for explaining current obesity and that even with the inclusion of these variables, models of obesity without individual-fixed effects were biased.

A number of the potential mechanisms that have been suggested to explain the relationship between food insecurity and obesity are plausible, but for the most part untested. It has been proposed that food insecurity may cause obesity as a result of: inexpensive high energy food choices (10,16,28,29); periods of overeating followed by periods of normal eating (16,28); periods of overeating followed by periods of deprivation (9,16,28,29); other types of disordered eating (9,10,16,17,28); and stress-induced biological changes (28).

Frongillo et al. (10) found that mild food insecurity is related to obesity through disordered eating patterns, but additional empirical research is needed to test the other potential mechanisms.

Townsend et al. (9) found that FSP participation is positively and significantly related to being overweight for women in models that also controlled for food insecurity. An essential question is whether there is a reasonable mechanism to explain the positive relationship between FSP participation and obesity for low income women, beyond the role of FSP participation as a proxy for food insecurity. Any possible mechanism must also explain the lack of association between FSP participation and obesity for low income men.

One possible mechanism for the relationship between FSP participation and overweight is that the mean food energy intake for FSP participants was more than one major shopping trip per month) or infrequently (one major shopping trip per month). They used data from the 1989–1991 CSFII, and found that mean food energy intake for frequent food shoppers remains steady during the four weeks of the FS month (at around 80% of RDA). In contrast, they found that the mean food energy intake for infrequent shoppers falls from 83% of RDA in the first week after benefits were received to 73.4% of RDA in the fourth week after benefits were received (a significant difference). These results did not provide evidence of extreme levels of energy consumption at the household level over the monthly benefit cycle. However, Wilde and Ranney noted that it is likely that there was underreporting of intake in this sample. More research is needed to establish the extent of the FS intake cycle and whether the variation in intake results in increasing weight.

The policy prescriptions suggested by these results depend on the mechanism for the relationship between FSP participation and obesity. If the relationship was due to increased energy consumption, then programs that provide education or policy changes that loosen or tighten existing restrictions on the use of FS benefits may be important. If the relationship was due to variation in food consumption over the FS benefit cycle, then providing benefits more frequently or providing education emphasizing budgeting of coupons or nutrition may be possible ways to reduce the connection between FSP participation and obesity.

In the empirical models of obesity the interpretation of the coefficient on the FSP participation variable is the relationship between participation and obesity holding all other independent variables constant. The results of the models without individual-fixed effects, as well as Townsend et al. (9), support the conclusion that low income women who participated in the FSP were more likely to be obese than were low income women who did not participate in the FSP. In models of obesity with individual-fixed effects, the individual is part of what is held constant. Therefore the results of these models support the further conclusion that a low income woman was more likely to be obese during times when she participated in the FSP than during times when she did not. The results do not establish that FSP participation caused an increase in obesity. However, regardless of causality, the results suggest that the FSP offered a way not only to reach individuals with a high likelihood of obesity, but also to reach these individuals at a time when they were more likely to be obese.

Education programs administered through the FSP may be a possible means of reducing the obesity of participants. Currently under the regulations of the FSP there is no requirement
that states provide nutrition education. States are allowed to run their own nutrition education plans (NEP), and if state NEP are approved by the Food and Nutrition Service of the USDA, states are reimbursed for 50% of the allowable costs expended. The amount of nutrition education provided by the FSP has varied substantially over time and across states. Only 9 states had NEP in 1992, but 49 states had NEP as of 1999 (2). Characteristics of NEP such as primary nutrition goals, implementing agency, target audience and method of information delivery vary across states (37). The education component of the FSP is still minimal given that the average expenditure on nutrition education per FSP participant by the USDA was $2.11 in 1998 (2).

Health Systems Research (37) examined 50 implementing agencies in 38 states, and found that weight management or weight reduction is a specific behavioral objective in the NEP of 10 of them. A question that remains to be addressed is how well these and other programs are able to achieve their goals. To date, the evaluations of nutrition education programs have been extremely limited (2). Evaluations of these programs are essential in order to know whether the use of targeted education programs is effective in reducing obesity or whether alternative policy solutions for reducing the obesity of FSP participants need to be considered.

For commentary on this article, see the article by Frongillo in this issue (38).

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LITERATURE CITED