Journal of Agricultural and Resource Economics 36(1):1–13

Household Food Stamp Program Participation and Childhood Obesity

Christina A. Robinson and Xiaoyong Zheng

This study examines the dynamic relationship between a household's Food Stamp Program (FSP) participation and the extent to which children in the household are overweight or obese. In contrast to previous studies employing static models, our results suggest that FSP participation significantly affects the deviation of current body mass index (BMI) from the ideal level in older male children who are currently underweight and for older female children who are already overweight. For older male children, the effect is desirable; for older females, however, our findings indicate that FSP participation has an adverse effect on their health and may contribute to being overweight or obese.

Key Words: child obesity, Food Stamp Program

Introduction

The number of children classified as overweight—i.e., having a body mass index (BMI) in the 85th percentile for children of a similar age and height of the 2000 BMI-for-age growth charts—has increased substantially over the past four decades. In the 2005–2006 calendar year, 10.9% of children and adolescents aged 2 through 19 were at or above the 97th percentile of the 2000 BMI-for-age growth charts, 15.5% were at or above the 95th percentile, and 30.1% were at or above the 85th percentile (Ogden, Carroll, and Flegal, 2008).[1] Of particular importance, the heaviest children today are significantly heavier than the heaviest children of 10 years ago.

The Centers for Disease Control (CDC) estimates that nearly 70% of obese children become obese adults, a serious cause for concern. In 2005, obesity was responsible for nearly 112,000 premature deaths (Flegal et al., 2005). Obese individuals also face higher risks of suffering from serious illnesses such as heart disease, stroke, diabetes, arthritis, and certain cancers, which may be preventable but costly to manage.

Many potential sources of obesity have received attention in the economics literature (e.g., Lakdawalla and Philipson, 2002; Chou, Grossman, and Saffer, 2004; Gelbach, Klick, and Stratmann, 2007; Zheng and Zhen, 2008). Recently, the connection between the Food Stamp Program (FSP) and obesity has been analyzed, and two avenues through which FSP participation is directly related to obesity have been identified.[2] First, FSP participation has been shown to increase food consumption by an amount greater than expected, as the marginal propensity to consume food from a dollar of food stamp benefits (FSB) is greater

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Review coordinated by Vincent H. Smith.

[1] The 2000 BMI-for-age growth charts were generated based on data gathered from children in the year 2000. The preceding statistics indicate, for example, that in the 2005–2006 calendar year, nearly 30.1% of children were at least as heavy as the heaviest 15% of children in the year 2000.

[2] As of October 1, 2008, the FSP was renamed the Supplemental Nutrition Assistance Program (SNAP).

than the marginal propensity to consume food from a dollar of money income. Empirically, an additional dollar of food stamp income appears to increase food expenditure by \$0.17 to \$0.47, while an additional dollar of cash income increases food consumption by only \$0.03 to \$0.17 (Fraker, 1990). Thus, the marginal propensity to consume food from a dollar of FSB is between 2% and 10% larger than the marginal propensity to consume food from cash income.

Individuals who receive food stamps are also more likely to be food insecure than individuals who do not (Nord, Andrews, and Carlson, 2003).[3] When individuals who are worried about having enough food are given the ability to purchase food products, they may focus on quantity over quality. An emphasis on quantity may lead an FSP participant to make poor choices and overconsume low-quality food. Fox and Cole (2004) find that FSP participants score lower on the Healthy Eating Index than nonparticipants (regardless of income). Wilde, McNamara, and Ranney (1999) report that FSP participants consume significantly more meat, added sugars, and fats than low-income nonparticipants. Taken together, these findings suggest FSP participants may consume an unhealthy diet, which may lead to increased body weight and obesity over an extended period of time.

As reported by Gibson (2003) in a seminal study, FSP participation tends to increase a low-income woman's BMI and her probability of being classified as obese. Studies conducted by Chen, Yen, and Eastwood (2005) and Meyerhoefer and Pylypchuk (2008) yielded similar results using different data sets.

Gibson (2004) also examined the effect of FSP participation on childhood obesity, concluding that long-term participation is positively and significantly correlated with being overweight among 5- to 11-year-old girls. Hofferth and Curtin (2005) found that FSP participation is associated with a BMI increase for children with lower than normal BMIs, but not for those with normal or higher than normal BMIs. Moreover, they found FSP participation did not increase the likelihood that a child is overweight. Other studies (e.g., Bhattacharya and Currie, 2001; Boumtje et al., 2005; and Ver Ploeg et al., 2007) have examined the effect of FSP participation on childhood weight outcomes in a static framework. These studies identified no significant relationship. Yet, FSP participation was found by Jones et al. (2003) to significantly reduce the odds that a low-income female (between the ages of 5 and 12) would be overweight.

The above studies used cross-section panel data to investigate the links between FSP participation and childhood obesity in a static framework. However, additional panel data have since become available, permitting dynamic analyses. Dynamic econometric models are able to exploit the information contained in a panel data set because there are variations in data both across different individuals as well as across different time periods for the same individual. In the context of this study, dynamic analysis also allows for the possibility that weight in one period is not independent of weight in the previous period.

Baum (2007) recognized the dynamic process through which a person's body mass index increases.[4] Using data from the National Longitudinal Survey of Youth 1979 (NLSY79) to study obesity in adults who receive food stamps, Baum reported positive interrelationships between FSP participation, BMI growth, and the probability of becoming obese. Baum's estimates of the effects of FSP participation on BMI were considerably larger than the effects reported in previous studies.

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[3] Individuals are considered to be food insecure if they have concerns about their ability to obtain enough food to sustain life.

[4] The importance of considering body weight in a dynamic framework has been highlighted by recent studies. Goldman, Lakdawalla, and Zheng (2009) examine how an increase in food price affects BMI. Courtemanche (2009) also considers weight change as a dynamic process and analyzes how an increase in cigarette price affects BMI.

Our paper contributes to this line of research by examining the effects of FSP participation on childhood obesity in a framework that models an individual's dynamic weight accumulation process. The model differs from Baum (2007) in four respects. First, the focus is on the child, whose ideal weight and BMI change as he or she grows older, even after controlling for gender and height. In contrast, the ideal BMI for adults remains constant after adjusting for gender and height. Second, we conduct separate analyses for different groups of children by gender, age group, and current weight status, in order to identify which subgroups of children are at the greatest risk and how policies can be designed to help them. Third, we employ a more general dynamic econometric model. In Baum's dynamic model, the coefficient for the lagged dependent variable is restricted to be one, while this study estimates the coefficient as a free parameter, leading to more robust results. Finally, for some subsamples, we also control for a child's level of physical activity in the regression analysis.

Here we use the deviation of a child's current BMI from the ideal BMI (measured as the BMI that corresponds to the 50th percentile of the 2000 age- and gender-specific growth charts) as a measure of obesity (Must, Dallal, and Dietz, 1991). This measure is modeled as a first-order autoregressive process which may be affected by living in a household that participates in the FSP. If deviations from ideal BMI are significantly higher among FSP participants, then FSP participation is positively correlated with childhood weight and obesity. This approach has two main advantages. First, modeling the dynamic weight accumulation process creates more reliable estimated effects of FSP participation on obesity. Second, in a dynamic setting, we can quantify both the short- and long-run effects of FSP participation on obesity.

For an older male child who is currently underweight, we find evidence to suggest a household's FSP participation closes the gap between the child's current BMI and the medically ideal BMI. For these children, the FSP is achieving its goal as desired, increasing their BMI and bringing them closer to their ideal weight. However, we also find that if an older female child is already overweight, then FSP participation increases the amount by which she is overweight.

We also identify a tendency for children to approach their ideal BMI, indicating there is neither a positive nor a negative momentum in the BMI growth path. Children who become more overweight (or underweight) in one period are likely to move closer to their ideal BMI in the next period. This effect dampens the adverse impacts of FSP participation.[5]

Empirical Model

The objective here is to model a child's BMI evolution process and the relationship between the household's FSP participation and the child's BMI. A dynamic model is employed because a child's weight is not independently determined in each period but accumulated over several periods. More specifically, we represent a child's BMI^D, which is defined as the difference between a child's current BMI and the ideal BMI, as a function of the child's previous BMI^D, the mother's BMI, the family's FSP participation, and other control variables including gender, race, family size, mother's educational attainment, household income, a period-specific effect, and a household fixed effect:

$$(1) \quad BMI_{it}^{D} = \beta_0 + \beta_1 BMI_{it-1}^{D} + \beta_2 MBMI_{it} + \beta_3 FS_{it} + \beta_4 Fam_{it} + \beta_5 Edu_{it} + \beta_6 \ln(Inc_{it}) + v_t + u_i + \varepsilon_{it},$$

[5] Previous studies have not identified these effects.

where $MBMI_{it}$ is the mother's current BMI, FS_{it} is the current FSP participation, Fam_{it} is family size, Edu_{it} is the mother's educational attainment, $\ln(Inc_{it})$ is the log of household income, v_t is a period-specific effect, u_i is a child-specific error term (fixed effect), and ε_{it} is the error term.

Equation (1) captures the dynamic nature of BMI^D by including the child's previous BMI^D in order to reduce the potential for reverse causality bias (Gibson, 2003, 2004; Baum, 2007) which has plagued previous studies examining the effect of FSP participation on obesity. These biases arise if a family's enrollment in the FSP influences a child's BMI^D, but at the same time, a child's BMI^D influences a family's decision to enroll in the FSP. In a dynamic model, it is possible for FS_{it} to be determined or influenced by BMI^D_{it-1}, but not by BMI^D_{it}, thus reducing the likelihood of reverse causality effects.

Accounting for fixed effects may also mitigate endogeneity bias.[6] Failure to account for fixed effects may result in estimates containing child- or family-specific information affecting the decision to enroll in the FSP and a child's BMI^D. For example, systematic and unobserved differences may exist between the behavior of children who have obese parents and those who do not. Obese parents may be more likely to be poor and enroll in the FSP. Simultaneously, it is also possible that obese parents may place a lower value on their child's BMI and have a lower level of parental concern for their child's BMI, making it easier for a child to exercise less, eat more, and have a positive BMI^D. In the estimation procedure, we eliminate fixed effects by differencing and estimating the following model:

$$(2) \qquad \Delta BMI^D_{it} = \beta_1 \Delta BMI^D_{it-1} + \beta_2 \Delta MBMI_{it} + \beta_3 \Delta FS_{it} + \beta_4 \Delta Fam_{it} + \beta_5 \Delta Edu_{it} + \beta_6 \Delta \ln(Inc_{it}) + \Delta v_t + \Delta \varepsilon_{it},$$

where $\Delta BMI^D_{it} = BMI^D_{it} - BMI^D_{it-1}$, and the other terms are similarly defined. In practice, since Δv_t cannot be observed directly, it is proxied by a set of period dummies. The main parameter of interest is β_3, which captures the effect of a family's FSP participation on a child's BMI^D. The coefficient that captures the effect of a child's BMI^D_{it-1} on the current period's BMI^D (β_1) is also of interest.

Controlling for fixed effects does not eliminate the potential endogeneity bias resulting from correlation between a family's FSP participation and the unobserved error, ε_{it}. To account for the potential endogeneity bias resulting from correlations between FS_{it} and ε_{it}, we use a two-stage instrumental variables (IV) approach, discussed in further detail below.

Data

Data were obtained from both the NLSY79 and the NLSY79 Child and Young Adult surveys. The NLSY79 is a longitudinal survey, initiated in 1979, in which 12,686 individuals between the ages of 14 and 22 were originally interviewed. The respondents were surveyed annually from 1979 to 1994, and subsequently once every two years.

The NLSY79 Child and Young Adult Survey, initiated in 1986, gathers detailed information about children born to the women of the NLSY79. The survey classifies anyone below the age of 15 as a child, and anyone over 15 as a young adult. Information about a child is

[6] The importance of controlling for individual-level fixed effects is also highlighted by Powell's (2009) study of fast food costs and adolescent BMI.

collected from the mother, while young adults are surveyed directly and asked a series of questions similar to those their mothers were asked in early waves of the NLSY79. Regardless of a person's classification, the survey gathers information about the participants' health, growth, and development. An additional feature of the NLSY79 and NLSY79 Child and Young Adult Survey is that parent and child information can be linked, making household-level analysis possible. We assume each mother represents a distinct household and allow for each mother to have an unlimited number of children.[7]

The NLYS79 Child and Young Adult Survey has completed 10 waves of interviews to date, providing nine potentially usable time periods.[8] The 1986–1988 period cannot be used since it is not possible to calculate previous change in a child's BMI^D. In addition, due to data limitations arising from the need for instrumental variables, we examine only the changes that occur between the five two-year periods from1994 to 2004.

A family's FSP participation is measured as the number of months in which a family receives a positive amount of FSB. Household income is measured as the mother's (or parents') pre-tax income earned from wages, salary, commissions, or tips. All income is measured in 2004 dollars.

To measure how a child's BMI is affected by the family's FSP participation, we utilize the variation in the deviation between a child's true and ideal BMI. This procedure is preferred to simply measuring the change in a child's current and past BMI, as a child's BMI grows with age. The CDC does not publish a measure of ideal BMIs for children and young adults. Hence, we proxy for a child's ideal BMI using the BMI for the 50th percentile of the 2000 age- and gender-specific growth charts.[9]

Estimates are obtained for a sample of children who live in households eligible for participation in the FSP (as based on the USDA's gross income test). We restrict our sample to include only those children between 5 and 18 years of age who are the offspring of core sample women (we do not include children of women who are members of a supplementary sample). Two years is a reasonably short period of time; therefore, limits are placed on the size of each change of interest. For example, the change in both a child's current and past BMI^D is restricted to be no larger than five index points, and the change in the child's family size is restricted to be no larger than five persons. In addition, the change in a mother's BMI is not allowed to alter by more than five index points over any two-year period, unless she is pregnant or has given birth within the past two years. The resulting sample consists of 1,147 child-year observations.

Summary statistics are presented in table 1. In this sample, 51.3% of observations are males and the average age of a child is 12.51 years, regardless of gender. The average change in a child's BMI^D over a two-year period was 0.27 BMI points, with a standard deviation of 1.99 points. The average previous change in BMI^D was 0.32 points, with a standard deviation of 1.91 points. The average change in months of food stamp participation was −1.03, and the average family income was $25,763.18, with a minimum of $131.40 and a maximum of $72,000.

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[7] The children of the NLSY79 Child and Young Adult Survey are those children born to female respondents of the NLSY79. These children are included regardless of the parent(s) with whom they live. The children born to NLSY79 women who live with both parents, with only their mother, or with only their father are included, while children born to male respondents of the NLSY79 (whose wife/partner is not also a survey participant) are not included.

[8] Specifically, changes are calculated between: 1986 and 1988, 1988 and 1990, 1990 and 1992, 1992 and 1994, 1994 and 1996, 1996 and 1998, 1998 and 2000, 2000 and 2002, and 2002 and 2004.

[9] We also defined a child's ideal BMI to be the BMI that corresponds to the 25th percentile of the 2000 age- and gender-specific growth charts. The results are not significantly affected.

Table 1. Summary Statistics for the Final Sample

Variable	*N*	Mean	Standard Deviation	Minimum	Maximum
Gender	1,147	0.49	0.50	0.00	1.00
Age (years)	1,147	12.51	3.45	5.00	18.00
Household Income (2004 $1,000s)	1,147	25.76	13.32	0.13	72.00
Change in BMI^D (points)	1,147	0.27	1.99	−4.93	4.96
Previous Change in BMI^D (points)	1,147	0.32	1.91	−4.99	4.99
Change in Mother's BMI (points)	1,147	0.33	1.87	−5.49	7.15
Change in Family Size (no. of persons)	1,147	0.02	0.76	−5.00	4.00
Change in FSP Participation (months)	1,147	−1.03	4.75	−21.00	20.00
Change in log (*Family Income*)	1,147	−0.19	1.14	−6.99	4.80
Change in Activity Level	220	0.33	0.93	−2.00	3.00

Results

One difficulty in identifying the effect of participation in the FSP on a child's BMI is the potential endogeneity of a family's FSP participation decision. Therefore, we employ an instrumental variables (IV) estimation procedure, where we treat ΔFS_{it} as endogenous and seek instruments that are highly correlated with the endogenous variable but not with the error term. Because eligibility criteria are likely to play a large role in a family's decision (and ability) to enroll in the FSP and are unlikely to be correlated with the error term (which captures factors that influence a child's BMI), we consider IVs that capture eligibility rules. Furthermore, to check the robustness of the results, we consider two sets of IVs (see table 2).

The first instrumental variable set (micro level) includes the value of vehicles owned by the household and the presence of an elderly individual in the household, both of which influence a household's eligibility for participation in the FSP. The main advantage of this instrument set is that it is defined at the household level and, as such, varies across observations. This in turn allows us to estimate the parameters more precisely. Unfortunately, this IV set may be highly correlated with the error term.

The second IV set (macro level) is a vector of state-level changes in FSP eligibility rules. Data for the IV vector were obtained from the Food Stamp Program Rules Database and Documentation, which began reporting detailed information on each state's FSP eligibility criteria in 1996 (when the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 granted states limited control over their own eligibility criteria). The data set contains detailed information on 59 program rules which are condensed into 10 categories: asset rules, immigrant rules, standard utility rules, recertification period, reporting requirement, able-bodied adults without dependents (ABAWD) rules, cash assistance rules, issuance method, outreach spending, and biometric technology implementation. To preserve as much of the available NLSY79 data as possible, the vector contains only those variables that can be observed from 1996–2004. These include rules relating to vehicle ownership, immigrant eligibility, ABAWD, recertification periods, outreach, benefit issuance methods, employment of biometric technology, a measure of the state's FSP participation rate, and the state's unemployment rate. Summary statistics for these variables are presented in table 2.

Table 2. Instrumental Variables Summary Statistics

Variable	Description	*N*	Mean (Std. Dev.)	Minimum, Maximum
Micro-Level IVs:				
Vehicle value	Dollar value (1,000s) of a household's vehicle(s)	1,092	11.67 (13.16)	0, 97.11
Presence of elderly household member	Indicates whether an individual over the age of 65 lives in a household (= 1 if yes, 0 otherwise)	1,132	0.04 (0.19)	0, 1
Macro-Level IVs:				
Vehicle asset rules	Measures the average strictness of the state's vehicle exemption rule. There are 4 possibilities, in order of decreasing strictness: one vehicle per household is fully exempt, one vehicle per adult is fully exempt, all vehicles are exempt, up to $15,000 of vehicle value is exempt.	1,071	1.45 (0.97)	1, 4
Immigrant child eligibility rules	Measures the average strictness of state eligibility rules for immigrant children. There are 3 possibilities, in order of decreasing strictness: immigrant children are not eligible, immigrant children are partially eligible, immigrant children are fully eligible	1,129	2.37 (0.68)	1, 3
Immigrant elderly eligibility rules	Measures the average strictness of state eligibility rules for elderly immigrants. There are 3 possibilities, in order of decreasing strictness: elderly immigrants are not eligible, elderly immigrants are partially eligible, elderly immigrants are fully eligible	1,129	2.29 (0.66)	1, 3
Immigrant adult eligibility rules	Measures the average strictness of state eligibility rules for adult immigrants. There are 3 possibilities, in order of decreasing strictness: adult immigrants are not eligible, adult immigrants are partially eligible, adult immigrants are fully eligible	1,129	2.26 (0.68)	1, 3
Recertification period for earners	Measures how often (in months) families with earners must recertify their eligibility	1,129	7.76 (3.31)	3.53, 13.45
Recertification period for non-earners	Measures how often (in months) families without earners must recertify their eligibility	1,129	9.30 (2.65)	4.95, 14.01
Recertification period for non-earning elderly	Measures how often (in months) elderly families without earners must recertify their eligibility	1,129	12.85 (3.02)	8.13, 24.96
Outreach spending per person	The sum (in dollars) of federal, state, and grant outreach spending divided by the state's population of individuals below 150% of the poverty threshold	1,129	0.01 (0.07)	0, 1.01
Outreach spending	The sum (in dollars) of federal, state, and grant outreach spending	1,129	76,800.16 (23,018.67)	0, 246,202.10
ABAWD rules [a]	Measures the percentage of available funds for able-bodied adults without dependents	1,129	0.64 (0.33)	0.03, 1.11
Benefits issued by authorized documents	Percentage of FSP benefits issued by authorized documents	1,129	0.08 (0.19)	0, 1
Benefits issued by direct access	Percentage of FSP benefits issued by direct access	1,129	0.20 (0.32)	0, 0.99
Benefits issued by direct mail (coupons)	Percentage of FSP benefits issued by direct mail	1,129	0.18 (0.30)	0, 1

(continued . . . →)

Table 2. Continued

Variable	Description	N	Mean (Std. Dev.)	Minimum, Maximum
Macro-Level IVs (cont'd.):				
Benefits issued by direct delivery	Percentage of FSP benefits issued by direct delivery	1,129	0.01 (0.07)	0, 0.81
Benefits issued over the counter	Percentage of FSP benefits issued over the counter	1,129	0.01 (0.05)	0, 0.42
Benefits issued through electronic benefit transfer	Percentage of FSP benefits issued by electronic benefit transfer	1,129	0.52 (0.46)	0, 1
Employment of biometric technology	Measures how states employ biometric technology to identify participants	1,132	0.19 (0.38)	0, 1
State FSP participation rate	Percentage of a state's residents enrolled in the FSP	1,129	0.08 (0.02)	0.04, 0.17
State unemployment rate	The state's average unemployment rate	1,129	5.02 (1.12)	2.26, 7.58

[a] The maximum value for ABAWD may exceed 100% because states can carry unused funds over to subsequent fiscal years.

Table 3 presents results from models that include both sets of IVs for the full sample of children living in FSP-eligible households for whom household income was observable.[10] To examine the quality of the instruments, we utilize both the first-stage global F-statistic and Hansen's J-statistic. For both sets of IVs, the global F-statistic is statistically significant. Hansen's J-statistic is statistically insignificant, indicating the null hypothesis that our model is properly specified is not refuted. The parameter estimates for FSP participation are not significant in the pooled analysis; however, we also estimate separate models for the age, gender, and weight group-specific subsamples, as different groups of children must be considered separately from a policy perspective.

Results from the weighted IV estimations for each segment are reported in table 4.[11] The global F-statistic is significant for most subsamples, while Hansen's J-statistic is insignificant for all subsamples, suggesting the model appears to be identified and the instruments are not weak. An increase in a family's FSP participation (measured in months) increases the BMI^D of girls between the ages of 12 and 18 who are already overweight and for boys between the ages of 12 and 18 who are currently underweight. The finding that FSP participation is positive and significant for underweight boys suggests the FSP is meeting its goal in improving nutrition to this specific subsample of children. However, the finding that FSP participation is significant and positive for overweight girls implies FSP participation has an adverse effect on the health of an overweight older girl. In terms of quantity, the effect is relatively large. For overweight older girls, an additional month of FSP participation leads to a 0.31 point increase in BMI. This finding is in sharp contrast with the previous studies employing static models and has important health implications.

[10] Results from regressions using a sample with imputed income values are similar and are available from the authors upon request.

[11] For purposes of brevity, we only report and discuss the parameter estimates for changes in FSP and previous BMI^D_{it-1}, the two variables of key interest. Parameter estimates for other variables are available from the authors upon request.

Table 3. Instrumental Variable Results for the Final Sample

	Micro-Level IVs		Macro-Level IVs	
Variable	Coefficient	Robust Std. Error	Coefficient	Robust Std. Error
Constant	0.174	0.154	0.208	0.130
Change in FSP Participation	−0.009	0.201	0.064	0.110
Change in Previous BMI^D	−0.203***	0.042	−0.190***	0.042
Change in Family Size	0.022	0.089	0.029	0.088
Change in log (*Family Income*)	−0.206	0.055	−0.020	0.058
Change in Mother's BMI^D	0.018	0.046	−0.003	0.041
1998	0.052	0.179	0.066	0.174
2000	0.519	0.222	0.486**	0.211
2002	0.414	0.239	0.444*	0.244
2004	−0.368	0.234	−0.416*	0.244
Global *F*-Statistic	8.21**		2.40**	
p-Value	0.0003		0.002	
Hansen's *J*-Statistic	0.389		19.426	
p-Value	0.533		0.195	
No. of Observations	1,092		1,041	

Note: Single, double, and triple asterisks (*,**,***) denote $p \leq 0.1$, $p \leq 0.05$, and $p \leq 0.01$, respectively.

To test the robustness of the results, we perform an additional analysis on a subsample of children for whom physical activity data are available.[12] A child's weight is affected by caloric intake and caloric expenditures. Consequently, information about physical activity may be important. However, the NLSY79 Child and Young Adult Survey only (consistently) asks children between the ages of 10 and 14 about their participation in sports and other activities, and so the sample utilized in this estimation is smaller than that used in the full estimations.[13] The results for this subsample, presented in table 5, show that a change in FSP participation significantly increases the BMI^D of males in the full and underweight samples and females in the full and overweight samples. These findings are consistent with our initial finding that FSP participation appears to improve the BMI of underweight males but has perverse effects on overweight females.

In nearly all samples and regardless of specification, the lagged value of a child's BMI has a statistically significant negative effect on the child's current BMI; i.e., children tend to approach their ideal BMI regardless of their current BMI and under/overweight classification. These findings suggest there is neither positive nor negative momentum in a child's weight accumulation process. Further, this dynamic "return to the mean" effect is also fairly large. For example, for older girls, the full sample results reveal that a one-point increase in last period's BMI^D will lead to a 0.19 point decrease in this period's BMI^D.

Montani et al. (2006) explored weight growth of children and also reported that weight cycling is common in children (regardless of their current weight). Exploring this finding, they conclude that the desire to look like celebrities in the media is one driving factor, indicating

[12] The mean and standard deviation for the change in a child's physical activity level are reported in table 1.

[13] In 2002, the survey began asking young adults about their physical activities; however, to maintain as consistent a sample as possible, this piece of our analysis is based only on the 10- to 14-year-olds.

Table 4. Instrumental Variable Age-Gender Subsamples

Variable	Full Sample	Underweight	Overweight
Male 5- to 11-Year-Old Sample:			
Change in FSP Participation	−0.066	−0.331	0.370
	(0.413)	(0.587)	(0.364)
Change in Previous BMI^D	−0.210**	−0.210*	−0.074
	(0.103)	(0.113)	(0.185)
Global *F*-Statistic	3.40**	2.20	2.29*
p-Value	0.035	0.117	0.066
Hansen's *J*-Statistic	0.224	2.697	0.445
p-Value	0.636	0.101	0.931
No. of Observations	207	106	102
Male 12- to 18-Year-Old Sample:			
Change in FSP Participation	0.199**	0.156**	0.393
	(0.096)	(0.070)	(0.605)
Change in Previous BMI^D	−0.233***	−0.370***	−0.031
	(0.075)	(0.097)	(0.148)
Global *F*-Statistic	2.24**	3.43**	2.34*
p-Value	0.010	0.001	0.098
Hansen's *J*-Statistic	5.236	12.723	1.868
p-Value	0.919	0.840	0.171
No. of Observations	347	128	224
Female 5- to 11-Year-Old Sample:			
Change in FSP Participation	−0.064	−0.415	0.313
	(0.247)	(0.282)	(0.299)
Change in Previous BMI^D	−0.172**	−0.481***	−0.129
	(0.082)	(0.105)	(0.173)
Global *F*-Statistic	2.69**	3.37**	2.48**
p-Value	0.047	0.038	0.038
Hansen's *J*-Statistic	0.375	0.007	5.044
p-Value	0.829	0.935	0.283
No. of Observations	219	120	100
Female 12- to 18-Year-Old Sample:			
Change in FSP Participation	−0.637	0.021	0.308**
	(0.421)	(0.057)	(0.116)
Change in Previous BMI^D	−0.194*	−0.249**	−0.143
	(0.100)	(0.097)	(0.093)
Global *F*-Statistic	3.49**	2.08**	2.12**
p-Value	0.032	0.037	0.036
Hansen's *J*-Statistic	0.151	7.327	8.769
p-Value	0.698	0.502	0.270
No. of Observations	315	133	181

Notes: Single, double, and triple asterisks (*,**,***) denote $p \leq 0.1$, $p \leq 0.05$, and $p \leq 0.01$, respectively. Values in parentheses are robust standard errors. For purposes of brevity, we report only the parameter estimates for the variables of key interest. Parameter estimates for other variables are available from the authors upon request.

Table 5. Instrumental Variable with Activity Data

Variable	Full Sample	Underweight	Overweight
Male 10- to 14-Year-Old Sample:			
Change in FSP Participation	0.186***	0.132**	0.046
	(0.065)	(0.042)	(0.179)
Change in Previous BMI^D	−0.145	−0.059	−0.136
	(0.136)	(0.332)	(0.237)
Change in Activity Level	0.305	0.072	0.288
	(0.293)	(0.464)	(0.343)
Global *F*-Statistic	2.04**	4.02**	3.02**
p-Value	0.048	0.012	0.04
Hansen's *J*-Statistic	7.491	6.981	1.340
p-Value	0.485	0.539	0.512
No. of Observations	89	32	59
Female 10- to 14-Year-Old Sample:			
Change in FSP Participation	0.194**	0.518	0.262***
	(0.087)	(0.420)	(0.072)
Change in Previous BMI^D	−0.233**	−0.222	−0.291**
	(0.111)	(0.154)	(0.139)
Change in Activity Level	−0.254	0.375	−0.301
	(0.218)	(0.381)	(0.314)
Global *F*-Statistic	2.73**	4.02**	2.35**
p-Value	0.048	0.025	0.033
Hansen's *J*-Statistic	3.849	1.126	7.930
p-Value	0.146	0.289	0.339
No. of Observations	118	54	64

Notes: Single, double, and triple asterisks (*,**,***) denote $p \leq 0.1$, $p \leq 0.05$, and $p \leq 0.01$, respectively. Values in parentheses are robust standard errors. For purposes of brevity, we report only the parameter estimates for the variables of key interest. Parameter estimates for other variables are available from the authors upon request.

the weight cycling they observe is the result of behavior and not a biological artifact. Moreover, Montani et al. do not consider other behavioral factors which may contribute to weight cycling, such as the type of food available in the household or the quantity of food allotted to a child by the parents, both of which may contribute to the variability of a child's weight.

Fluctuations in a child's BMI around the medically ideal level may indicate parents are not aware or (alternatively) not concerned that their child's weight is above or below the ideal level until the deviation becomes visually apparent. As such, parents can't (in the case where they are not aware) or won't (in the case where they are not concerned) intervene until their child's weight diverges substantially from the medical ideal. Once a child's weight deviation is large enough to require their attention, parents appear to take the actions necessary to bring their child closer to the medically "ideal" BMI. Based on these results, development of an "early intervention" educational program designed to provide parents with information about child growth and development patterns may help them to make healthier decisions for their children.

One of the advantages of estimating a dynamic model is that it can quantify both the short- and long-run effects of FSP participation. For example, we find that for overweight older girls who live in low-income families, if the family is not a participant in the FSP and starts to participate for the entire period (24 months), then the expected increase in BMI by the end of the period is 7.39 points. However, due to the "fluctuation" effect we identify above, the initial increase in BMI will be offset by a subsequent decrease in BMI of 1.03 ($7.39 * 0.14$) points if the household remains in the FSP for another 24 months, dampening the initial adverse effects of FSP participation.

Conclusions

This paper explores the relationship between a family's FSP participation and the deviation of a child's current BMI from the medically ideal BMI in a dynamic framework that models how a child's weight evolves over time. In contrast to previous studies in which static models are estimated, we find a statistically significant relationship between participation in the FSP and weight outcomes for overweight girls and underweight boys between the ages of 12 and 18. For those boys who are currently underweight, FSP participation has a positive effect, increasing their BMI and bringing them closer to their medically ideal level. For older girls who are already overweight and living in households participating in the FSP, we find that participation in the FSP has an adverse effect on weight and could potentially cause severe health problems if the issue is not addressed.

Additionally, this study provides new insight into the dynamics of a child's deviation from ideal BMI. It examines how a child's BMI fluctuates from the ideal level and finds that there is a tendency for any deviation from ideal to be counteracted in the next period. Specifically, a child whose BMI deviation was positive in one period had a tendency to have a lower BMI deviation in the next period, while children with negative BMI deviations experienced the opposite. This dampens the adverse effect from participation in FSP in the long run for older overweight girls.

[*Received October 2009; final revision received November 2010.*]

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