Expanding Exposure:
Can Increasing the Daily Duration of Head Start Reduce Childhood Obesity?

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Abstract

Participation in Head Start has been shown to improve health and education outcomes; yet, little is known about the impact of the recent, national expansions in the availability of full-day services on child outcomes. Using unique, administrative data, we examine the effect of full-day Head Start attendance compared to half-day attendance on childhood obesity. In 2002, the unexpected elimination of a state-provided full-day expansion grant led to an exogenous change in the supply of full-day classes for the program in our study. Our results suggest that the reduction in the availability of full-day Head Start increased the proportion of obese children at the end of the academic year by at least four percentage points, or 25 percent, relative to half-day participation.

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1. Introduction

The link between early childhood conditions and adult outcomes suggests that public investments in the health and human capital of poor youths may significantly improve individual and social welfare (e.g., Holzer et al, 2007). The Head Start program, which began as part of the War on Poverty in 1965, has been one of the largest federal investments in the development of disadvantaged children. The program currently provides educational, health, nutritional, and social services to approximately 900,000 children and their families each year at an annual cost of $7 billion. Participation in Head Start is generally associated with improvements in health and human capital, and recent estimates suggest that the benefits of Head Start have exceeded the costs (Ludwig and Phillips, 2007).

Significant increases in federal appropriations since the late 1980s have expanded the Head Start program by increasing the total enrollment and the number of children who attended full-day classes, as shown in Figure 1.[1] Increases in the availability of full-day, as opposed to half-day, Head Start services may better serve the needs of low-income families following the work requirements of the 1996 welfare reform. However, little is known about the effect on child outcomes of full-day attendance relative to part-day attendance. Since 2001, the total enrollment of Head Start has remained constant, while full-day enrollment has increased. Yet, the existing research yields more insight about the impact of expanding the number of children served than the impact of expanding the daily intensity of services.

It is not clear, a priori, that increasing the daily duration in Head Start would lead to positive effects on child outcomes. For example, greater exposure to child care is related to higher levels of behavioral problems in the United States (NICHD ECCRN, 2003). Additionally,

[1] Thanks to Kevin Costigan in the Administration for Children and Families and Don Stark at Xtria for providing us with the full-day enrollment figures from the Head Start Program Information Reports.

the expansion of child care in Canada for middle and higher income married families increased hyperactivity, aggressiveness, and illness in children (Baker, Gruber, Milligan, 2005). On the other hand, Head Start classrooms are of higher quality on average than other preschools programs and child care centers (Currie, 2001) and Head Start participation increases cognitive and social development (U.S. Department of Health and Human Services, 2005). Further, higher quality child care is associated with improvements in cognitive development and less aggressive behavior, particularly for low-income children (Love et al, 2003). Greater participation for children in disadvantaged families in a high quality developmental program could further improve child outcomes.

To learn more about the impact of Head Start, including the impact of full-day and half-day attendance, Congress mandated that the Department of Health and Human Services study the circumstances under which Head Start achieves the greatest impact. The ensuing randomized evaluation, which is still in the field, has focused on many key domains of development, but neglected the study of child nutrition and obesity.

Childhood obesity is a significant public health concern that is associated with a variety of health consequences. The prevalence of childhood obesity has risen dramatically over the past 30 years, nearly tripling for children ages 2 through 5 from 5 percent in the 1970s (Ogden et al, 2002) to 14 percent in 2003-4 (Ogden et al, 2006). Childhood obesity is associated with various comorbidities including hypertension and other cardiovascular disease risk factors, type 2 diabetes, sleep apnea, and asthma (Ebbeling, Pawlak, and Ludwig, 2002). Additionally, childhood obesity is predictive of obesity during adolescence and young adulthood (Nader et al, 2006; Whitaker et al, 1997). Obesity among adults is the second highest cause of premature death in the United States (Mokdad et al, 2004; Flegal et al, 2005) and the social costs of obesity are estimated to be $117 billion (Office of the Surgeon General, 2001).[2]

This research examines the impact of full-day Head Start attendance, compared to half-day attendance, on childhood obesity. The comprehensive services, including the nutritional, educational, and exercise aspects of the Head Start curriculum, have the potential to influence participants' weight status in early life. In addition, these services are provided during ages that are influential in the development of behavioral patterns associated with diet and physical activity (Birch, 1999).

Previous research suggests that participation in Head Start reduces the likelihood of being obese (Frisvold, 2007; Lumeng and Frisvold, 2007) but has not examined the difference from participating in full-day services compared to half-day services. An important distinction in the program options is that federal guidelines require that children in half-day classes receive at least 1/3 of the recommended daily allowance of vitamins, minerals, and protein through meals and snacks, while children in full-day classes are provided with twice that amount. Additionally, children in full-day Head Start are provided with additional exercise time. Further, the additional structured time in full-day classes, with nutritious food and exercise opportunities, may limit children's intake of low-nutrition foods and periods of inactivity outside of Head Start.

Using unique, administrative data from a Michigan Head Start program spanning 2001 to 2006, we examine information about approximately 1800 participants, their families, and Head Start centers. These data include height and weight measured at the beginning and end of the

[2] The social costs of obesity consist of preventive, diagnostic, and treatment services for obesity ($61 billion) and the value of lost productivity from illness and lost future productivity from premature death ($56 billion). These costs are primarily the result of comorbidities associated with childhood obesity, such as type 2 diabetes, coronary heart disease, and hypertension (Wolf, 1998).

program year, pre-Head Start family background information from the Head Start application, and program characteristics.

We compare the change in weight status and body mass index (BMI) of children enrolled in full-day services to those enrolled in half-day services. Because the sample contains information only for children who enrolled in Head Start, we focus our empirical strategy on the nonrandom selection of children into full-day and half-day programs and allow for selection on unobserved characteristics to influence the decision to participate in Head Start. Initially, we utilize the extensive information on pre-Head Start characteristics and assume that the assignment to a full-day classroom is based on these observed characteristics. Differences in means, regression estimates, and matching estimates suggest that full-day participation reduces the rate of obesity at the end of the academic year by approximately four percentage points, or 25 percent relative to half-day services.

Additionally, we use the unexpected elimination of a state-provided full-day expansion grant in 2002 to identify the impact of changes to the supply of full-day program slots on childhood obesity. In 2002, sixteen full-day classrooms were operated by this Head Start program. In response to a state budgetary deficit, full-day expansion grants were eliminated statewide and the number of full-day classrooms in this program fell to four. This change in funding led to a 31 percentage point change in the number of children attending full-day Head Start. Our results suggest that the reduction in the supply of full-day services increased the proportion of obese children at the end of the academic year by four percentage points. Overall, these results suggest that the recent expansions to the availability of full-day services in the Head Start program have reduced childhood obesity.

2. Background

Head Start is a comprehensive, national, federally funded program designed to augment the human and health capital of disadvantaged children to better prepare them for subsequent educational experiences. Since its inception in 1965, Head Start has provided services to more than 25 million preschool children (Office of Head Start, 2007a). In 2006, 909,201 children, who are primarily 3- and 4-years old, attended Head Start at an average cost of $7,209 per child (Office of Head Start, 2007a).[3]

A child is eligible for Head Start if the family's gross annual income, including unemployment compensation and other sources of transfer income, is less than or equal to the poverty guideline (Office of Head Start, 2007b). A child in a family whose income exceeds the poverty guideline is eligible for Head Start if the family receives public assistance, if the child is in foster care, or if the child is disabled. Additionally, a child must be at least 3 years old, based on the date used by the community to determine public school eligibility, to be eligible for Head Start participation. Once enrolled in Head Start, children may remain in the program until kindergarten or first grade is available in the community.

Based on the current funding and costs of Head Start, about 55 percent of eligible children nationwide have the opportunity to participate in the program. Each Head Start program must establish a formal selection mechanism for determining which eligible children are admitted into the program. At least 90 percent of participants must come from families with incomes below the poverty line, and at least 10 percent of the enrollment opportunities must be

[3] Fifty-one percent of Head Start participants in 2006 were 4 years old and 35 percent were 3 years old. The remaining children were either 2 or 5 years old. Blacks and Hispanics are disproportionally represented in Head Start, compared to the population. Thirty-one percent of Head Start participants in 2006 were black and 34 percent were Hispanic, although these numbers are not mutually exclusive (Office of Head Start, 2007a).

available for children with disabilities. Children with the greatest need for Head Start services – the most disadvantaged – are selected by the program administrators.

Head Start offers two center-based programs for participants; children either attend full-day sessions, which are six hours or more per day, or part-day sessions.[4] For children to be eligible for full-day services, parents are generally required to be working or in training full-time (Brush et al, 1995). Because there are likely to be more children eligible for full-day services than slots for these children, it is common for Head Start programs to use the same formal selection mechanism for determining which children attend full-day services as for determining admittance into Head Start.

Head Start participation is generally associated with improvements in child well-being. For example, participation in Head Start has led to increases in cognitive development (U.S. Department of Health and Human Services, 2005) and increases in educational attainment (Garces, Thomas, and Currie, 2002; Ludwig and Miller, 2007). It is associated with a reduction in behavioral problems (U.S. Department of Health and Human Services, 2005) and criminal activity (Garces, Thomas, and Currie, 2002). Head Start participants are more likely to receive health screenings (Hale, Seitz, and Zigler, 1990), dental examinations (U.S. Department of Health and Human Services, 2005), and immunizations (Currie and Thomas, 1995). Head Start also significantly reduced childhood mortality rates (Ludwig and Miller, 2007). Additionally, Head Start participants are less likely to smoke cigarettes as adults (Anderson, Foster, and Frisvold, 2007) and are less likely to be obese (Frisvold, 2007; Lumeng and Frisvold, 2007).

[4] Head Start also offers home-based services, combination services that include center-based care and home-based care, family child care, and locally designed program options. In 2004, as reported by the Head Start grantees on the Head Start Program Information Reports, ninety four percent of Head Start attendees attended center-based programs.

These substantial benefits from Head Start attendance have led the Head Start program to be successful according to a cost-benefit analysis (Ludwig and Phillips, 2007). However, the Head Start evaluation literature has generally ignored the heterogeneity within Head Start services, with a few important exceptions.[5,6] Currie and Neidell (2007) find that greater levels of spending on Head Start programs is related to higher reading and vocabulary scores, and that children in programs that spend a greater proportion of expenditures on education and health services are less likely to be held back a grade in school and have fewer behavioral problems.

The Head Start Impact Study, a randomized evaluation, plans to examine the impact of differences in program quality, teacher characteristics, and program options such as full-day services on child outcomes (U.S. Department of Health and Human Services, 2005).[7] The current reports of this evaluation have focused on differences in impacts on child outcomes for various demographic groups. While the Head Start Impact Study is an important contribution to the understanding of the current impact of this program on child welfare, one limitation of this evaluation is that the health outcomes are measures of access to care and health status that are reported by parents. No objective measure of health is evaluated, and childhood nutrition, a key component of the Head Start services, is not examined.

Exposure to the services in the Head Start program may reduce overweight and obesity as a result of the emphasis on exercise, the nutritional services, increases in non-cognitive skills, and greater access to a continuous source of pediatric care (Frisvold, 2007). Greater exposure to

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[5] For a discussion of the costs associated with the different Head Start program options, see Besharov, Myers, and Morrow (2007).

[6] Additional related research includes the impact of full-day kindergarten on academic outcomes (Cannon, Jacknowitz, Painter, 2006; DeCicca, 2007) and the impact of length of attendance in a Bolivian preschool program on a variety of child outcomes (Behrman, Cheng, and Todd, 2004). The randomized evaluation of the Early Head Start program, which is available for pregnant women and families with children up to age 3, did focus on differences in program approach (center-based, home-based, mixed-approach) but did not explore the differences in full-day and half-day center-based services and did not examine childhood nutrition (Love et al, 2004).

[7] These results have not yet been released.

these services from full-day attendance may lead to a greater impact compared to half-day attendance, primarily due to more exercise and improved nutrition. Dietary intake and physical activity levels of preschoolers accounts for more of the variance in body mass index than whether or not a young child's parents are obese (Klesges et al, 1995). Additionally, the preschool environment can explain more of the variation in physical activity levels than demographic characteristics (Pate et al, 2004). Head Start performance standards emphasize exercise and the development of gross motor skills (Office of Head Start, 2007b). Greater exposure to Head Start is likely to reduce obesity if children exercise more during Head Start than they would have if they had not been in Head Start.

The nutritional aspects of Head Start's services include nutritional screening, nutritional education, and providing healthy meals. Head Start personnel determine the child's nutritional needs through nutritional assessments, height and weight measurements, and hemoglobin/hematocrit testing conducted within the first 45 days of enrollment, and then design and implement a nutritional plan. Meal times provide the opportunity for nutrition education and children are encouraged to try a variety of foods. The Head Start nutritional guidelines are consistent with the recommendations of the American Dietetic Association (Briley and Roberts-Gray, 1999). Fox et al. (1997) found that the nutrient intake from all meals is consistent with the Head Start performance standards.

An important difference in the Head Start program options that is likely to influence childhood obesity is the intensity of exposure to the nutrition provided through meals. Federal guidelines require that children in a full-day program receive meals and snacks that provide one-half to two-thirds of their daily nutritional needs, while children in a half-day program receive only one-third. Thus, children in full-day services consume a greater number of calories while in

Head Start, but the extended time in a regulated setting also limits the opportunity for further consumption outside of Head Start. In a 24-hour dietary recall study, Worobey et al. (2005) find that, during the day, children who attend Head Start consumed similar levels of protein, carbohydrate, and fat as middle-income children who attended a private preschool. However, the quantity and quality of calories consumed outside of school differs greatly for these two groups of children. In comparison to the middle-income children in the study, the fat, carbohydrate, and caloric intake of the Head Start children is 2 to 3 times greater after school. Thus, Head Start is likely to improve the nutritional quality of participants' diet by providing nutritious meals and limiting participants' exposure to the poor nutrition offered at home.[8] This impact is likely to be larger for children who are in the Head Start program for a greater period of time during the day.

The Head Start program may also indirectly influence parental behavior. Parents may reduce the amount of food offered to their children at home, if resources are scarce, because children were provided with meals during Head Start (Behrman, Cheng, and Todd, 2004). More generally, if Head Start, as a publicly-provided program that offers child care and developmental services, lowers the marginal cost of child quality, then parental investment in children may increase (Becker and Tomes, 1976).[9] Greater parental investment could improve a variety of child outcomes, including reducing obesity. If full-day Head Start services lead to a greater reduction in the marginal cost of child quality, then the resulting impact on child outcomes would be magnified.

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[8] The evidence in support of the hypothesis based on only one dietary recall study with small sample sizes is admittedly weak. However, further support of this idea is provided in the discussion at the end of this paper about the potential mechanisms that are producing the estimated results.

[9] Parents could also respond with compensating behaviors such as decreasing their investment in the child if the Head Start program leads to an endowment and not a price effect (Becker and Tomes, 1976). The estimated treatment effect of the program is the net result of the direct effect of the program and the augmenting or diminishing indirect effect of changes in parents' behavior (Behrman, Cheng, and Todd, 2004).

3. Data

The data for this analysis are provided by a Head Start grantee in southern Michigan for the program years spanning 2002 through 2006. Children in this program in full-day classes attend Head Start for eight hours per day, five days per week; children in half-day classes attend Head Start for 3.5 hours per day, four days per week.[10] These data include measured height and weight at the beginning and end of the program year. This administrative data set also includes the family background information that is included on the Head Start application and is reported prior to Head Start attendance. This data set is unique because of the multiple measures of height and weight throughout the year combined with program characteristics and detailed family background information.

Head Start children are weighed and measured without shoes during the first 45 days of attendance in the program and at the end of the academic year by their teachers, using the same equipment for each measurement. Additionally, measures of height and weight from pediatric visits are included in the data. Objective measurements of height and weight are more reliable than self-reported measures, which are subject to reporting error (Cawley, 2004). For this analysis, we defined the first measurement in August, September, or October as the beginning of the year measurement and the last measurement in March, April, or May as the end of the year measurement. Height and weight are used to calculate body mass index (BMI), which is correlated with body fat and is recommended by the National Heart, Lung, and Blood Institute for use in clinical practice and epidemiological studies (National Heart, Lung, and Blood Institute, 1998). The Centers for Disease Control and Prevention (CDC) and the American Academy of Pediatrics recommend the use of BMI to screen for overweight and obesity in

[10] In 2006, children in two classrooms attended Head Start for eight hours per day for two days per week; these children are not included in much of this analysis.

children beginning at 24 months old (CDC, 2007). Dichotomous measures of obese, overweight, and underweight and the continuous measure of BMI z-score are constructed from BMI. Obesity for individuals greater than or equal to 24 months old and less than 20 years old is defined by the CDC as a BMI greater than or equal to the 95th percentile of the historical age- and sex-specific BMI distribution. Overweight is classified as a BMI greater than or equal to the 85th percentile and underweight is classified as a BMI less than the 5th percentile.[11] The BMI z-score is calculated by converting the age- and sex-specific BMI distribution into a standard normal distribution; thus the values of the BMI z-score are units of standard deviations from the mean.

Children without valid measures of height and weight at both the beginning and the end of the academic year are excluded from the analysis sample. Thus, children who left the program prior to May or began after October are excluded.[12] Additionally, children with implausible measurements are excluded, where implausible measurements are a z-score for BMI, height, or weight less than 4 (BMI, height, or weight measurements 4 standard deviations below the age- and sex-specific mean), a height z-score above 4, a change in BMI during the academic year of greater than or less than 5 units, and a decrease in height of at least 2 inches.[13] Sample

[11] These measures of overweight and obese are sometimes referred to in the medical literature as "at risk of overweight" and "overweight." Keeping with the common practice in the economics literature and the recommendations of the Institute of Medicine, we refer to these measures as overweight and obese. The percentile thresholds for the BMI categories are derived from historical data from the National Health Examination Surveys (NHES) and National Health and Nutrition Examination Surveys (NHANES) from 1963 through 1980, as well NHANES III data from 1988-94 for children under 6 years old (Kuczmarski et al, 2000).

[12] There are 215 children in the sample who left the program prior to the end of the year. These children are more likely to be white and living in families with lower incomes with a primary adult who is less likely to be employed full time than children in the analysis sample. The weight status of these 215 children at the beginning of the year is not different from the weight status of the children in the analysis sample. Children who dropped out of the program are not more or less likely to be enrolled in full-day classes than children in the analysis sample. There were 146 children who began the program after October. These children are less likely to have a disability and are less likely to live with a primary adult who was employed full time than children in the analysis sample. These children are less likely to be enrolled in full-day classes than children in the analysis sample. The weight status of these 146 children at the end of the year is not different from the weight status of the children in the analysis sample.

[13] These are likely the results of error in recording the measurements in the data set. Including the implausible measurements does not influence the matching estimates, but decreases the regression-based estimates. Overall, the conclusions are not affected by excluding these measurements.

exclusions due to implausible measurements remove 65 observations. In 2006, 85 children attended Head Start for 8 hours per day for two days per week; these children are excluded from most of the analysis. These sample restrictions result in a sample of 1833 observations from 1532 children, since some children enrolled in Head Start for multiple years. Three hundred and twenty seven children with 424 observations attended full-day classes, while 1,205 children with 1,409 observations attended half-day classes.

4. Empirical Strategy and Results

Our objective in this paper is to determine the marginal impact of full-day Head Start services compared to half-day services. In other words, we are interested in estimating the average treatment effect of full-day services, conditional on participating in Head Start. Also, we seek to determine the average treatment effect, not the average treatment effect on the treated, of full-day services, since we are interested in the potential impact of full-day services on all children in Head Start.[14]

We utilize a sample that contains information only on children who enrolled in Head Start and we compare children who received full-day services to those who received half-day services. Therefore, we focus on the nonrandom selection of children into full-day and half-day programs and allow for selection on unobserved characteristics to influence the decision to participate in Head Start (e.g., Behrman, Cheng, and Todd, 2004).

The children who attended full-day services are likely to differ from children in half-day services as a result of the decision rules used by the program to determine the child's placement. To be eligible for full-day classes, parents must be working full-time (at least 35 hours per

[14] We are estimating the average treatment effect for the population of children participating in Head Start, not for the population of all children. This average treatment effect on the treated would be the average treatment effect for the population of children participating in full-day Head Start.

week), in training full-time, or in school; however, exceptions are made as needed. The same criteria used to determine Head Start attendance are used by this Head Start grantee to determine which eligible children are selected for full-day classes. Thus, children in families with a history of domestic violence and substance abuse, with chronically ill parents or siblings, with parents in the military, in limited English homes, who have moved two or more times in the past 12 months, and who do not have access to other programs are more likely to be selected to attend full-day classes. Not all of the information that is used to determine eligibility is available in the data. Table 1 displays the individual and family background characteristics of full-day and half-day children and includes information on employment. The primary adult caregivers of children in full-day classes are more likely to be employed full-time than the primary adult caregivers of children in half-day classes; presumably as a result, family income is also higher for full-day children.

To determine the impact of full-day Head Start participation on childhood obesity compared to half-day participation, we begin by examining the differences in the change in the proportion of obese, overweight, and underweight children and the mean BMI z-score from the beginning to the end of the Head Start year. We also examine the distributions of BMI z-score at the beginning and the end of the year for full-day and half-day children. Then, to control for selection on observable characteristics into full-day and half-day classes, we implement regression and matching methods. Finally, to control for selection on unobservable characteristics, we estimate the impact of full-day Head Start participation utilizing an exogenous shock to the supply of full-day slots.

A. Comparisons of Means and Distributions

The proportion of children obese, overweight, and underweight and the mean BMI z-score at the beginning and end of Head Start are shown in Table 2 for children who attended full-day classes and those who attended half-day classes. At the beginning of Head Start, approximately 17 percent of full-day and half-day children were obese. By the end of the program year, only 12 percent of full-day children were obese and 16 percent of half-day children were obese. Overall, the prevalence of obesity decreased 2.3 percentage points by the end of the year, but the decrease for full-day children was 3.8 percentage points higher than for half-day children. The difference-in-difference of means was -3.7 percentage points for the prevalence of overweight; however, this value is not statistically significant. There is little change in the prevalence of underweight for children in either program option. The differences in BMI z-score reflect the changes in obesity. Children in full-day and half-day program options had similar BMI z-scores of approximately 0.5 standard deviations above the mean at the beginning of the year, but the BMI z-score decreased by 9 percent of a standard deviation more for children in full-day classes than for children in half-day classes.

The changes in the means of these weight categories are reflected in the beginning and the end of the year distributions of BMI z-score. Figure 2 displays kernel density estimates of BMI z-score at the beginning (the dashed line) and the end (the solid line) of the year for half-day participants and full-day participants. The dashed vertical lines are the means of BMI z-score at the beginning of the year; the solid vertical lines are the means of BMI z-score at the end of the year. The dotted vertical lines represent the underweight threshold on the left of the graphs and the obese threshold on the right of the graphs; the overweight threshold is approximately equal to a BMI z-score of one. The graph for half-day participants demonstrates that the distribution changed so that the density above the obese threshold is lower and the density between the mean and the obese threshold is higher. Thus, while the mean BMI z-score for half-day participants did not change from the beginning to the end of the year, the prevalence of obesity is lower. The graph for full-day participants demonstrates that the peak of the distribution in the normal weight range became taller and shifted to the left, while the right tail of the distribution in the obese range is smaller.[15]

The comparisons in means in Table 2 and the distribution graphs in Figure 2 suggest that full-day Head Start services led to a significant decrease in obesity compared to half-day services. However, these simple comparisons do not account for the differences in individual and family characteristics that may be related to childhood obesity.[16] For example, Anderson, Butcher, and Levine (2002) find that maternal employment is related to childhood obesity; however, these authors also show that maternal employment is not related to childhood obesity for women with low levels of education and family income.

B. Regression Estimates

To control for the observed differences in individual and family characteristics of full-day and half-day children, the weight status (obese, overweight, underweight, BMI z-score) of child *i* in period *t* ($W_{i,t}$) is specified as:

$$W_{i,t} = \beta_0 + \beta_1 FD_i + \beta_2 X_{i,t-1} + \beta_3 W_{i,t-1} + \phi_t + \varepsilon_{i,t} \quad (1)$$

where t = 2002, …, 2006, FD indicates full-day attendance, X includes individual and family characteristics that are determined prior to Head Start enrollment, ϕ represents year-specific

[15] As is also shown in the mean statistics, there is a slight increase in the density at the underweight threshold. The change in the proportion underweight from 0.033 to 0.040 is not statistically significant.
[16] For differences in individual or family characteristics to influence the simple comparisons in means, then these differences must influence the change in obesity over the course of the year, not simply the level of obesity at the beginning of the year.

binary variables, ε is the error term, and β represents the parameters to be estimated. The specific variables in X are binary measures of race/ethnicity (Hispanic, non-Hispanic black, non-Hispanic black and white, other; non-Hispanic white omitted), sex, whether the child has a disability, whether there is only one parent in the family, whether the primary adult caregiver graduated from high school, the primary adult caregiver's employment status (full-time; part-time; seasonal, retired, in school, or disabled; otherwise not in the labor force or unemployed is omitted), and whether the family receives benefits from the Temporary Assistance for Needy Families (TANF) program, and the continuous measures of age in months at the end of the year measurement, the log of family income, and family size.[17,18] Heteroskedasticity-robust standard errors are estimated for all regression estimates.[19] For the dichotomous outcome variables, obese, overweight, and underweight, the above equation is estimated using a probit specification and the reported coefficients are average partial effects for the full-day attendance binary variable.[20] For BMI z-score, the above equation is estimated by OLS.

Table 3 displays the estimates of the impact of full-day services on weight status.[21,22] The first row of numbers repeats the comparisons of means reported in Table 2. The baseline

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[17] The primary adult caregiver is the mother for 94 percent of the sample. Including a dichotomous measure of whether the primary adult caregiver is the mother does not influence the results.
[18] Missing data for the variables other than full-day attendance and the dependent variables are imputed using linear regression based on the control variables with non-missing data. Thirty four missing observations were imputed for race, 130 for family income, 1 for TANF receipt, 16 for whether the primary adult caregiver graduated high school, and 4 for the primary adult caregiver's employment status. There were no missing observations for age, sex, family size, and whether there is only one parent in the family.
[19] Clustering the standard errors to account for the repeated observations of the approximately 20 percent of the sample with multiple years of Head Start attendance has little influence on the standard errors. For example, the standard error for the baseline regression estimate for obesity in Table 3 changes from 0.0157 to 0.0159. The inference is also similar when the standard errors are clustered by classroom identifiers and by classroom × year.
[20] The results from linear probability models are similar, although the point estimates are slightly larger in absolute value for overweight and obese.
[21] These results are also not sensitive to the inclusion of age squared, a set of year of age binary variables, including the number of years participating in the program, or including the number of children less than age 6 in the family instead of family size.
[22] The results for BMI z-score are similar to results obtained using age-adjusted BMI, where the 50th percentile of the sex- and age in months-specific distribution is subtracted from BMI.

regression estimates display the regression results for the entire sample. These results are very similar to the comparisons of means. Participation in full-day services leads to a 3.3 percentage point larger decrease in obesity and a 3.9 percentage point larger decrease in overweight than participation in half-day services. These changes in overweight and obesity are reflected in the estimated decrease in BMI of 0.089 standard deviations.

These estimates are based on the sample of 1833 observations, which includes children who are not likely to be eligible for full-day classes. Because ineligible half-day children are likely to provide a poor comparison group to children in full-day classes, we construct a selected sub-sample of the 1833 observations that improves the overlap between the full-day and half-day samples. Children in families who specify on the application form that the children are not in need of full-day/full-year care are not included in the sample; this restriction removes 295 children.[23] Eight hundred and twenty seven children whose primary adult caregiver was not employed full-time are also excluded. The propensity score for the remaining 780 observations is estimated and 13 observations not in the common support are excluded. The sample is further trimmed to include only observations with propensity scores in the range of [0.1, 0.9].[24] This final exclusion removes two observations. The resulting sample size of the selected subsample is 765 observations for 646 children, consisting of 300 full-day observations for 252 children and 465 half-day observations for 394 children.

The means and standard deviations of this selected sample are shown in Table 2. The differences in means between the full-day sample and the half-day sample as a percentage of the average standard deviation (Rosenbaum and Rubin, 1985) are also shown. Restricting the

[23] Approximately 39 percent of children had non-missing responses to this question on their application. There were no missing responses in 2002, but there were few non-missing responses in 2004, 2005, and 2006.
[24] Crump et al (2006) show that the set of observations with propensity scores in the interval [0.1, 0.9] approximates the optimal subsample for estimating the average treatment effect under a wide range of distributions.

sample to these 765 observations improves the overlap of the full-day and half-day samples; the standardized difference in means decreases for nearly every family background variable. In particular, there is greater similarity in family income and parents' education between full-day and half-day children in this selected sample.[25]

Table 3 also displays the regression estimates using the selected sample. These results are similar to the results from the entire sample. With the smaller sample, the standard errors are slightly larger and the point estimates are larger. Participation in full-day Head Start services reduces obesity by 3.6 percentage points, overweight by 4.8 percentage points, and BMI by 0.104 standard deviations in comparison to half-day services.[26]

C. Matching Estimates

An additional strategy to estimate the impact of full-day Head Start services is to use matching. Similar to regression, matching estimates maintain the assumption of selection on observables and overlap between the treated and control samples.[27] One limitation of regression is that the estimates may be sensitive to changes in the specification; the counterfactual estimates are based on extrapolation using the estimated regression function (Imbens, 2004).

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[25] An alternative strategy for trimming the sample, which removes children with a primary adult caregiver who is unemployed or not in the labor force, instead of keeping children with a primary adult caregiver who is employed full-time prior to estimating the propensity score, yields similar regression and matching estimates. This alternative sample consists of 1099 observations, with 383 observations for full-day Head Start participation. In this alternative sample, the standardized difference in family income and whether the primary adult graduated high school is more, but the difference in race and whether the family has a single parent is less.

[26] Changes in BMI can result because of change in height and/or changes in weight. Height can increase considerably throughout the course of the year due to improved nutrition (Perez-Escamilla and Pollitt, 1995) and less stressful living conditions (Skuse et al, 1996). Estimates of the impact of full-day Head Start on height z-score and weight z-score suggest that the impact on BMI, and thus obesity, are the result of changes in weight and not height.

[27] Formally, the assumption of selection on observables states that the treatment assignment is independent of the potential outcomes conditional on the explanatory variables, and the overlap assumption states that the probability of receiving the treatment conditional on the explanatory variables is bounded away from zero and one (Imbens, 2004).

Alternatively, matching estimators predict the counterfactual of treated observations using only the nearest neighbors of the control observations (Imbens, 2004).

Matching estimators are not necessarily $\sqrt{N}$ -consistent and are biased in finite samples when the matching is not exact (Abadie and Imbens, 2002). To overcome this drawback, we use the bias-adjusted nearest neighbor matching with replacement procedure developed by Abadie and Imbens (2002), which is $\sqrt{N}$ -consistent and asymptotically normal, to estimate the population average treatment effect.[28] This procedure is implemented using a minimum of three matches per observation. The same control variables used in the regression estimates are used as the matching variables and the distance metric used to match observations is the diagonal matrix formed by the inverses of the variances of the control variables. Heteroskedasticity-robust standard errors are used for all matching estimates.

Table 3 displays the bias-adjusted nearest neighbor matching with replacement estimates for the entire sample and the selected sample. The results for the entire sample demonstrate a larger impact of full-day services on childhood obesity than the regression estimate; participation in full-day services leads to a 5.7 percentage point larger decrease in obesity than participation in half-day services. The estimate for overweight is near zero and not statistically significant. The estimate for BMI z-score is much smaller and is less precisely estimated than the regression estimate.

In comparison to the entire sample, the matching estimates for the selected sample are closer to the unadjusted mean differences and the regression estimates. Full-day Head Start participation is estimated to reduce childhood obesity by 4.6 percentage points. The point

[28] Matching with replacement improves the quality of the matches and reduces the bias of the simple matching estimates. Additionally, the bias-adjusted matching estimator adjusts the difference between matches by the regression-adjusted differences in the covariate values. Although the bias-adjusted matching estimator is not fully efficient, this estimator is robust to misspecification (Abadie and Imbens, 2002).

estimates for overweight and BMI z-score suggest full-day participation reduces overweight by 3.8 percentage points and BMI by 0.121 standard deviations, but these estimates are not precise. Overall, the unadjusted difference-in-difference estimates, the regression estimates, and the matching estimates suggest that full-day participation decreases obesity by approximately 4 percentage points, or by 25 percent of the control group mean (the proportion obese for half-day Head Start at the end of the year).

D. Cohort Estimates

An alternative strategy is implemented that relaxes the assumption of selection on observables. In the spring of 2002, budgetary problems and the resulting decrease in funds to education programs throughout the state led to the unexpected elimination of a state-funded full-day expansion grant. Two features of the elimination of this grant are important to note. First, the elimination of this grant was unanticipated. The full-day expansion grant began in the 2001-2 academic year and had been provided to the Head Start grantee for what was expected to be at least 3 years. The expansion grant was unexpectedly eliminated and only four full-day classes were available during the 2002-3 year (down from 16 full-day classes the year before). It was not until 2003-4 that this Head Start grantee reallocated program resources to offer more full-day slots to better meet the demands of the low-income working parents in the community. Second, the elimination of this grant was not specific to or targeted at this Head Start program, but instead was part of a statewide budget cut to education programs.

Figure 3 displays the percent of Head Start children attending full-day classes each year and the change in the proportion of obese children within each year from 2002 to 2006. As shown in the figure, the trend of the change in the proportion of obese children closely follows the trend of the percent of full-day children. In 2002, 42 percent of children attended full-day Head Start and there was a 5.5 percentage point decrease in the prevalence of obesity from the beginning to the end of the academic year. In 2003, only 11 percent of children attended full-day Head Start and there was no change in the prevalence of obesity. In 2004, the percentage of children attending full-day Head Start increased to 23 percent and there was a decrease in the prevalence of obesity of 2.2 percentage points.

To further analyze the impact of the exogenous shock to the supply of full-day slots, the weight status of child *i* in period *t* ($W_{i,t}$) is specified as:

$$W_{i,t} = \delta_0 + \delta_1 YEAR\,2002_{\,i} + \delta_2 YEAR_{\,i} + \delta_3 X_{\,i,t-1} + \delta_4 W_{i,t-1} + \eta_{\,i,t} \qquad (2)$$

where YEAR2002 is a binary variable equal to one in 2002, YEAR is specified as a linear year variable, η is random error, δ represents the parameters to be estimated, and all other variables remain as specified in equation (1).[29] Because YEAR is specified as a linear year variable, δ_1 represents the deviation in weight status from the linear cohort trend as a result of the expansion of full-day Head Start classes. The results from this cohort-based empirical strategy estimate a different parameter of interest from the regression and matching estimators. Instead of an estimate of the average treatment effect of full-day Head Start compared to half-day Head Start, this strategy estimates the average treatment effect of full-day Head Start that results because of a change in the supply of full-day slots.

Table 4 displays the estimates of the impact of full-day Head Start classes for individuals whose attendance in the full-day program was influenced by the change in the availability of full-day classroom slots from the unanticipated elimination of the state full-day expansion

[29] Because information about full-day participation is not included in equation (2), this equation is estimated with the larger sample of 1918 that includes the 85 children who attended Head Start for 8 hours per day for 2 days per week in 2006.

grant.[30] These results show that the likelihood of being obese at the end of Head Start is four percentage points lower in 2002 when compared to the linear trend.[31] Estimates from specifications controlling for covariates are similar to estimates from specifications not controlling for covariates, which suggests that these results are not driven by changes in the demographics or family background of full-day participants across cohorts.[32] The estimated impacts on overweight and BMI z-score are negative as well, but these results are not statistically significant.

Estimates from alternative specifications, focusing on obesity, that impose a less restrictive time trend are displayed in Table 5. Specifications (A) and (B) include a set of binary variables denoting the years 2002, 2004, 2005, and 2006, so that the coefficient for 2002 compares the likelihood of being obese at the end of the year in 2002 to 2003. Specification (A) does not control for individual and family characteristics prior to Head Start attendance; specification (B) includes these covariates. This alternative specification of year variables yields similar results to the results in Table 4 that impose a linear time trend. Specification (C) restricts the sample to 2002 and 2003. The results from this specification show that the likelihood of being obese at the end of the academic year in 2002 is 5.4 percentage points lower than at the

[30] The results in Table 4 are estimates of a different parameter than the estimates in Table 3. Table 3 displays estimates of the average treatment effect, while Table 4 displays reduced-form estimates of the local average treatment effect. A 31 percentage point change in full-day attendance leads to the 4.4 percentage point change in obesity in Table 4. This estimate is the average partial effect from a probit specification. This result implies that a change from full-day to half-day leads to a 14.2 percentage point change in the probability of being obese for children whose attendance in full-day Head Start was influenced by the change in the availability of full-day classroom slots from the unanticipated elimination of the state full-day expansion grant. The linear IV estimate based on the reduced-form specification in equation (2) is -0.178 with a standard error of 0.094 and a first stage F statistic of 62. The corresponding bivariate probit estimate is -0.711 with a standard error of 0.285 and a marginal effect of -0.093.

[31] The linear trend for obesity has a slope of -0.004.

[32] County economic variables are only available from the U.S. Census Bureau's Small Area Income and Poverty Estimates for 2002 through 2004. Restricting the sample to the years 2002 through 2004 slightly increases the absolute value of the coefficient estimates reported in Table 5. Including the log of the median income has no impact on the coefficient estimates. Including the percent of children in poverty increases the absolute value of the coefficient estimates and the estimates for overweight and BMI z-score become statistically significant.

end of the academic year in 2003, which is one percentage point larger than the result in specification (B) based on all years of the sample.

As a falsification test, specification (D) compares obesity at the end of the academic year in 2004 to 2005. During the academic years of 2004 and 2005, there was not a change in funding that influenced the supply of full-day slots. In both 2004 and 2005, there were nine full-day classrooms provided by this program and 23 percent of the children in the sample attended full-day classes. The results from specification (D) show that there was no change in obesity between these years.

Specifications (E) and (F) in Table 5 examine the change in obesity status as the dependent variable, instead of obesity status at the end of the academic year. Specification (E) is a more restrictive version of equation (2) that imposes that $\delta_4=1$. Specification (F) is similar to (E) except that it includes binary variables for each year, with 2003 omitted. The results shown in Table 5 demonstrate that the change in obesity in 2002 was 6 percentage points greater compared to the linear trend. Similarly, the change in obesity throughout the 2002 academic year was 6 percentage points greater than the change in 2003, as shown by the results from specification (F). Overall, the estimates in Tables 4 and 5 suggest that the decrease in the percent of children attending full-day from 42 percent in 2002 to 11 percent in 2003 increased obesity by at least four percentage points.

5. Discussion and Conclusion

Our results demonstrate that attending full-day Head Start classes leads to a substantially larger reduction in childhood obesity than attending half-day classes. Differences in means, regression, and matching estimates suggest that participating in full-day Head Start reduces the probability of being obese by four percentage points, or 25 percent of the control group mean.

Additional estimates demonstrate that the 31 percentage point decrease in the percent of children attending full-day classes due to the unexpected elimination of a state-funded full-day expansion grant increased childhood obesity by approximately four percentage points. This implies that a change from full-day to half-day leads to a 14.2 percentage point change in the probability of being obese for children whose attendance in full-day Head Start was influenced by the change in the availability of full-day classroom slots from the unanticipated elimination of the state full-day expansion grant.

While the regression and matching estimates are based on the assumption that unobserved characteristics are not related to full-day attendance, the cohort-based estimates are not based on this assumption. The most disadvantaged of the eligible children are selected for full-day classrooms by Head Start administrators. If the selected children are disadvantaged according to unobserved characteristics, and these unobserved characteristics are positively correlated with childhood obesity, then estimators that assume selection only on observed characteristics are likely to be biased towards zero. To assess the importance of this difference in the estimators, we include additional variables in each model that reflect family needs for assistance. These variables are based on self-reports of the child's adult caregivers provided to Head Start staff members at the beginning of the academic year. Specifically, the additional variables measure whether job training, literacy, mental health, transportation, clothing, emergency, food, and housing services and crisis assistance are needed for the family.

Estimates based on specifications with these additional variables are shown in Table 6. The regression and matching estimates without the need for assistance variables are duplicated from the estimates for the selected sample from Table 3 for comparison. Including these additional measures of family needs has substantial impact on the results for obesity. The regression estimate changes from -0.036 to -0.050, while the standard error remains approximately the same. Similarly, the matching estimate changes from -0.046 to -0.077 and the standard error is unaffected. The cohort-based estimates without the need for assistance variables are duplicated from the estimates with covariates shown in Table 4 for comparison. Including the additional measure of family needs has little impact on the results for obesity; the estimate changes from -0.044 to -0.047. The results in this table suggest that differences in the assumptions about unobserved characteristics contribute considerably to the different magnitudes of the estimators.

To better understand the magnitude of our estimates, following Cutler, Glaeser, and Shapiro (2003) and Schanzenbach (2005), we simulate the potential impact of a change in caloric intake on the rate of obesity.[33] This simulation is based on the assumption that, in equilibrium, calories consumed equates with calories expended; thus, a change in the amount of calories consumed, with no offsetting change in calories expended, leads to a change in weight. This simulation suggests that a 4 to 14 percentage point change in obesity can be explained by a change in caloric intake of 20 to 50 calories per day. Thus, a small change in the amount of calories consumed can lead to important changes in obesity for children at these young ages.[34]

This paper demonstrates that full-day Head Start participation reduces obesity in comparison to half-day participation. Unfortunately, with these data it is not possible to isolate the mechanism that determines our results. Important differences between the full-day and half-

[33] Further details about this simulation are provided in the appendix.
[34] In comparison, Schanzenbach (2005) attributes the increase in obesity of 2 percentage points for children in first grade from the National School Lunch program to an excess intake of 40 calories per day and Cutler, Glaeser, and Shapiro (2003) attribute the increase in adult obesity from the 1970s through the 1990s to an excess of approximately 100 to 150 calories per day.

day program options are the quantity of meals served and the amount of time available for exercise. Additionally, full-day classes potentially limit children's exposure to foods with limited nutritional value available outside of Head Start.

The caloric intake simulation suggests that a small reduction in calories can explain the results. The dietary recall study of Worobey et al (2005) suggests that Head Start reduces the number of calories consumed by children. Further evidence that Head Start participation influences caloric intake is based on data from the food intake files in What We Eat in America 2003-4, combined with NHANES 2003-4. Table 7 compares the amount of calories consumed throughout the day by Head Start participants during a weekday to a weekend day and to other children ages 36 through 71 months old in families below the poverty line during a weekday.[35] For dinner and evenings snacks, Head Start participants consume similar levels of calories on a weekday as on a weekend day and consume similar levels of calories during the week as other impoverished children. During the day, Head Start participants consume fewer calories during the week than on the weekend and consume fewer calories than non-Head Start children during the week. This finding suggests that the eating habits of Head Start participants revert to those of their non-Head Start peers when the participants are not in a Head Start classroom. In addition, this finding suggests that the caloric intake of Head Start children is reduced during the hours of Head Start attendance.

Our results suggest that expansions to the Head Start program that increase the availability of full-day services have the potential to reduce the prevalence of childhood obesity for low-income children. Given the health consequences of obesity, the benefits of expansions to the intensity of Head Start services could be substantial, particularly if the weight reduction lasts

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[35] The information on the caloric intake of Head Start participants during the week is not from the same children as the information of Head Start participants during a weekend.

throughout childhood. As a result of the timing of Head Start within an age frame that is influential in the development of behaviors related to diet and exercise (Birch, 1999), behavioral changes may lead to longer-term benefits that are not captured in the short-term impacts estimated here. Fitzgibbon et al. (2005) demonstrate that a dietary and physical activity intervention for Head Start children can lead to a persistent impact on body weight at least two years later. Frisvold (2007) finds that Head Start participation, compared to not participating in Head Start, leads to a reduction in childhood obesity that persists until at least age 10. However, that study examines obesity in 2002 and is not able to disentangle an individual's age from their cohort. Thus, the perception that the impact of Head Start does not persist with age could be due to changes in the Head Start program in recent years that have led to a reduction in childhood obesity. The recent expansion of full-day services is an important change that likely contributes to the estimated impact of Head Start participation on childhood obesity. Unfortunately, with these data it is not possible to determine how long the impact of full-day Head Start participation lasts.

Suggestive evidence on the persistence of the impact of full-day Head Start participation is available from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99. These data include measured height and weight information for a cohort of children who began kindergarten in the 1998-99 academic year, and also include height and weight data in the follow up surveys from the first, third, and fifth grades. Importantly, this survey includes information about full-day and half-day Head Start attendance prior to kindergarten. Table 8 demonstrates that, for children who attended half-day Head Start classes, the percent of children who are obese is larger than the percent of children who are obese for full-day Head Start participants through at least fifth grade, although the difference is statistically significant only through first grade.

Full-day Head Start participants are approximately 4.5 percentage points less likely to be obese through first grade and 2 percentage points less likely to be obese through fifth grade.[36]

Overall, our results demonstrate participating in a longer daily duration in Head Start reduces the likelihood of being obese. Obesity is one of a broad array of outcomes that are influenced by Head Start participation. As more results from the Head Start Impact Study are released that examine the impact of full-day services on cognitive and behavioral outcomes, further information will be available to assess the implications of and tradeoffs between expansions to the intensity and the breadth of the Head Start program.

[36] Unfortunately, this survey does not include information about family background prior to Head Start attendance. Thus, it is not possible to estimate the relationship between full-day Head Start attendance and obesity in later years conditional on pre-Head Start family and individual characteristics with these data. However, the results throughout this article suggest that the unconditional differences in means between full-day and half-day children represent a lower bound of the impact of full-day Head Start attendance. Thus, the two percentage point difference in the percent of obese children in fifth grade may be a lower bound of the persistent impact of full-day Head Start attendance.

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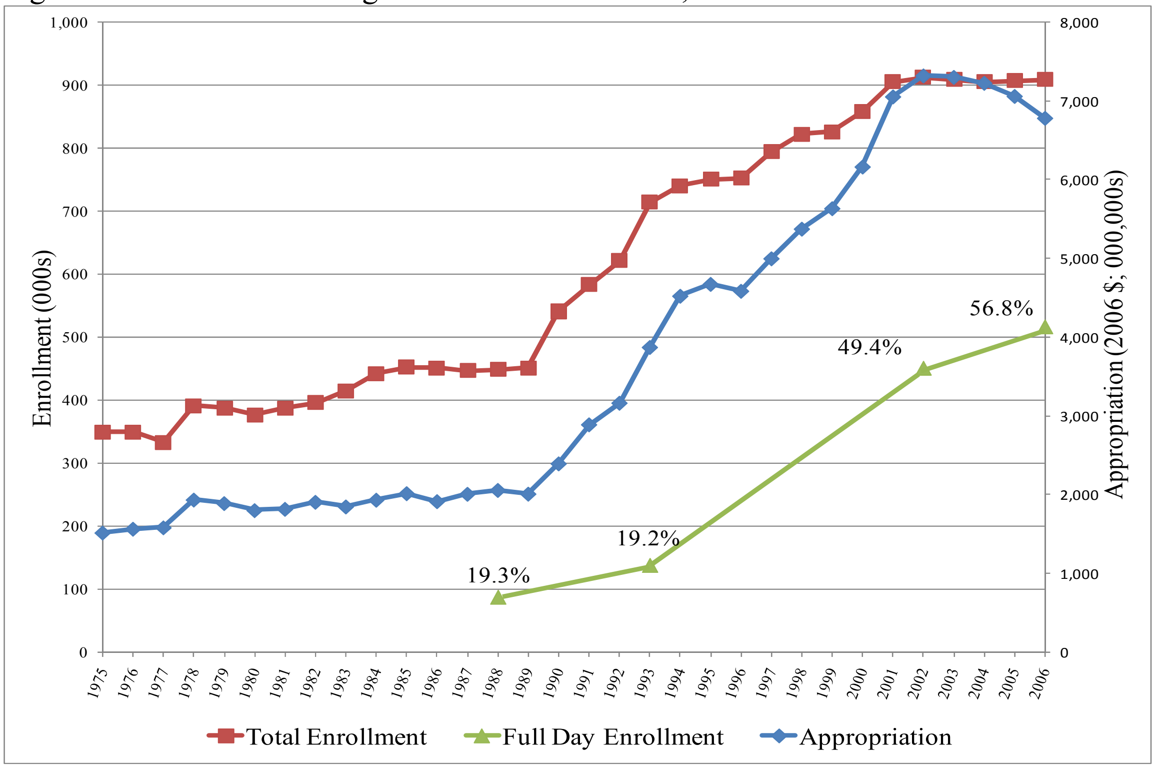
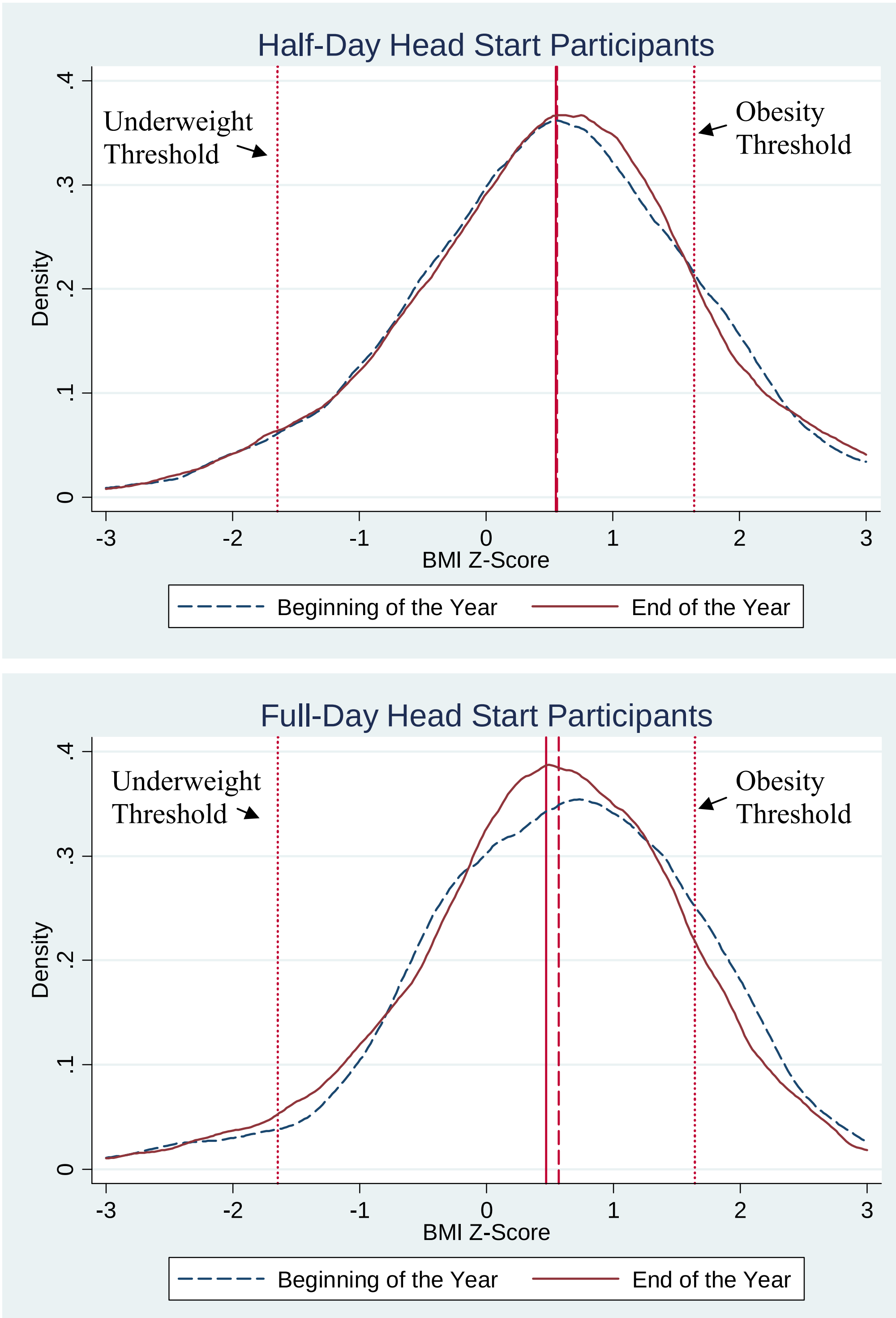
Figure 1: Head Start Funding and Enrollment Trends, 1975-2006



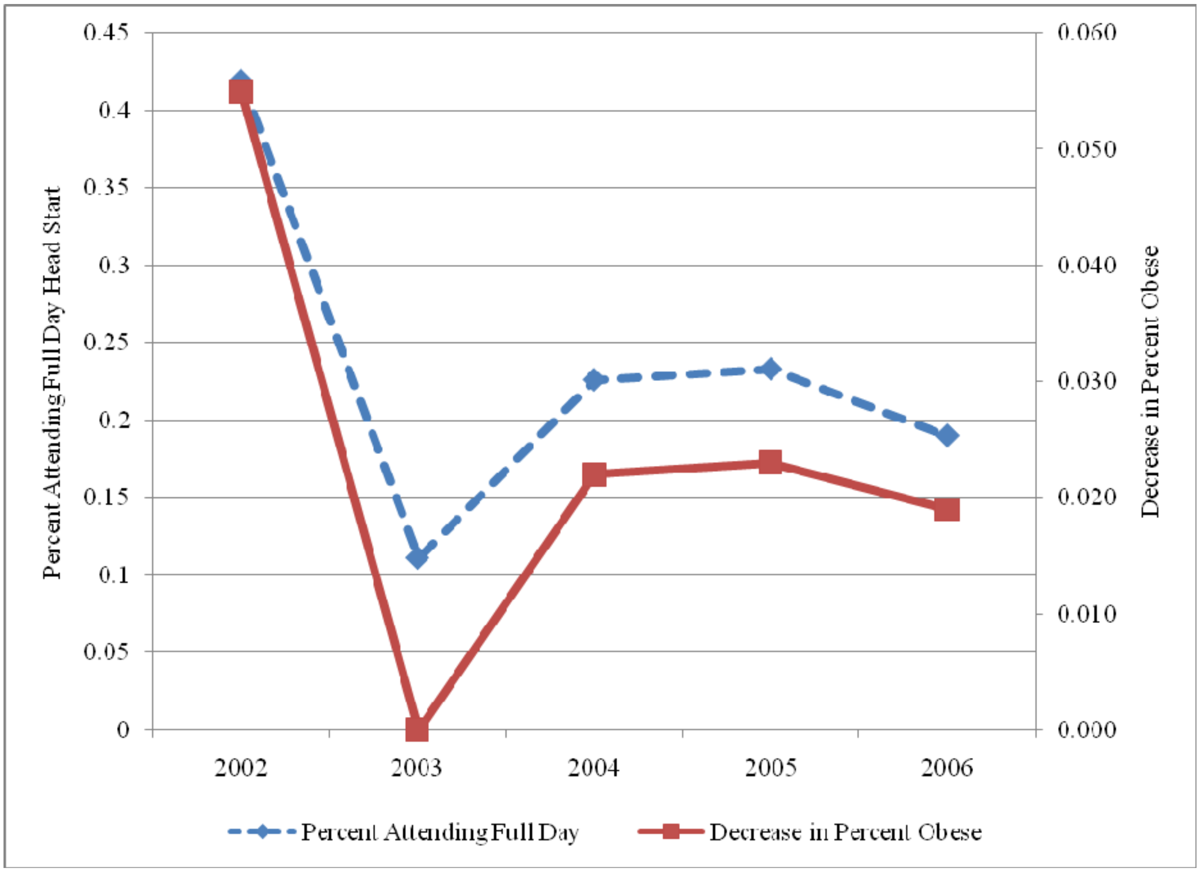
Notes: The total federal appropriation to the Head Start program was converted in to 2006 dollars using the Consumer Price Index for All Urban Consumer annual data. The percent values on the chart represent full day enrollment as a percent of total enrollment.
Sources: Total enrollment and total federal appropriation are from the 2007 Head Start Program Fact Sheet (Office of Head Start, 2007a). Full day enrollment figures are based on tabulations from the Head Start Program Information Reports that were provided by Kevin Costigan in the Administration for Children and Families and Don Stark at Xtria.

Figure 2: BMI Z-Score Density at the Beginning and the End of the Year



Notes: These figures are kernel density estimates using the Epanechnikov kernel of the BMI z-score at the beginning and the end of the year for full-day and half-day Head Start participants. The dashed vertical lines are means at the beginning of the year; the solid vertical lines are means at the end of the year. The dotted vertical lines represent the underweight threshold on the left and the obese threshold on the right.
Source: Administrative data provided by a Head Start grantee in Michigan from 2001 through 2006.

Figure 3: Change in Percent Obese and Percent of Children Attending Full Day Head Start by Year



Notes: The decrease in the percent obese is plotted on the positive y axis so that the value of 0.055 on the graph means that the proportion of obese children at the end of the year is 5.5 percentage points less than the proportion of obese children at the beginning of the year.
Source: See Figure 2.

Table 1: Means (and Standard Deviations) of Individual and Family Characteristics by Program Type

	Entire Sample				Selected Sample			
	All	Full Day	Half Day	Diff / S.D.	All	Full Day	Half Day	Diff / S.D.
Age (months)	52.297	52.226	52.319	-0.01	52.346	52.067	52.527	-0.07
	(6.932)	(6.941)	(6.931)		(6.817)	(6.827)	(6.812)	
Hispanic	0.066	0.069	0.065	0.02	0.058	0.068	0.051	0.07
	(0.245)	(0.253)	(0.243)		(0.230)	(0.250)	(0.217)	
Black	0.266	0.341	0.244	0.21	0.303	0.358	0.267	0.20
	(0.439)	(0.471)	(0.427)		(0.455)	(0.475)	(0.439)	
Black & White	0.083	0.113	0.075	0.13	0.083	0.106	0.069	0.13
	(0.274)	(0.314)	(0.260)		(0.273)	(0.304)	(0.250)	
Other Race	0.013	0.012	0.013	-0.01	0.007	0.010	0.005	0.07
	(0.111)	(0.108)	(0.112)		(0.081)	(0.100)	(0.066)	
White	0.572	0.465	0.604	-0.28	0.549	0.458	0.608	-0.31
	(0.491)	(0.495)	(0.485)		(0.492)	(0.493)	(0.483)	
Female	0.487	0.519	0.478	0.08	0.497	0.497	0.497	0.00
	(0.500)	(0.500)	(0.500)		(0.500)	(0.501)	(0.501)	
Disabled	0.229	0.203	0.237	-0.08	0.220	0.210	0.226	-0.04
	(0.420)	(0.403)	(0.425)		(0.414)	(0.408)	(0.419)	
Family Income (ln)	9.397	9.555	9.349	0.28	9.589	9.627	9.565	0.09
	(0.738)	(0.707)	(0.741)		(0.702)	(0.694)	(0.707)	
Family Income (000s)	15.392	17.671	14.706	0.26	18.118	18.854	17.643	0.10
	(10.891)	(12.566)	(10.241)		(12.386)	(13.593)	(11.531)	
Family Size	3.977	3.849	4.016	-0.12	3.885	3.817	3.929	-0.08
	(1.437)	(1.369)	(1.455)		(1.435)	(1.391)	(1.463)	
Single Parent Family	0.570	0.634	0.550	0.17	0.631	0.677	0.602	0.16
	(0.495)	(0.482)	(0.498)		(0.483)	(0.469)	(0.490)	
Primary Adult Graduated	0.639	0.723	0.614	0.23	0.700	0.718	0.688	0.07
High School	(0.479)	(0.445)	(0.486)		(0.457)	(0.449)	(0.462)	
Primary Adult is Employed	0.473	0.768	0.384	0.84	1.000	1.000	1.000	0.000
Full-Time	(0.499)	(0.422)	(0.486)					
Primary Adult is Employed	0.151	0.121	0.161	-0.12	0.000	0.000	0.000	0.000
Part-Time	(0.358)	(0.326)	(0.367)					
Primary Adult is in School, Disabled	0.074	0.061	0.077	-0.06	0.000	0.000	0.000	0.000
Employed Seasonally, Retired	(0.261)	(0.240)	(0.267)					
TANF	0.395	0.401	0.393	0.02	0.422	0.433	0.415	0.04
	(0.489)	(0.491)	(0.488)		(0.494)	(0.496)	(0.493)	
Sample Size	1833	424	1409		765	300	465	

Notes: Standard deviations in parentheses. Diff/S.D. is the differences in means between the full-day sample and the half-day sample as a percentage of the square root of the sample variances for both groups (Rosenbaum and Rubin, 1985). The selected sample is the sample of children not in need of full-day/full-year services with a primary adult caregiver who is employed full-time and in the common support of the propensity score distributions with a propensity score in the range of [0.1, 0.9].
Source: Administrative data provided by a Head Start grantee in Michigan spanning 2001 through 2006.

Table 2: Mean Differences in Weight Status Throughout the Year by Program Type

	Half Day	Full Day	Full - Half
Proportion Obese			
Beginning of the Year	0.174	0.172	-0.002
	(0.010)	(0.018)	(0.021)
End of the Year	0.160	0.120	-0.039**
	(0.010)	(0.016)	(0.020)
Change	-0.014*	-0.052***	-0.038**
	(0.008)	(0.017)	(0.017)
Proportion Overweight			
Beginning of the Year	0.334	0.344	0.010
	(0.013)	(0.023)	(0.026)
End of the Year	0.326	0.300	-0.027
	(0.012)	(0.022)	(0.026)
Change	-0.008	-0.045**	-0.037
	(0.011)	(0.022)	(0.023)
Proportion Underweight			
Beginning of the Year	0.044	0.033	-0.011
	(0.005)	(0.009)	(0.011)
End of the Year	0.046	0.040	-0.006
	(0.006)	(0.010)	(0.011)
Change	0.002	0.007	0.005
	(0.006)	(0.011)	(0.013)
BMI Z-Score			
Beginning of the Year	0.562	0.568	0.005
	(0.033)	(0.054)	(0.067)
End of the Year	0.555	0.470	-0.084
	(0.033)	(0.053)	(0.066)
Change	-0.008	-0.097**	-0.089*
	(0.021)	(0.043)	(0.045)
Sample Size	1409	424	1833

Notes: Standard errors in parentheses.
Source: See Table 1.
* Statistically significant at 10 percent.
** Statistically significant at 5 percent.
*** Statistically significant at 1 percent.

Table 3: Estimates of the Impact of Full Day Head Start on Weight Status

	Obese	Overweight	Underweight	BMI Z-Score	N
Unadjusted Differences	-0.038**	-0.037	0.005	-0.089*	1833
	(0.017)	(0.023)	(0.013)	(0.045)	
Regression Estimates					
Baseline Estimates	-0.033**	-0.039*	0.004	-0.089*	1833
	(0.016)	(0.022)	(0.012)	(0.048)	
Selected Sample	-0.036*	-0.048*	0.014	-0.104*	765
	(0.019)	(0.029)	(0.013)	(0.061)	
Matching Estimates					
Baseline Estimates	-0.057***	0.010	-0.011	-0.023	1833
	(0.016)	(0.026)	(0.012)	(0.059)	
Selected Sample	-0.046**	-0.038	0.007	-0.121	765
	(0.021)	(0.032)	(0.015)	(0.075)	

Notes: The unadjusted differences are the mean differences in weight status throughout the year by program type shown in Table 2. The regression coefficients for obese, overweight, and underweight are average partial effects from a probit model. Heteroskedasticity-robust standard errors are in parentheses for regression and matching estimates. Additional control variables used in the regression estimates are weight status at the beginning of the year, the binary measures of race/ethnicity (Hispanic, non-Hispanic black, non-Hispanic black and white, other; non-Hispanic white omitted), sex, whether the child has a disability, whether there is only one parent in the family, whether the primary adult in the family graduated from high school, the primary adult's employment status (full-time; part-time; seasonal, retired, in school, or disabled; otherwise not in the labor force or unemployed is omitted), and whether the family receives TANF, and the continuous measures of age in months at the end of the year measurement, the log of family income, and family size. Matching estimates are population average treatment effects from bias-adjusted nearest neighbor with replacement matching. The selected sample is the sample of children not in need of full-day services with a primary adult caregiver who is employed full-time and in the common support of the propensity score distributions with a propensity score in the range of [0.1, 0.9].
Source: See Table 1.
* Statistically significant at 10 percent.
** Statistically significant at 5 percent.
*** Statistically significant at 1 percent.

Table 4: Estimates of the Impact of Full Day Head Start on Weight Status

	Obese	Overweight	Underweight	BMI Z-Score
Year 2002 Deviation from Linear Trend				
Without Covariates	-0.039**	-0.025	0.011	-0.078
	(0.020)	(0.030)	(0.019)	(0.061)
With Covariates	-0.044**	-0.040	0.010	-0.076
	(0.019)	(0.030)	(0.018)	(0.063)
Sample Size	1918			

Notes: Heteroskedasticity-robust standard errors are in parentheses. The coefficients for obese, overweight, and underweight are average partial effects from a probit model. All estimates control for weight status at the beginning of the year. Covariates include the binary measures of race/ethnicity (Hispanic, non-Hispanic black, non-Hispanic black and white, other; non-Hispanic white omitted), sex, whether the child has a disability, whether there is only one parent in the family, whether the primary adult in the family graduated from high school, the primary adult's employment status (full-time; part-time; seasonal, retired, in school, or disabled; otherwise not in the labor force or unemployed is omitted), and whether the family receives TANF, and the continuous measures of age in months at the end of the year measurement, the log of family income, and family size.

Source: See Table 1.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent.

*** Statistically significant at 1 percent.

Table 5: Alternative Specifications of the Impact of Full Day Head Start on Obesity

	Obese at the End of the Year				Change in Obesity	
	(A)	(B)	(C)	(D)	(E)	(F)
Year = 2002	-0.041**	-0.044***	-0.054***		-0.060**	-0.060**
	(0.017)	(0.017)	(0.018)		(0.028)	(0.025)
Year = 2003	omitted	omitted	omitted			omitted
Year = 2004	-0.024	-0.023		-0.008		-0.022
	(0.019)	(0.019)		(0.021)		(0.024)
Year = 2005	-0.018	-0.019		omitted		-0.024
	(0.017)	(0.017)				(0.022)
Year = 2006	-0.014	-0.018				-0.019
	(0.017)	(0.017)				(0.023)
Year					-0.006	
					(0.007)	
Includes Covariates		X	X	X	X	X
Sample Size	1918	1918	709	751	1918	1918

Notes: Specifications (1)-(4) include obesity at the end of the year as the dependent variable and include obesity at the beginning of the year as a covariate. Specifications (5) and (6) include the change in obesity status as the dependent variable. Heteroskedasticity-robust standard errors are in parentheses. The coefficients in specifications (1)-(4) are average partial effects from a probit model. Specifications (5) and (6) are estimated using OLS. Covariates include the binary measures of race/ethnicity (Hispanic, non-Hispanic black, non-Hispanic black and white, other; non-Hispanic white omitted), sex, whether the child has a disability, whether there is only one parent in the family, whether the primary adult in the family graduated from high school, the primary adult's employment status (full-time; part-time; seasonal, retired, in school, or disabled; otherwise not in the labor force or unemployed is omitted), and whether the family receives TANF, and the continuous measures of age in months at the end of the year measurement, the log of family income, and family size.

Source: See Table 1.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent.

*** Statistically significant at 1 percent.

Table 6: Estimates of the Impact of Full Day Head Start on Weight Status Including Families Need for Social Services as Additional Covariates

	Obese	Overweight	Underweight	BMI Z-Score
Regression Estimates				
Without Need Variables	-0.036*	-0.048*	0.014	-0.104*
	(0.019)	(0.029)	(0.013)	(0.061)
With Need Variables	-0.050***	-0.050*	0.014	-0.089
	(0.017)	(0.029)	(0.014)	(0.062)
Matching Estimates				
Without Need Variables	-0.046**	-0.038	0.007	-0.121
	(0.021)	(0.032)	(0.015)	(0.075)
With Need Variables	-0.077***	-0.043	0.004	-0.121
	(0.020)	(0.034)	(0.017)	(0.079)
Cohort Estimates				
Without Need Variables	-0.044**	-0.040	0.010	-0.076
	(0.019)	(0.030)	(0.018)	(0.063)
With Need Variables	-0.047**	-0.042	0.004	-0.056
	(0.020)	(0.030)	(0.017)	(0.064)

Notes: The regression and matching estimates without the need for social services variables are the estimates for the selected sample shown in Table 3. The cohort estimates without the need for social services variables are the estimates with covariates shown in Table 4. The regression coefficients for obese, overweight, and underweight are average partial effects from a probit model. Heteroskedasticity-robust standard errors are in parentheses. The variables that reflect family needs for additional assistance are binary variables for whether job training, literacy, mental health, transportation, clothing, emergency, food, and housing services and crisis assistance are needed for the family. Additional control variables used in the regression estimates are weight status at the beginning of the year, the binary measures of race/ethnicity (Hispanic, non-Hispanic black, non-Hispanic black and white, other; non-Hispanic white omitted), sex, whether the child has a disability, whether there is only one parent in the family, whether the primary adult in the family graduated from high school, the primary adult's employment status (full-time; part-time; seasonal, retired, in school, or disabled; otherwise not in the labor force or unemployed is omitted), and whether the family receives TANF, and the continuous measures of age in months at the end of the year measurement, the log of family income, and family size. Matching estimates are population average treatment effects from bias-adjusted nearest neighbor with replacement matching. The selected sample is the sample of children not in need of full-day services with a primary adult caregiver who is employed full-time and in the common support of the propensity score distributions with a propensity score in the range of [0.1, 0.9]. The sample size for the regression and matching estimates is 765. The sample size for the cohort estimates is 1918.

Source: See Table 1.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent.

*** Statistically significant at 1 percent.

Table 7: Comparisons of Caloric Intake Throughout the Day of Head Start Participants on a Weekday and Weekend and Other Low-Income Children on a Weekday

	Head Start, Weekday	Head Start, Weekend	Not in Head Start, Weekday
Calories during the Day (8am - 5pm)	929	1314	1248
	(62)	(121)	(85)
Calories during the Morning (8am - 12pm)	435	552	621
	(57)	(67)	(54)
Calories during the Afternoon (12pm - 5pm)	494	762	627
	(45)	(93)	(50)
Calories during the Evening/Night 5pm - 12am)	614	679	653
	(70)	(91)	(48)
Total Calories	1635	2010	1945
	(101)	(159)	(105)
Sample Size	20	16	84

Notes: Standard errors in parentheses. Estimates are for children 36 through 71 months old in families below the poverty line and are weighted by the Day 1 survey weights in the What We Eat in America file. The NHANES data do not identify whether Head Start participation was full-day or half-day.
Sources: NHANES 2003-4, What We Eat In America 2003-4.

Table 8: The Percent of Obese Children in Subsequent Grades Based on the Type of Head Start Program Attended

	Full-Day	Half-Day	Full-Day – Half-Day
Kindergarten	0.122	0.168	-0.046
	(0.014)	(0.015)	(0.020)
	[588]	[600]	[1188]
First Grade	0.146	0.193	-0.047
	(0.015)	(0.017)	(0.023)
	[541]	[538]	[1079]
Third Grade	0.219	0.245	-0.026
	(0.020)	(0.020)	(0.028)
	[447]	[453]	[900]
Fifth Grade	0.296	0.316	-0.020
	(0.023)	(0.024)	(0.034)
	[385]	[370]	[755]

Notes: Standard errors in parentheses. Sample sizes in brackets. Estimates are based on the spring measure for each grade.
Sources: Early Childhood Longitudinal Study, Kindergarten Class of 1998-99

Appendix: Caloric Intake Simulation

Following Cutler, Glaeser, and Shapiro (2003) and Schanzenbach (2005), we simulate the potential impact of a change in caloric intake on the rate of obesity using the equation:

$$K = a + (B + E)*Weight + .1K,$$

where K is caloric intake in kilocalories, a and B are estimates that determine the Basal Metabolic Rate (BMR), and E is energy expenditure from physical activity. This equation equates calories consumed with calories expended in the steady-state. Energy is used to keep the body alive (BMR = a + B*Weight), in physical activity (E*Weight), and to consume calories (the thermic effect of food is .1K). As a result of a lack of information of the physical activities of Head Start children and the energy expenditure from physical activity for children at these ages, following Schanzenbach (2005), we assume that energy expenditure from physical activity is independent of weight.

The change in weight from a change in caloric intake, holding physical activity constant is:

$$\Delta Weight = .9*\Delta K / B.$$

The values of B are based on Schofield's (1985) estimates of BMR in megajoules per 24 hours, which vary according to age and gender. For children age 3 to 10 years, B is 0.095 for boys and 0.085 for girls. These constants are then multiplied by 238.8915 to convert the units to kilocalories.

To generate the simulations in this paper, the additional weight is added to the individuals in the sample based on their gender and age at the end of the year. Using the new weight, body mass index is calculated and then whether the individual is underweight, overweight, or obese and the BMI z-score is determined. The estimated four percentage point change in obesity of full-day Head Start compared to half-day Head Start implies that the counterfactual estimate of the proportion of full-day Head Start children who would be obese at the end of the year is the sample mean of 12 percent plus 4 percent (or 16 percent). An increase of 15 calories per day is predicted to increase the proportion obese to 15.6 percent and an increase of 20 calories per day is predicted to increase the proportion obese to 17.5 percent. The estimated 14 percentage point change in obesity corresponds to a counterfactual of 26 percent of obese full-day children at the end of the year. An increase of 45 calories per day is predicted to increase the proportion obese to 25 percent. An increase of 50 calories per day is predicted to increase the proportion obese to 27 percent.