Expanding Exposure

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

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ABSTRACT

Coinciding with the work requirements of welfare reform in the mid-1990s, the early childhood education program, Head Start, significantly expanded to increase the availability of full-day classes. Using unique administrative data, we examine the effect of full-day compared to half-day attendance on childhood obesity. This effect is identified from changes in obesity over time and from the elimination of a state-provided full-day expansion grant that decreased the supply of full-day classes. Our results suggest that full-day Head Start attendance significantly reduces the proportion of obese children at the end of the academic year.

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I. Introduction

The Head Start program, which began as a half-day program in the War on Poverty in 1965, has been one of the largest federal investments in the human capital of poor children. Coinciding with the work requirements of welfare reform in the mid-1990s, the structure of the program changed to substantially increase the availability of full-day classes. Little is known about the effect of this significant change in the design of the program on child outcomes. In particular, does attending full-day instead of half-day Head Start classes further improve child outcomes or are the benefits of Head Start delivered in a half-day class? These questions are important not only for understanding more about the impact of this major programmatic change and the optimal design of the program, but also for understanding more about the impact of the program. For example, following a dose-response argument, if full-day Head Start attendance improves child outcomes relative to half-day attendance, then it is likely that any Head Start attendance would also be beneficial.

This research examines the impact of full-day Head Start attendance, compared to half-day attendance, on childhood obesity. Childhood obesity is a significant public health concern that is associated with a variety of health consequences.[1] The prevalence of childhood obesity has risen dramatically over the past 30 years, more than doubling for children ages two through five years from 5 percent in the 1970s (Ogden et al. 2002) to 12.4 percent in 2003–2006 (Ogden et al. 2008). Childhood obesity is associated with various comorbidities including hypertension and other cardiovascular disease risk factors, type two diabetes, and obstructive sleep apnea (Ebbeling, Pawlak, and Ludwig 2002). Additionally, longitudinal studies demonstrate that childhood obesity predicts 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 exceed $100 billion (Office of the Surgeon General 2001).

The comprehensive services, including the nutrition, 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 food preferences (Birch 1999). Previous research suggests that participation in Head Start reduces the likelihood of being obese (Frisvold 2007; Carneiro and Ginja 2008) but has not examined the impact of participating in a full-day class, which has become more common in recent years. Full-day Head Start participation offers greater opportunities to exercise and consume nutritious food, which, combined with the additional structured time in full-day classes, may limit children's intake of low-nutrition foods and periods of inactivity. This paper complements the previous research and provides further evidence, using an alternative identification strategy with administrative data that includes repeated

1. A potential externality related to childhood obesity is that parents may underinvest in their child relative to the child's desired amount. Incomplete information related to nutrition and obesity may exist among parents and incomplete markets prevent children from changing these investments.

measures of height and weight, on the impact of Head Start participation on obesity, since if any participation reduces childhood obesity then it is likely that more intensive participation further reduces obesity.[2]

Using unique, administrative data from a Michigan Head Start program spanning 2002 to 2006, we examine information about approximately 1,800 participants, their families, and Head Start centers. These data include height and weight measured, as opposed to parent-reported, at the beginning and end of the program year, pre-Head Start family background information from the Head Start application, and program characteristics. To our knowledge, these data represent the only available source of multiple measures of height and weight throughout the year for Head Start children.

We compare the change in weight status and body mass index (BMI) of children enrolled in full-day classes to those enrolled in half-day classes. 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. Unadjusted and regression-adjusted difference-in-differences estimates suggest that full-day participation reduces the prevalence of obesity at the end of the academic year by approximately four percentage points. This result is further supported by additional estimates using the elimination of a state-provided full-day expansion grant to identify the impact of changes to the supply of full-day program slots on childhood obesity.

II. Conceptual Framework and Background on Head Start

The conceptual framework for this research is based on the model of preschool enrollment in Behrman, Cheng, and Todd (2004). Simplifying and adapting their model, households are assumed to maximize utility that depends on consumption, leisure, and child quality subject to a child-quality production function and standard resource constraints. Child quality is determined by parents' time inputs, Head Start attendance and the program option (full-day vs. half-day) attended conditional on eligibility and admittance, and other purchased goods and services. Within this framework, weight, which is determined by nutrition and physical activity, is considered to be one aspect of the multidimensional array of child quality.

2. Both Frisvold (2007) and Carneiro and Ginja (2008) find that Head Start participation leads to a large reduction in adolescent obesity. Frisvold (2007) determines that a small degree of selection on unobservables leads to a reduction in adolescent obesity due to Head Start participation, but the point estimates are based on the assumption that the number of openings per eligible child in a county is a valid instrument for Head Start participation. Carneiro and Ginja (2008) use the income-eligibility thresholds to examine the impact on adolescent obesity for males through a fuzzy regression discontinuity design. Their estimates are based on the assumption that households are not able to strategically influence their income and the estimates are local to the eligibility thresholds; however, federal guidelines emphasize that the most disadvantaged children (and thus, poorest) should be selected for admission. Our paper builds upon these previous studies using a dose-response framework that does not focus on the decision to participate in Head Start, but instead compares full-day to half-day participation, which is likely to be less influenced by selection on unobservables.

An implication of this framework is that parents' may alter the amount of time and the amount of purchased goods and services that influence child quality, such as other forms of childcare, in response to their child attending half-day or full-day Head Start. For example, in response to a child not being admitted to a full-day class and instead attending a half-day class, parents may reduce their hours of paid work to invest their own time in providing additional childcare or may purchase other forms of childcare. The reduced wages or additional costs of these childcare options, even if partially subsidized, could reduce the amount of the household budget available for food or other consumption. Additionally, parents of children in full-day classes may alter the amount of food provided at home because of the meals provided in Head Start (Behrman, Cheng, and Todd 2004).

The important point to note is that it is not clear, a priori, that a longer daily duration of time spent in Head Start would lead to positive effects on child outcomes. The estimated impact of full-day Head Start attendance is the net result of the direct effect of the program and the augmenting or diminishing indirect effect of changes in parents' behavior. To better understand why full-day Head Start attendance might influence obesity, in the following subsections, we provide an overview of the Head Start program, the physical activity and nutrition components that might lead to a direct effect of full-day attendance, and the childcare alternatives.

A. Overview of the Head Start Program

Head Start is a national program designed to augment the human and health capital of disadvantaged children to better prepare them for subsequent educational experiences. More than 25 million preschool children have participated in the program since its inception in 1965 (Office of Head Start 2007b). A child is eligible for Head Start if the child is at least three years old and the family's gross annual income is less than or equal to the poverty guideline, the family receives public assistance, the child is in foster care, or the child is disabled (Office of Head Start 2007a). 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. Due to space constraints, federal guidelines require that children with the greatest need for Head Start services—the most disadvantaged—are selected among the eligible children by the program administrators using a formal selection mechanism (Office of Head Start 2007a).

Head Start participation is generally associated with improvements in child well-being. For example, participation in Head Start accelerates cognitive development (U.S. Department of Health and Human Services 2005) and educational attainment (Garces, Thomas, and Currie 2002; Ludwig and Miller 2007; Deming 2009). It is associated with a reduction in behavioral problems (U.S. Department of Health and Human Services 2005) and adult criminal activity (Garces, Thomas, and Currie 2002). Head Start participation also increases the likelihood of receiving a health screening (Hale, Seitz, and Zigler 1990), dental examination (U.S. Department of Health and Human Services 2005), and immunizations (Currie and Thomas 1995), and decreases the likelihood of smoking as an adult (Anderson, Foster, and Frisvold 2010), being obese in later childhood (Frisvold 2007; Carneiro and Ginja 2008), and being in poor health (Deming 2009). Head Start also significantly reduced childhood mortality rates (Ludwig and Miller 2007).

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 not examined the optimal structure nor identified the useful components in the "black box" of the program, with a few important exceptions.[3] For example, 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. In particular, to our knowledge, no research has compared the impact of full-day attendance to half-day attendance, even though a major change in the design of the program has been the transition from primarily providing half-day classes to providing both full-day and half-day classes.

As shown in Figure 1, significant increases in federal appropriations have expanded the Head Start program by increasing total enrollment since the late 1980s and by increasing the number of children who attend full-day classes since the early 1990s. Since 2001, total Head Start enrollment has remained constant, while full-day enrollment has increased. Increases in the availability of full-day, as opposed to half-day, classes may better serve the needs of low-income families following the work requirements of welfare reform in the mid-1990s.

The specific Head Start program that provides the data for this study operates two program options: full-day classes for eight hours per day for five days per week and half day class for 3.5 hours per day for four days per week. Thus, children in a full-day class attend Head Start for 26 more hours each week than children in a half-day class. According to the Head Start Program Information Report in 2006, these program options are the two most common throughout the United States. All classes use the same curriculum and the geographic location, growth assessments, nutrition screening, and opportunities for parental education about nutrition, health, or parenting do not differ based on the whether the child attends a full-day or half-day class.

To be eligible for full-day classes, parents must be working full-time (at least 35 hours per week), in training full-time, or in school prior to the beginning of Head Start; however, exceptions are made at the discretion of the program's administrators.[4] There are more children with full-time working parents than the number of slots in full-day classes. The same criteria used to determine Head Start attendance are used to determine which eligible children are selected for full-day classes, which

3. Related research includes the impact of full-day kindergarten on academic outcomes (Cannon, Jacknowitz, Painter 2006; DeCicca 2007). Other related research, which has focused mostly on cognitive skills and behavioral characteristics, finds that greater exposure to childcare improves outcomes, primarily for low-income children, but also has negative consequences, primarily for higher-income children (Behrman, Cheng, and Todd 2004; Baker, Gruber, Milligan 2008; Belsky et al. 2007). Higher quality childcare is associated with improvements in cognitive development and less aggressive behavior, particularly for low-income children (Love et al. 2003) and Head Start classrooms are of higher quality on average than other preschool programs and childcare centers (Currie 2001).

4. These criteria are consistent with those of other Head Start programs (Brush et al. 1995).

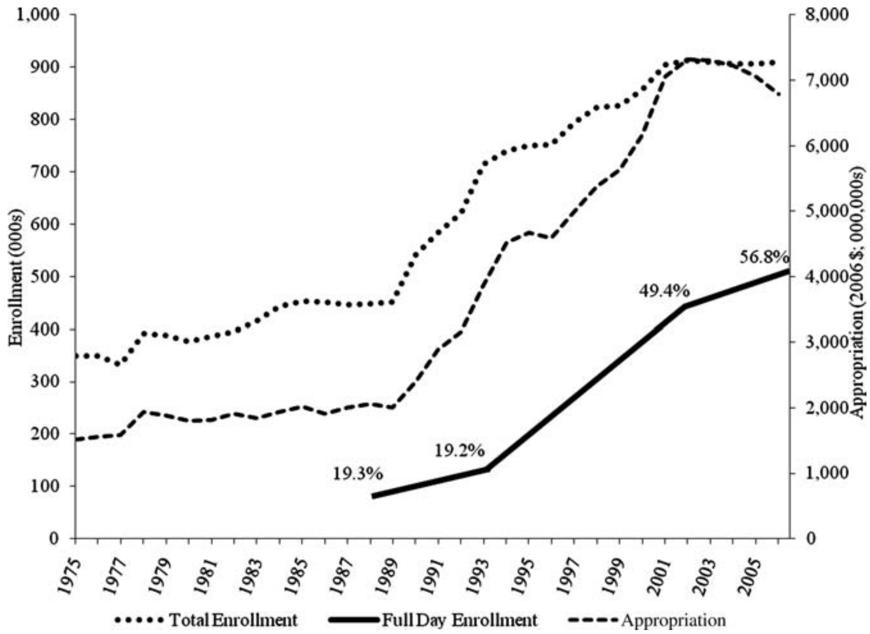


Figure 1
Head Start Funding and Enrollment Trends, 1975–2006

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.
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.

ensures that the most disadvantaged of the eligible children are selected. 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-proficiency homes, and who have moved two or more times in the past 12 months are more likely to be selected to attend full-day classes.

B. The Physical Activity and Nutrition Components of Head Start

The reasons that participation in a full-day Head Start class may lead to a greater impact on overweight and obesity than a half-day class are, primarily, more exercise and improved nutrition. 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 2007a). The actual practices and environment of most Head Start programs exceeds these federal regulations (Whitaker et al. 2009). In the specific program in this study, each center has an on-site playground. One of the primary differences in the schedule for full-day, compared to half-day, classes is the amount of time available for active play. Full-day classes allow for 30 additional minutes of exercise and 15 additional minutes of active activities such as dancing.

A second important difference in the two program options is amount of food provided. 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 at least one-third. The Head Start nutrition guidelines are consistent with the recommendations of the American Dietetic Association (Briley and Roberts-Gray 1999). Further, Fox et al. (1997) find that the actual nutrient intake of children is consistent with the Head Start Performance Standards and, more recently, Whitaker et al. (2009) find that the food provided in Head Start centers nationally is healthier than required by the federal guidelines. In the specific program in this study, the program's nutrition coordinator designs a menu that applies to the meals served in all classes throughout the program. In comparison to half-day classes, children in full-day classes receive an extra snack consisting of a serving of dairy and meat or a serving of vegetable and meat.

C. Head Start in Comparison to Other Childcare Arrangements

The measured effect of full-day Head Start participation depends on the alternative childcare arranged by parents of half-day classes, as described in the above conceptual framework, and whether the counterfactual arrangements would have lead to less exercise or a higher caloric intake. Worobey et al. (2005) provide suggestive evidence of the nutritional influence of Head Start attendance. In a 24-hour dietary recall study, the authors find that, although the diets of Head Start children were lower quality with higher calories after school, during the day, children who attend a full-day Head Start class consume similar levels of protein, carbohydrate, and fat and less calories than middle-income children. Thus, Head Start may improve the nutritional quality of participants' diets by providing nutritious meals and limiting participants' exposure to the poor nutrition offered at home. 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.

Previous research on the relationship between maternal employment and childhood obesity suggests that an increase in hours worked increases the incidence of childhood obesity; however, this relationship does not hold for low-income households (Anderson, Butcher, and Levine 2003). This finding supports the claim that early childhood education programs and childcare arrangements other than parental care may not increase children's weight. Additionally, as a result of the higher-quality, structured program, Head Start participation could be more beneficial than other preschool programs or childcare arrangements (Currie 2001). The two primary alternative childcare arrangements for full-time working parents of Head Start children are informal care by other relatives or subsidized childcare.[5]

5. Information about the childcare activities of half-day participants with full-time working parents for the program in this study is not available for children once they attend Head Start, but information prior to Head Start attendance reveals that the childcare activities for these children include being cared for by a relative or subsidized childcare. Another option for parents not working full-time or with nontraditional work schedules is parent-provided care.

The structured environment of the Head Start program, as opposed to informal care provided by relatives or parents, may limit the opportunities for excessive caloric intake by reducing the time available for snacking and watching television. Time spent watching television is associated with obesity in preschool-aged children (Lumeng et al. 2006), in part due to exposure to food advertisements (Lewis and Hill 1998) and a reduction in metabolic rate while watching television (Klesges, Shelton, and Klesges 1993). Additionally, food consumed outside of Head Start may be less nutritious due to the limited access to healthy food in poor neighborhoods (Morland, Wing, and Diez Roux 2002) or because parents and other caregivers are not as knowledgeable about nutrition as the trained specialists who prepare the meals in Head Start (Keane et al. 1996).

Formal childcare alternatives to Head Start also could provide a structured environment that limits excessive caloric intake due to state regulations of center-based and family home childcare providers. Similar to Head Start, Michigan requires that center-based care menus should be based on the Dietary Guidelines for Americans, but this regulation does not apply to group or family childcare homes and only one other state has a similar mandate (Kaphingst and Story 2009). Most states, including Michigan, also require that all licensed childcare facilities provide physical activity opportunities. However, Hecht et al. (2009) find that Head Start centers provide the highest-quality meals and most physical activity opportunities. Additionally, Herbst and Tekin (2009) suggest that childcare subsidies, which are targeted to low-income households, increase obesity. Thus, longer participation in Head Start could reduce obesity more than alternative forms of childcare.

III. Data

The data for this analysis are provided by a Head Start grantee in southern Michigan for the program years spanning 2001–2002 through 2005–2006. This administrative data set includes measured height and weight at the beginning and end of the program year. These data also include 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, typically in October, and at the end of the academic year, typically in March, by their teachers, using the same equipment for each measurement. 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 define 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 to correspond to the academic year spanning September to May.[6] Height and weight are used to calculate body mass index

6. Approximately two-thirds of the measurements occurred in October and a similar percentage occurred at the end of the year in March for both full-day and half-day children. There is no correlation between the amount of days between measurements and full-day attendance; including the number of days between measurements has no impact on the results below.

(BMI), which is correlated with body fat and is recommended by the National Heart, Lung, and Blood Institute (NHLBI) for use in clinical practice and epidemiological studies (NHLBI 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 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 based on the CDC guidelines. Obesity 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 for individuals greater than or equal to 24 months old and less than 20 years old. We define overweight as a BMI greater than or equal to the 85th percentile, thus our measure of overweight includes children who are overweight and obese. Underweight is defined as a BMI less than the 5th percentile. 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. Because these variables are standardized by age (in months) and gender, these outcome measures account for the natural growth that occurs among children during the preschool ages; thus, changes in obesity are not the result of the natural cycle of growth among young children.

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. There are 215 children in the sample who left the program prior to the end of the year. 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.[7] Additionally, 20 observations are excluded due to implausible measurements, which are likely the results of error in recording the measurements in the data set. Overall, the conclusions are not affected by excluding these measurements. Implausible measurements are a BMI *z*-score less than -4 (BMI measurements four standard deviations below the age- and sex-specific mean), a height *z*-score above four, a change in BMI during the academic year of greater than or less than five units, and a decrease in height of at least two inches. These sample restrictions result in a sample of 1833 observations from 1532 children, since some children enrolled in Head Start for multiple years.[8] 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.

Table 1 displays the individual and family background characteristics of full-day and half-day children. As would be expected because of the full-day selection cri-

7. The possibility that children initially assigned to a half-day class switch to a full-day when children in a full-day class leave the Head Start program could lead to an overestimate of the impact of full-day attendance; however, the upward bias is likely to be small due to the small number of children who could possibly switch classes and the amount of time that these children spend in a full-day class is less than the full academic year.

8. The results throughout the paper are not sensitive to including the number of years participating in the program as an additional explanatory variable; however, this variable may not be exogenous. Restricting the sample to children in their first year of the program slightly increases (in absolute value) the estimate for obesity. The sample size of children in their second year is too small to precisely estimate the impact of full-day attendance.

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

	Michigan				National	
	All	Full Day	Half Day	p-value	FACES	ECLS-B
Obese: beginning of the year	0.173	0.172	0.174	0.943	0.157	0.191
	(0.379)	(0.378)	(0.379)	[0.799]		(0.394)
Obese: end of the year	0.151	0.120	0.160	0.041	—	—
	(0.358)	(0.326)	(0.366)	[0.058]		
Overweight: beginning of the year	0.337	0.344	0.334	0.761	0.324	0.378
	(0.473)	(0.476)	(0.472)	[0.752]		(0.485)
Overweight: end of the year	0.320	0.300	0.326	0.371	—	—
	(0.467)	(0.459)	(0.469)	[0.298]		
Underweight: beginning of the year	0.041	0.033	0.044	0.361	0.030	0.030
	(0.199)	(0.179)	(0.205)	[0.667]		(0.170)
Underweight: end of the year	0.045	0.040	0.046	0.655	—	—
	(0.207)	(0.196)	(0.210)	[0.832]		
BMI Z-score: beginning of the year	0.564	0.568	0.562	0.954	—	0.733
	(1.211)	(1.115)	(1.239)	[0.964]		(1.198)
BMI Z-score: end of the year	0.535	0.470	0.555	0.435	—	—
	(1.197)	(1.097)	(1.225)	[0.364]		
Age (months)	52.297	52.226	52.319	0.925	—	53.263
	(6.932)	(6.941)	(6.931)	[0.904]		(4.070)
Hispanic	0.066	0.069	0.065	0.793	0.349	0.260
	(0.245)	(0.253)	(0.243)	[0.435]		(0.439)
Black	0.266	0.341	0.244	0.119	0.327	0.322
	(0.439)	(0.471)	(0.427)	[0.220]		(0.467)
Black & white	0.083	0.113	0.075	0.080	0.052	0.068
	(0.274)	(0.314)	(0.260)	[0.064]		(0.252)

Other race	0.013	0.012	0.013	0.835	0.038	0.120
	(0.111)	(0.108)	(0.112)	[0.637]		(0.326)
White	0.572	0.465	0.604	0.087	0.235	0.230
	(0.491)	(0.495)	(0.485)	[0.108]		(0.421)
Female	0.487	0.519	0.478	0.127	0.483	0.482
	(0.500)	(0.500)	(0.500)	[0.290]		(0.500)
Disabled	0.229	0.203	0.237	0.292	0.109	0.311
	(0.420)	(0.403)	(0.425)	[0.345]		(0.463)
Family income (000s)	15.392	17.671	14.706	0.001	—	20.475
	(10.891)	(12.566)	(10.241)	[0.179]		(18.256)
Family size	3.977	3.849	4.016	0.119	4.65	4.771
	(1.437)	(1.369)	(1.455)	[0.297]		(1.630)
Single parent family	0.570	0.634	0.550	0.067	0.472	0.422
	(0.495)	(0.482)	(0.498)	[0.330]		(0.494)
Primary adult graduated high school	0.639	0.723	0.614	0.002	0.620	0.704
	(0.479)	(0.445)	(0.486)	[0.102]		(0.457)
Primary adult is employed full-time	0.473	0.768	0.384	0.000	0.315	0.352
	(0.499)	(0.422)	(0.486)	[—]		(0.478)
Primary adult is employed part-time	0.151	0.121	0.161	0.090	0.201	0.156
	(0.358)	(0.326)	(0.367)	[—]		(0.363)
Primary adult is in school, disabled, employed seasonally,	0.074	0.061	0.077	0.171	—	—
	(0.261)	(0.240)	(0.267)	[—]		
TANF	0.395	0.401	0.393	0.866	0.226	0.283
	(0.489)	(0.491)	(0.488)	[0.951]		(0.451)
Sample size	1,833	424	1,409		3,315	1,100

Sources: Administrative data provided by a Head Start grantee in Michigan spanning 2002 through 2006 (Columns 1 through 5). West et al. (2008) is the source for FACES data.

Notes: Standard deviations in parentheses. The p-value is calculated from a null hypothesis that the mean for full-day children equals the mean for half-day children, where the standard errors are adjusted to allow for clustering within classrooms. The p-value in brackets is calculated from a null hypothesis that the mean for full-day children equals the mean for half-day children after adjusting for 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), where the standard errors are adjusted to allow for clustering within classrooms. Statistics from FACES data are weighted to represent all children entering Head Start for the first time in Fall 2006. Statistics from ECLS-B are calculated from the four year old wave in 2005–2006 and are not weighted. The sample size for ECLS-B is rounded to the nearest 50.

teria, 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 and family income is also higher for full-day children. The *p*-values in brackets in the table demonstrate that, after conditioning on the employment status of the primary adult caregivers, the differences in the observable characteristics of children in full-day and half-day class are not statistically significant. However, differences in many of the characteristics that determine whether administrators select children for full-day classes from the eligible group of children are unknown.

Table 1 also includes summary statistics from alternative samples to address whether this sample is representative of Head Start children nationally. West et al. (2008) provides means from the Head Start Family and Child Experiences Survey (FACES) data collection in Fall 2006, which are shown in the fifth column. Means and standard deviations from the four-year-old wave of the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B), which occurred primarily in Fall 2005, are shown in the last column. Both surveys include measured height and weight, but these measurements occur only once during the academic year, which further highlights the uniqueness of the data in this analysis. The weight status of children in this Michigan sample is similar to the alternative samples, but Hispanic children are underrepresented and white children are overrepresented in this analysis. The estimates in Tables 2 and 3 below and the high prevalence of obesity among Hispanic children nationally, relative to white children, suggests that the overall impact of full-day Head Start participation may be underestimated as a result of these demographic differences.

IV. Empirical Strategy and Results

Our objective in this paper is to determine the marginal impact of participating in a full-day Head Start class compared to a half-day class. We utilize a sample that contains information only on children who enrolled in Head Start and we compare children who participated in a full-day class to those who participated in a half-day class. 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 (Behrman, Cheng, and Todd 2004).

To determine the impact of full-day, compared to half-day, Head Start participation on childhood obesity, 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 academic year. Then, we control for selection on observable characteristics into full-day and half-day classes using a value-added regression model. 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 classes.

A. Comparisons of Means

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 1 for children

Table 2
Estimates of the Impact of Full Day Head Start on Weight Status

	All Children			Males	Females	White	Black	Single Parent Households	Two Parent Households
Obese	−0.038	−0.039	−0.042	−0.092	−0.001	−0.010	−0.060	−0.037	−0.029
	(0.021)	(0.018)	(0.024)	(0.026)	(0.027)	(0.024)	(0.037)	(0.023)	(0.025)
Overweight	−0.037	−0.042	−0.043	−0.048	−0.035	−0.017	−0.047	−0.051	−0.041
	(0.026)	(0.026)	(0.037)	(0.044)	(0.029)	(0.037)	(0.039)	(0.028)	(0.043)
Underweight	0.005	0.001	−0.001	0.008	−0.003	−0.015	0.024	0.010	−0.012
	(0.013)	(0.013)	(0.015)	(0.016)	(0.019)	(0.018)	(0.023)	(0.012)	(0.019)
BMI Z-Score	−0.089	−0.089	−0.114	−0.210	0.003	0.037	−0.180	−0.092	−0.103
	(0.064)	(0.075)	(0.124)	(0.088)	(0.080)	(0.087)	(0.115)	(0.072)	(0.120)
Covariates:									
Individual & family characteristics		X	X	X	X	X	X	X	X
Beginning of the year weight status		X		X	X	X	X	X	X
Sample size	1,833	1,833	1,833	940	893	1,022	481	1,044	789

Source: Administrative data provided by a Head Start grantee in Michigan spanning 2002 through 2006.
Notes: Heteroskedasticity-robust standard errors that allow for clustering within classrooms are in parentheses. Estimates are based on separate regressions and are the coefficient estimates for full-day Head Start participation. The dependent variables are the outcomes listed in the leftmost column. Individual and family characteristics used as covariates are year dummies, 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.

Table 3
The Impact of Full-Day Head Start Attendance on BMI Z-Score Based on Weight Status at the Beginning of the Year

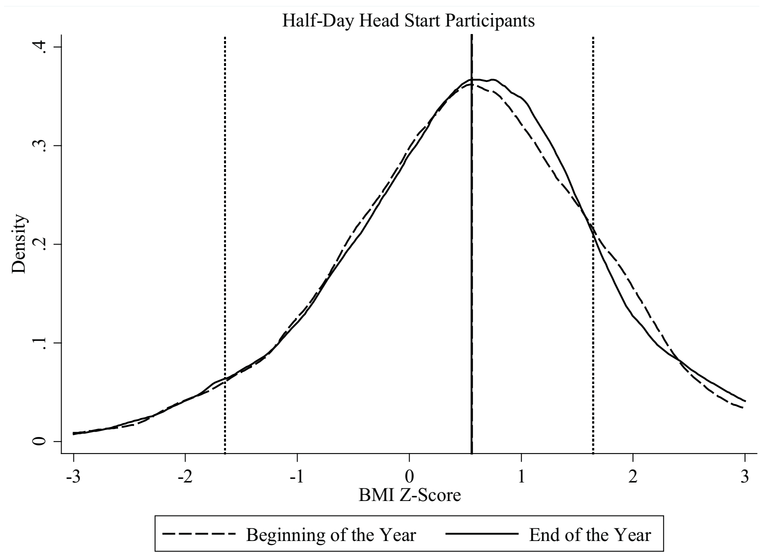
	Obese	Overweight and Not Obese	Normal Weight	Underweight
Full-day attendance	−0.231	−0.344	0.019	0.005
	(0.113)	(0.158)	(0.079)	(0.390)
Sample size	318	299	1,140	76

Source: See Table 2.
Notes: Heteroskedasticity-robust standard errors that allow for clustering within classrooms are in parentheses. Estimates are based on separate regressions and are the coefficient estimates for full-day Head Start participation. The dependent variable for each regression is BMI Z-score at the end of the year. The sample is restricted based on the beginning of the year weight status. Control variables used, but not reported, in all regression estimates are year dummies, 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.

who attend full-day classes and those who attend half-day classes. At the beginning of Head Start, about 17 percent of full-day and half-day children are obese. By the end of the academic year, only 12 percent of full-day children are obese and 16 percent of half-day children are obese. Overall, the prevalence of obesity decreases 2.3 percentage points by the end of the year, but the decrease for full-day children is 3.8 percentage points greater than for half-day children. The difference in the change in the prevalence of obesity for full-day compared to half-day children is also highlighted in Column 1 of Table 2.

The decrease in the prevalence of obesity for all children in the Head Start program contrasts with the increase in the prevalence of obesity among preschool-aged children nationwide (Ogden et al. 2002, 2008; Nader et al. 2006). In combination, these trends are consistent with the results of Frisvold (2007) and Carneiro and Ginja (2008) that Head Start participation reduces the likelihood of being obese.

The decrease in the proportion of overweight children in full-day Head Start classes is 3.7 percentage points greater than the decrease for half-day children; 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 0.09 standard deviations 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, which are shown in Figure 2. Importantly, these distributions highlight that the decrease in obesity for full-day



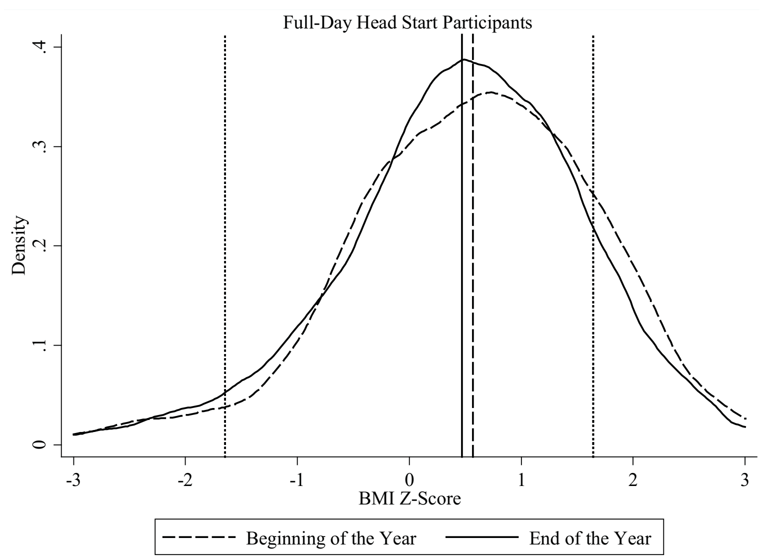


Figure 2

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

Source: Administrative data provided by a Head Start grantee in Michigan from 2002 through 2006.
Notes: These figures are kernel density estimates of the BMI z-score using the Epanechnikov kernel. 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.

participants is not due to a decrease in BMI just above the obesity threshold. Instead the density of the BMI *z*-score distribution is lower at the end of the year compared to the beginning of the year for full-day participants throughout the entire right tail of the distribution above the obese threshold.

B. Value-Added Regression Estimates

The comparisons in means in Table 1 suggest that full-day Head Start attendance decreases obesity compared to half-day attendance. However, these simple comparisons do not account for the differences in individual and family characteristics that may be related to childhood obesity. Using a difference-in-differences specification that is equivalent to a value-added model and exploits the unique feature of the data that measured height and weight are available at both the beginning and the end of the Head Start year, the weight status (obese, overweight, underweight, BMI *z*-score) of child i (W_i) is specified as:

$$(1) \quad W_{i1} = \alpha + \delta FD_i + \gamma W_{i0} + \zeta X_{i0} + \sum_{j=2002; j \neq 2003}^{2006} \phi_j 1(year = j) + \upsilon_i,$$

where W_{i1} is the weight status of individual i at the end of the Head Start year; W_{i0} is the weight status of individual i at the beginning of the year; FD indicates full-day participation; X is a vector of individual and family characteristics that are determined prior to Head Start enrollment; $1(\cdot)$ is an indicator function so that $1(year = j)$ denotes dummy variables for each year; α, δ, γ, ζ, and ϕ are the parameters to be estimated; and ν is random error. δ is the coefficient of interest.[9]

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, the log of family income, and family size.[10,11] Equation 1 is estimated using ordinary least squares.

9. Estimates from Equation 1 are similar to estimates using an alternative difference-in-differences specification: $W_i = \beta_0 + \beta_1 FD_i + \beta_2 T_i + \beta_3 FD_i \times T_i + \beta_4 X_i + \varepsilon_i$, where T is an indicator variable equal to 1 at the end of the Head Start year and equal to 0 at the beginning of the year, ε is the error term, and β represents the parameters to be estimated. For obesity, the difference-in-differences estimate of the impact of full-day Head Start participation (β_3) is a 3.8 percentage point reduction in the likelihood of being obese. Although this specification and Equation 1 imply different assumptions (Imbens and Wooldridge 2009), the estimates of the impact of full-day Head Start participation for each weight status measure are nearly identical. The resemblances in the estimates are due to the similarities of the proportion obese, overweight, and underweight and the mean BMI z-score of full-day and half-day Head Start children at the beginning of the year.

10. 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 nonmissing data. Thirty-four missing observations were imputed for race, 130 for family income, one for TANF receipt, 16 for whether the primary

As suggested by Bertrand, Duflo, and Mullainathan (2004), heteroskedasticity-robust standard errors that allow for clustering within Head Start classrooms are calculated for all regressions.

Equation 1 is equivalent to a value-added model, which is a commonly used specification in the estimation of the influence of school resources and teacher characteristics on cognitive achievement (Clotfelter, Ladd, and Vigdor 2007). One assumption of this specification is that the beginning of the year weight status measure is a sufficient statistic for the influence of genetic endowments, unobserved parental investments, or other unobserved influences of weight (Todd and Wolpin 2003). Kane and Staiger (2008) find that value-added models controlling for prior student test scores, analogous to Equation 1, yield unbiased predictions of teachers' effect on test scores, when compared to experimental estimates.

Column 1 of Table 2 displays the estimates of δ from a modified version of Equation 1 that excludes the individual and family characteristics, beginning of the year weight status, and year dummies. These estimates are equivalent to unadjusted difference-in-differences estimates derived from the means in Table 1 with clustered standard errors. Column 2 of Table 2 displays the estimates of δ from Equation 1. Full-day Head Start participation reduces the likelihood of being obese at the end of the year by 3.9 percentage points. The similarity between the estimates in Columns 1 and 2 demonstrates that controlling for observable individual and family background characteristics has no impact on the estimates. Thus, the differences between children in full-day and half-day classes that are shown in Table 1 do not influence the estimate of the impact of full-day attendance.[12] Analogously to the results for obesity, the estimates for overweight, underweight, and BMI *z*-score are similar to the unadjusted difference-in-differences estimates in Column 1. These results suggest that full-day Head Start participation reduces the likelihood of being overweight and reduces children's normalized BMI, but the estimates are not precisely measured.

One potential source of bias in Equation 1 is that the beginning of the year weight status variable is endogenous due to the correlation of weight over time (Todd and Wolpin 2003). To assess the influence of controlling for the initial weight status on the estimated impact of full-day participation, Equation 1 is modified to eliminate W_{i0}:

$$(2) \quad W_{i1} = \pi + \theta FD_i + \varphi X_{i0} + \sum_{j=2002; j \neq 2003}^{2006} \xi_j 1(year = j) + \nu_i.$$

The results of the estimates of θ are displayed in Column 3 of Table 2. As would be expected since initial weight status did not influence whether a child participated

adult caregiver graduated high school, and four 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.

11. Information about whether the child's family receives WIC benefits is not available for almost all children in 2002. Imputing missing values and including WIC participation does not influence the results. These results are also not sensitive to the inclusion of age squared, a set of year of age binary variables, the number of children less than age six in the family instead of family size, or a dichotomous measure of whether the primary adult caregiver is the mother.

12. Restricting the sample to improve covariate balance between the full-day and half-day samples by excluding children who may not be eligible for full-day classes yields similar estimates of the impact of full-day Head Start attendance.

in a full-day class, the estimates of the impact of full-day participation in Column 3 are similar to the estimates in Column 2.

Columns 4 through 9 of Table 2 display the estimates based on Equation 1 for various demographic groups. These estimates show that the results in the previous columns are driven by males, compared to females, and blacks, compared to whites. Full-day Head Start participation reduces obesity by 9.2 percentage points for males and by six percentage points for black children, but has no impact for females or white children. The results based on children residing in single-parent and two-parent households are not precisely estimated, but are similar to the results for all children.

Table 3 displays the estimates of the impact on BMI *z*-score based on Equation 1 for children according to their beginning of the year weight status. The estimates show that full-day Head Start participation has an impact only for children who are overweight or obese at the beginning of the year, which is consistent with the changes in the distribution of BMI *z*-score for full-day participants shown in Figure 2. Full-day participation decreases the BMI *z*-score of obese children by 0.23 standard deviations and the BMI *z*-score of overweight children by 0.34 standard deviations.

Overall, the unadjusted difference-in-difference estimates and the regression estimates suggest that full-day participation decreases obesity by approximately four 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).[13] However, the estimates do not account for the selection on unobservable characteristics that may influence the estimate of the impact of full-day participation.

C. Changes in State Funding as a Source of Identification

An alternative strategy based on changes in state supplemental funding for full-day Head Start classes is implemented that relaxes the assumption of selection on observables. In 1999, the State of Michigan's School Aid budget for fiscal year 2000 established a full-day expansion grant program with $5 million for Head Start centers to expand half-day classes to full-day classes in the 2000–2001 academic year. In 2000, as the result of a surplus in the state's budget, funding for full-day expansion grants increased to $20 million in 2001 and was projected to increase to $25 million in 2002 and $30 million in 2003.[14] In early 2001, the Governor's proposed budget for the 2002 and 2003 fiscal years maintained the increases in funding for full-day expansion grants. However, due to the recession that began in March 2001 and the resulting decrease in tax revenues, immediate reductions to the School Aid budget were considered in October 2001 (Keller 2001a, 2001b). Budget Stabilization Funds, or rainy day funds, were used to prevent budget cuts to the 2001 School Aid budget

13. 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 not height.

14. Information about the funding changes in the School Aid budget is available from the Executive Budget of the State of Michigan for various years at: http://www.michigan.gov/budget/0,1607,7-157-11460_18526---,00.html.

and kept intact the $20 million for full-day expansion grants. However, for the 2002 School Aid budget, new earmarked programs that were not part of the basic foundation aid were cut, including the funds set aside for full-day expansion grants.

The Head Start grantee in this study received $1.6 million during fiscal year 2001 to increase the availability of full-day Head Start classes during the 2002 academic year. The following year, this state-funded full-day expansion grant was eliminated. Four features of the withdrawal of this grant make it useful for identifying the impact of full-day Head Start participation. First, the elimination of this grant was unanticipated by this grantee, in the sense that removing the state-funded full-day classes did not immediately influence the schedule of the federally-funded other classes. The full-day expansion grant began in the 2002 academic year and had been provided to the Head Start grantee for what was expected to be at least three years. After the expansion grant was eliminated, only four full-day classes were provided during the 2003 academic year (down from 16 full-day classes the year before). It was not until 2004 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.

Figure 3 displays the percent of funded enrollment slots designated full-day classes each year from 2002 to 2006. In 2002, 40 percent of children attended full-day classes, while only 11 percent of children attended full-day classes in 2003. From 2004 through 2006, 22, 22, and 17 percent of children attended full-day classes, respectively.

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 funding. Third, similar funding or participation changes did not occur in related state programs for low-income children. As shown in Table 4, changes in economic conditions and social programs throughout Michigan do not exhibit a similar pattern and magnitude as the changes in the percent of Head Start children who attended a full-day class.[15] The budget cut to education funding did not reduce funding for Michigan's subsidized childcare program, which is administered through the state's Department of Human Services. Additionally, there was little change in the participation of children in the Special Supplemental Nutrition Program for Women, Infant, and Children (WIC) between 2002 and 2003. Further, Michigan does not provide supplementary funding for Head Start, except for the full-day expansion grant. Fourth, although funding for the full-day expansion grant was cut following a recession, the economic conditions of children were not related to the trend in full-day Head Start attendance.

Figure 3 also displays the change in the proportion of obese children within each year from 2002 to 2006. The trend of the change in the proportion of obese children closely follows the trend of the percent of full-day children, which provides further evidence that full-day Head Start participation influences childhood obesity. In 2002, when the full-day expansion grant enabled 40 percent of children to attend a full-day class, there was a 5.5 percentage point decrease in the prevalence of obesity

15. Additionally, as shown in Castner and Schirm (2006), Food Stamp participation rates among all eligible people and among the working poor changed by no more than three percentage points from 2002 to 2003.

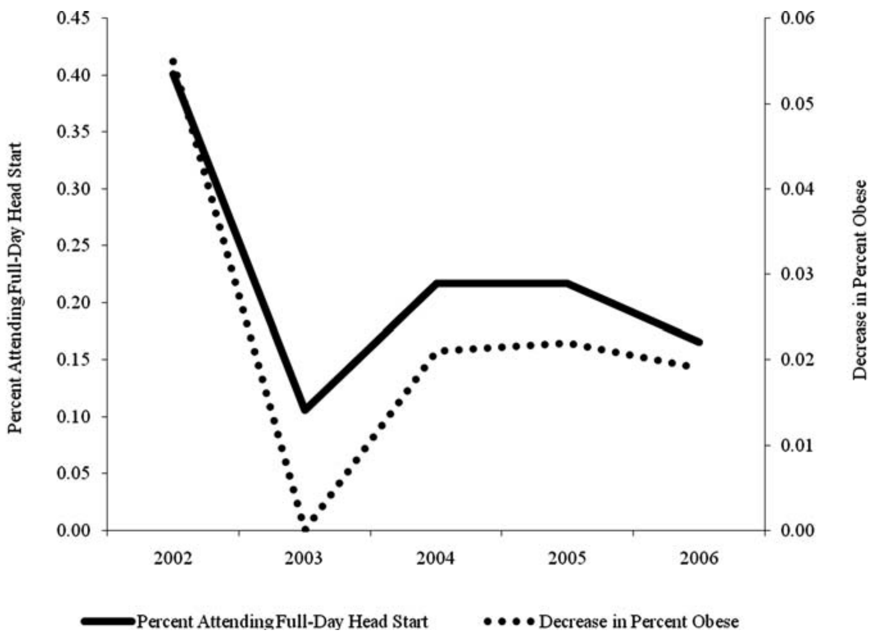


Figure 3
Change in Percent Obese and Percent of Children Attending Full Day Head Start by Year

Source: See Figure 2.
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.

from the beginning to the end of the academic year. In 2003, after the removal of the grant, there was no change in the prevalence of obesity. For 2004 through 2006, there was a decrease in the prevalence of obesity of 2.1, 2.2, and 1.9 percentage points, respectively.

To further analyze the impact of the change in state funding, the difference-in-differences specification from Equation 1 is modified to focus on the change in weight status as a result of annual changes to the supply of full-day slots. We remove the indicator variable for whether the child participated in a full-day class from Equation 1 and instead focus on the coefficient estimates for each year of attendance binary variable. Table 5 displays the estimates of Head Start attendance for each specific year. Each specification includes a set of binary variables denoting the years 2002, 2004, 2005, and 2006, so that the coefficient for 2002 is the estimate of the impact of attending Head Start in the year that the state-funded full-day expansion grant increased the supply of full-day slots, compared to attending Head Start in the year following the withdrawal of this grant. In Specification A, whether the child attended a full-day class is the dependent variable. This specification reveals that, conditional on individual and family characteristics, enrolling in Head Start in 2002 compared to 2003 increased the probability of attending a full-day class by 26.8 percentage points.

Specifications B through F examine the change in obesity as a result of the year of Head Start attendance. Specification B does not control for individual or family characteristics prior to Head Start attendance; Specification C includes these covariates. These results show that the change in obesity is 4.5 percentage points lower in 2002 than in 2003. Estimates from the specification controlling for covariates are similar to estimates from the specification not controlling for covariates, which suggests that these results are not driven by changes in the observed demographics or family background of full-day participants across cohorts. The estimated impacts on overweight and BMI *z*-score, which are not shown for the sake of brevity, are negative as well, but these results are not statistically significant. Specification D also includes the county child poverty rate and Food Stamp Program county expenditures per person. The estimate of the change in obesity in 2002 increases slightly, but is robust to including these additional characteristics.

Specification E restricts the sample to children with nonworking primary caregivers, who are unlikely to be eligible for full-day Head Start. Changes in the supply of full-day slots should not influence the type of Head Start class attended by these children. The results from Specification E show that there was no change in obesity between 2002 and 2003 for children with nonworking parents, which provides further evidence that the estimate for 2002 is measuring the increase in full-day Head Start attendance as opposed to alternative changes over time. As additional falsification tests, Columns F and G show there is not a statistically significant relationship between Head Start attendance in 2002 and the predetermined characteristics of obesity status or family income at the beginning of the Head Start year.

The estimates in Table 5 suggest that attending Head Start in 2002, when the supplementary state funding increased the supply of full-day slots, increased the likelihood of attending a full-day class by 26.8 percentage points and led to a decrease in the prevalence of obesity of 4.8 percentage points, compared to the following year. These estimates imply that attending a full-day Head Start class leads to a decrease in the prevalence of obesity of 17.9 percentage points.

Instrumental variables estimates based on Equation 1 that instrument for full-day attendance with the percent of Head Start children who attend a full-day class, which is graphed in Figure 3 and shown in Table 5, suggest that full-day Head Start participation leads to a decrease in obesity of 17.6 percentage points.[16] The F statistic on the excluded instrument in the first stage is 12.23 and the partial R squared is 0.04. However, from a Hausman test, the null hypothesis that the value-added and IV estimates are equivalent cannot be rejected at a significance level less than 0.18. Thus, the value-added regression estimates in Table 2 are the preferred estimates of the impact of full-day Head Start attendance. The similarity in the estimates from

16. This specification is similar to the implied IV specification from the columns in Table 5. Year dummy variables are replaced with a linear year variable in this specification. Similar to the falsification tests in Table 5, there is no impact of full-day attendance on obesity at the end of the year for children with nonworking parents, on obesity at the beginning of the year, or beginning of the year income in the IV results.

Table 4
Changes in State Economic Conditions and Social Programs

Panel A: Head Start Statistics

	Percent of Head Start Participants in a Full-Day Class	Percent Change	Change in the Prevalence of Obesity	Federal Funding for Head Start Per Participant in Michigan	Percent Change	State Funding for Head Start Per Participant in Michigan	Percent Change
2001				6998.66		162.10	
2002	0.406		−0.055	7158.29	2.28	635.47	292.02
2003	0.106	−73.99	0.000	7118.66	−0.55	0.00	−100.00
2004	0.217	105.69	−0.021	7055.77	−0.88	0.00	—
2005	0.217	0.00	−0.022	6885.57	−2.41	0.00	—
2006	0.166	−23.73	−0.019	6615.34	−3.92	0.00	—

Panel B: Participants in Michigan

	Food Stamp Program	Percent Change	Subsidized Childcare	Percent Change	WIC	Percent Change	TANF	Percent Change	Younger than 18 in Poverty	Percent Change
2001	662,072		118,698		286,869		193,211		340,985	
2002	762,105	15.11	117,941	−0.64	288,168	0.45	201,695	4.39	358,843	5.24
2003	871,100	14.30	122,360	3.75	289,335	0.40	200,557	−0.56	377,665	5.25
2004	980,573	12.57	120,623	−1.42	292,649	1.15	212,182	5.80	433,845	14.88
2005	1,067,795	8.90	118,939	−1.40	296,145	1.19	214,547	1.11	454,296	4.71
2006	1,156,311	8.29	114,758	−3.52	299,215	1.04	219,813	2.45	444,913	−2.07

	Panel C: Total Receipts to Michigan									
2001	609,180,332		39,668,870		134,622,698		972,952,791			
2002	737,580,327	21.08	43,046,475	8.51	139,928,286	3.94	991,142,475	1.87		
2003	890,280,939	20.70	43,509,443	1.08	133,261,566	−4.76	902,696,870	−8.92		
2004	1,020,198,454	14.59	43,435,248	−0.17	135,687,200	1.82	847,682,643	−6.09		
2005	1,157,924,129	13.50	39,885,419	−8.17	140,556,500	3.59	761,907,613	−10.12		
2006	1,275,331,000	10.14	37,107,000	−6.97	146,696,242	4.37	647,819,000	−14.97		
	Panel D: Total Receipts to Michigan Divided by Participants									
2001	920.11		334.20		469.28		5,035.70			
2002	967.82	5.19	364.98	9.21	485.58	3.47	4,914.07	−2.42		
2003	1022.02	5.60	355.59	−2.57	460.58	−5.15	4,500.95	−8.41		
2004	1040.41	1.80	360.09	1.27	463.65	0.67	3,995.07	−11.24		
2005	1084.41	4.23	335.34	−6.87	474.62	2.37	3,551.24	−11.11		
2006	1102.93	1.71	323.35	−3.58	490.27	3.30	2,947.14	−17.01		
	Panel E: Total Receipts to Michigan Divided by Total Poor Children									
2001	1786.53		116.34		394.81		2,853.36			
2002	2055.44	15.05	119.96	3.11	389.94	−1.23	2,762.05	−3.20		
2003	2357.33	14.69	115.21	−3.96	352.86	−9.51	2,390.21	−13.46		
2004	2351.53	−0.25	100.12	−13.10	312.76	−11.36	1,953.88	−18.25		
2005	2548.83	8.39	87.80	−12.31	309.39	−1.07	1,677.12	−14.16		
2006	2866.47	12.46	83.40	−5.00	329.72	6.57	1,456.06	−13.18		
	Panel F: Total Receipts to Michigan Divided by Total Population									
2001	60.89		3.97		13.46		97.25		13.4	
2002	73.48	20.68	4.29	8.16	13.94	3.60	98.75	1.53	14.2	5.97
2003	88.45	20.36	4.32	0.79	13.24	−5.03	89.68	−9.18	15	5.63
2004	101.11	14.32	4.30	−0.41	13.45	1.57	84.01	−6.32	17.3	15.33
2005	114.72	13.47	3.95	−8.20	13.93	3.56	75.49	−10.15	18.3	5.78
2006	126.47	10.24	3.68	−6.88	14.55	4.47	64.24	−14.89	18.3	0.00

Sources: Small Area Income and Poverty Estimates, Bureau of Economic Analysis Regional Economic Accounts, Administration for Children and Families, and Food and Nutrition Service.
Notes: Expenditures are in 2006 dollars.

Table 5
Full-Day Attendance and Obesity by Year

		Obesity					
	Full-Day (A)	All Children (B)	All Children (C)	All Children (D)	Children with Non-working Parents (E)	Obese in the Beginning of the Year (F)	Beginning of the Year Income (G)
Year = 2002	0.268	−0.045	−0.048	−0.056	−0.010	0.030	0.034
	(0.080)	(0.025)	(0.026)	(0.026)	(0.035)	(0.033)	(0.049)
Year = 2003	omitted	omitted	omitted	omitted	omitted	omitted	omitted
Year = 2004	0.114	−0.024	−0.021	−0.041	−0.039	0.002	0.016
	(0.056)	(0.022)	(0.023)	(0.032)	(0.040)	(0.033)	(0.056)
Year = 2005	0.124	−0.019	−0.02	−0.060	0.020	0.008	0.004
	(0.054)	(0.022)	(0.022)	(0.053)	(0.040)	(0.031)	(0.054)
Year = 2006	0.082	−0.011	−0.015	−0.043	0.000	0.009	−0.034
	(0.075)	(0.022)	(0.024)	(0.063)	(0.033)	(0.031)	(0.048)
Covariates:							
Individual & family characteristics	X		X	X	X	X	X
Economic conditions				X			
Sample size	1,833	1,833	1,833	1,833	553	1,833	1,833

Source: See Table 2.
Notes: Heteroskedasticity-robust standard errors that allow for clustering within classrooms are in parentheses. The dependent variable in Column A is an indicator variable for whether the child participated in a full-day class. The dependent variable in Columns B through E is the change in obesity status. The sample in Column E is restricted to children with nonworking primary caregivers. The dependent variable in Column F is obesity status at the beginning of the year. The dependent variable in Column G is the log of income in the beginning of the year. All regressions, except in Column F, control for whether the child was obese at the beginning of the year. With the exception that the alternative outcome variables are dropped from the list of covariates as appropriate, additional control variables included, but not reported, are specified in the text and in the notes to Table 2.

these two different identification strategies provides further support for the interpretation of the estimates in Table 2 as a causal effect of the program.

V. Discussion and Conclusion

Our results demonstrate that attending full-day Head Start classes leads to a substantially larger reduction in the prevalence of childhood obesity than attending half-day classes of four percentage points. To better understand the magnitude of this estimate, following Cutler, Glaeser, and Shapiro (2003) and Schanzenbach (2009), we simulate the potential impact of a change in caloric intake on the prevalence of obesity. 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. We simulate the change in calories, holding physical activity constant. This simulation suggests that a 4 percentage point change in obesity can be explained by a change in caloric intake of approximately 20 calories per day with no change in physical activity. Thus, a small change in the amount of calories consumed can lead to important changes in the prevalence of obesity for children at these young ages. Since obese preschool-aged children are approximately five times more likely to be obese adults than nonobese preschool-aged children (Whitaker et al. 1997), this small change in caloric intake has the potential to significantly reduce the prevalence of obesity.

Evidence that Head Start participation influences caloric intake, in addition to the dietary recall study of Worobey et al. (2005), is based on data from the food intake files in What We Eat in America 2003–2004, combined with the National Health and Nutrition Examination Survey (NHANES) 2003–2004. Table 6 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. 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. Although this information is not available for full-day and half-day Head Start participants, this finding suggests that the caloric intake of Head Start children is reduced during the hours of Head Start attendance.[17]

Our results suggest that expansions to the Head Start program that increase the availability of full-day classes have the potential to reduce the prevalence of childhood obesity for low-income children. These results lead to an interesting question: Would public resources be more optimally allocated by increasing the number of children who attend Head Start for a half-day class or by increasing the availability

17. The reduction in obesity from full-day Head Start participation is likely influenced by a reduction in calories from the nutrition provided and less exposure to foods with limited nutritional value available outside of Head Start, as well as the additional time available for exercise within Head Start. With these data it is not possible to determine the exact contribution of each mechanism to the overall estimate.

Table 6
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	929	1314	1248
(8am–5pm)	(62)	(121)	(85)
Calories during the morning	435	552	621
(8am–12pm)	(57)	(67)	(54)
Calories during the afternoon	494	762	627
(12pm–5pm)	(45)	(93)	(50)
Calories during the evening/night	614	679	653
(5pm–12am)	(70)	(91)	(48)
Total calories	1635	2010	1945
	(101)	(159)	(105)
Sample size	20	16	84

Sources: NHANES 2003–2004, What We Eat In America 2003–2004.
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. 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.

of full-day classes? Our results demonstrate that increasing the availability of full-day classes has a positive impact on one aspect of child welfare. Ultimately, though, the optimal allocation of resources within Head Start will depend on the effect of both half-day and full-day classes, and the difference between the two options, on all potential outcomes. This remains an interesting area for future research.

This research contributes to the literature on early childhood interventions, and the Head Start program in particular, by examining the influence of increasing children's daily exposure to Head Start, providing information about useful components in the "black box" of early childhood intervention programs, and providing information about the optimal structure of the Head Start program. Additionally, this research contributes to the literature on the economics of obesity by demonstrating the impact of a change in a program—the additional time in Head Start—that has the potential to lead to a sizeable impact on obesity. A growing body of literature demonstrates that school-based policies can influence obesity (Anderson and Butcher 2006; Millimet, Tchernis, and Husain 2008; Schanzenbach 2009). In contrast with food assistance programs or school-based policies that target childhood obesity by influencing specific aspects of children's daily environment, full-day Head Start participation represents a complete change in the environment of a large portion of each day.

As a result of the timing of Head Start within an age frame that is influential in the development of food preferences (Birch 1999), behavioral changes may lead to longer-term benefits that are not captured in the short-term impacts estimated here. Even in the absence of behavioral changes, a short-term reduction in weight that does not affect the rate of weight gain would lead to a persistent reduction in the prevalence of obesity as the child continues to grow along a nonoverweight percentile on the BMI or weight growth curve. Unfortunately, with these administrative data it is not possible to determine how long the impact of full-day Head Start participation lasts. If the contemporaneous benefits do indeed persist throughout childhood, full-day Head Start participation could lead to a significant impact on health outcomes. Given that obesity is one of a broad array of child outcomes affected by the program, the benefits of expanding the intensity of Head Start services could be substantial.

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