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

David E. Frisvold[*] & Julie C. Lumeng[†,‡]

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Abstract

Coinciding with the work requirements of welfare reform in the mid-1990s, the early childhood education program, Head Start, increased 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 using the elimination of a state-provided full-day expansion grant that led to an exogenous decrease in the supply of full-day classes for the program in our study. 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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[*] Corresponding Author; Emory University, Department of Economics, Atlanta, GA 30322-2240; Phone: 404-727-7833; Fax: 404-727-4639; E-mail: david.frisvold@emory.edu

[†] University of Michigan, Center for Human Growth and Development and Department of Pediatrics, 300 NIB, 10th Floor, Ann Arbor, MI 48109-0406; Phone: 734-764-2443; Fax: 734-936-9288; E-mail: jlumeng@umich.edu

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1. Introduction

Growing up in poverty has a persistent impact on a broad range of social and economic outcomes, including educational attainment (Duncan et al., 1998), crime (Holzer et al., 2007), and health (Case, Lubotsky, and Paxson, 2002). Holzer et al. (2007) estimate the aggregate social costs of childhood poverty in the United States at approximately $500 billion per year. Thus, public investments in the cognitive, social, and physical development of poor youths may significantly improve individual and social welfare.

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. The program currently provides educational, health, nutritional, and social services to approximately 900,000 preschool-aged children and their families each year through both full-day and half-day classes at an annual cost of $7 billion.

Participation in Head Start is generally associated with improvements in health and human capital; however, the majority of the recent research on the impact of Head Start is based on the early years of the program when it was primarily a half-day program (e.g., Ludwig and Miller, 2007). Coinciding with the work requirements of welfare reform in the mid-1990s, Head Start changed the structure of the program by dramatically increasing the availability of full-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, Head Start classes may better serve the needs of low-income families following the work requirements of welfare reform. However, little is

known about the effect of full-day attendance, relative to part-day attendance, 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 be delivered in a half-day class?

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. For example, greater exposure to child care is related to greater behavioral problems, primarily for children from middle and higher income families (Baker, Gruber, Milligan, 2005; Belsky et al., 2007). On the other hand, higher quality child care is associated with improvements in cognitive development and less aggressive behavior, particularly for low-income children (Love et al., 2003). Head Start classrooms are of higher quality on average than other preschool programs and child care centers (Currie, 2001) and Head Start participation improves both cognitive and social development (U.S. Department of Health and Human Services, 2005). Thus, greater participation for children in disadvantaged families in a high quality child development program could further improve child outcomes.

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. The prevalence of childhood obesity has risen dramatically over the past 30 years, more than doubling for children ages 2 through 5 years from 5 percent in the 1970s (Ogden et al., 2002) to 12.4 percent in 2003-6 (Ogden et al., 2008). Childhood obesity is associated with various comorbidities including hypertension and other cardiovascular disease risk factors, type 2 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 be $117 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.

Using unique, administrative data from a Michigan Head Start program spanning 2002 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 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 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 rate of obesity at the end of the academic year by approximately four percentage points.

Additionally, we use the 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. The elimination of a full-day expansion grant due to statewide budget cuts to education programs reduced the number of full-day classrooms in this program in 2003 to four. This change in funding decreased the percent of children attending full-day Head Start by 29 points. Using the percent of funded slots for Head Start that are scheduled for full-day classes as an instrument for full-day attendance, we find that full-day attendance decreases the rate of obesity by 17.6 percentage points.

Our results suggest that attendance in a full-day Head Start class can considerably reduce the rate of childhood obesity. Due to the young age of Head Start children, the impact on obesity is the result of a small change in weight; simulations suggest that full-day Head Start attendance slows the rate of growth by nearly 3 pounds. Since obese preschool-aged children are approximately five times more likely to be obese adults than non-obese preschool-aged children (Whitaker et al., 1997), this small change in weight has the potential to significantly reduce obesity. Overall, these results suggest that the recent expansions to the availability of full-day services in the Head Start program may have reduced childhood obesity.

2. Background

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. Since its inception in 1965, Head Start has provided services to more than 25 million preschool children

(Office of Head Start, 2007b). 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, 2007b).

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, 2007a). 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 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 available for children with disabilities. Federal guidelines require that children with the greatest need for Head Start services – the most disadvantaged – are selected by the program administrators (Office of Head Start, 2007a).

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.[1] 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

[1] 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.

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 increases cognitive development (U.S. Department of Health and Human Services, 2005) and 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 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, 2008) and being obese in later childhood (Frisvold, 2007; Carneiro and Ginja, 2008). 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.[2,3] 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

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

[3] 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).

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).[4] 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.

There are a variety of reasons why participation in the Head Start program may reduce overweight and obesity.[5] The reasons that participation in a full-day class may lead to a greater impact than a half-day class are, primarily, more exercise and improved nutrition, as well as greater time spent in a structured environment.

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).

[4] These results have not yet been released.

[5] Exposure to the services in the Head Start program may reduce overweight and obesity as a result of the emphasis on exercise, the nutrition services, increases in cognitive and non-cognitive skills, and greater access to a continuous source of pediatric care (Frisvold, 2007). The nutrition services include screening, nutrition education for parents and children, and providing healthy meals. Screening for nutrition deficiencies and height and weight and the extent of nutrition education is not likely to differ between full-day and half-day participants. An objective of the Head Start guidelines is to ensure that children have access to a continuous source of pediatric care. Increased pediatric care could improve the nutrition of children as physicians counsel parents and children and monitor the height and weight changes of children. Additionally, Head Start participation reduces behavior problems (U.S. Department of Health and Human Services, 2005), which are associated with childhood obesity (Lumeng et al., 2003).

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 nutrition aspects of Head Start's services include nutrition screening, nutrition education, and providing healthy meals. Head Start personnel determine the child's nutrition needs through nutrition assessments, height and weight measurements, and hemoglobin/hematocrit testing conducted within the first 45 days of enrollment, and then design and implement a nutrition plan. Mealtimes provide the opportunity for nutrition education and children are encouraged to try a variety of foods. The Head Start nutrition 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 classes 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.[6] In a 24-hour dietary recall study, Worobey et al. (2005) find that, during the day, children who attend Head Start consume similar levels of protein, carbohydrate, and fat as middle-income children who attend private preschool. However, the

[6] A structured environment 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).

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' 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.

The Head Start program may also indirectly influence parental behavior. 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). Greater parental investment could improve a variety of child outcomes, including reducing obesity. If full-day Head Start participation leads to a greater reduction in the marginal cost of child quality, then the resulting impact on child outcomes would be magnified. On the other hand, 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 impact of the full-day Head Start participation is the net result of the direct effect of the full-day classes 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 2001-2002 through 2005-2006. 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. Further details about this specific Head Start program are included in Appendix I.

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 and at the end of the academic year 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. 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 (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.[7] 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.[8]

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 March or began after October are excluded.[9] Additionally, 65 observations are excluded due to implausible measurements.[10] These sample restrictions result in a sample of 1833

[7] 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).

[8] For example, for girls between the ages of 3 and 5 years absolute body mass index decreases at the 50th percentile of the BMI distribution as growth occurs more in height than in weight. After this period, adiposity rebound occurs, which leads to an increase in the absolute body mass index. The constructed outcome variables, which follow the CDC guidelines, incorporate these natural changes in growth.

[9] 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.

[10] These 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 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.

observations from 1532 children, since some children enrolled in Head Start for multiple years.[11] 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 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.[12] 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 classes are likely to differ from children in half-day classes 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 week), in training full-time, or in school; however, exceptions are made at the discretion of the program's administrators. 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 by this Head Start grantee to determine which eligible children are selected for full-day classes, which ensures that the most disadvantaged of the eligible children are selected. Thus,

[11] The results throughout the paper are not sensitive to 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 IV estimate on obesity. The sample size of children in their second year is too small to precisely estimate the impact of full-day attendance.

[12] Information about the child care activities of half-day participants with full-time working parents is not available for children once they attend Head Start, but information prior to Head Start attendance reveals that the child care activities for these children include being cared for by a relative or subsidized child care.

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. Not all of the information used by the grantee to determine eligibility is available in the administrative data.

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 criteria, 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. 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.

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. 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, we control for selection on observable characteristics into full-day and half-day classes using regression adjustment. 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 and instrumenting for full-day attendance with the percent of funded slots for Head Start that are scheduled for full-day classes.

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 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 decrease in the obesity rate for all children in the Head Start program contrasts with the increasing 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. Figure 2 displays kernel density estimates of BMI z-score at the beginning and the end of the year for half-day participants and full-day

participants. 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 higher and shifted to the left. Additionally, the density is lower at the end of the year compared to the beginning of the year throughout the entire right tail of the distribution above the obese threshold.[13]

B. Regression Estimates

The comparisons in means in Table 2 and the distribution graphs in Figure 2 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. 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* (W_i) is specified as:

$$W_i = \beta_0 + \beta_1 FD_i + \beta_2 T_i + \beta_3 FD_i \times T_i + \beta_4 X_i + \varepsilon_i , \quad (1)$$

where *FD* indicates full-day participation, *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, *X* includes individual and family characteristics that are determined prior to Head Start enrollment, ε is the error term, and β represents the parameters to be estimated. β_1 represents the difference in weight status for children in full-day compared to half-day classes for both the beginning and end of the year. β_2 represents the change in weight status throughout the course of the academic year. β_3 represents

[13] As is also shown in the differences in weight status in Table 2, 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.

the average change over the course of the year for full-day compared to half-day participants and is the parameter of interest.

The specific variables in *X* are year fixed effects, 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.[14,15,16] Equation (1) is estimated using ordinary least squares. 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.

Column (1) of Table 3 displays the estimates of the regression-adjusted difference-in-differences estimates of the impact of full-day participation on weight status.[17] For obesity, the coefficient estimate for full-day Head Start participation is small (-0.004) and not statistically significant. This estimate demonstrates that there is not a constant difference in the weight status of children in full-day and half-day Head Start classes and the (conditional) proportion obese at

[14] 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.

[15] 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.

[16] 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, or the number of children less than age 6 in the family instead of family size.

[17] 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.

the beginning of the year is similar for both groups of children. The estimate for the end of the year indicator variable demonstrates that any Head Start participation decreases the likelihood of being obese at the end of the year by 2.1 percentage points. The difference-in-differences estimate of the impact of full-day Head Start participation is a 3.8 percentage point reduction in the likelihood of being obese. 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 Table 2, with the exception that the clustered standard errors are larger. 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 disadvantage of the difference-in-differences specification in equation (1) is that it does not utilize the panel nature of the data (Imbens and Wooldridge, 2008). An alternative specification that 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 is:

$$W_{i1} - W_{i0} = \alpha + \delta FD_i + \gamma W_{i0} + \zeta X_{i0} + \upsilon_i , \quad (2)$$

where W_{i1} is the weight status of individual *i* at the end of the Head Start year (when $T = 1$); W_{i0} is the weight status of individual *i* at the beginning of the year; α, δ, γ, and ζ are the parameters to be estimated; and υ is random error. δ is the coefficient of interest.[18]

Given the panel nature of the data, equation (1) is very similar to equation (2) with an exception that equation (2) conditions on weight status at the beginning of the year, W_{i0}. If W_{i0} is correlated with the unobserved characteristics that determine full-day participation, then equation (1) would be the preferred specification. If the correlation between W_{i0} and υ_i is zero,

[18] Estimates of the equation $W_{i1} = \alpha + \delta FD_i + \gamma W_{i0} + \zeta X_{i0} + \upsilon_i$ yield an equivalent estimate of δ.

then adjusting for beginning of the year weight status improves the comparability between full-day and half-day children (Imbens and Wooldridge, 2008).

Column (2) of Table 3 displays the estimates of δ from equation (2). Although equations (1) and (2) imply different assumptions, the estimates of the impact of full-day Head Start participation for each weight status measure are nearly identical. Full-day Head Start participation reduces the likelihood of being obese at the end of the year by 3.9 percentage points. 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.

To assess the influence of controlling for the initial weight status on the estimated impact of full-day participation, equation (2) is modified to eliminate W_{i0}:

$$W_{i1} = \pi + \theta FD_i + \varphi X_{i0} + \nu_i \,. \tag{3}$$

The results of the estimates of θ are displayed in column 3 of Table 3. As would be expected if initial weight status did not influence whether a child participated in a full-day class, the estimates of the impact of full-day participation in column 3 are similar to the estimates in columns 1 and 2.

Overall, the unadjusted difference-in-difference estimates and the regression 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).[19,20] However, the estimates do not account for the selection on unobservable characteristics that may influence the estimate of the impact of full-day participation.

[19] One disadvantage of the regression results is that they are based on the full sample, which includes children who may not be eligible for full-day classes. However, restricting the sample to improve covariate balance between the

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.[21] 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 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

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full-day and half-day samples by dropping children based on the primary adult's employment status yields similar estimates. Additionally, matching estimates based on the restricted sample produce similar results.

[20] 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.

[21] We thank Philip Boone in the Michigan Department of Education for providing us with funding information about the grants for full-day services. Additional sources of information about the funding changes in the School Aid budget are 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.

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. 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 3 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.[22] The budget cut to education funding did not influence funding for Michigan's subsidized child care program, which is administered through the state's Department of Human Services.[23] Additionally, there was little change in the participation of children in the Special

[22] The 2002 Farm Bill (the Farm Security and Rural Investment Act of 2002) influenced the Food Stamp Program (now known as the Supplemental Nutrition Assistance Program), and the changes differed across states. Increases in the recertification period in South Carolina following the 2002 Farm Bill led to greater participation in the Food Stamp Program (Ribar, Edelhoch, and Liu, 2008). A similar change did not occur in Michigan and there was not a large increase in participation in the Food Stamp Program throughout the state or the counties in this dataset from 2002 to 2003, especially when compared to other annual changes in Food Stamp participation since 2001 (Castner and Schirm, 2006; author's calculations from the Small Area Income and Poverty Estimates of the U.S. Census Bureau).

[23] Based on average fiscal year statistics from Michigan's Department of Human Services, available at http://www.michigan.gov/dhs/0,1607,7-124-5458_7696_10831---,00.html, the average number of children receiving

Supplemental Nutrition Program for Women, Infant, and Children (WIC) between 2002 and 2003.[24] 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 shown in Figure 3. The Small Area Income and Poverty Estimates of the U.S. Census Bureau show that there was a larger change in the percent of children living in poverty in Michigan and the areas served by this Head Start grantee in 2004 and 2005 than there was in 2002 or 2003.

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. 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 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 (2) 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

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subsidized child care throughout the year and the average payment by the state per child was relatively constant between 2002 and 2006 with neither figure changing by more than four percent annually in any year.

[24] We thank Diane Revitte at the Michigan Department of Community Health for providing us with information on the number of infants and children certified to receive WIC services between 2001 and 2006 in Michigan. Statewide enrollment for infants and children increased less than 0.5 percent between 2002 and 2003. Enrollment in the areas served by the Head Start grant increased between 2002 and 2003 by a rate similar to the increase in other years.

child participated in a full-day class from equation (2) and instead focus on the coefficient estimates for each year of attendance binary variable. Table 4 displays the estimates of Head Start attendance for each specific year. Specifications (A), (B), (C), and (F) include 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 (E) 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) restricts the sample to 2002 and 2003. The results from this specification show that the decrease in obesity is 5.1 percentage points larger in 2002 than in 2003. Specification (E) 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 (E) show that there was no change in obesity between these years. Specification (F) restricts the sample to children with non-working 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 attend by these children. The results from specification (F) show that there was no change in obesity between 2002 and 2003 for children with non-working parents.

Overall, the estimates in Tables 4 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 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 obesity of 17.9 percentage points.

To further investigate the impact of full-day Head Start attendance on obesity utilizing the change in the supply of full-day slots that arose due to the exogenous changes in state funding, we estimate equation (2) using instrumental variables. We instrument for full-day attendance using the percentage of funded Head Start slots that are designated for full-day classes. Table 5 displays the IV estimates. As shown by the first stage results, a 10 percentage point increase in the percent of full-day slots increases the likelihood of full-day attendance by 9.3 percentage points. The F statistic on the excluded instrument in the first stage is 12.23 and the partial R squared is 0.04. The IV estimates suggest that full-day Head Start participation leads to a decrease in obesity of 17.6 percentage points.[25]

[25] The estimate of the impact of full-day Head Start attendance for boys is similar to the estimate for girls.

The similarity between the IV estimate and the implied estimate of attending a full-day class in 2002 suggests that the IV result is primarily due to the change in the supply of full-day slots between 2002 and 2003. Thus, the validity of the percentage of full-day Head Start slots as an instrument is determined by whether the change in supply that was induced by the elimination of the state-funded full-day expansion grant is uncorrelated with the unobserved determinants of obesity. While the details of the withdrawal of this grant that are described above suggest that that the changes in state supplemental funding are likely to be exogenous, a series of falsification tests add further evidence to support the validity of the instrument. As shown in Table 6, full-day Head Start participation does not influence the predetermined characteristics of obesity status, receipt of TANF benefits, family income, or age at the beginning of the Head Start year.

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. Regression estimates suggest that participating in full-day Head Start reduces the probability of being obese by 4 percentage points. Estimates identified from the change in the availability of full-day classroom slots due to the elimination of a state full-day expansion grant suggest that participating in full-day Head Start reduces the probability of being obese by 17.6 percentage points. Since 12 percent of children who attend a full-day class are obese at the end of the year, the IV estimates suggest that slightly less than 30 percent of these children would have been obese at the end of the year had they not attended a full-day class and had instead attended a half-day class, while the OLS estimates suggest that 16 percent of these children would have been obese.

The estimated treatment effect and the counterfactual implied by the OLS and IV results differ due to the assumptions of the estimators and the different parameters that are estimated. While the OLS estimates are based on the assumption that unobserved characteristics are not related to full-day attendance, the IV estimates are not based on this assumption. The most disadvantaged of the eligible children are selected for full-day classrooms by Head Start administrators and most of the characteristics that the administrators use to select children are not available in the dataset. These unobserved characteristics are likely related to childhood obesity. For example, exposure to childhood emotional, physical, or sexual abuse and household dysfunction in childhood are associated with severe obesity (Felitti et al., 1998). Therefore, since full-day attendance is likely positively correlated with unobserved characteristics that are positively correlated with childhood obesity, estimators that assume selection only on observed characteristics are likely to be biased towards zero and the IV results would be larger in absolute value than the OLS results.

The results from the IV specifications estimate a different parameter of interest from the regression specifications. Instead of an estimate of the average treatment effect of full-day Head Start compared to half-day Head Start, the IV strategy estimates the average treatment effect of full-day Head Start that results because of a change in the supply of full-day classroom slots from the elimination of the state-funded full-day expansion grant. If the average treatment effect of full-day Head Start is heterogeneous, then these two parameters may differ. The local average treatment effect that is estimated with IV may differ from the average treatment effect because the change in state supplementary funding and the supply of full-day classroom slots may influence aspects of the program and who attends a full-day class.

The reduction in the supply of full-day classroom slots in 2003 could influence who attends Head Start. Eighty of the 138 children who attended a full-day class in 2002 were age-eligible to attend Head Start in 2003. However, 69 percent of these children, or 55 children, did not participate in Head Start in 2003, which is approximately double the percentage of age-eligible children who did not re-enroll in Head Start from 2004 to 2005. Many children likely did not participate in 2003 because full-time employed parents sought alternatives to a half-day Head Start class.

Because the most disadvantaged children are selected, when the supply of full-day slots is greater, relatively less disadvantaged children may be selected. Thus, children who attended a full-day class in 2003 might be more disadvantaged, on average, than children who attended a full-day class in 2002. However, the observed characteristics of full-day children are not statistically different between 2002 and 2003. The unobserved characteristics of full-day children could differ between 2002 and 2003. If this is the case, then the IV results would be larger in absolute value than the OLS results.

The reduction in state funding that reduced the supply of full-day slots could have also influenced the program. The components of the program for both half-day and full-day classes did not change. However, the average salaries of teachers and number of assistant teachers did change as the program reduced costs. In 2002, one teacher and two assistant teachers taught each full-day class. After 2002, one teacher and one assistant teacher taught each full-day class. While the average years of schooling of teachers did not change between 2002 and 2003, the average teachers salary decreased by $8,560. If the number of assistant teachers or the average teacher's salary influences the effect of the program, then the IV results would be larger in absolute value than the OLS results.

Our results reveal a large reduction in obesity from full-day Head Start attendance of 17.6 percentage points. To better understand the magnitude of this estimate, we simulate the change in pounds needed to generate the implied counterfactual estimate of 29.6 percent obese full-day children. We construct a hypothetical measure of children's weight at the end of the year that adds additional weight to their measured weight. Using the new weight measure, we calculate body mass index and determine whether the child is obese. Slightly more than an additional 2.5 pounds yields the counterfactual estimate. Thus, the 17.6 percentage point reduction in obesity implies that children who attended a full-day Head Start class would have been nearly 3 pounds heavier if they had attended a half-day class instead. At the end of the year, the mean weight of full-day children was 39.7 pounds and the simulated weight change is approximately a 7 percent change in weight. Due to the young age of Head Start children, a small change in weight can generate large changes in the rate of obesity. Since obese preschool-aged children are approximately five times more likely to be obese adults than non-obese preschool-aged children (Whitaker et al., 1997), this small change in weight has the potential to significantly reduce obesity.

Additionally, 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. 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. Further details about this simulation are provided in Appendix II. 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 and a nearly 18 percentage point

change in obesity can be explained by a change in caloric intake of 75 calories per day with no change in physical activity. Thus, a small change in the amount of calories consumed, equal to approximately one-half of a 12 ounce soda, can lead to important changes in obesity for children at these young ages.

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 2003-4, combined with the National Health and Nutrition Examination Survey (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. 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 caloric intake of Head Start children is reduced during the hours of Head Start attendance.

The reduction in obesity from full-day Head Start participation is likely influenced by a reduction in calories from the nutrition provided and the limited 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. The weight simulation suggests that our result is due to a change of 2.6 pounds, which is approximately 52 calories per day. The caloric simulation holding physical activity constant suggests that the result is due to a change of 75 calories per

day. Thus, a reduction in calories alone cannot explain this result. Instead, it is likely that the comprehensive nature of Head Start services contributes to the result that participating in a longer daily duration in Head Start reduces the likelihood of being obese.

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. 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. 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. An important question when evaluating early childhood interventions is whether the impact persists. Unfortunately, with these administrative data it is not possible to determine how long the impact of full-day Head Start participation lasts. However, there is suggestive evidence available from the measured height and weight information and recall data about the type of Head Start program attended from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-

K). In the ECLS-K data, 12.2 percent of former full-day Head Start children are obese in the spring of kindergarten, while 16.8 percent of former half-day Head Start children are obese and the difference of 4.6 percentage points is statistically significant. This difference is very similar to the difference in means in the administrative data used in this paper. In fifth grade, 29.6 and 31.6 percent of former full-day and half-day Head Start students are obese and the 2 percentage point difference is not statistically significant. Thus, this comparison of means demonstrates that the prevalence of obesity of former full-day Head Start participants, who are the more disadvantaged children, does not exceed the prevalence of former half-day children by the end of elementary school. Given that one of the findings from this paper is that the difference in means represents a lower bound on the impact of full-day Head Start, the ECLS-K data suggest that the reduction in obesity from full-day Head Start attendance may continue beyond the length of the program. 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.

References

Anderson, Kathryn, James Foster, and David Frisvold (2008) "Investing in Health: The Long-Term Impact of Head Start on Smoking," *Economic Inquiry*, forthcoming.

Baker, Michael, Jonathan Gruber, and Kevin Milligan (2005) "Universal Childcare, Maternal Labor Supply, and Family Well-being," National Bureau of Economic Research Working Paper 11832.

Behrman, Jere R., Yingmei Cheng, and Petra E. Todd (2004) "Evaluating Preschool Programs when Length of Exposure to the Program Varies: A Nonparametric Approach," *Review of Economics and Statistics*, 86 (1), 108-132.

Belsky, Jay, Deborah Lowe Vandell, Margaret Burchinal, K. Alison Clarke-Stewart, Kathleen McCartney, Margaret Tresch Owen, and The NICHD Early Child Care Research Network (2007) "Are There Long-Term Effects of Early Child Care?" *Child Development*, 78(2), 681-701.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan (2004) "How Much Should We Trust Differences-in-Differences Estimates?" *Quarterly Journal of Economics*, 119(1), 249-275.

Besharov, Douglas J., Justus A. Myers, and Jeffrey S. Morrow (2007) "Costs Per Child for Early Childhood Education and Care," American Enterprise Institute for Public Policy Research.

Birch, Leann L. (1999) "Development of Food Preferences," *Annual Review of Nutrition*, 19, 41-62.

Briley, Margaret E. and Cindy Roberts-Gray (1999) "Position of the American Dietetic Association: Nutrition Standards for Childcare Programs," *Journal of the American Dietetic Association*, 99 (8), 981-988.

Brush, Lorelei, Sharon Deich, Kerry Traylor, Nancy Pindus (1995) *Options for Full-Day Services for Children Participating in Head Start*, Washington, DC: Pelavin Research Institute and Urban Institute.

Cannon, Jill S., Alison Jacknowitz, Gary Painter (2006) "Is Full Better Than Half? Examining the Longitudinal Effects of Full-Day Kindergarten Attendance," *Journal of Policy Analysis and Management*, 25(2), 299-321.

Carneiro, Pedro and Rita Ginja (2008) "Preventing Behavior Problems in Childhood and Adolescence: Evidence from Head Start," University College London working paper.

Case, Anne, Darren Lubotsky, and Christina Paxson (2002) "Economic Status and Health in Childhood: The Origins of the Gradient," *American Economic Review*, 92(5), 1308-1334.

Castner, Laura A. and Allen L. Schirm (2006) "Empirical Bayes Shrinkage Estimates of State Food Stamp Participation Rates in 2002 and 2003 for All Eligible People and the Working Poor," Mathematica Policy Research, Inc. unpublished paper.

Cawley, John (2004) "The Impact of Obesity on Wages," *Journal of Human Resources*, 39 (2), 451-474.

Centers for Disease Control and Prevention (2007) "About BMI for Children and Teens," Accessed at www.cdc.gov/nccdphp/dnpa/bmi/childrens_BMI/about_childrens_BMI.htm on October 25, 2007.

Currie, Janet (2001) "Early Childhood Education Programs," *Journal of Economic Perspectives*, 15(2), 213-238.

Currie, Janet and Matthew Neidell (2007) "Getting Inside the 'Black Box' of Head Start Quality: What Matters and What Doesn't," *Economics of Education Review*, 26, 83-99.

Currie, Janet and Duncan Thomas (1995) "Does Head Start Make a Difference?" *American Economic Review*, 85 (3), 341-364.
Cutler, David M., Edward L. Glaeser, and Jesse M. Shapiro (2003) "Why Have Americans Become More Obese?" National Bureau of Economic Research Working Paper 9446.
DeCicca, Philip (2007) "Does Full-Day Kindergarten Matter? Evidence from the First Two Years of Schooling," *Economics of Education Review*, 26, 67-82.
Duncan, Greg J., W. Jean Yeung, Jeanne Brooks-Gunn, and Judith R. Smith (1998) "How Much Does Childhood Poverty Affect the Life Chances of Children?" *American Sociological Review*, 63(3), 406-423.
Ebbeling, Cara B., Dorota B. Pawlak, and David S. Ludwig (2002) "Childhood Obesity: Public-Health Crisis, Common Sense Cure," *Lancet*, 360, 473-482.
Felitti, Vincent J., Robert F. Anda, Dale Nordenberg, David F. Williamson, Alison M. Spitz, Valerie Edwards, Mary P. Koss, and James S. Marks (1998) "Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults," *American Journal of Preventive Medicine*, 14 (4) 245-258.
Flegal, Katherine M., Barry I. Graubard, David F. Williamson, and Mitchell H. Gail (2005) "Excess Deaths Associated with Underweight, Overweight, and Obesity," *Journal of the American Medical Association*, 293(15), 1861-1867.
Fox, Mary Kay, Frederic B. Glantz, Lynn Geitz, and Nancy Burstein (1997) "Early Childhood and Child Care Study, Nutritional Assessment of the CACFP: Final Report Volume II" Abt Associates Inc.
Frisvold, David (2007) "Head Start Participation and Childhood Obesity," Early Childhood Research Collaborative Discussion Paper 108.
Garces, Eliana, Duncan Thomas, and Janet Currie (2002) "Longer-Term Effects of Head Start," *American Economic Review*, 9 (4), 999-1012.
Hale, Barbara, Victoria Seitz and Edward Zigler (1990) "Health Services and Head Start: A Forgotten Formula," *Journal of Applied Developmental Psychology*, 11, 447-458.
Holzer, Harry J., Diane Whitmore Schanzenbach, Greg J. Duncan, and Jens Ludwig (2007) "The Economic Costs of Poverty in the United States: Subsequent Effects of Children Growing Up Poor," Institute for Research on Poverty Discussion Paper 1327-07.
Imbens, Guido W. and Jeffrey M. Wooldridge (2008) "Recent Developments in the Econometrics of Program Evaluation," mimeo.
Keller, Bess (2001a) "Michigan Legislature Cuts Budget, But Keeps Basic Aid to Schools Intact," *Education Week*, 21(5), 25.
Keller, Bess (2001b) "After Budget Veto, Michigan Schools Brace for Cutbacks," *Education Week*, 21(6), 21-23.
Klesges, R., M. Shelton, and L. Klesges (1993) "Effects of Television on Metabolic Rate: Potential Implications for Childhood Obesity," *Pediatrics*, 91, 281-286.
Kuczmarski, RJ, Ogden CL, Grummer-Strawn LM, et al. (2000) "CDC Growth Charts: United States," *Advance Data from Vital and Health Statistics*, 314, 1-28.
Lewis, MK and AJ Hill (1998) "Food advertising on British children's television: a content analysis and experimental study with nine-year olds," *International Journal of Obesity and Related Metabolic Disorders*, 22, 206-214.
Love, John M., Linda Harrison, Abraham Sagi-Schwartz, Marinus H. van Ijzendoorn, Christine Ross, Judy A. Ungerer, Helen Raikes, Christy Brady-Smith, Kimberly Boller, Jeanne Brooks-Gunn, Jill Constantine, Ellen Eliason Kisker, Diane Paulsell, and Rachel Chazan-

Cohen (2003) “Child Care Quality Matters: How Conclusions May Vary with Context,” *Child Development*, 74(4), 1021-1033.

Love, John M., Ellen Eliason Kisker, Christine M. Ross, Peter Z. Schochet, Jeanne Brooks-Gunn, Diane Paulsell, Kimberly Boller, Jill Constantine, Cheri Vogel, Allison Sidle Fuligni, Christy Brady-Smith (2004) *Making a Difference in the Lives of Infants and Toddlers and Their Families: The Impacts of Early Head Start*, Volume I: Final Technical Report, Washington, DC: U.S. Department of Health and Human Services.

Ludwig, Jens and Douglas L. Miller (2007) “Does Head Start Improve Children’s Life Chances? Evidence from a Regression Discontinuity Design,” *Quarterly Journal of Economics*, 122 (1), 159-208.

Ludwig, Jens and Deborah A. Phillips (2007) “The Benefits and Costs of Head Start,” National Bureau of Economic Research Working Paper 12973.

Lumeng, J., K. Gannon, J. Cabral, D. Frank, and B. Zuckerman (2003) "The Association between Clinically Meaningful Behavior Problems and Overweight in Children," *Pediatrics*, 112, 1138-1145.

Lumeng, Julie C., Sahand Rahnama, Danielle Appugliese, Niko Kaciroti, and Robert H. Bradley (2006) “Television Exposure and Overweight Risk in Preschoolers,” *Archives of Pediatrics and Adolescent Medicine*, 160, 417-422.

Mokdad, Ali H., James S. Marks, Donna F. Stroup, and Julie L. Gerberding (2004) “Actual Causes of Death in the United States, 2000,” *Journal of the American Medical Association*, 291(10), 1238-1245.

Morland, Kimberly, Steve Wing, and Ana Diez Roux (2002) “The Contextual Effect of the Local Food Environment on Residents’ Diets: The Atherosclerosis Risk in Communities Study,” *American Journal of Public Health*, 92 (11), 1761-1767.

Nader PR, O'Brien M, Houts R, Bradley RH, Belksy J, Crosnoe R, Friedman S, Mei Z, Susman EJ, Development National Institute of Child Health and Human Development Study of Early Child Care and Youth (2006) “Identifying risk for obesity in early childhood,” *Pediatrics*, 118, e594-e601.

National Heart, Lung, and Blood Institute (1998) “Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—the evidence report,” *Obesity Research*, 6 (S2), 51S–209S.

Office of Head Start (2006a) *Head Start Program Performance Standards and Other Regulations*, Washington, DC: U.S. Department of Health and Human Services.

Office of Head Start (2006b) *2006 Head Start Program Fact Sheet*, Washington, DC: U.S. Department of Health and Human Services.

Office of the Surgeon General (2001) *The Surgeon General’s Call to Action to Prevent Overweight and Obesity*, Rockville, MD: U.S. Department of Health and Human Services.

Ogden, Cynthia L., Katherine M. Flegal, Margaret D. Carroll, Clifford L. Johnson (2002) “Prevalence and Trends in Overweight Among US Children and Adolescents, 1999-2000,” *Journal of the American Medical Association*, 288(14), 1728-1732.

Ogden, Cynthia L., Margaret D. Carroll, Katherine M. Flegal, (2008) “High Body Mass Index for Age Among US Children and Adolescents, 2003-2006,” *Journal of the American Medical Association*, 299(20), 2401-2405.

Pate, Russell R., Karin A. Pfeiffer, Steward G. Trost, Paula Ziegler, and Marsha Dowda (2004) "Physical Activity Among Children Attending Preschools," *Pediatrics*, 114(5), 1258-1263.

Perez-Escamilla, Rafael and Ernesto Pollitt (1995) "Growth Improvements in Children above 3 Years of Age: The Cali Study," *Journal of Nutrition*, 125, 885-893.

Ribar, David C., Marilyn Edelhoch, and Qiduan Liu (2008) "Watching the Clocks: The Role of Food Stamp Recertification and TANF Time Limits in Caseload Dynamics," *Journal of Human Resources*, 43(1), 208-239.

Schanzenbach, Diane Whitmore (2005) "Do School Lunches Contribute to Childhood Obesity?" Harris School Working Paper 05.13.

Skuse, David, Assunta Albanese, Richard Stanhope, Jane Gilmour, and Linda Voss (1996) "A New Stress-Related Syndrome of Growth Failure and Hyperphagia in Children, Associated with Reversibility of Growth-Hormone Insufficiency," *Lancet*, 348(9024), 353-8.

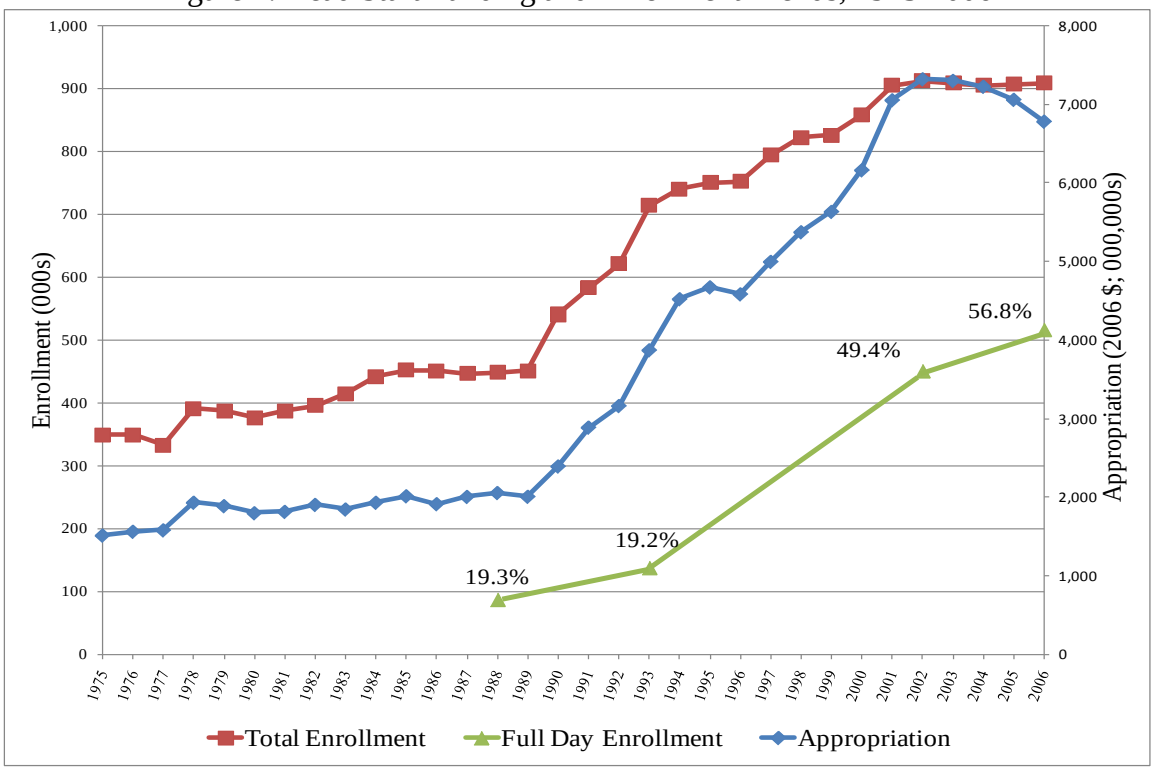
U.S. Department of Health and Human Services, Administration for Children and Families (2005), *Head Start Impact Study: First Year Findings*, Washington, DC.

Whitaker, RC, JA Wright, MS Pepe, KD Seidel, WH Dietz (1997) "Predicting Obesity in Young Adulthood from Childhood and Parental Obesity," *New England Journal of Medicine*, 337, 869-873.

Wolf, A. (1998) "What is the Economic Case for Treating Obesity?" *Obesity Research*, 6 (S1), 2S-7S.

Worobey, John, Harriet S. Worobey, and Audrey L. Adler (2005) "Diet, Activity, and BMI in Preschool-Aged Children: Differences Across Settings," *Ecology of Food and Nutrition*, 44, 455-466.

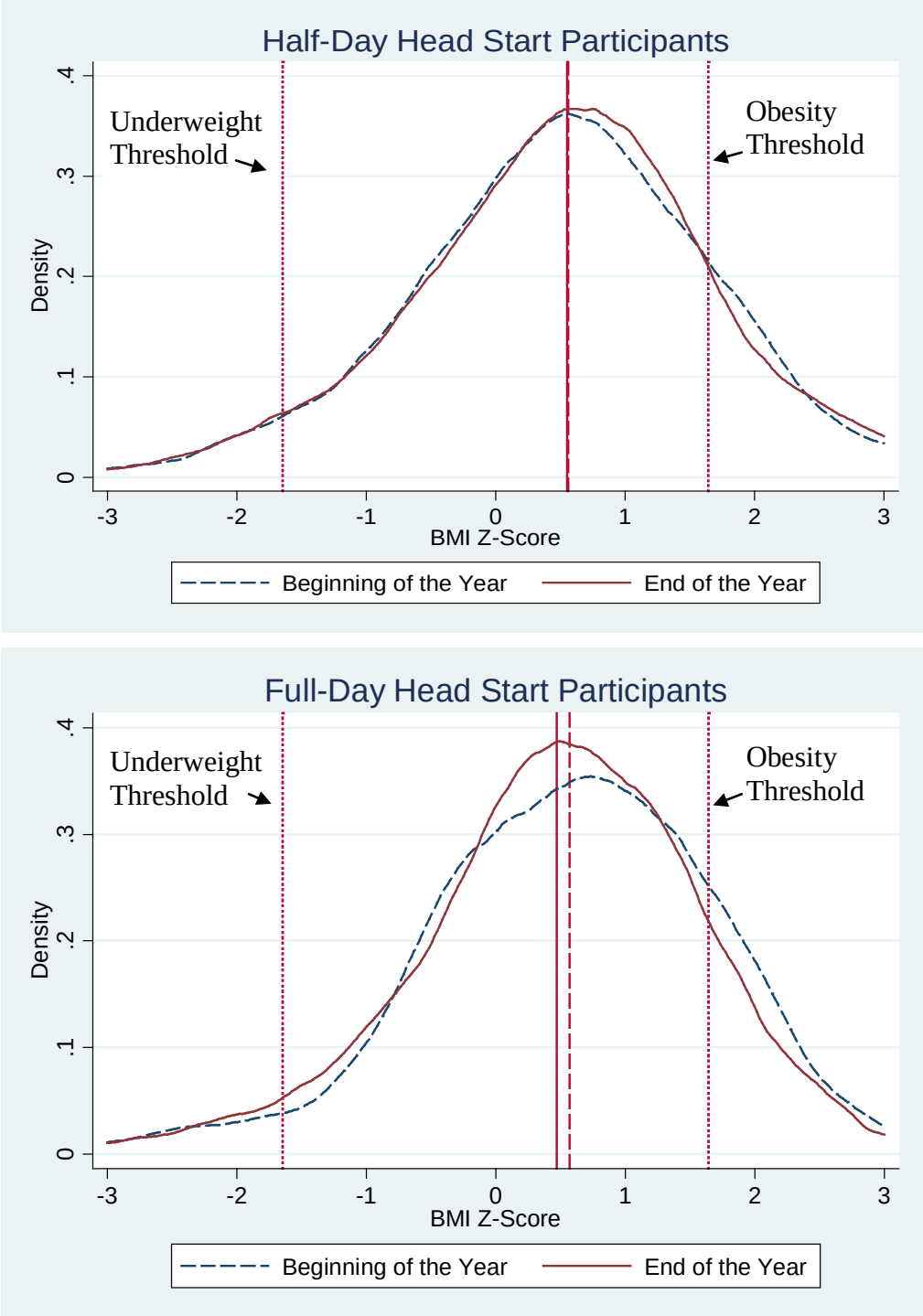
Figure 1: Head Start Funding and Enrollment Trends, 1975-2006



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.

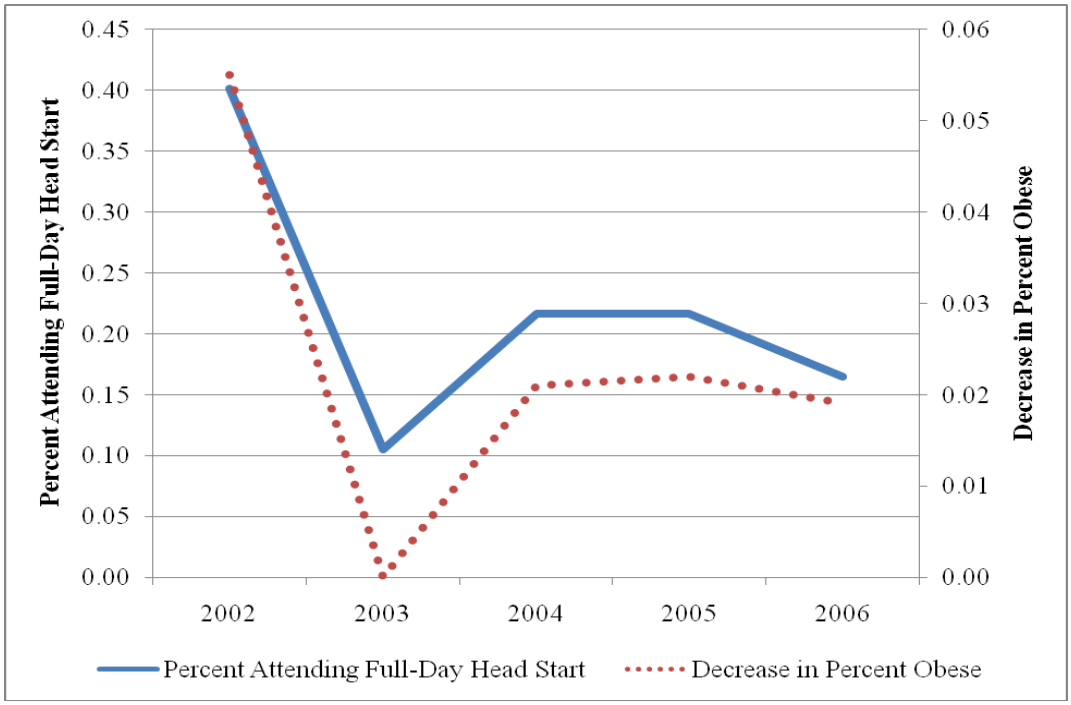
Sources: Total enrollment and total federal appropriation are from the 2007 Head Start Program Fact Sheet (Office of Head Start, 2007a). Full day enrollment figures are based on tabulations from the Head Start Program Information Reports that were provided by Kevin Costigan in the Administration for 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 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.
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

	All	Full Day	Half Day
Age (months)	52.297	52.226	52.319
	(6.932)	(6.941)	(6.931)
Hispanic	0.066	0.069	0.065
	(0.245)	(0.253)	(0.243)
Black	0.266	0.341	0.244
	(0.439)	(0.471)	(0.427)
Black & White	0.083	0.113	0.075
	(0.274)	(0.314)	(0.260)
Other Race	0.013	0.012	0.013
	(0.111)	(0.108)	(0.112)
White	0.572	0.465	0.604
	(0.491)	(0.495)	(0.485)
Female	0.487	0.519	0.478
	(0.500)	(0.500)	(0.500)
Disabled	0.229	0.203	0.237
	(0.420)	(0.403)	(0.425)
Family Income (ln)	9.397	9.555	9.349
	(0.738)	(0.707)	(0.741)
Family Income (000s)	15.392	17.671	14.706
	(10.891)	(12.566)	(10.241)
Family Size	3.977	3.849	4.016
	(1.437)	(1.369)	(1.455)
Single Parent Family	0.570	0.634	0.550
	(0.495)	(0.482)	(0.498)
Primary Adult Graduated High School	0.639	0.723	0.614
	(0.479)	(0.445)	(0.486)
Primary Adult is Employed Full-Time	0.473	0.768	0.384
	(0.499)	(0.422)	(0.486)
Primary Adult is Employed Part-Time	0.151	0.121	0.161
	(0.358)	(0.326)	(0.367)
Primary Adult is in School, Disabled, Employed Seasonally, Retired	0.074	0.061	0.077
	(0.261)	(0.240)	(0.267)
TANF	0.395	0.401	0.393
	(0.489)	(0.491)	(0.488)
Sample Size	1833	424	1409

Notes: Standard deviations in parentheses.
Source: Administrative data provided by a Head Start grantee in Michigan spanning 2002 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

	(1)	(2)	(4)
Obese			
Full Day Head Start	-0.004	-0.039**	-0.042*
	(0.026)	(0.018)	(0.024)
End of the Year	-0.021**		
	(0.009)		
Full Day × End of the Year	-0.038*		
	(0.021)		
Overweight			
Full Day Head Start	-0.003	-0.042	-0.043
	(0.039)	(0.026)	(0.037)
End of the Year	-0.006		
	(0.016)		
Full Day × End of the Year	-0.037		
	(0.026)		
Underweight			
Full Day Head Start	-0.006	0.001	-0.001
	(0.013)	(0.013)	(0.015)
End of the Year	0.008		
	(0.007)		
Full Day × End of the Year	0.005		
	(0.013)		
BMI Z-Score			
Full Day Head Start	-0.030	-0.089	-0.114
	(0.100)	(0.075)	(0.124)
End of the Year	-0.030		
	(0.035)		
Full Day × End of the Year	-0.088		
	(0.065)		
Sample Size	3666	1833	1833

Notes: Heteroskedasticity-robust standard errors that allow for clustering within classrooms are in parentheses. 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. For column (1), weight status is the dependent variable. For column (2), the change in weight status is the dependent variable and weight status at the beginning of the year is an additional control variable. For column (3), weight status at the end of the year is the dependent variable.
Source: See Table 1.
* Statistically significant at 10 percent; ** Statistically significant at 5 percent; *** Statistically significant at 1 percent.

Table 4: Full-Day Attendance and Obesity By Year

	Full-Day	Obesity				
	(A)	(B)	(C)	(D)	(E)	(F)
Year = 2002	0.268***	-0.045*	-0.048*	-0.051*		-0.010
	(0.080)	(0.025)	(0.026)	(0.027)		(0.035)
Year = 2003	omitted	omitted	omitted	omitted		omitted
Year = 2004	0.114**	-0.024	-0.021		-0.004	-0.039
	(0.056)	(0.022)	(0.023)		(0.025)	(0.040)
Year = 2005	0.124**	-0.019	-0.02		omitted	0.020
	(0.054)	(0.022)	(0.022)			(0.040)
Year = 2006	0.082	-0.011	-0.015			0.000
	(0.075)	(0.022)	(0.024)			(0.033)
Includes Covariates	X		X	X	X	X
Sample Size	1833	1833	1833	709	751	553

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 (F) is the change in obesity status. The sample in column (F) is restricted to children with non-working primary caregivers. All regression control for whether the child was obese 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: IV results of the Impact of Full-Day Head Start Participation on Weight Status

	First Stage	Obese	Overweight	Underweight	BMI Z-Score
Full-Day Attendance		-0.176*	-0.160	0.072	-0.448
		(0.093)	(0.152)	(0.071)	(0.325)
Pct. Full-Day Funded Slots	0.925***				
	(0.265)				
F statistic (excluded instrument)	12.23				
Partial R-squared	0.0402				
Sample Size	1833	1833	1833	1833	1833

Notes: Heteroskedasticity-robust standard errors that allow for clustering within classrooms are in parentheses. The dependent variable is the change in the corresponding measure of weight status. The percentage of funded Head Start slots that are designated for full-day classes is an instrument for full-day attendance. Covariates include 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, family size, and year of attendance.
Source: See Table 1.
* Statistically significant at 10 percent; ** Statistically significant at 5 percent; *** Statistically significant at 1 percent.

Table 6: IV results of the Impact of Full-Day Head Start Participation on Characteristics at the Beginning of the Year

	Obese	TANF	Log (Income)	Age
Full-Day Attendance	0.105	0.027	0.100	3.086
	(0.138)	(0.197)	(0.189)	(3.192)
F statistic	12.16	12.16	12.33	12.06
Partial R-squared	0.0402	0.0401	0.0403	0.0402
Sample Size	1833	1833	1833	1833

Notes: Heteroskedasticity-robust standard errors that allow for clustering within classrooms are in parentheses. For each column, the specified variable, measured at the beginning of the Head Start year, is the dependent variable. The percentage of funded Head Start slots that are designated for full-day classes is an instrument for full-day attendance. With the exception that the alternative outcome variables are dropped from the list of covariates as appropriate, covariates include the binary measures of whether the child was obese at the beginning of the year, 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, family size, and year of attendance.
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. 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.

Sources: NHANES 2003-4, What We Eat In America 2003-4.

Appendix I: Detailed Description of the Head Start Program

This appendix provides a detailed description of the specific Head Start program in Michigan that provided the administrative data set for this research. From 2002 through 2006, 73 distinct classes were offered. Four half-day classes offered in one location were accredited by the National Association for the Education of Young Children in February 2002 and the Head Start grantee is designated as a Quality Program by the Office of Head Start.

All classes use the Building Bridges curriculum. 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.

All classes are offered and serve residents in an area of Michigan that does not include a major metropolitan area. The geographic location of full-day and half-day does not vary substantially. Many full-day classes are offered at a site that provides only full-day Head Start, but for all sites that offer a full-day class, there is a site in the same zip code that offers a half-day class.

To determine which eligible children are selected to enroll in a full-day class, children are assigned risk points. Children with the most risk points are selected to enroll, up to the number of slots available in full-day classes. Children are assigned three risk points if they are a returning child, disabled, in foster care, if the family income is below the poverty line, if the family receives TANF assistance, if there is a history of domestic violence, if there is a history of substance use, if the child is homeless, if there is a history of death or parental separation in the family, if the child is 5 years old and not ready to attend kindergarten, if a parent or sibling is disabled or chronically ill, if limited English is spoken in the home, if a parent is currently enlisted in the military, if the child was referred by PS Prevention Services, if the family moved two or more times in the past year, or if there are special circumstances. Children are assigned two risk points if the parent is a teenager, if there is only one parent in the family, if the family is socially isolated or there is low support for the family, if the family suffers a financial hardship, if the child does not have health insurance, if the child has a history of using infant mental health services, if the child has a history of depression or mental illness, if there is a family trauma not previously listed, or if a parent is incarcerated. Children are assigned one risk point if the child's mother is currently pregnant, if a person besides a parent has custody of the child, if the family size is six or more, if the parent is 40 years old or older, if the parent did not graduate from high school, if the child will be the first generation from the family to attend Head Start, or if the child was referred by another community agency.

The full-day class operates from 8am to 4pm for 5 days per week for 35 weeks per year. The class size is between 15 and 20 children and there is one teacher and one teacher's assistant in each class, except that there were two teacher's assistants in each class in 2002. Shortly after arrival, children are provided breakfast, which typically consists of a serving of dairy, meat, and fruit. In the morning, children participate in a variety of group activities such as story time. Thirty minutes are schedule for more active events such as "movement activities" and "music and movement." Children are also given 70 minutes of free time to choose their own activities. At noon, children are provided lunch, which typically consists of a serving of dairy, meat, vegetable, and fruit. In the afternoon, children rest for one hour and participate in 25 minutes of outside exercise. A snack is provide shortly before the children leave for the day that typically consists of a serving of dairy and meat or a serving of vegetable and meat.

The half-day class operates 8 to 11:30am for morning classes or from 1 to 4:30pm or 12:30 to 4pm for afternoon classes for 4 days per week for 35 weeks per year. The class size is between 15 and 17 children and there is one teacher and one teacher's assistant in each class. For morning classes, shortly after arrival, children are provided breakfast, which typically consists of a serving of dairy, meat, and fruit. Children participate in 25 minutes of outside exercise and 15 minutes of music time with dancing and singing. Children are also given 60 minutes of free time to choose their own activities. Lunch is provided shortly before the children leave for the day, which typically consists of a serving of dairy, meat, vegetable, and fruit. For afternoon classes, shortly after arrival, children are provided lunch. A snack is provide shortly before the children leave for the day that typically consists of a serving of dairy and meat or a serving of vegetable and meat. The remainder of the schedule for afternoon classes is the same as the schedule for morning classes. In 2006, 10 half-day classes were offered for 7 hours per day for 2 days per week. Children in these classes are excluded from the analysis.

The difference between morning and afternoon half-day classes within Head Start is whether the child is fed breakfast or an afternoon snack; however, there may also be differences in the morning and afternoon activities of half-day children outside of Head Start. Results based on equation (2) that restrict the sample to children who attended a half-day class show that afternoon attendance reduces obesity by 1.8 percentage points more than morning attendance, but this estimate is not measured precisely (the standard error is 0.018). The year of attendance in Head Start has no impact on whether a child attends a morning or afternoon half-day class. The percent of full-day Head Start slots has no influence on whether a child attends a morning or afternoon half-day class and is not an appropriate instrument for this comparison. Selection on unobservable characteristics for the comparison of morning and afternoon attendance is not likely to be as severe as the comparison of half and full-day attendance.

The meals served in all classes throughout the program are based on the same menu that is designed by the program's nutrition coordinator. Children are not able to bring in outside food with the exception that pre-packaged food purchased from a store with an ingredients list can be brought in for special occasions such as birthdays. Meals are served family-style in the classrooms and staff members eat with the children. Meals for children in full-day classes are required to provide one-half to two-thirds of the recommended daily allowance of vitamins, minerals, and protein. Meals for children in half-day classes are required to provide at least one-third of the recommended daily allowance of vitamins, minerals, and protein.

Appendix II: 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:

$$K = a + (B + E) \times Weight + .1K, \quad \text{(A1)}$$

where K is caloric intake in kilocalories, a and B are estimates that determine the Basal Metabolic Rate (BMR), E is energy expenditure from physical activity, and *Weight* is measured in kilograms. This equation equates calories consumed with calories expended in the steady-state. Energy is used to keep the body alive (BMR = $a + B \times Weight$), in physical activity ($E \times Weight$), and to consume calories (the thermic effect of food is $.1K$).

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

$$\Delta Weight = .9 * \Delta K / (B + E). \quad \text{(A2)}$$

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.

E is measured by how strenuous an activity is multiplied by the amount of time engaged in the activity. The strenuousness of an activity is measured as the ratio of the activity metabolic rate to the resting metabolic rate. The energy expenditure for sitting quietly is 1.0 MET and all other activities are measures of energy expenditure relative to sitting quietly. As opposed to adults, the energy expenditure from physical activity for children at these ages has not been well-studied. If we assume that energy expenditure from physical activity is independent of weight, then E would not enter in to equation (A2). However, this assumption would lead to an underestimate of the change in calories that might generate the estimated impact of full-day Head Start participation. We instead assume that average energy expenditure throughout the day is 1.5 METs and the $E = 1.5 \times 24$. This assumption is based on MET levels for adults and that preschool-aged children sleep for 12 hours per day, watch television for 3 hours per day, spend 2 hours eating (1.5 METs), engage in low energy expenditure activities (2 METs) for 5 hours, and engage in moderate energy expenditure activities (4 METs) for 2 hours.

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 20 calories per day is predicted to increase the proportion obese to 16 percent. The estimated 17.6 percentage point change in obesity corresponds to a counterfactual of 29.6 percent of obese full-day children at the end of the year. An increase of 75 calories per day is predicted to increase the proportion obese to 29.5 percent.