BEHAVIORAL RESPONSES TO EDUCATIONAL INVESTMENTS

By

David E. Frisvold

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Approved:

Professor James E. Foster

Professor Kathryn H. Anderson

Professor R. Dale Ballou

Professor William J. Collins

Professor Robert A. Margo

To my wife, Jen, and my daughter, Sierra

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

This dissertation considers individuals' behavioral responses to two major forms of public investment in education designed to increase educational opportunities: Head Start and reductions in class size.

Head Start is a comprehensive, early childhood development program designed to augment the human capital and health capital levels of disadvantaged children. Economic and medical research suggests that early investments of this type could have lasting effects on health outcomes. The second chapter of this dissertation estimates the impact of Head Start participation on childhood overweight and obesity, a significant public health problem that also has economic consequences. While Head Start is more commonly known as an educational intervention, a large part of the program includes the provision of nutritious foods and nutritional education for parents and children. The impact of Head Start participation is identified from variation in the relative availability of Head Start in each community, as measured by the number of available slots per eligible child in the local community. For black children, Head Start participation is shown to significantly reduce the likelihood of being overweight or obese.

While the second chapter demonstrates that Head Start participation can influence one measure of childhood health that is linked to adult health, Head Start participation may have a lasting impact a variety of other measures of adult health. This impact on adult health can arise for at least two reasons. First, the health component of Head Start is designed to improve children's health, which is predicted to increase adult health. Second, the cognitive goals of the program are intended to increase the education of participants, and education has been strongly linked to adult health. The third chapter (co-authored with Kathryn Anderson and James Foster) evaluates the impact of Head Start on long-term health by comparing health outcomes and behavioral indicators of adults who attended Head Start with those of siblings who did not. The results suggest that there are long-term health benefits from participation in Head Start and that these benefits result from lifestyle changes.

The fourth chapter of this dissertation examines students' behavioral responses to public investments in education that reduce the number of students in a classroom. Reductions in class size are popular among parents, teachers, and policy makers because of the commonly held notion that smaller classes lead to more individualized attention for students and greater achievement. The greatest benefits from class size reduction policies are realized when the resulting change in incentives does not reduce or crowd out the private investments in education by students. This chapter estimates the impact of class size on students' effort, as measured by the amount of time students spend on homework. The results suggest that smaller classes do not crowd out students' effort. On the contrary, black students in smaller classes spend more time on homework.

CHAPTER II

HEAD START PARTICIPATION AND CHILDHOOD OBESITY

Introduction

The prevalence of childhood obesity in the United States has risen dramatically in the last thirty years, doubling for children ages 6 to 11 and tripling for children ages 12 to 17 (Dietz, 2004). This increase is a concern for public health officials due to the association between childhood obesity and a myriad of health consequences, such as hypertension and other cardiovascular disease risk factors, type 2 diabetes, sleep apnea, and asthma (Ebbeling, Pawlak, and Ludwig, 2002). Additionally, childhood obesity is a significant determinant of adult obesity (Whitaker et al., 1997), and adult obesity is linked to an increased risk of various comorbidities (Office of the Surgeon General, 2001, table 1) and premature death (Fontaine et al., 2003; Peeters et al, 2003).

According to Cutler, Glaeser, and Shapiro (2003), the recent rise in obesity is the result of an increase in the amount of calories consumed, not a decrease in the amount of calories expended. Caloric intake has increased because the cost of food preparation has gone down. The technological innovations that led to decreases in food prices were welfare-enhancing for most of the population, but not for individuals with limited self-control. These individuals would prefer to weigh less than they do, but are not able to realize their ideal weight. For such individuals, the cost of obesity is high, as evidenced by the $30 to $50 billion spent annually on dieting (Cutler, Glaeser, and Shapiro, 2003).

The private costs of obesity are not restricted to dieting expenses. White females suffer a wage penalty as a result of obesity that is equivalent to approximately one and a half years of schooling or three years of experience (Cawley, 2000). Additionally, obese white women have lower family incomes, mainly resulting from a lower probability of marriage and lower spouse's earnings (Averett and Korenman, 1993).

The social costs of obesity are extensive; in 2000, these costs were estimated at $117 billion (Office of the Surgeon General, 2001). This figure is composed of $61 billion in direct costs associated with preventive, diagnostic, and treatment services for obesity, and $56 billion in indirect costs consisting of the value of lost productivity from illness due to obesity, and the value of lost future productivity from premature death. These costs mainly result from type 2 diabetes, coronary heart disease, and hypertension – comorbidities associated with childhood obesity (Wolf, 1998).

Given that childhood obesity leads to adult obesity, that the social costs of adult obesity are driven by diseases linked to childhood obesity, and that social investments in young children are generally more productive than similar investments in adults (Heckman and Masterov, 2004), social programs targeted towards children may be the most effective public policies in reducing obesity and increasing social welfare. Grossman's (1972) health capital model reiterates this idea – health is determined cumulatively, and early childhood investments in health can have a lasting impact. As described in Healthy People 2010, establishing behaviors that prevent obesity – healthful dietary and physical activity behaviors – should begin in childhood (U.S. Department of Health and Human Services, 2000).

To combat the rise in childhood obesity, many public health officials and researchers have advocated reforms in the public school system (e.g., Office of the Surgeon General, 2001; James et al., 2004; Dietz and Gortmaker, 2001). However, the increase in childhood obesity is evident in children as young as 4 years old (Ogden et al., 1997). Early prevention activities during the preschool years may, in fact, be the most effective (Davis and Christoffel, 1994). This period of time is influential in determining behavior patterns associated with diet and physical activity (Birch, 1999). Dietary intake and physical activity of preschoolers can account for more of the variance in body mass index than whether or not a young child's parents are obese (Klesges et al., 1995). To prevent childhood obesity, Deckelbaum and Williams (2004) suggest that preschool programs provide children with exposure to a variety of foods and flavors, assist in the development of healthy food preferences, encourage appropriate parental feeding practices, monitor the weight of children, and provide child and parent nutritional education. Head Start, the early childhood development program targeted towards disadvantaged youths, is an example of one such program.

As the cornerstone of President Lyndon Johnson's "War on Poverty," Head Start provides a comprehensive array of services to poor and disabled children to better prepare them for subsequent educational experiences. Even though the overall goal is educational, Head Start's planning committee designed the program with a variety of development services believing that nutrition, physical and mental health, parental involvement, and social services – in conjunction with early childhood education – would contribute to the educational development of participants far more than offering strictly academic instruction. Because of the program's overall goal, most evaluations have focused on educational outcomes; however, based on the menu of services offered, it is reasonable to expect that additional outcomes are influenced by Head Start participation. In particular, Head Start provides nutritious meals that encourage children to try a variety of foods, screens children for nutritional deficiencies and obesity, and emphasizes nutritional education, both for children and for parents. Based on these components of the program and the timing of these services at a critical point in child development, Head Start participation may impact childhood obesity.

Previous research on the efficacy of school-based intervention programs has demonstrated that it is possible to reduce the prevalence of childhood obesity.[1] However, these programs often serve older children than Head Start, offer less comprehensive nutritional services, and do not target disadvantaged children who are at a higher risk of childhood obesity. It is possible then that Head Start, a program not specifically designed to prevent childhood obesity, could result in larger benefits than obesity intervention programs.

This paper estimates the impact of Head Start participation on childhood overweight and obesity using data from the Panel Study of Income Dynamics and its Child Development Supplement. The key advantages of these data are that height and weight for children are measured, not self-reported, and that family background

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[1] Story (1999), in a review of school-based obesity treatment programs, finds that these interventions reduce the prevalence of childhood obesity by 10 percentage points, on average, and that these effects are generally larger for younger children. However, these programs were mostly conducted prior to 1985 when the prevalence of obesity was lower than it is today. Gortmaker et al (1999) finds that a middle-school intervention that targets behavioral modification through child education reduced the probability of being obese by roughly five percentage points. Veugelers and Fitzgerald (2005) report that a two and a half year intensive program that began in fifth grade that involved children and their families, emphasized daily physical activity, provided nutritious meals, and promoted nutritional education reduced the probability of being obese by approximately six percentage points. Because this intervention occurred in Canada, which has lower obesity rates than the United States, this intervention decreased the prevalence of childhood obesity by approximately 50 percent. All of these interventions were population-based in the since that these programs served all students at the school and the schools were not selected because they were located in community with a high prevalence of obesity.

characteristics, including parents' height and weight, are available prior to Head Start attendance.

The difficulty that arises in examining the effect of Head Start participation is that selection into Head Start is the result of choices made by parents and administrators. The determinants of these choices may be related to the future outcomes of Head Start participants and, thus, simple estimators such as OLS may lead to inconsistent estimates of the impact of Head Start participation. To overcome this problem, an instrumental variables approach is implemented. Because the outcome variables – overweight and obese – are binary and the endogenous variable – Head Start participation – is binary, a bivariate probit model is estimated. This framework allows for the unobserved determinants of overweight and obesity to be correlated with the unobserved determinants of Head Start participation. The impact of participating in Head Start is identified from an exclusion restriction based on program availability; variation in the relative availability of Head Start, as measured by the number of available slots per eligible child in the local community, influences Head Start participation, but does not directly affect overweight and obesity.

After selection into Head Start is accounted for, the results suggest that Head Start significantly reduces the probability that a participant will be overweight in later childhood. This result is driven by the impact of Head Start for black participants; black children are less likely to be overweight and less likely to be obese as a result of Head Start. Given the health and economic consequences of obesity, these results demonstrate that participation in Head Start can improve the lives of disadvantaged youths and social welfare in ways not previously established.

Background on Head Start

Head Start is a comprehensive, national, federally funded program designed to augment the human and health capital of disadvantaged children to better prepare them for subsequent educational experiences. Since its inception in 1965, Head Start has provided services to more than 22 million preschool children (Head Start Bureau, 2005). In 2004, 905,851 children attended Head Start at an average cost of $7,222 per child. Fifty-two percent of these children were 4 years old and 34 percent were 3 years old. Thirty-one percent of Head Start participants in 2004 were black, 31 percent were Hispanic, and 27 percent were white (Head Start Bureau, 2005).

Head Start is currently administered through the Head Start Bureau in the Administration for Children and Families (ACF) of the Department of Health and Human Services. Head Start appropriations, determined annually as a component of the federal budget, are earmarked for states based on the number of children less than 5 years of age in families with incomes below the poverty line. Based on the allotment of funding across states, Head Start funds are directly provided to local Head Start programs that are awarded grants by the ACF. Grants are awarded to agencies that are able to demonstrate the most cost-effective program with qualified and experienced staff that will adhere to the Head Start Performance Standards, provided that there is a sufficient need for Head Start services in the community (Head Start Bureau, 2004). While grants are awarded for only three years, previously funded agencies are given funding priority. Each grantee must contribute 20 percent of the total costs; however, this requirement can be satisfied from in-kind donations through community partnerships. Head Start programs are operated through community development agencies, local school districts, private organizations, and Indian Tribes. There were 1,604 grantees that operated 20,050 centers with 48,260 classrooms in 2004 (Head Start Bureau, 2005).

Eligibility for Head Start participation is determined primarily by family income. A child is eligible if the family's gross annual income, including unemployment compensation and other sources of transfer income, is less than or equal to the poverty line (Head Start Bureau, 2004). A child in a family whose income exceeds the poverty line 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, based on the date used by the community to determine public school eligibility. Once enrolled in Head Start, children may remain in the program until kindergarten or first grade is available in the community, provided that they continue to meet the Head Start eligibility criteria.

The service area for each Head Start program is defined in its Head Start grant application as either a county or sub-county area (e.g., census tract) – with the exception of rural programs, which often serve multiple counties – and is approved by the Department of Health and Human Services to ensure that the service area does not overlap with other Head Start programs (Head Start Bureau, 2004). Within the service area, each Head Start program must actively recruit and inform as many families with eligible children as possible. To ensure that programs are recruiting as many children as possible, the number of applications for each program must exceed the expected enrollment.

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. Additionally, children with the greatest need for Head Start services should be selected by the program administrators. This ensures that children in families with incomes farthest below the poverty line are most likely to be chosen to enroll in the program, as well as children with more severe disabilities. Children without two parents are more likely to be selected into the program than children from two parent families. Also, children in high risk families are preferentially admitted into the program. Although high risk may be defined differently across programs, this category can include children in families with substance abuse or domestic violence; children in families afflicted by a crisis such as death, separation, terminal illness, or chronic health issues; children referred into Head Start by a community agency; or other special circumstances.

Head Start provides comprehensive child development services to achieve the program's overall goal of improved school readiness. To enhance participants' cognitive skills, Head Start centers implement a curriculum that emphasizes age-appropriate literacy, numeracy, reasoning, problem-solving, and decision-making skills (Head Start Bureau, 2004). Parents are encouraged to assist in creating the center's curriculum and an individualized developmental strategy for their child. Continual assessments are conducted by the program staff to promote each child's progress.

Head Start, however, offers more than simply cognitive activities to increase participants' human capital. For example, Head Start's federal guidelines emphasize nutritional health as an essential component of child development. Nutrition services are provided because malnutrition can dampen educational growth, and nutritional problems such as iron deficiency anemia are often associated with poverty. Increasing nutrition can lead to cognitive improvements and greater educational attainment (Maluccio et al., 2005).

The nutritional aspects of Head Start's services include nutritional screening, providing healthy meals, and nutritional education. Head Start personnel determine the child's nutritional needs through nutritional assessments (height, weight, and hemoglobin/hematocrit testing) and from information about the child's and family's eating habits, and then design and implement a nutritional plan. At the beginning of each day, children who have not received breakfast prior to their arrival at a Head Start center are provided a nutritious breakfast. Children in a full-day program receive meals and snacks that provide one-half to two-thirds of their daily nutritional needs. Meal times provide the opportunity for nutritional education and children are encouraged to try a variety of foods. These Head Start guidelines are consistent with the recommendations of the American Dietetic Association (Briley and Roberts-Gray, 1999). Parents also receive training, through classes and informal discussion, on food preparation and nutrition. This helps them improve the nutritional content of the food consumed by Head Start participants and helps children develop sound nutritional habits. Parental education carries over to the home; Head Start parents frequently report discussing good nutrition and healthy foods at home with their child (Keane et al., 1996).

The services provided by Head Start have generally been successful in increasing children's educational outcomes. Head Start participation leads to short-term cognitive benefits (McKey et al., 1985; Currie and Thomas, 1995; U.S. Department of Health and Human Services, 2005) that persist throughout elementary school for white, but not black, participants (Currie and Thomas, 1995). Perhaps because of improvements in non-cognitive skills (e.g., Heckman, 1999; Blau and Currie, forthcoming), Head Start leads to sizeable longer-term educational benefits. However, these benefits accrue for whites, but not blacks. Estimates of the impact of Head Start, in comparison to other preschools, suggest that Head Start participants are 40 percentage points less likely to be held back a grade in school (Currie and Thomas, 1995), are 22 percentage points more likely to graduate high school (Garces, Thomas, and Currie, 2002), and are 19 percentage points more likely to attend college (Garces, Thomas, and Currie, 2002).

Head Start participation also results in health and social benefits, although these outcomes have received less attention in the literature than cognitive and educational outcomes. Participants are more likely to receive age-appropriate health screenings or dental examinations (Hale, Seitz, and Zigler, 1990; U.S. Department of Health and Human Services, 2005) and are 8 percentage points more likely to be immunized for measles than children who did not attend any form of preschool (Currie and Thomas, 1995). Head Start participation is also associated with a 33 to 75 percent reduction in child mortality rates (Ludwig and Miller, 2005). Additionally, Head Start participants are 17 percentage points less likely to smoke cigarettes as young adults than other preschool participants (Anderson, Foster, and Frisvold, 2004). Black Head Start participants are 12 percentage points less likely to be arrested for or charged with a crime than other preschool participants (Garces, Thomas, and Currie, 2002). Descriptive evidence, provided by parents, suggests that children and parents improve their nutritional behaviors as a result of Head Start attendance (Keane et al., 1996). These outcomes from Head Start participation suggest that the comprehensive services provided to increase the educational opportunities of disadvantaged children also lead to comprehensive benefits. In particular, it is plausible that exposure to the services of Head Start, including nutrition and nutritional education, will benefit participants by reducing the likelihood of becoming overweight or obese.

Estimation Strategy

The two outcomes of interest used to measure the impact of Head Start participation are overweight and obesity. Let Y denote these outcomes, where Y = 1 if the individual is overweight or obese, depending on the outcome, and Y = 0 otherwise. Let D be an indicator variable for whether an individual has participated in Head Start. Let Y_1 and Y_0 denote the potential outcomes for an individual if they had participated in Head Start (i.e., if D = 1) and if they had not (i.e., if D = 0).

The focus of this paper is to estimate the average effect of Head Start participation on overweight and obesity for individuals who participated in Head Start (i.e., the average treatment effect on the treated).[2] This impact of Head Start is defined as $E(Y_1 - Y_0 \mid D = 1)$. This expectation is equal to $Pr(Y_1 = 1 \mid D = 1) - Pr(Y_0 = 1 \mid D = 1)$, which is the difference between the probability that an individual who attended Head Start is overweight or obese and the probability that he would have been overweight or obese had he not attended Head Start. The identification problem that arises in estimating this treatment effect is that because Y_1 and Y_0 cannot exist for the same individual (i.e., an individual either attended Head Start or did not), the counterfactual outcome $Pr(Y_0 = 1 \mid$

[2] For a general discussion of treatment effect estimation, see Heckman, LaLonde, and Smith (1999).

D = 1) is unobservable. Instead, $Y = Y_1 \times D + Y_0 \times (1 - D)$ is observed for each individual.

The probabilities that are easily computable with cross-sectional data are $\Pr(Y_1 = 1 \mid D = 1)$ and $\Pr(Y_0 = 1 \mid D = 0)$. Under the assumption that $\Pr(Y_0 = 1 \mid D = 1) = \Pr(Y_0 = 1 \mid D = 0)$, then

$$E(Y_1 - Y_0 \mid D = 1) = \Pr(Y_1 = 1 \mid D = 1) - \Pr(Y_0 = 1 \mid D = 0),$$

and the impact of Head Start participation could be estimated by comparing the difference in the sample means of overweight and obesity rates for Head Start participants and non-Head Start participants in any nationally representative survey. However, this assumption implies that the outcomes of individuals who did not attend Head Start would be the same as Head Start participants under the hypothesized counterfactual state that these individuals had not attended Head Start (i.e., $Y_0 \perp D$). This assumption is not likely to be correct because of both observable selection and unobservable selection of individuals into the program.

Observable characteristics associated with selection into Head Start are likely to be associated with childhood obesity. As described in the previous section, poverty status and disability status are the key eligibility criteria for Head Start participation. Thus, if either poverty status or disability status is correlated with childhood obesity, then the observable determinants of Head Start participation also influence childhood obesity, and Y_0 is not independent of D. Because income constraints influence which foods are available for consumption and cheaper foods are often high in fats and caloric content, poverty status may be related to childhood obesity. Hofferth and Curtin (2005) show that children in families below the poverty line are more likely to be obese than children in families with incomes twice the poverty line. To incorporate observable selection, the impact of Head Start participation becomes $E(Y_1 – Y_0 | X, D = 1)$, where X represents observed family and individual characteristics. Under the assumption that $Pr(Y_0 = 1 | X, D = 1) = Pr(Y_0 = 1 | X, D = 0)$, then

$$E(Y_1 – Y_0 | X, D = 1) = Pr(Y_1 = 1 | X, D = 1) – Pr(Y_0 = 1 | X, D = 0).$$

This treatment effect could be estimated with a probit model. Under the specification $Pr(Y = 1) = Pr(X\beta + D\alpha + \varepsilon > 0) = \Phi(X\beta + D\alpha)$, where β and α represent the coefficients to be estimated, ε is a standard normally distributed random error term, and $\Phi(.)$ is the standard normal cdf, the impact of Head Start participation is $E(Y_1 – Y_0 | X, D = 1) = \Phi(X\beta + D\alpha) – \Phi(X\beta)$.[3]

The assumption that $Pr(Y_0 = 1 | X, D = 1) = Pr(Y_0 = 1 | X, D = 0)$ states that, after adjusting for observed individual and family background characteristics, the probability that a non-Head Start participant is overweight or obese would be the same regardless of whether the child attended Head Start (i.e., $Y_0 \perp D | X$). This assumption is unlikely to hold if unobserved behaviors that are related to childhood obesity influence whether an individual attends Head Start. Because parents choose to send their child to Head Start, it is possible that they also make other investments that could influence their child's later health and weight outcomes. For example, in 2004, 27 percent of Head Start staff members were parents of current or former Head Start participants, and over 880,000 parents volunteered with Head Start (Head Start Bureau, 2005). These parents have

[3] Alternatively, the impact of Head Start participation could be estimated using propensity score-matching. In the method of matching, individuals who are similar in observable characteristics from both treatment and control groups are paired together. The treatment effect is then the difference in outcomes for these matched individuals. Propensity score-matching reduces the dimensionality of the characteristics need to match individuals by using the probability of receiving treatment conditional on observable characteristics, which is an individual's propensity score. For an application of this technique, see Dehejia and Wahba (2002).

made a commitment to their children that could lead to a bias towards finding positive impacts from Head Start participation estimated through a probit model.[4] However, this does not seem to be likely. The decision to send a child to Head Start is not associated with other parental actions that are investments in children's health. In particular, Head Start children were not more likely to be breastfed as infants, which is linked to a variety of health benefits including lower obesity rates (Dietz, 2001), or to be properly immunized prior to Head Start attendance, in comparison to non-Head Start children.[5]

Because children selected by program administrators are the most disadvantaged of the Head Start-eligible applicants in the program's service area, it is likely that these individuals are disadvantaged across a variety of dimensions, not simply the observable characteristics that determine Head Start eligibility. If Head Start participants are more disadvantaged than their peers in ways unobservable to an econometrician and if these sources of disadvantage are related to future health and weight outcomes, then estimated average treatment effects that ignore these unobserved characteristics will be biased against finding a beneficial impact of Head Start participation. Unobserved determinants of Head Start participation include the severity of a disability, the family environment experienced by a child in a family classified as high risk, and any other characteristic that is associated with Head Start children and families, but not associated with other families with similar incomes.

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[4] Estimates based on propensity score-matching are also likely to be biased under this scenario and other situations in which unobserved behaviors that are related to childhood obesity influence whether an individual attends Head Start.

[5] The statements in this sentence are based on regression estimates (not shown) from probit models with indicator variables for having been breastfed and having been properly immunized as the outcome variables. The control variables used were the same as those displayed in Table 2.

Disability status is correlated with overweight and obesity (Rimmer and Wang, 2005). Individuals with intellectual disabilities are more likely to be obese, and individuals with more severe disabilities are even more likely to be obese (Emerson, 2005). Thus, for individuals with severe disabilities, the impact of Head Start participation estimated from a probit model that controls for only the disability status of an individual is likely to be downward biased.

A child's family environment is an important determinant of future overweight and obesity. Exposure to childhood emotional, physical, or sexual abuse and household dysfunction in childhood are associated with adverse health behaviors later in life, including severe obesity (Felitti et al., 1998). Women raised in families characterized by family tension at mealtimes or frequent parental arguments, who received little parental affection, who had limited contacts with parents, or who cared for an ill parent are more likely than other women to develop a binge eating disorder (Striegel-Moore et al., 2005), and a binge eating disorder is associated with child and adult obesity (Lamerz et al., 2005). Because individuals in an abusive family environment are more likely to be accepted in to Head Start and these individuals are also more likely to be overweight or obese later in life, estimates based on models that do not account for these relationships are likely to be biased.

Additionally, individuals who are disadvantaged across observed characteristics are also likely to be disadvantaged in a variety of unobserved characteristics (e.g., Altonji, Elder, and Taber, 2005). Some important characteristics that are not observed include parents' nutritional behaviors and parents' nutritional knowledge. Parents' nutritional behaviors influence childhood obesity because the amount of food children eat is determined by the amount of food they are served, and children do not adjust their consumption in response to the energy density of the meal (Mrdjenovic and Levitsky, 2005). Parents' nutritional knowledge is an important determinant of children's diets, especially at younger ages (Variyam et al., 2005). Head Start parents' nutritional knowledge and behaviors may differ from other parents in ways that are not captured in parents' body mass index. Therefore, estimates of the impact of Head Start participation that fail to completely account for the disadvantaged family environment of the program's participants are likely to be biased downwards.

An instrumental variables approach that accounts for the binary nature of the outcome and treatment variables is implemented to allow for the possibility that unobserved selection influences the estimated impact of Head Start participation. The probability of Head Start attendance is specified as:

$$\Pr(D = 1) = \Pr(Z\delta + \upsilon > 0),$$

and the probability of being overweight or obese is specified as:

$$\Pr(Y = 1) = \Pr(X\beta + D\alpha + \varepsilon > 0),$$

where Z and X represent observable characteristics that are independent of (υ, ε) and Z contains at least one variable that is not in X; δ, β, and α are parameters to be estimated; and υ and ε are random error terms. The assumption that υ and ε are distributed bivariate normal with $E(\upsilon) = 0$, $E(\varepsilon) = 0$, $Var(\upsilon) = 1$, $Var(\varepsilon) = 1$, and $Cov(\upsilon, \varepsilon) = \rho$ allows for the possibility that the unobserved determinants of Head Start participation are correlated with the unobserved determinants of overweight and obesity. Under this estimation strategy, which accounts for observable and unobservable selection, the impact of Head Start participation is $E(Y_1 - Y_0 \mid X, D = 1) = \Phi(X\beta + D\alpha) - \Phi(X\beta)$.

An appropriate choice for an instrument is a variable that is related to Head Start attendance, but is not directly related to overweight or obesity, which ensures that the variable is contained in Z but not X.[6] Program availability will influence the probability that a child attends Head Start, but is not likely to impact the probability that a child is overweight or obese independent of the association with Head Start attendance. Head Start is not a fully funded program, in the sense that some eligible children who apply for admission are not admitted due to funding constraints. Only about 55 percent of eligible children are able to attend the program.[7] Prior to the selection decisions of the program administrators, the probability that a child who is eligible for Head Start will attend is based on the number of available slots in the local program divided by the number of children in the service region who are eligible. Therefore, the instrument for Head Start participation is the relative availability of Head Start: the enrollment divided by the number of eligible children in a Head Start service area.

The number of funded slots available in a program is determined by the Department of Health and Human Services based on the historical evolution of funding to the local program and changes in the federal appropriations to Head Start. The number of funded positions for each grantee does not always fluctuate annually, but was likely to

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[6] A logical starting point in finding an instrument would be the eligibility criteria for Head Start; however, eligibility is determined by poverty status (constructed from family income and family size) and disability status. These variables are likely to influence the outcome variables directly and should be included in X. An additional approach to identify the treatment effect of Head Start participation is to use the discontinuity in program funding that resulted because the Office of Economic Opportunity provided grant writing assistance to the 300 poorest counties, but not other counties, prior to the initial appropriation of Head Start funds (e.g., Ludwig and Miller, 2005). While the discontinuity in funding persisted over time, it did not persist throughout the 1990s (Ludwig and Miller, 2005), and, thus, would not be appropriate for this analysis.

[7] This estimate is based on the author's calculations from data available from the Head Start Bureau and the Census Bureau. In 2004, 905,851 children attended Head Start and 4,116,000 children under age 5 lived in families below poverty. Assuming that 2/5ths of the children under age 5 are ages 3 or 4 and that income is the only determinant of eligibility, then 1,646,400 children are eligible for Head Start. Thus, about 55 percent of income-eligible children attend Head Start.

increase throughout the latter part of the twentieth century when Head Start enrollment changed from 448,464 children in 1988 to 905, 235 children in 2001 due to an over 400 percent increase in funding (Head Start Bureau, 2005). Increases in appropriations are first used to increase the quality of existing programs, and then remaining funds are distributed based on the number of eligible children not served by Head Start, which is commonly driven by changes in the population.[8] Currie and Neidell (forthcoming) report that expenditure levels of Head Start programs has no detectable effect on the observable characteristics of children selected in the program or who chose to enroll in the program. Therefore, variation in the number of Head Start openings available to a child in a given year is determined by federal legislation and the extent to which the local community was underserved by Head Start – factors that are unlikely to be related to the unobserved determinants of childhood overweight and obesity. The number of children in the community who are eligible for Head Start services is based on the local variation in the size of the population of children ages 3 through 5, and business cycle fluctuations

[8] By 1988, the Head Start program had sufficiently expanded throughout the country that almost all counties offered Head Start services. If better quality program directors are able to obtain additional funds, and better quality program directors administer higher quality programs, then funding and the number of funded slots could be related to child outcomes and childhood obesity. However, Currie and Neidell (forthcoming) find no evidence that program directors' education, experience, or salary is positively related to children's educational outcomes. If additional funds are appropriated to local programs based on the quality of the program and the quality of the program influences a family's decision to enroll their child and the outcomes from the program, then the number of funded positions in a local Head Start is not exogenous. In this case, community dummy variables could be included to control for the unobservable quality of the program. Then, the instrument identifies Head Start participation based on variation in the number of funded slots within the community. Including community fixed effects is explored in a linear IV model, but not in the bivariate probit model. Models with community fixed effects show a larger impact of Head Start participation than the linear IV results described in the appendix tables. Additional specifications include adding region dummy variables and state dummy variables to the bivariate probit models that account for endogenous selection; estimates from these specifications are similar to those presented in Tables 3 and 4.

that influence the number of families in poverty status, factors that are likely to be exogenous for a Head Start participant.[9]

Data

The impact of Head Start participation on childhood overweight and obesity is evaluated using data from the Panel Study of Income Dynamics (PSID) and its Child Development Supplement (CDS). The PSID is a longitudinal study of U.S. households and individuals that began in 1968 with a national sample of approximately 4,800 households. Members of these households, their offspring, and current co-residents have been interviewed on an annual or biennial basis since the inception of the PSID. In 1997, the CDS collected additional information about PSID parents and their children ages 0-12 years. A total of 2,394 families and 3,563 children were interviewed. In 2002, 2,021 families and 2,907 children ages 5 to 19 years were re-interviewed.

A variety of health, education, and childcare variables are collected in the CDS, but most importantly for this research, Head Start participation was identified and height

[9] Ruhm (2000, 2005) finds that temporary economic downturns are related to better health behaviors for adults, largely due to declining work hours. While macroeconomic conditions are not likely to directly influence children's health behaviors, temporary economic downturns might influence childhood obesity if parents reduce their work hours and spend more time preparing healthier meals, ignoring the influence of income on food purchases and obesity. Economic recessions would increase the number of children eligible for Head Start as the number of children in families below the poverty line rises, which would decrease the value of the instrument. Thus it could be the case that the relative availability of Head Start influences the probability that a child attends Head Start and has an independent effect on childhood obesity. Based on the results described later, a decrease in the relative availability of Head Start would decrease the probability that a child attends Head Start, and would increase the probability that a child is obese. On the other hand, a decrease in the relative availability of Head Start that is driven by economic downturns could have a direct decrease in the probability that a child is obese because of the influence of the macroeconomy on work hours and parental behavior. Thus, business cycle fluctuations would have a larger impact on childhood obesity if the business cycle only influenced the size of the population eligible for Head Start. So if it is the case that temporary economic downturns are related to the relative availability of Head Start and childhood obesity, then the estimated results understate the true impact of Head Start participation. It is important to note, however, that, as of 1995, only 28 percent of Head Start parents were employed full time and 17 percent were employed part-time (Blau and Currie, forthcoming).

and weight were measured by the interviewer in 2002.[10] Objective measurements of height and weight are important because self-reported measures of weight are subject to reporting error (Cawley, 2000). The outcome variables for this analysis – a binary variable equal to one if the child is overweight or obese and a binary variable equal to one if the child is obese – are determined using the international standards for childhood overweight and obesity established by Cole et al. (2000).[11] These age- and gender-specific cutoffs for children at least 2 years old are based on body mass index, a measure which is correlated with body fat and is recommended by the National Heart, Lung, and Blood Institute for use in clinical practice and epidemiological studies (National Heart, Lung, and Blood Institute, 1998).

Individual characteristics included in both X and Z are race (white, black, Hispanic, and other race), birth weight and birth weight squared, a binary variable indicating that the individual is the oldest child, and a binary variable equal to one if the individual is disabled. Measures of parents' marital status (single, married, divorced, and widowed) and residence (suburban, urban, and rural) are also included. Mothers' and fathers' body mass index and their squared terms, measured in 1986 prior to children

[10] Height and weight were measured without shoes on and with empty pockets. If the child refused to be measured, then height and weight were self-reported by either the child or the parent. In the analysis sample of 2,301 children, the height and weight of 22 children were self-reported instead of being measured by the interviewer. Removing these 22 children from the sample does not qualitatively change the results displayed in Tables 3 and 4. Black children who attended Head Start were 33.2 percentage points (s.e.=0.162) and 32.9 percentage points (s.e.=0.161) less likely to be overweight or obese compared to other black children.

[11] Alternative measures of child overweight and obesity developed by the Centers for Disease Control and Prevention are a body mass index above the 85th percentile and the 95th percentile, respectively. These measures are often referred to in the medical literature as "at risk of overweight" and "overweight." Using these measures decreases the prevalence of overweight but increases the prevalence of obesity in this sample. For the alternative measures of child overweight and obesity, black children who attended Head Start were 30.1 percentage points (s.e.=0.196) and 33.1 percentage points (s.e.=0.140) less likely to be overweight or obese compared to other black children. The point estimate for overweight is measured with less precision using this alternative definition of overweight (and is smaller); however, the estimate for all children pooled together is very similar for both measures – Head Start participants are 25.6 percentage points (s.e.=0.073) less likely to be overweight compared to children who did not attend Head Start.

being age-eligible for Head Start attendance, are included. Body mass index measures prior to Head Start attendance are important because current measures of parental BMI could be influenced by the child's Head Start participation.[12] Family income and family size are averaged over the years when the child was ages 3 through 5. Additionally, an indicator variable equal to one if the father was not present during the ages 3 through 5 is included.

The relative availability of Head Start when the child was 3 and 4 years old – the percent of eligible children in the community who attended Head Start – is calculated based on enrollment figures for each Head Start program in the Head Start Program Information Reports and the number of children in poverty in the U.S. Census Bureau's Small Area Income and Poverty Estimates. This measure is then linked to the PSID and CDS data through the county identifying codes in the restricted-access PSID geocode file.[13]

For an individual to be included in the analysis sample, the child must have height and weight information in the 2002 CDS, information about Head Start attendance, have been a member of a responding family to the PSID at age 3 or 4, and report the county of residence at age 3 or 4. These sample restrictions yield 2,301 children. Missing data for the other variables are imputed using linear regression based on the control variables with non-missing data.[14]

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[12] If the nutritional education provided to parents influences their nutritional behavior, then current measures of body mass index are an outcome of the child's Head Start participation, as opposed to an exogenous determinant of the child's probability of being overweight or obese.

[13] Further information about the construction of each variable is available in the data appendix.

[14] Five missing observations were imputed for family income, 19 for the oldest sibling dummy, 3 for urbanicity, 109 for mothers' education, 598 for fathers' education, 414 for mothers' body mass index, 809 for fathers' body mass index, 2 for disability, and 67 for birth weight. The high numbers of missing observations for the fathers' variables are present because 31 percent of the sample did not have a father as

Table 1 describes the characteristics of the sample and displays the differences between Head Start participants and non-Head Start participants. The sample means, with standard errors in brackets, are weighted by the 2002 CDS survey weight to be nationally representative of children ages 5 through 19. These data show that Head Start participants are more likely to be overweight and obese than non-Head Start participants. If the assumption $\Pr(Y_0 = 1 \mid D = 1) = \Pr(Y_0 = 1 \mid D = 0)$ was true, then this comparison between sample means would suggest that Head Start worsens the health of participants. However, it is also shown in Table 1 that Head Start participants are less likely to be the oldest child, more likely to have a disability, and less likely to have married parents. Additionally, Head Start participants were raised in larger families with lower incomes, with less educated parents, with mothers with a higher body mass index, and with fathers less likely to be present. These differences in individual and family characteristics highlight the need to control for observable characteristics to determine the impact of Head Start participation.

Head Start participants are also more likely to be black. Because the prevalence of overweight and obesity differs by race and the impact of Head Start participation differs by race for educational and social outcomes (Garces, Thomas, and Currie, 2002), the impact of Head Start participation on overweight and obesity is also examined separately by race. The descriptive statistics of blacks and whites are included in Table 1. Blacks are more likely than whites to be overweight and obese, and are disadvantaged, in comparison to whites, based on family background characteristics.

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part of the family during the preschool years. Additionally, five missing observations were imputed for race; these five individuals were not included in the race-specific samples analyzed in the next section.

Table 1: Descriptive Statistics

	All	Head Start	No Head Start	Black	White
Overweight	0.332	0.420	0.320	0.408	0.306
	[0.013]	[0.040]	[0.013]	[0.028]	[0.015]
Obese	0.144	0.189	0.137	0.193	0.127
	[0.010]	[0.032]	[0.010]	[0.022]	[0.011]
BMI	20.749	21.537	20.644	22.409	20.543
	[0.143]	[0.404]	[0.153]	[0.322]	[0.172]
Head Start	0.118	1.000	0.000	0.381	0.045
	[0.009]			[0.029]	[0.007]
Black	0.166	0.535	0.116	1.000	0.000
	[0.009]	[0.041]	[0.007]		
Hispanic	0.075	0.128	0.068	0.000	0.000
	[0.008]	[0.031]	[0.008]		
Other Race	0.055	0.068	0.053	0.000	0.000
	[0.007]	[0.025]	[0.007]		
Birth Weight	119.864	119.230	119.948	112.655	121.700
	[0.532]	[1.694]	[0.559]	[1.133]	[0.632]
Oldest	0.349	0.242	0.364	0.296	0.366
	[0.013]	[0.030]	[0.014]	[0.024]	[0.015]
Disability	0.149	0.270	0.132	0.160	0.147
	[0.010]	[0.037]	[0.010]	[0.023]	[0.012]
Urban	0.381	0.313	0.390	0.451	0.329
	[0.013]	[0.035]	[0.014]	[0.027]	[0.015]
Rural	0.039	0.035	0.040	0.017	0.047
	[0.005]	[0.016]	[0.006]	[0.007]	[0.007]
Married	0.760	0.468	0.798	0.401	0.849
	[0.012]	[0.040]	[0.012]	[0.027]	[0.012]
Widowed	0.019	0.031	0.017	0.049	0.011
	[0.004]	[0.013]	[0.004]	[0.012]	[0.004]
Divorced	0.142	0.209	0.133	0.208	0.124
	[0.009]	[0.031]	[0.010]	[0.021]	[0.011]
Family Income	60.061	23.178	64.983	30.902	69.654
	[1.309]	[1.313]	[1.420]	[1.376]	[1.659]
Family Size	4.206	4.478	4.170	4.320	4.145
	[0.031]	[0.119]	[0.031]	[0.093]	[0.032]
Father Not Present	0.234	0.593	0.186	0.629	0.1406
	[0.012]	[0.039]	[0.012]	[0.026]	[0.012]
Mother’s Education	13.141	11.460	13.365	12.100	13.665
	[0.065]	[0.187]	[0.067]	[0.126]	[0.064]
Father’s Education	13.070	11.129	13.330	11.612	13.694
	[0.070]	[0.154]	[0.073]	[0.124]	[0.073]
Mother’s BMI	23.610	25.747	23.325	26.629	22.714
	[0.125]	[0.308]	[0.134]	[0.333]	[0.137]
Father’s BMI	25.696	25.608	25.707	26.106	25.559
	[0.092]	[0.211]	[0.100]	[0.181]	[0.120]
Female	0.501	0.443	0.509	0.439	0.509
	[0.014]	[0.040]	[0.014]	[0.027]	[0.016]
Age	12.038	11.521	12.107	12.701	12.228
	[0.102]	[0.274]	[0.110]	[0.183]	[0.122]
Relative Availability	0.410	0.466	0.402	0.431	0.407
of Head Start	[0.006]	[0.018]	[0.006]	[0.013]	[0.007]
Sample Size	2301	414	1887	973	1138

Notes: Weighted means with standard errors in brackets. The sample in the second column includes all children in the 2002 Child Development Supplement to the Panel Study of Income Dynamics (PSID) with information on Head Start attendance, body mass index, and county of residence at age 3 or 4. The sample in the third and fourth columns is the subset of individuals who attended Head Start and who did not. The sample in the fifth and sixth columns is the subset of black and white individuals. See text or data appendix for further information about the definitions of these variables.

Sources: PSID, PSID Geocode file, Child Development Supplement to the PSID, Head Start Program Information Reports, and U.S. Census Bureau Small Area Income and Poverty Estimates

Results

Table 2 displays probit estimates of the relationship between Head Start participation and childhood overweight and obesity that do not include an instrument for Head Start participation.[15] The reported coefficients are marginal effects. These results demonstrate that under the assumption $Pr(Y_0 = 1 \mid X, D = 1) = Pr(Y_0 = 1 \mid X, D = 0)$, Head Start participation has no statistically significant impact on the probability that an individual is overweight or obese.

Table 3 displays the bivariate probit estimates that identify the impact of Head Start participation by using the relative availability of Head Start to instrument for participation in the program.[16] The average treatment effect on the treated is a reduction of 24.9 percentage points (s.e.=0.075) in the probability of being overweight for all individuals. The estimate of ρ is positive and statistically significant, which means that the unobserved characteristics that influence Head Start participation are positively correlated with the unobserved determinants of overweight. This is consistent with the idea that the children who are selected into the program are the most disadvantaged of the eligible children in both observed and unobserved characteristics.

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[15] Estimation of the average treatment effect on the treated using propensity score-matching yields similar results to the average treatment effect on the treated based on the probit estimates reported in Table 2.

[16] These estimates do not include age and gender because both age and gender are incorporated into the definitions of childhood overweight and obesity. When age and gender are included in the models, neither variable has a significant impact on overweight or obesity. However, older children are significantly less likely to have attended Head Start than younger children. This result occurs because of the large increases in Head Start funding that occurred throughout the 1990s, which lead to greater numbers of children enrolling in the program. The increases in enrollment are an exogenous source of variation that is captured by the instrument and is unrelated to childhood overweight and obesity. However, it is possible that the time trend in Head Start enrollment that underlies the age variable is related to time trends in childhood overweight and obesity. Including age and gender in the models, Head Start participants are 22.2 percentage points (s.e.=0.077) less likely to be overweight. Black Head Start participants are 26.2 percentage points (s.e.=0.176) and 32.9 percentage points (s.e.=0.161) less likely to be overweight or obese compared to other black children.

Table 2: Probit Estimates of the Relationship between Head Start Participation and Overweight/Obesity

	Overweight			Obese		
	All	Black	White	All	Black	White
Head Start	-0.000	0.003	0.019	0.009	0.013	-0.025
	[0.030]	[0.039]	[0.069]	[0.022]	[0.031]	[0.035]
Black	0.079			0.050		
	[0.031]			[0.021]		
Hispanic	0.043			0.052		
	[0.061]			[0.040]		
Other Race	0.025			0.015		
	[0.055]			[0.040]		
Birth Weight	0.002	0.003	0.001	-0.001	-0.000	-0.001
	[0.003]	[0.004]	[0.004]	[0.002]	[0.003]	[0.002]
Birth Weight ^{2}	-0.004	-0.294	-0.008	0.717	0.349	0.755
	[1.180]	[1.800]	[1.700]	[0.735]	[1.200]	[0.956]
Oldest	-0.002	-0.031	0.022	-0.005	-0.036	0.029
	[0.022]	[0.037]	[0.030]	[0.015]	[0.028]	[0.018]
Disability	0.046	0.080	0.011	0.034	0.083	0.003
	[0.030]	[0.051]	[0.039]	[0.021]	[0.044]	[0.026]
Urban	-0.021	-0.050	0.008	-0.025	-0.033	-0.019
	[0.025]	[0.036]	[0.036]	[0.017]	[0.028]	[0.021]
Rural	0.050	0.258	-0.003	0.019	0.182	-0.039
	[0.071]	[0.179]	[0.082]	[0.047]	[0.186]	[0.044]
Married	0.083	0.066	-0.147	0.035	0.051	-0.112
	[0.040]	[0.054]	[0.150]	[0.028]	[0.043]	[0.102]
Widowed	0.060	0.080	-0.212	0.014	0.031	-0.076
	[0.085]	[0.111]	[0.093]	[0.056]	[0.079]	[0.036]
Divorced	0.043	0.047	-0.163	0.042	0.073	-0.073
	[0.042]	[0.051]	[0.102]	[0.033]	[0.046]	[0.039]
Family Income	0.001	0.004	0.000	0.001	0.000	0.001
	[0.001]	[0.002]	[0.001]	[0.001]	[0.002]	[0.001]
Family Income ^{2}	-0.153	-1.660	-0.015	-1.060	0.197	-0.953
	[0.147]	[1.440]	[0.149]	[0.425]	[1.240]	[0.463]
Family Size	-0.020	-0.027	-0.010	-0.021	-0.032	-0.007
	[0.010]	[0.013]	[0.017]	[0.007]	[0.011]	[0.011]
Father Not Present	0.019	0.074	0.004	-0.010	-0.032	0.017
	[0.033]	[0.048]	[0.051]	[0.024]	[0.037]	[0.036]
Mother's Education	-0.004	-0.014	-0.005	-0.007	-0.010	-0.005
	[0.007]	[0.012]	[0.010]	[0.005]	[0.009]	[0.006]
Father's Education	-0.005	0.013	-0.013	0.002	0.005	0.000
	[0.007]	[0.013]	[0.009]	[0.005]	[0.009]	[0.005]
Mother's BMI	0.038	0.058	0.032	0.031	0.050	0.021
	[0.008]	[0.021]	[0.010]	[0.008]	[0.015]	[0.007]
Mother's BMI ^{2}	-0.390	-0.677	-0.306	-0.358	-0.596	-0.237
	[0.112]	[0.347]	[0.105]	[0.120]	[0.241]	[0.085]
Father's BMI	0.041	0.002	0.061	0.012	0.004	0.012
	[0.013]	[0.023]	[0.022]	[0.008]	[0.015]	[0.009]
Father's BMI ^{2}	-0.479	0.208	-0.811	-0.105	0.035	-0.134
	[0.195]	[0.380]	[0.372]	[0.120]	[0.237]	[0.122]
Observations	2301	973	1138	2301	973	1138

Notes: The reported coefficients are the estimated marginal effects from a probit model. Heteroskedasticity-robust standard errors in brackets allow for clustering within households. The coefficients and standard errors for birth weight^2 and family income^2 are multiplied by 10^5. The coefficients and standard errors for mother's BMI^2 and father's BMI^2 are multiplied by 10^3.
Sources: See Table 1.

Table 3: Bivariate Probit Estimates of the Relationship between Head Start Participation and Overweight

	All		Black		White	
Dependent Variable	Head Start	Overweight	Head Start	Overweight	Head Start	Overweight
ATT	-0.249		-0.334		-0.174	
	[0.075]		[0.157]		[0.220]	
Head Start		-0.705		-0.950		-0.495
		[0.223]		[0.471]		[0.659]
Relative Availability of Head Start	0.772		0.584		1.582	
	[0.157]		[0.185]		[0.339]	
Black	0.658	0.297				
	[0.107]	[0.085]				
Hispanic	0.245	0.071				
	[0.217]	[0.143]				
Other Race	0.286	0.144				
	[0.195]	[0.162]				
Birth Weight	-0.009	0.002	-0.013	0.002	-0.001	0.003
	[0.007]	[0.007]	[0.007]	[0.010]	[0.018]	[0.012]
Birth Weight ^{2}	0.051	0.008	0.066	0.015	0.012	0.001
	[0.030]	[0.031]	[0.032]	[0.044]	[0.073]	[0.049]
Oldest	0.146	0.011	0.159	-0.028	0.294	0.072
	[0.083]	[0.060]	[0.104]	[0.096]	[0.194]	[0.087]
Disability	0.530	0.195	0.431	0.291	0.799	0.071
	[0.115]	[0.084]	[0.149]	[0.135]	[0.209]	[0.122]
Urban	-0.069	-0.074	-0.084	-0.164	0.171	0.027
	[0.094]	[0.067]	[0.111]	[0.093]	[0.209]	[0.104]
Rural	-0.146	0.116	0.075	0.618	-0.622	-0.033
	[0.261]	[0.201]	[0.461]	[0.485]	[0.496]	[0.245]
Married	0.080	0.150	0.055	0.155	0.094	-0.434
	[0.125]	[0.111]	[0.142]	[0.136]	[0.449]	[0.379]
Widowed	-0.380	0.030	-0.229	0.105	-6.781	-0.907
	[0.210]	[0.214]	[0.231]	[0.264]	[0.439]	[0.541]
Divorced	-0.027	0.032	-0.085	0.059	-0.076	-0.564
	[0.129]	[0.109]	[0.143]	[0.128]	[0.487]	[0.379]
Family Income	-0.032	-0.001	-0.029	-0.003	-0.036	-0.001
	[0.003]	[0.002]	[0.012]	[0.009]	[0.007]	[0.002]
Family Income ^{2}	0.050	0.001	0.000	0.014	0.058	0.001
	[0.005]	[0.004]	[0.185]	[0.051]	[0.011]	[0.005]
Family Size	0.109	-0.034	0.088	-0.034	0.213	-0.016
	[0.034]	[0.027]	[0.037]	[0.037]	[0.092]	[0.052]
Father Not Present	0.279	0.128	0.325	0.265	0.326	0.046
	[0.102]	[0.090]	[0.123]	[0.126]	[0.243]	[0.152]
Mother's Education	-0.042	-0.019	-0.042	-0.040	-0.035	-0.020
	[0.026]	[0.018]	[0.035]	[0.027]	[0.059]	[0.029]
Father's Education	0.007	-0.013	0.036	0.037	-0.036	-0.040
	[0.026]	[0.019]	[0.035]	[0.031]	[0.060]	[0.027]
Mother's BMI	0.108	0.108	0.125	0.167	0.070	0.092
	[0.046]	[0.020]	[0.048]	[0.043]	[0.046]	[0.027]
Mother's BMI ^{2}	-0.152	-0.112	-0.180	-0.203	-0.067	-0.089
	[0.075]	[0.029]	[0.073]	[0.069]	[0.053]	[0.030]
Father's BMI	-0.116	0.088	-0.183	-0.047	0.083	0.167
	[0.051]	[0.036]	[0.066]	[0.071]	[0.167]	[0.063]
Father's BMI ^{2}	0.132	-0.102	0.240	0.117	-0.211	-0.223
	[0.078]	[0.055]	[0.100]	[0.111]	[0.294]	[0.103]
Constant	-0.140	-3.886	1.252	-2.710	-3.420	-4.011
	[1.094]	[0.807]	[1.320]	[1.609]	[2.915]	[1.337]
ρ	0.452		0.595		0.337	
	[0.133]		[0.288]		[0.353]	
Observations	2301		973		1138	

Notes: Heteroskedasticity-robust standard errors in brackets allow for clustering within households. To identify these models, the Relative Availability of Head Start is used to determine Head Start participation, but not overweight. The coefficients and standard errors for birth weight^2 and family income^2 are multiplied by 10^3. The coefficients and standard errors for mother's BMI^2 and father's BMI^2 are multiplied by 10^2.
Sources: See Table 1.

After dividing the sample by race, it becomes evident that the previous result holds strongly among black children, but is weaker among whites. Black Head Start participants are 33.4 percentage points (s.e.=0.157) less likely to be overweight during the ages of 5 through 19 than black children who did not attend Head Start, holding other characteristics fixed. The estimate of the correlation coefficient is 0.595 with a standard error of 0.288. The corresponding heteroskedasticity-robust Wald statistic used to test the null hypothesis that the population correlation parameter is zero is 2.366; based on the chi-square distribution with one degree of freedom, the null hypothesis cannot be rejected for a level of significance less than 0.124. While this is not statistically significant at conventional levels, the size of the correlation estimate suggests that there is a relationship between υ and ε and the bivariate probit model should not be rejected in favor of the probit estimates.

Table 4 displays the estimates of the bivariate probit model for the relationship between Head Start participation and childhood obesity that includes the instrument.[17] The average treatment effect on the treated for all individuals is not statistically different from zero, but after examining this relationship separately for black and white children, a

[17] One concern that arises because of the Head Start eligibility criteria is that, as evidenced in the descriptive statistics in Table 1, the Head Start (treatment) group is sufficiently different from the non-Head Start (control) group that regression methods are not able to adequately adjust across these two groups to elicit comparisons between a child who attended Head Start and an otherwise similar child who did not attend. To address this concern, the propensity score that an individual would attend Head Start is estimated and individuals not included in the common support are removed from the analysis sample. This insures that the Head Start and non-Head Start samples more closely overlap. The region of common support based on the propensity score is [0.0015, 0.8735]. This removed 310 children with propensity scores below the region of common support and one child with a propensity score above the region of common support. Estimates of the impact of Head Start participation using bivariate probit models for this restricted sample differed little from the estimates reported in Tables 3 and 4. Black children who attended Head Start were 33.9 percentage points (s.e.=0.167) and 33.8 percentage points (s.e.=0.154) less likely to be overweight or obese compared to other black children. Restricting the sample to individuals who were eligible for Head Start reduces the sample of blacks to 628 individuals. The point estimates for this sample are larger in absolute terms (-0.495 for overweight and -0.434 for obesity), but only the estimate for overweight is statistically significant.

Table 4: Bivariate Probit Estimates of the Relationship between Head Start Participation and Obesity

	All		Black		White	
Dependent Variable	Head Start	Obese	Head Start	Obese	Head Start	Obese
ATT	-0.089		-0.332		0.040	
	[0.156]		[0.158]		[0.351]	
Head Start		-0.340		-1.167		0.142
		[0.606]		[0.491]		[1.217]
Relative Availability	0.755		0.563		1.484	
of Head Start	[0.166]		[0.186]		[0.349]	
Black	0.671	0.268				
	[0.110]	[0.118]				
Hispanic	0.284	0.241				
	[0.201]	[0.177]				
Other Race	0.225	0.067				
	[0.224]	[0.178]				
Birth Weight	-0.009	-0.006	-0.013	-0.006	0.001	-0.006
	[0.007]	[0.008]	[0.007]	[0.009]	[0.019]	[0.013]
Birth Weight ^{2}	0.050	0.036	0.000	0.000	-0.001	0.042
	[0.032]	[0.033]	[0.000]	[0.000]	[0.075]	[0.054]
Oldest	0.136	-0.013	0.156	-0.056	0.337	0.156
	[0.085]	[0.069]	[0.104]	[0.104]	[0.208]	[0.106]
Disability	0.531	0.188	0.422	0.379	0.818	-0.000
	[0.116]	[0.114]	[0.140]	[0.133]	[0.206]	[0.163]
Urban	-0.080	-0.121	-0.103	-0.160	0.184	-0.112
	[0.097]	[0.077]	[0.114]	[0.097]	[0.213]	[0.120]
Rural	-0.111	0.080	0.136	0.496	-0.512	-0.210
	[0.277]	[0.215]	[0.481]	[0.489]	[0.509]	[0.246]
Married	0.081	0.141	0.055	0.162	0.183	-0.501
	[0.126]	[0.133]	[0.145]	[0.143]	[0.507]	[0.403]
Widowed	-0.341	0.008	-0.255	-0.008	-6.931	-0.641
	[0.210]	[0.244]	[0.244]	[0.233]	[0.623]	[0.600]
Divorced	-0.017	0.145	-0.094	0.152	0.064	-0.525
	[0.131]	[0.137]	[0.143]	[0.150]	[0.537]	[0.401]
Family Income	-0.033	0.003	-0.029	-0.016	-0.038	0.008
	[0.003]	[0.007]	[0.011]	[0.010]	[0.007]	[0.007]
Family Income ^{2}	0.049	-0.030	0.000	0.000	0.060	-0.060
	[0.006]	[0.031]	[0.000]	[0.000]	[0.011]	[0.035]
Family Size	0.108	-0.082	0.085	-0.061	0.197	-0.046
	[0.034]	[0.036]	[0.036]	[0.052]	[0.092]	[0.068]
Father Not Present	0.269	-0.012	0.312	0.030	0.300	0.081
	[0.102]	[0.115]	[0.119]	[0.143]	[0.240]	[0.196]
Mother’s Education	-0.041	-0.035	-0.053	-0.040	-0.014	-0.029
	[0.027]	[0.023]	[0.040]	[0.031]	[0.067]	[0.037]
Father’s Education	0.009	0.011	0.043	0.028	-0.059	0.004
	[0.026]	[0.021]	[0.035]	[0.031]	[0.068]	[0.030]
Mother’s BMI	0.105	0.141	0.111	0.195	0.057	0.116
	[0.044]	[0.035]	[0.048]	[0.044]	[0.046]	[0.039]
Mother’s BMI ^{2}	-0.148	-0.165	-0.002	-0.002	-0.051	-0.133
	[0.071]	[0.054]	[0.001]	[0.001]	[0.050]	[0.049]
Father’s BMI	-0.128	0.044	-0.184	-0.057	0.000	0.072
	[0.051]	[0.041]	[0.072]	[0.070]	[0.190]	[0.051]
Father’s BMI ^{2}	0.154	-0.034	0.002	0.001	-0.073	-0.078
	[0.075]	[0.058]	[0.001]	[0.001]	[0.321]	[0.069]
Constant	0.066	-3.709	1.625	-2.069	-2.013	-3.573
	[1.066]	[1.055]	[1.356]	[1.876]	[2.961]	[1.355]
ρ	0.236		0.757		-0.175	
	[0.362]		[0.302]		[0.619]	
Observations	2301		973		1138	

Notes: Heteroskedasticity-robust standard errors in brackets allow for clustering within households. To identify these models, the Relative Availability of Head Start is used to determine Head Start participation, but not obesity. The coefficients and standard errors for birth weight^2 and family income^2 are multiplied by 10^3. The coefficients and standard errors for mother’s BMI^2 and father’s BMI^2 are multiplied by 10^2.
Sources: See Table 1.

different picture of the impact of Head Start participation emerges. Black children who participated in Head Start are 33.2 percentage points (s.e.=0.158) less likely to be obese than other black children. Once again, the correlation coefficient for the error terms is large (0.757), although not statistically significant for significance levels less than 0.161.

While these results are significant, their credibility rests on the validity of the instrument. This requires that the relative availability of Head Start is correlated with Head Start participation but not otherwise correlated with the unobserved determinants of childhood overweight and obesity. No statistical tests of these assumptions have been designed specifically for the bivariate probit model; therefore, these assumptions are tested in a linear IV model.[18] Within this framework, the F statistic on the excluded instrument – based on a linear regression of Head Start participation on Z – is 18.32 for all children, 11.46 for black children, and 8.62 for white children. This suggests that the percent of eligible children in the community who attend Head Start is strongly correlated with whether a child participates in Head Start. Thus, there is not a weak instrument problem (Staiger and Stock, 1997). A test of overidentifying restrictions, which jointly tests the hypotheses of correct model specification and that the excluded instruments are not correlated with the error term, is not available, however, for the case where there is one endogenous variable and one excluded instrument.

A concern with the bivariate probit model is whether the linearity and normality assumptions or the exclusion restriction is driving the identification of the estimated treatment effect of Head Start participation (Altonji, Elder, and Taber, 2005b). If the linearity and normality assumptions of the model are the primary source of identification, then the use of a weak instrument can lead to seemingly precise estimates of the

[18] Linear IV results are available in Appendix Tables 1 and 2.

treatment effect. Following Altonji, Elder, and Taber (2005b), I replace the relative availability of Head Start with a weak instrument to see how the estimated impact of Head Start participation changes. If the estimated treatment effect does not change significantly, then this suggests that identification results primarily from the functional form assumptions, not from the instrument. To implement this specification check, the log of the average cost of childcare in the state is used as an instrument instead of the relative availability of Head Start. The log of the average cost of childcare in the state is likely to be related to Head Start participation because Head Start may be viewed by some parents as a substitute for childcare and this cost is unlikely to be related in other ways to childhood overweight and obesity. This instrument is not included in the main specifications because including it is a weak predictor of Head Start participation. For the estimates of childhood obesity for the black sample, with the log of average child care costs in the state as the only instrument, the coefficient for child care costs is -0.364 (s.e.=0.605) and the coefficient for Head Start is -0.752 (s.e.=2.315), which leads to an ATT of -0.207 with a standard error of 0.666. The coefficient is smaller and is not estimated precisely, suggesting that the primary source of identification in the bivariate probit model is the instrument (the relative availability of Head Start) and not the functional form assumptions of the model.

Discussion

The results describing a significant impact on childhood overweight and obesity for black Head Start participants, but not whites, raise questions about why these results differ by race. Previous research that has evaluated the impact of Head Start found that the benefits, in terms of cognitive achievement, persist for whites, but not for blacks. Interestingly, splitting the sample of black children into two groups – ages 5 to 12 and ages 12 to 19 – and estimating a bivariate probit model for each age group reveals that results displayed in Tables 3 and 4 do not persist.[19] Younger black children who attended Head Start were 46.8 percentage points (s.e.=0.069) and 44.4 percentage points (s.e.=0.030) less likely to be overweight or obese compared to other black children ages 5 to 12. However, there was no statistically significant effect of Head Start participation on the probability of overweight or obesity for older black children.[20] These results for overweight and obesity suggest that, similarly to achievement scores, Head Start participation leads to a substantial initial benefit that does not persist.

One possible explanation for the results that Head Start participation reduces the probability of becoming overweight or obese for blacks and that this health benefit does not persist into an individual's teenage years is that overweight and obesity are related to cognitive achievement. For blacks, the low quality of schools attended after Head Start causes the achievement benefits from Head Start participation to be short-lived (Currie and Thomas, 2000). It is well established that education and health are related, and Chou, Grossman, and Saffer (2002) demonstrate that schooling and obesity are related. It is less clear, however, whether childhood achievement scores are related to obesity. Perhaps, Head Start increases the nutritional education of participants, which positively

[19] For this sample, there are 484 black children older than 5 years old and less than 12 years old and 489 black children at least 12 years old.
[20] The point estimate of the average treatment effect on the treated for overweight was -0.070 with a standard error of 0.199; the point estimate for obesity was 0.041 with a standard error of 0.260.

influences nutritional behavior, but that the low quality of subsequent schooling erases the gains achieved during Head Start.[21]

An additional explanation that is similar to the one offered above is that the low quality schools that blacks attend after Head Start offer food services that are lacking in nutritional value. Anderson and Butcher (2005) document that schools under financial pressure are more likely to make junk foods available through vending machines or school stores, are more likely to grant a soft drink manufacturer exclusive rights to supply their soft drink to students, and are more likely to allow soda or snack food advertising. The authors demonstrate that these food policies, particularly the availability of junk food, lead to an increase in children's body mass index. Thus, if black Head Start participants attend primary or secondary schools under financial pressure, then the food policies and the quality of the school food of the subsequent schools could counteract the Head Start benefits. However, these explanations that emphasize the influence of later schooling do not clarify why the reduced rates of childhood overweight and obesity do not occur for whites.[22]

An alternative explanation for the racial differences in the benefits of Head Start participation and the reduction in benefits over time is that Head Start provides nutritious foods, which may compensate for the lack of access to healthy foods in poor, black

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[21] Unfortunately, the nutritional knowledge of children is not available in the dataset used for this analysis. Nutritional knowledge is available for parents only in 1999. Descriptive analysis suggests that, for blacks, the nutritional knowledge of parents of Head Start child is not statistically different from that of other parents. The similarity in nutritional knowledge may result because the nutritional education programs in Head Start increased the knowledge of Head Start parents to be comparable to other parents. If this were the case, then the increased nutritional knowledge did not strongly influence parents' nutritional behavior. Analysis of the BMI of parents demonstrates no statistical difference in the change in BMI after children attend Head Start (1999) versus prior to children attending Head Start (in 1986) for black Head Start parents compared to other black parents.

[22] An alternative explanation for the result that the overweight and obesity benefits fade with age is that, because the age effect cannot be distinguished from the cohort effect, the quality of Head Start programs has recently increased. Thus, younger children would show a larger benefit from the program.

neighborhoods.[23] This is a plausible explanation if access to nutritious foods differs between low-income black households and low-income white households. The increase in nutritional access would provide short-term benefits to children and these benefits would begin to fade away after this access ends.[24]

Among poor neighborhoods, distance to supermarkets is much greater for predominantly black neighborhoods than predominantly white neighborhoods (Zenk et al, 2005) and access to supermarkets positively influences dietary patterns (Morland, Wing, and Diez Roux, 2002). Residing in a census tract with one supermarket is associated with an increased intake of fruits and vegetables for blacks, compared to a neighborhood without supermarkets, and a second supermarket is associated with a further increase in the consumption of fruits and vegetables (Morland, Wing, and Diez Roux, 2002). On the other hand, residing in a neighborhood with a small grocery store is not associated with higher levels of fruit and vegetable consumption for blacks (Morland, Wing, and Diez Roux, 2002). Supermarkets provide better availability and selection of nutritious foods

[23] Although the national figures for Head Start suggest that many races and ethnicities are present in the program, at the local level there is a high degree of racial segregation, which reflects the racial composition of the local communities. For example, when black participants are the most represented racial group in a program, 73 percent of the participants are black. This is true for whites as well (source: authors calculations based on the 2002 Head Start Program Information Reports). When blacks are the dominant racial group, only 11 percent of the participants are white. When whites are the dominant racial group, only 9 percent of the participants are black. Thus, black and white Head Start participants are likely to attend different programs.

[24] If the provision of nutritious foods is the driving force behind these results, then this explanation raises additional questions about why other programs that provide food to low-income children do not have the same benefits. For example, the overweight and obesity benefits for black children should persist if other governmental programs that target older children also provide access to nutritious foods. However, the relationship between poverty and poor nutrition is stronger for preschool children than older children (Bhattacharya, Currie, and Haider, 2003). Regarding the nutritional benefits of other food provision programs, Food Stamp Program participants increase their consumption of meats, sugars, and fats, as opposed to fruits, vegetables, grains, or dairy products (Wilde, McNamara, and Ranney, 2000). Participation in the National School Lunch Program and the School Breakfast Program leads to the consumption of a higher percentage of calories from fat and saturated fat (Gordon, Devaney, and Burghardt, 1995). Bhattacharya, Currie, and Haider (2004) find that the School Breakfast Program increases the quality of dietary intake for high income children, but not children in families below the poverty line. Participation in these three programs is not shown to lead to a decrease or an increase in childhood overweight or obesity (Hofferth and Curtin, 2005).

and higher quality foods at a lower cost than smaller food providers (Zenk et al, 2005). Among the most impoverished neighborhoods, the nearest supermarket to predominantly black neighborhoods is slightly over one mile farther away than the nearest supermarket to predominantly white neighborhoods (Zenk et al, 2005). Within a 3-mile radius of the most impoverished neighborhoods, there were approximately two and a half fewer supermarkets for predominantly black neighborhoods than predominantly white neighborhoods (Zenk et al, 2005). Clearly, access to nutritious foods is greater for poor white children than poor black children. Thus, for black Head Start participants, access to healthy foods would be limited without the availability of Head Start, while the same would not be true for white Head Start participants. This explanation suggests that the provision of nutritious foods provides short-term benefits to Head Start participants that diminish with time.

Conclusion

This paper estimates the impact of Head Start participation on childhood overweight and obesity for individuals ages 5 through 19. Because of the nutrition services and nutrition education provided to parents and children, Head Start participation is expected to influence participants' nutritional behavior and affect childhood overweight and obesity. Plausibly exogenous variation in the relative availability of Head Start in the local community is used to identify the average treatment effect on Head Start participants. The results demonstrate that Head Start significantly reduced the probability that a black participant would become overweight or obese in later childhood. This finding is noteworthy because many of the educational benefits of Head Start participation that have been previously estimated demonstrate a positive impact of the program for whites, but not blacks. This suggests that Head Start participation can influence outcomes for all of the participants, not just whites. Additionally, these results suggest that the influence on overweight and obesity results from the nutritional services in the program, not because Head Start improved educational outcomes that had secondary health benefits. It is likely that the reduction in childhood overweight and obesity from Head Start participation results from the provision of nutritious foods, in addition to the parent and child nutritional education. Further research, however, is needed to more completely discern the importance of the different pathways through which Head Start's services can reduce childhood obesity. Until then, it is difficult to gauge the role of Head Start as a policy in reducing the prevalence of childhood obesity. Demonstrating that Head Start participation can influence a wider set of outcomes than previously considered, however, is an important contribution to the policy discussion of the efficacy of investments in early childhood.

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Appendix

This appendix provides the results of the linear IV estimates that correspond to the bivariate probit estimates displayed in Tables 3 and 4.

Table 5: Linear IV Estimates of the Relationship between Head Start Participation and Overweight

	All		Black		White	
Dependent Variable	Head Start	Overweight	Head Start	Overweight	Head Start	Overweight
Head Start		-0.597		-0.531		-0.703
		[0.344]		[0.445]		[0.584]
Relative Availability of Head Start	0.151		0.174		0.119	
	[0.035]		[0.059]		[0.035]	
Black	0.123	0.152				
	[0.021]	[0.051]				
Hispanic	0.045	0.063				
	[0.040]	[0.069]				
Other Race	0.007	0.028				
	[0.034]	[0.053]				
Birth Weight	-0.003	0.000	-0.005	-0.000	-0.001	0.001
	[0.002]	[0.003]	[0.003]	[0.004]	[0.002]	[0.004]
Birth Weight ^{2}	0.012	0.007	0.023	0.010	0.002	0.003
	[0.008]	[0.012]	[0.012]	[0.020]	[0.008]	[0.018]
Oldest	0.024	0.011	0.041	-0.004	0.019	0.031
	[0.016]	[0.025]	[0.031]	[0.044]	[0.015]	[0.032]
Disability	0.106	0.104	0.110	0.131	0.076	0.059
	[0.025]	[0.048]	[0.049]	[0.073]	[0.026]	[0.060]
Urban	-0.013	-0.036	-0.026	-0.072	0.014	0.010
	[0.018]	[0.028]	[0.033]	[0.043]	[0.014]	[0.037]
Rural	-0.028	0.037	0.023	0.255	-0.045	-0.032
	[0.045]	[0.086]	[0.154]	[0.180]	[0.040]	[0.102]
Married	-0.092	0.021	0.005	0.060	-0.065	-0.208
	[0.038]	[0.058]	[0.047]	[0.057]	[0.094]	[0.155]
Widowed	-0.157	-0.044	-0.063	0.028	-0.176	-0.425
	[0.055]	[0.104]	[0.070]	[0.115]	[0.096]	[0.218]
Divorced	-0.102	-0.026	-0.038	0.017	-0.059	-0.247
	[0.039]	[0.058]	[0.048]	[0.055]	[0.097]	[0.156]
Family Income	-0.003	-0.001	-0.012	-0.003	-0.001	-0.001
	[0.000]	[0.001]	[0.002]	[0.006]	[0.000]	[0.001]
Family Income ^{2}	0.006	0.002	0.053	0.013	0.003	0.002
	[0.001]	[0.002]	[0.010]	[0.028]	[0.001]	[0.002]
Family Size	0.023	-0.005	0.026	-0.010	0.021	0.005
	[0.008]	[0.013]	[0.011]	[0.017]	[0.011]	[0.021]
Father Not Present	0.106	0.080	0.086	0.115	0.056	0.042
	[0.024]	[0.051]	[0.036]	[0.063]	[0.032]	[0.065]
Mother's Education	-0.009	-0.010	-0.007	-0.017	-0.007	-0.010
	[0.004]	[0.008]	[0.010]	[0.012]	[0.005]	[0.011]
Father's Education	0.002	-0.004	0.008	0.016	-0.007	-0.018
	[0.004]	[0.007]	[0.009]	[0.013]	[0.004]	[0.010]
Mother's BMI	0.013	0.043	0.033	0.069	0.005	0.034
	[0.005]	[0.009]	[0.014]	[0.022]	[0.005]	[0.011]
Mother's BMI ^{2}	-0.016	-0.045	-0.047	-0.084	-0.004	-0.032
	[0.008]	[0.012]	[0.022]	[0.034]	[0.005]	[0.012]
Father's BMI	-0.026	0.023	-0.055	-0.020	-0.009	0.044
	[0.009]	[0.016]	[0.023]	[0.035]	[0.006]	[0.013]
Father's BMI ^{2}	0.031	-0.025	0.073	0.046	0.009	-0.056
	[0.012]	[0.022]	[0.037]	[0.050]	[0.007]	[0.016]
Constant	0.588	-0.691	1.006	-0.466	0.322	-0.539
	[0.204]	[0.371]	[0.426]	[0.715]	[0.190]	[0.443]
F statistic of excluded instrument	18.32		11.46		8.62	
Observations	2301	2301	973	973	1138	1138

Notes: Heteroskedasticity-robust standard errors in brackets allow for clustering within households. Columns with Head Start as the dependent variable are OLS regressions. Columns with Overweight as the dependent variable are instrumental variables regressions with Relative Availability of Head Start the excluded instrument. The coefficients and standard errors for birth weight^2 and family income^2 are multiplied by 10^3. The coefficients and standard errors for mother's BMI^2 and father's BMI^2 are multiplied by 10^2.
Sources: See Table 1.

Table 6: Linear IV Estimates of the Relationship between Head Start Participation and Obesity

	All	Black	White
Head Start	-0.335	-0.378	-0.202
	[0.250]	[0.356]	[0.383]
Black	0.100		
	[0.039]		
Hispanic	0.062		
	[0.051]		
Other Race	0.019		
	[0.042]		
Birth Weight	-0.002	-0.002	-0.002
	[0.002]	[0.003]	[0.003]
Birth Weight ^{2}	0.012	0.012	0.011
	[0.009]	[0.015]	[0.012]
Oldest	0.004	-0.015	0.038
	[0.018]	[0.032]	[0.022]
Disability	0.070	0.123	0.011
	[0.036]	[0.058]	[0.042]
Urban	-0.037	-0.052	-0.020
	[0.020]	[0.036]	[0.023]
Rural	0.015	0.218	-0.054
	[0.066]	[0.208]	[0.054]
Married	0.016	0.043	-0.144
	[0.043]	[0.044]	[0.123]
Widowed	-0.031	-0.003	-0.181
	[0.076]	[0.078]	[0.174]
Divorced	0.012	0.043	-0.149
	[0.044]	[0.047]	[0.120]
Family Income	-0.001	-0.005	-0.001
	[0.001]	[0.005]	[0.001]
Family Income ^{2}	0.002	0.024	0.000
	[0.002]	[0.023]	[0.001]
Family Size	-0.013	-0.017	-0.003
	[0.009]	[0.013]	[0.013]
Father Not Present	0.016	0.006	0.016
	[0.037]	[0.049]	[0.049]
Mother's Education	-0.011	-0.014	-0.006
	[0.006]	[0.011]	[0.008]
Father's Education	0.004	0.009	0.001
	[0.005]	[0.010]	[0.007]
Mother's BMI	0.035	0.055	0.025
	[0.007]	[0.017]	[0.008]
Mother's BMI ^{2}	-0.039	-0.068	-0.028
	[0.009]	[0.026]	[0.009]
Father's BMI	0.004	-0.025	0.015
	[0.012]	[0.029]	[0.010]
Father's BMI ^{2}	0.002	0.049	-0.015
	[0.018]	[0.044]	[0.013]
Constant	-0.284	-0.051	-0.255
	[0.288]	[0.595]	[0.311]
Observations	2301	973	1138

Notes: Heteroskedasticity-robust standard errors in brackets allow for clustering within households. Relative Availability of Head Start is used as an instrument for Head Start. The F statistic for the excluded instrument is the same as reported in Appendix Table 1. The coefficients and standard errors for birth weight^2 and family income^2 are multiplied by 10^3. The coefficients and standard errors for mother's BMI^2 and father's BMI^2 are multiplied by 10^2.
Sources: See Table 1.

Data Appendix

This appendix provides a detailed explanation of the creation of variables used for this analysis.

Relative Availability of Head Start: The relative availability of Head Start is defined as the number of children who attend Head Start divided by number of eligible children in the local community. The local community is defined as the county or a group of counties commonly served by the same Head Start grantee(s). The regions that each grantee in each state served were obtained from the websites of the state's Head Start Association, the state's Head Start Collaboration Office, or through personal communication with a staff member in either of these groups.

The number of children who attend Head Start in each county in the U.S. is determined from the Head Start Program Information Reports, available from Xtria, from 1988 until 2001. These data are reported by each Head Start grantee annually. The number of children who actually attended the centers managed by each grantee is aggregated to the county level. Attendance figures from Early Head Start Centers and Parent Child Centers were not included because these centers served parents and children ages 0 through 3. American Indian/Alaskan Native programs and Migrant programs were also not included because these programs can have a much larger service region than other programs, and these programs serve a relatively small number of children. The address of each grantee is provided in the Program Information Reports, but not the county identifier. Each Head Start grantee was assigned a county code by linking the reported zip code with the Federal Information Processing Standards county codes using geographic data available from the Missouri Census Data Center. Remaining missing county codes were then determined based on the county of the grantee in other years, the county of the reported city, or by looking up the county that corresponds to the zip code using the Melissa Data Geocoder Lookup. The number of children who attend Head Start in each county was then aggregated to the service region to form the numerator in this variable.

The number of eligible children is derived from the Small Area Income and Poverty Estimates (SAIPE) of the U.S. Census Bureau. Eligibility is estimated based on poverty, which underestimates the true number of children eligible. However, at least 90 percent of children who attend Head Start in each program must be living in poverty, and measures of other eligibility criteria are not available annually for each county nationwide. In the SAIPE data, the number of children under age 5 in poverty is available for each state, but not for each county. For each county, the number of poor children under age 5 is the difference between the estimate of people ages 0 through 17 in poverty and the estimate of related children ages 5 through 17 in families in poverty. This difference is close to the number of children under age 5 in poverty, but is slightly incorrect because the figure for children ages 5 through 17 is based on related children in families. The degree to which this difference overestimates the number of poor children under age 5 is determined from the state level data. Each county estimate is then divided by this correction factor. The number of eligible children in each county is then defined as the number of children age 3 or 4 in poverty or two-fifths of the number of children under age 5 in poverty. County-level estimates are only available in 1989, 1993, and

1995-2001 from the SAIPE data. Estimates for the remaining years were determined through linear interpolation. The number of eligible children in each county was then aggregated to the service region to form the denominator in this variable.

The number of children who attend Head Start is divided by the number of income eligible children for each service region and constrained to be greater than or equal to zero and less than or equal to one. This value represents the probability that an income eligible child will attend Head Start in the region before the selection decisions of the local Head Start administrators. This variable in then linked to Head Start attendance and other variables in the PSID by the county of residence, available from the restricted-access Geocode file of the PSID, and corresponding region code for each year between 1988 and 2001. The final value of this variable is then defined as the average number of children who attend Head Start divided by the number of income eligible children in the child's region of residence at ages 3 and 4.

Some of the data used in this analysis are derived from Sensitive Data Files of the Panel Study of Income Dynamics, obtained under special contractual arrangements designed to protect the anonymity of respondents. These data are not available from the author. Persons interested in obtaining PSID Sensitive Data Files should contact the PSID staff through the Internet at PSIDHelp@isr.umich.edu.

Head Start: Determination of Head Start participation is based on three sets of questions asked of PSID and CDS respondents. In 1995, the responding family member was asked, for each individual ages 5 through 40 in the family, if each family member attended Head Start. In 1997, in the CDS, each primary caregiver was asked if the child participated in any intervention program, such as Head Start, Early Start (a family intervention program for children below age 7), or Fair Start (a Canadian child development program). Also, in the CDS in 1997, primary caregivers were asked about the childcare history, which included Head Start. In the CDS in 2002, primary caregivers were asked to update the childcare history from 1997 forward. For each question, Head Start participation was determined. For each of these questions about Head Start participation, possible sources of misreporting were corrected; the child was defined as having not participated in Head Start if participation began before age 2 (Early Head Start, not Head Start), if the family income – averaged across ages 3, 4, and 5 – was greater than twice the poverty line (adjusted for family size) and the child was not disabled, or if the child did not live in the U.S. at age 3 or 4 (Fair Start, not Head Start). Then Head Start participation was determined from the 1995 PSID question, the CDS intervention question, and the CDS childcare questions. If all three groups of questions agreed, then Head Start participation was easily determined. If two out of the three groups of questions agreed, then Head Start participation was coded based on the questions in agreement. If two out of the three groups of questions were missing, then Head Start participation was coded based on the non-missing question. The remaining cases were those in which no information was available from the 1995 question and the responses to the intervention and childcare questions differed. The responses to these questions could differ if the parent did not view Head Start to be a form of childcare, but instead a form of preschool or an intervention program, which would align the weighted response of Head Start participation with other reported estimates in the literature. These remaining cases were counted as participating in Head Start.

Overweight/Obese: Height and weight were measured by the CDS interviewer in 2002. Body mass index is then determined as weight in kilograms / (height in meters)^2. Based on the age- and gender-specific cutoffs specified in Cole et al (2000), a child is defined as overweight (or obese) if their body mass index is greater than or equal to the appropriate threshold level.

Race: Individuals are categorized as either white, black, Hispanic, or another race according to the reports of the primary caregiver in the CDS. A child's race is then specified by a set of binary variables for each racial group.

Birth weight: Birth weight in ounces is provided by the primary caregiver in the CDS.

Oldest: This dichotomous variable is equal to one if the child is the firstborn child of the mother.

Disability: This dichotomous variable is equal to one if the primary caregiver in the 1997 CDS reports that a doctor or health professional has ever said that the child had a speech impairment, hearing difficulty, difficulty seeing, retardation, emotional disturbance, orthopedic impairment, developmental delay, learning disability, or autism. This corresponds with the Head Start Bureau's definition of a disability.

Urban/Rural: Based on the Beale-Ross urban-rural codes from the 2001 PSID wave, residence is coded as urban if the family resides in a metropolitan area with a population of one million or more or a fringe county of such a metropolitan area. Residence in a rural location is coded dichotomously if, according to this categorization, the family's residence is completely rural.

Marital Status: Parents' marital status is defined as married (including permanent cohabitation), divorced or separated, widowed, or single. A set of dichotomous variables are defined accordingly.

Family Income: Family income is defined as the total family income averaged over the years in which the child was 3, 4, and 5 years old. Total family income includes the taxable and transfer income of all household members. Income is converted into 2001 prices using the Consumer Price Index (for all urban consumers, the U.S. city average).

Family Size: Family size is defined as the total number of individuals in the family unit averaged over the years in which the child was 3, 4, and 5 years old.

Father Not Present: This dichotomous variable is defined as one if the father or a stepfather was not part of the family unit when the child was 3, 4, or 5 years old.

Parents' Education: These variables represent the years of schooling completed by the mother (female parental figure) and the father (male parental figure) averaged over the years in which the child was 3, 4, and 5 years old. The median years of schooling completed for each category were used to convert years of schooling into a continuous variable.

Parents' BMI: These variables are the body mass index of the child's mother (female parental figure) and father (male parental figure) in 1986. Height and weight are self-reported and then converted into body mass index using the formula: BMI = weight in kilograms / (height in meters)^2.

CHAPTER III

INVESTING IN HEALTH: THE LONG-TERM IMPACT OF HEAD START

Introduction

There is mounting evidence that early childhood socioeconomic conditions have long-term health consequences, reinforcing and sustaining health disparities over the life course (e.g. Hayward and Gorman, 2004). The health capital theory (Grossman, 1972) suggests that early investments in human capital and health capital have lasting effects on health outcomes later in life. This possible link between early childhood investments in education and health and later health conditions and outcomes, if established, could help explain the remarkable extent and persistence of socioeconomic disparities in health.

Head Start is a comprehensive, national, federally-funded program designed to augment the human and health capital of disadvantaged children to better prepare them for subsequent educational experiences. The program began in 1965 as part of President Johnson's "War on Poverty" and has provided services to over 22 million children since its inception (Head Start Bureau, 2004). Federal guidelines state that at least 90 percent of the children enrolled in each of the Head Start centers must be from families with income levels below the poverty line and at least 10 percent of the participants must be children with disabilities (Head Start Bureau, 2002). There were 19,200 centers located throughout the country that enrolled 909,608 children at an average cost of $7,092 per child in the 2003 fiscal year. Fifty three percent of these children were 4 years old and 34 percent were 3 years old. Thirty two percent of Head Start participants in 2003 were black, 31 percent were Hispanic, and 28 percent were white (Head Start Bureau, 2004).

Head Start seeks to enhance cognitive skills by developing age-appropriate literacy, numeracy, reasoning, problem-solving, and decision-making skills. Head Start also helps parents provide adequate nutrition for participating children and ensures that children receive proper immunizations and other preventive health measures, as well as continuous access to pediatric health care.

This emphasis on education, nutrition, and health care has an immediate effect on the health of preschoolers. We also expect to see a positive impact of Head Start participation on adult health for two reasons. First, the health component of Head Start is designed to increase children's health, which is predicted to increase adult health. Second, the cognitive goals of the program are intended to increase the education of participants, and education has been strongly linked to adult health (Grossman and Kaestner, 1997). If this program affects the long-term health of participants, then Head Start may be one way to reduce the health disparities that are correlated with inequality in childhood socioeconomic conditions.

Although a major component of the Head Start curriculum is aimed at improving the health of its participants, most evaluations of this program focus on cognitive outcomes. The limited numbers of studies that investigate the health outcomes of program participants concentrate on short-term outcomes or specific benefits such as immunization; these studies demonstrate a positive effect of participation.

This research evaluates the impact of Head Start on long-term health using the Panel Study of Income Dynamics. We follow the methodology of Currie and Thomas

(1995) and Garces, Thomas, and Currie (2002) and control for unobservable family characteristics that may affect health or the decision to participate in Head Start. The effect of Head Start participation is determined by comparing the health outcomes of individuals who attended Head Start with those of siblings who did not participate. Because Head Start began in 1965, even its earliest participants have not yet reached old age and many chronic diseases that plague older individuals are not yet evident in former Head Start participants; therefore, to assess the impact of Head Start on long-term health we focus on intermediary behaviors and measures of health that are related to health throughout an individual's life. Measures of health outcomes include self-reported health status, obesity, incidence of high blood pressure, and whether or not an individual smokes or exercises. Additionally, the relationship between Head Start participation and health insurance coverage is estimated because insurance can be related to the likelihood that an individual utilizes medical care.

Head Start participation is shown here to reduce the likelihood that an individual smokes cigarettes. Given that tobacco use is the leading cause of mortality in the United States (Mokdad et al., 2004) and is associated with cancer, heart disease, chronic obstructive pulmonary disease, and stroke (National Center for Health Statistics, 2001), the reduction in smoking from Head Start participation can result in a substantial improvement in health. Benefits to younger siblings include increased exercise and health insurance coverage for blacks and a decrease in overweight for whites. Poor diet and physical inactivity together forms the second leading cause of mortality (Mokdad et al., 2004). These results suggest that there are long-term health benefits from participation in Head Start and these benefits result primarily from lifestyle changes.

The Benefits of Early Childhood Investment and Head Start Participation

Early Childhood Investment and Adult Health

Grossman's (1972) fundamental theory of the demand for health identifies the key roles that human capital and health capital play in the production of good health. Within a utility maximizing framework, health is demanded as a source of utility and is produced by individuals because health determines the number of illness-free days available for labor and leisure activities. Individuals inherit an initial stock of health capital that depreciates over time and can be increased or decreased each period through an individual's health investment. Investment is determined according to a health production function, which associates changes in health capital with health inputs such as medical care utilization, diet, exercise, and the consumption of cigarettes.

The efficiency of the production function is determined by the individual's human capital. Education, as a component of human capital, can affect health directly by increasing the productivity of the health inputs or indirectly by providing knowledge of how to efficiently combine inputs to produce better health.

One implication of this conceptual model is that, for a given level of education, increased medical care and nutrition can result in improved health and early childhood investment can increase health capital in all future periods. Additionally, if preschool education leads to an increase in the level of education, an improvement in health can result from changes in health-related behaviors that are encouraged through education.

Early Childhood Investment and Health Disparities

Disparities in mortality are reflected through differences in socioeconomic status (Pappas et al., 1993). Recent evidence on health over the life course seems to support the underlying hypothesis that adult health is dependent upon childhood conditions and that disparities in adult health result from differences in the initial levels of human and health capital among young children. Socioeconomic status during childhood is negatively related to adult body mass index (Blane et al., 1996), the incidence of Type 2 diabetes for women (Maty et al., 2002), and mortality (Davey Smith et al., 1998; Hayward and Gorman, 2004). Hayward and Gorman (2004) find that the impact of socioeconomic status during childhood on adult mortality results, in part, because of the relationships between childhood socioeconomic status and educational attainment and adult body mass index. Consequently if early childhood investments in children from low socioeconomic status backgrounds can overcome the relationships between a disadvantaged child background and low educational attainment and adult obesity, these investments have the potential to reduce socioeconomic disparities in mortality.

An Overview of Head Start and its History

Head Start began in 1965 as part of President Lyndon Johnson's War on Poverty. The impetus for this project was a preschool program for mentally retarded children directed by Dr. Susan Gray. In early 1965, Dr. Robert Cooke, chaired a committee formed to design a preschool program that would improve the school preparedness of disadvantaged children. Although President Johnson and Sargent Shriver, one of the chief architects of the War on Poverty, had envisioned a program that would emphasize

IQ development, the Cooke committee recommended that Head Start provide comprehensive services targeting nutrition, physical and mental health, parent involvement, social services for families, and early childhood education. The Cooke committee also recommended that federal appropriations for Head Start should be directly provided to local communities, fearing that state politicians would not support a program that many viewed as part of the Civil Rights movement. The recommendations of the Cooke committee for comprehensive services and direct local funding were enacted by the Johnson administration; however the committee's recommendation to begin the program on a small scale was not.

Four months after the Cooke committee's recommendations, Head Start begin with an initial enrollment of over half of a million children funded at slightly less than $100 million. The program began as an eight-week summer program run out of the Office of Economic Opportunity. The decision to begin Head Start as a summer program was based on a lack of trained early childhood teachers; as a summer program, elementary school teachers on summer vacation were able to work for Head Start (Richmond, 2004). Additional funds were provided to universities for training and over the next few years, many summer programs were expanded to full-year programs. In 1969, Head Start was moved to the Office of Child Development in the U.S. Department of Health, Education, and Welfare. Head Start currently resides in the Administration for Children and Families in the Department of Health and Human Services.

The components of Head Start services have remained consistent throughout the life of the program. The federally defined Head Start Program Performance Standards target education services, health services, social services, and parent involvement. The local Head Start centers implement these standards while maintaining programs that are designed to meet the needs of the community.

Eligibility for Head Start participation is primarily determined by family income (Head Start Bureau, 2002). At least 90 percent of the children enrolled in Head Start must be from families whose total annual income before taxes is less than or equal to the poverty line. Additionally, at least ten percent of Head Start enrollees must be children with disabilities and a child must be at least three years old to be eligible for Head Start participation.

Each Head Start center must make an active attempt to recruit as many applications from eligible children and their families as possible. The strong incentives for eligible children and families to apply to participate in Head Start coupled with the limited number of available spaces in each Head Start center results in a subset of eligible children being admitted into Head Start. Lee, Brooks-Gunn, and Schnur (1988) provide evidence that program administrators may select children from the most disadvantaged backgrounds to participate in Head Start.

Educational Outcomes of Head Start Participation

Although Head Start participation may have substantial health benefits, most evaluations of the program have focused solely on cognitive outcomes. Head Start participation is generally believed to be associated with short-term cognitive benefits; however a few years after program completion, these benefits fade (McKey et al., 1985; Lee, Brooks-Gunn, and Schnur, 1988; Lee et al., 1990; Barnett, 1995; Currie and Thomas, 1995; Aughinbaugh, 2001). This decrease in the effect of Head Start participation may result because of the lesser quality of the subsequent schools that Head Start participants attend (Lee and Loeb, 1995).

Currie and Thomas (1995) demonstrate that the benefits of Head Start participation are not uniform across all races. The increase in cognitive ability – measured by the Picture Peabody Vocabulary Test (PPVT) score – that results from participation in the program is erased by age 10 for black children, but not for white children. There is also a decrease in the likelihood of grade repetition for white Head Start participants, relative to not attending preschool or attending other preschools. In a later paper, Currie and Thomas (2000) offer evidence that this fade in test score gains may result because, after completion of the Head Start program, black participants attend lower quality primary schools than other black children. However, this is not the case for white participants.

In addition to lower rates of grade retention, long-term effects on school success are found for whites through an increased probability of completing high school and attending college (Garces, Thomas, and Currie, 2002). No statistically significant effect of Head Start participation is found on high school graduation rates or college attendance for blacks.

The result that Head Start participation confers short-term cognitive benefits and improves educational attainment lends further credibility to the hypothesis that Head Start participation may have long-term health benefits. Extensive research has shown that increases in education result in improved health (Grossman and Kaestner, 1997). Education has a causal influence on self-reported health status (Grossman, 1975; Gilleskie and Harrison, 1998); disability, functional limitation, and blood pressure

(Berger and Leigh, 1989); disease (Behrman and Wolfe, 1989); and mortality (Lleras-Muney, 2002).

Education also has an effect on adult health through the positive impact of schooling on nutrition (Behrman and Wolfe, 1989; Variyam et al., 1999), exercise (Kenkel, 1991; Gilleskie and Harrison, 1998), and the frequency of preventive physician visits (Gilleskie and Harrison, 1998). Additionally, schooling has a negative impact on smoking (Kenkel, 1991; Sander, 1995a; Gilleskie and Harrison, 1998) and increases the probability that an adult who smokes will quit (Sander, 1995b).

The Health Components of Head Start

The physical development goals of Head Start target nutrition, pediatric health care, and health education (Head Start Bureau, 2002). Head Start staff members, with the cooperation of the child's family members, determine each child's nutritional needs, as well as design and implement a nutritional plan for each child. Children who have not received breakfast prior to their arrival at a Head Start center at the beginning of each day are provided a nutritious breakfast. Children in a full-day program receive meals and snacks that provide one-half to two-thirds of the child's daily nutritional needs. Parents are educated in preparation and nutritional skills.

Head Start centers determine if the child has an adequate source of ongoing, continuous, and assessable pediatric health care. If the child does not have an appropriate source of pediatric health care, then program administrators assist parents in finding one. Head Start staff members also assist children and families in developing an age-appropriate schedule of preventive and primary health care that includes child immunizations. The provision of health care services is monitored throughout the duration of the program. Children are screened for developmental problems upon program enrollment and parents are notified of any concerns. Parents are familiarized with pediatric health care and developmental screening procedures and the importance of these procedures.

Health Outcomes of Head Start Participation

Although health services are a major component of the Head Start program, little research has addressed the impact of Head Start participation on health. Early qualitative and quantitative research on this subject concluded that Head Start participation results in positive short-term health benefits for children in terms of general physical health, motor skills, and nutrition (McKey et al., 1985). Hale, Seitz, and Zigler (1990) determine that Head Start participants are more likely than children on the Head Start waiting list or middle-class children to receive age-appropriate health screenings or dental examinations.

Currie and Thomas (1995) investigate the impact of Head Start on two health measures: the probability of measles immunization and child height–for-age, a long-run measure of health and nutrition. Head Start participation is not shown to have an effect on child height-for-age; however, participation improves the probability of being immunized for the measles, relative to not attending preschool. This benefit of Head Start is not limited to the participant, as there is evidence that the younger siblings of Head Start participants are more likely to receive the immunization as well. Increased vaccination coverage has short-term and lasting health benefits as a result of the prevention of specific diseases; however immunizations are only one component of the health services provided in Head Start.

While existing research concentrates mainly on educational outcomes or short-term health effects of Head Start participation, little is known about the long-term health effects. Head Start is a comprehensive development program, which is designed to provide a wide array of benefits for participants. This research seeks to highlight an outcome that is often ignored: the long-term health benefits of Head Start participation.

Estimation Strategy

In this paper, we estimate the effect of attending Head Start on adult health. In an ideal setting, children would be randomly assigned to attend Head Start or would not attend any form of preschool. Then, the health of these individuals would be monitored as they aged. The difference in the health outcomes between Head Start participants and individuals who did not attend Head Start would be the impact of attendance in Head Start. However, this ideal setting is not available.[25] In the analysis of existing secondary data, several deviations from this ideal setting lead to complications which are addressed in turn.

First, children who do not attend Head Start may attend other forms of preschool. As a result of the beneficial impacts of other forms of preschool, the difference of health outcomes between Head Start participants and non-Head Start participants would

[25] In the fall of 2002, as part of the congressionally-mandated evaluation of Head Start, Head Start eligible children were randomly assigned into Head Start or a non-Head Start control group. These children will be evaluated until the spring of 2006. The Head Start Impact Study will allow for the estimation of the short-term benefits of Head Start participation in a randomized setting, but not the long-term benefits.

underestimate the effects of Head Start participation in comparison to individuals who did not attend any form of preschool. To allow for the options that individuals attend Head Start, other forms of preschool, or no preschool, the relationship between Head Start and adult health is modeled as:

$$H_i = \alpha_0 + \alpha_1 HS_i + \alpha_2 PS_i + \varepsilon_i \, , \qquad (1)$$

where *H* is a measure of health of individual *i*, *HS* and *PS* are indicator variables for participation in Head Start or other preschool programs, and ε is random error. The coefficient α_1 is the marginal impact of Head Start, while α_2 is the impact of attending another preschool program.

Second, observable characteristics of families are associated with selection of participants into Head Start and the development of long-run health. Head Start participants are from disadvantaged families. As described above, eligibility for Head Start participation is primarily determined by family income. At least 90 percent of the children enrolled in Head Start must be from families whose total annual income before taxes is less than or equal to the poverty line. For the purposes of eligibility, income is defined as gross cash income, which includes unemployment compensation and other sources of transfer income. Additionally, at least ten percent of Head Start enrollees must be children with disabilities and a child must be at least three years old to be eligible for Head Start participation. Because Head Start participation is correlated with childhood socioeconomic status, which is correlated with adult health, estimation of equation (1) would lead to a biased estimate of the impact of Head Start participation. To overcome this problem, equation (1) is modified to include family background characteristics during the preschool years:

$$H_i = \beta_0 + \beta_1 HS_i + \beta_2 PS_i + \boldsymbol{\beta}_3 \boldsymbol{X}_i + \eta_i \,, \qquad (2)$$

where $\boldsymbol{X}$ is a vector of exogenous family background characteristics and η is random error. The coefficient β_1 is the marginal impact of Head Start, β_2 is the impact of other preschool programs, and $\boldsymbol{\beta}_3$ is the impact of childhood conditions on health behavior. The characteristics in $\boldsymbol{X}$ include family income, disability status of the child, and other demographic characteristics.

Third, unobservable characteristics that influence health outcomes may be correlated with the decision to enroll children in Head Start. Over 880,000 parents volunteer in Head Start (Head Start Bureau, 2004); these parents may choose to make other investments in their child that could positively influence health outcomes. Alternatively, children are more likely to be selected in to Head Start if the family is more disadvantaged; this includes both observed and unobserved (to an econometrician) sources of disadvantage. Children in at-risk families are often referred in to Head Start. These sources of unobserved characteristics suggest that it is characteristics associated with families that primarily drive any potential unobserved selection that could bias estimates based on equation (2). Thus, we compare sibling outcomes to determine the effects of Head Start participation. This estimation strategy has been previously used by Currie and Thomas (1995) and Garces, Thomas, and Currie (2002) to examine the impact of Head Start participation. We restrict the sample to individuals with at least one sibling and include a family-specific fixed effect in the health models. The fixed effect controls for fixed unobservable family characteristics that affect health and are correlated with the decision to participate in Head Start. The health of an individual in early adulthood is estimated as:

$$H_{if} = \delta_0 + \delta_1 HS_{if} + \delta_2 PS_{if} + \boldsymbol{\delta}_3 \boldsymbol{X}_{if} + \phi_f + \nu_{if} \; , \qquad (3)$$

where H is now a measure of health of individual i in family f, ϕ is the family-specific fixed effect, and ν is random error. The coefficient δ_1 is the marginal impact of Head Start, δ_2 is the impact of other preschool programs, and $\boldsymbol{\delta}_3$ is the impact of childhood conditions on health behavior.

If the unobserved household characteristics that are related to selection into Head Start are constant across siblings, then the impact of Head Start could be measured by comparing the health of siblings who attended Head Start to the health of siblings who did not attend any form of preschool (δ_1). However, as noted by Currie and Thomas (1995) and Garces, Thomas, and Currie (2002) if parental favoritism results in differential investments among siblings, then δ_1 is a biased estimate of the impact of Head Start.[26] To reduce this potential bias, we compare the effects of participation in Head Start to participation in other preschools ($\delta_1 - \delta_2$). This is a consistent estimator of the effect of Head Start if parents view Head Start and other preschool of comparable quality. This is a lower bound estimate of the effect of Head Start if parents view other preschool as higher quality than Head Start and send their favorite children to other preschools (Currie and Thomas, 1995).[27]

[26] For example, if parents choose to invest more in the human capital of the favored sibling by sending that child to Head Start and not sending other siblings to preschool, then they may also choose to make other investments in that child that positively influence their behavior. This could also hold true for the case when one sibling is sent to a form of preschool other than Head Start and another sibling is not sent to any form of preschool. In these cases, the estimated coefficients of Head Start and other preschools overestimate the true impacts of attending Head Start and other forms of preschool. On the other hand, parents may choose to make compensating investments for the sibling not sent to either form of preschool that positively affect behavior. In this case, the estimated Head Start effect underestimates the true impact of early childhood education.

[27] Currie and Thomas (1995) provide empirical evidence from sibling comparisons that other preschool children may be the beneficiaries of favoritism relative to their siblings more so than Head Start children are to their siblings.

The coefficient for Head Start (δ_1) is biased if children who do not attend the program receive benefits from the sibling who does attend. Spillover effects could result from the family-centered emphasis of Head Start. Parents of participants learn about family nutrition and increase their health knowledge. If Head Start participation changes parents' attitudes or behaviors in a positive manner, then all children are likely to benefit. Because δ_1 compares the health measures of siblings who attended Head Start to the health measures of siblings who did not, if the siblings who did not attend Head Start benefit from the other child's attendance, then δ_1 is biased downward. If benefits from attending other forms of preschool do not spill over to other siblings, perhaps because other programs may not involve parents as intensively as Head Start, then δ_2 is unlikely to be biased and ($\delta_1 - \delta_2$) provides a lower bound of the effect of Head Start participation. To examine if spillover effects occur, we interact the Head Start and other preschools variables with birth order and oldest child variables and add these interactions to the fixed effects model.

Additional models adapt equation (3) to allow for the effect of Head Start participation to vary according to the year of enrollment, the length of enrollment and the race of the participant. Although the broad goals for Head Start participants have remained consistent over time, the benefits of Head Start participation may vary across the life of the program. To evaluate the possibility that the effects of Head Start participation vary according to the year of enrollment, we include two additional variables in the fixed effects model: an interaction between Head Start participation and current age and an interaction between participation in other preschools and current age.

Once children enroll in Head Start, they can remain in the program until kindergarten or first-grade, depending on the availability of these programs in their community, provided that the child continues to meet the Head Start eligibility criteria. The length of participation in Head Start can differ for children, and the difference in exposure to the program can affect the benefits received. To determine if this is the case, we include a set of dummy variables in equation (3) that measure the length of participation.

Currie and Thomas (1995) and Garces, Thomas, and Currie (2002) report positive educational benefits of Head Start participation for whites but not for blacks. Therefore, we examine if the benefits from Head Start participation differ by race. To estimate if there is a racial difference in the effect of Head Start participation, we first include interaction terms in equation (3) between Head Start, other preschools, and a dummy variable that equals one if the individual is black. Second, we estimate equation (3) for each race separately. While the latter method estimates the potentially differential impact of Head Start participation by race with greater flexibility, the decrease in sample size reduces the precision of the estimates.

Data

This research evaluates the impact of Head Start on long-term health using data from the Panel Study of Income Dynamics (PSID). The PSID is a longitudinal study of U.S. households and individuals that began in 1968 with a national sample of approximately 4,800 households. Members of these households, their offspring, and current co-residents have been interviewed on an annual or biennial basis since the inception of the PSID. The information collected focuses on economic and demographic characteristics, but also includes sociological and psychological traits.

Supplements to the PSID occasionally expand the information collected. In 1995, additional questions were asked of interviewees that related to early childhood education. All household members between the ages of 5 and 49 were asked about whether they had ever enrolled in Head Start or any other preschool or daycare program, the length of attendance, and their age of initial attendance. Collecting information retrospectively about early childhood education experiences leads to the possibility of recall error. After comparing reported enrollment rates, racial composition, and family income to the national Head Start data, Garces, Thomas, and Currie (2002) validate the quality of the data from the 1966 birth cohort onward. Data from the 1964-1965 birth cohorts are not as reliable because participation rates in the PSID are significantly lower than the national rates. However, their results (based on data from the 1966-1977 birth cohorts) are robust to the inclusion of the 1964-1965 birth cohorts (personal communication with Eliana Garces).

In the 1999 supplement, an extensive set of health-related questions was included. Information regarding height, weight, health behaviors, health conditions including disease prevalence, and self-reported health status was obtained for adult members of the household. The exclusion of children limits the ability to examine the short-term, but not the long-term, effects of Head Start on health. Gouskova and Schoeni (2002) report that the response rates, prevalence estimates, and parameter estimates in multivariate models of the health measures in the PSID are similar to the health measures in the National Health Interview Survey (NHIS).

The key advantage of using PSID data is the panel nature of the data set, which allows for the coordination of data from the 1995 supplement regarding Head Start participation, the 1999 health supplement, and the respondent's childhood. This enables the estimation of the effect of early childhood education programs, such as Head Start, on health outcomes, while controlling for the childhood environment. The data sample used will examine the health of individuals in 1999. The data from the 1995 supplement are used to determine which individuals experienced Head Start or other preschool programs. Data from the 1999 wave of the PSID and years for which the individual was between the ages of 3 through 6 provide control variables. Controlling for family background throughout the period of early childhood education (ages 3 through 6), as opposed to capturing a snapshot of the family environment at the most common age of preschool attendance (age 4), minimizes measurement error, reduces missing data, and provides a more accurate description of the family environment during the early childhood years. Because the PSID began in 1968, individuals who were older than 4 years old in 1968 were excluded from this analysis. The resulting sample includes individuals between the ages of 18 and 35 in 1999.

The measures of health that are the focus of this research consist of health-related behaviors and overall indicators of health that have previously been shown to be related to education. The specific health behaviors are whether or not the individual currently smokes cigarettes or ever smoked and whether or not the individual participates in the recommended amounts of light or heavy exercise per week.[28] The overall indicators of

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[28] Light exercise is light physical activity such as walking, dancing, gardening, golfing, bowling, etc. Light exercise activities are recommended at least 5 times per week. Heavy exercise is vigorous physical activity or sports, such as heavy housework, aerobics, running, swimming, or bicycling. Heavy exercise activities

health are whether or not an individual is overweight,[29] reports fair or poor health,[30] and has ever had high blood pressure or hypertension. Because health insurance can affect the likelihood that an individual seeks medical care, whether or not an individual has health insurance is an additional dependent variable.

The individual and family characteristics include demographic characteristics and childhood conditions. The demographic characteristics are age, gender, race, marital status, whether the individual lives in an urban or rural community, birth order, and whether the individual is the oldest child. Variables that measure early childhood conditions include the average total family income between ages 3 through 6[31], the mother's and father's average years of formal schooling completed between ages 3 through 6, the average family size between ages 3 through 6, and whether the father was present between ages 3 through 6. As a measure of initial health status, whether the individual was a low-birth-weight baby is included.[32] In addition to family income, eligibility for Head Start is determined by disability status. Therefore a dichotomous variable that captures whether or not an individual is disabled during childhood is

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are recommended at least 3 times per week. The goals for Healthy People 2000 were based on these baselines (National Center for Health Statistics, 2001).

[29] This dichotomous measure is derived from an individual's body mass index (BMI). The formula for BMI is: BMI = weight in kilograms / [height in meters]^2. This binary variable equals one when an individual's BMI is at least 25.0. Although this measure includes the overweight and obese ranges of BMI, for the sake of brevity this variable will be referred to as measuring if an individual is overweight.

[30] This variable is constructed from a survey question that asks individuals to rate their health as excellent, very good, good, fair, or poor.

[31] Total family income includes the taxable income and transfer income, which includes public assistance, of all household members. Taxable income includes labor, asset, rental, interest, and dividend income. The reported estimates in the next section are robust to the inclusion of taxable income and a dummy variable that captures receipt of public assistance in place of total family income. Income is converted into 1999 prices using the Consumer Price Index.

[32] Low birth weight is defined as a weight of less than 5.5 pounds (88 ounces).

included.[33] We also include dummy variables that reflect participation in Head Start or other preschool for individuals born prior to 1966.[34]

Missing values for race were assigned the race of any siblings; this affected less than one half of a percent of the sample. After filling in these missing values, the sample is limited to black and white respondents to facilitate comparisons of the impact of Head Start across racial groups. Missing values for other demographics or family background characteristics were assigned the mean value of the sample and indicator variables to reflect that the values were missing were included in the regressions (e.g., Lillard and Willis, 1994; Garces, Thomas, and Currie, 2002). In the sample of respondents with at least one sibling in the sample, less than five percent of the respondents had missing values for the variables that reflect early childhood conditions. Approximately ten percent of these respondents had missing values for whether the individual was a low-birth-weight baby and approximately one quarter of this sample had missing values for the urban and rural variables. Approximately one percent of this sample had missing values for birth order and less than one percent had missing values for marital status and whether the individual is the oldest child.

Descriptive statistics for the data are provided in Table 7. The descriptive statistics provide the means and standard errors for the early childhood education

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[33] Whether an individual is disabled or requires extra care is only assessed from 1969 to 1972 and 1976 to 1978 in the PSID. Additionally, in 1999, individuals were asked to provide a self-assessment of their health during childhood. An individual is considered disabled during childhood if they report a disability or requiring extra care during the ages of 3 through 6 or if they report their health status as poor during childhood.

[34] These two variables are included to allow for the possibility that recall error influenced the responses of individuals born prior to 1966. The influence of early childhood experiences on health does not vary according to whether an individual was born before or after 1966. Individuals born before 1966 are more likely to have ever smoked cigarettes and are more likely to report their health as fair or poor, although both of these relationships are significant only at the ten percent level.

Table 7: Descriptive Statistics: Sample Means and Standard Errors

Variable	Entire Sample	Head Start	Preschool	Neither	Sibling Sample	Head Start	Preschool	Neither
Program Participation								
Head Start	0.070	1.000	0.034	0.000	0.074	1.000	0.037	0.000
	(0.007)		(0.009)		(0.010)		(0.014)	
Other Preschool	0.293	0.144	1.000	0.000	0.279	0.141	1.000	0.000
	(0.014)	(0.035)			(0.018)	(0.049)		
Overall Indicators of Health								
Fair or Poor Health	0.048	0.104	0.018	0.056	0.039	0.078	0.015	0.044
	(0.006)	(0.032)	(0.007)	(0.009)	(0.007)	(0.030)	(0.010)	(0.010)
Overweight	0.489	0.614	0.380	0.525	0.487	0.593	0.396	0.515
	(0.015)	(0.050)	(0.028)	(0.019)	(0.020)	(0.067)	(0.038)	(0.025)
High Blood Pressure	0.076	0.128	0.081	0.071	0.077	0.158	0.084	0.069
	(0.008)	(0.038)	(0.016)	(0.009)	(0.011)	(0.057)	(0.022)	(0.012)
Health Insurance	0.864	0.773	0.890	0.861	0.866	0.780	0.907	0.856
	(0.010)	(0.046)	(0.018)	(0.013)	(0.013)	(0.060)	(0.021)	(0.017)
Adult Health Behaviors								
Smoke Cigarettes	0.251	0.245	0.227	0.263	0.249	0.239	0.218	0.262
	(0.013)	(0.040)	(0.024)	(0.016)	(0.017)	(0.053)	(0.032)	(0.021)
Ever Smoked Cigarettes	0.444	0.471	0.390	0.464	0.427	0.497	0.377	0.439
	(0.015)	(0.052)	(0.028)	(0.019)	(0.020)	(0.070)	(0.038)	(0.024)
Light Exercise	0.547	0.442	0.532	0.563	0.545	0.500	0.499	0.566
	(0.015)	(0.052)	(0.029)	(0.019)	(0.020)	(0.071)	(0.039)	(0.024)
Heavy Exercise	0.403	0.359	0.421	0.398	0.403	0.359	0.432	0.395
	(0.015)	(0.049)	(0.028)	(0.018)	(0.020)	(0.064)	(0.038)	(0.024)
Demographics								
Age	28.609	27.744	27.716	29.090	28.625	27.569	28.255	28.911
	(0.124)	(0.521)	(0.211)	(0.155)	(0.153)	(0.695)	(0.268)	(0.187)
Female	0.531	0.599	0.560	0.512	0.522	0.607	0.525	0.511
	(0.015)	(0.052)	(0.028)	(0.019)	(0.020)	(0.069)	(0.039)	(0.024)
Black	0.120	0.657	0.114	0.072	0.101	0.570	0.097	0.057
	(0.008)	(0.050)	(0.016)	(0.007)	(0.010)	(0.069)	(0.022)	(0.007)
Married	0.549	0.316	0.475	0.603	0.552	0.351	0.474	0.605
	(0.015)	(0.047)	(0.029)	(0.018)	(0.020)	(0.064)	(0.039)	(0.024)
Urban	0.550	0.506	0.589	0.537	0.544	0.572	0.568	0.532
	(0.013)	(0.047)	(0.023)	(0.016)	(0.017)	(0.064)	(0.032)	(0.021)
Rural	0.022	0.005	0.021	0.025	0.026	0.004	0.028	0.028
	(0.003)	(0.001)	(0.006)	(0.005)	(0.005)	(0.001)	(0.010)	(0.006)
Birth Order	2.456	4.021	2.073	2.478	2.511	4.604	2.180	2.449
	(0.057)	(0.426)	(0.085)	(0.062)	(0.076)	(0.571)	(0.125)	(0.074)
Oldest	0.324	0.209	0.390	0.307	0.276	0.130	0.306	0.278
	(0.014)	(0.036)	(0.027)	(0.017)	(0.018)	(0.037)	(0.035)	(0.022)
Family Background								
Family Income (000s)	50.819	28.232	59.668	48.990	51.082	29.953	62.912	48.111
	(0.948)	(1.642)	(2.177)	(1.013)	(1.312)	(1.924)	(3.492)	(1.217)
Family Size	4.797	6.247	4.367	4.852	5.030	6.971	4.567	5.036
	(0.051)	(0.402)	(0.081)	(0.054)	(0.070)	(0.565)	(0.116)	(0.063)
Father Not Present	0.159	0.434	0.167	0.130	0.138	0.372	0.151	0.112
	(0.011)	(0.051)	(0.021)	(0.012)	(0.013)	(0.063)	(0.027)	(0.015)
Mother's Education	12.150	10.598	13.102	11.874	12.238	10.627	13.188	11.997
	(0.065)	(0.225)	(0.120)	(0.074)	(0.084)	(0.291)	(0.167)	(0.092)
Father's Education	12.659	11.573	13.883	12.222	12.740	11.459	14.090	12.312
	(0.081)	(0.162)	(0.144)	(0.099)	(0.105)	(0.234)	(0.201)	(0.123)
Childhood Health								
Low Birth-weight Baby	0.076	0.080	0.068	0.078	0.072	0.071	0.065	0.074
	(0.008)	(0.030)	(0.013)	(0.010)	(0.010)	(0.031)	(0.017)	(0.012)
Disabled	0.045	0.033	0.036	0.050	0.043	0.013	0.043	0.046
	(0.006)	(0.014)	(0.011)	(0.009)	(0.008)	(0.008)	(0.016)	(0.011)
Sample Size	2397	325	572	1542	984	135	252	615

Notes: Standard errors in parentheses. The means and standard errors are weighted by the PSID sample weights to be representative of the national population. The entire sample is the sample of black and white individuals ages 18 through 35 who were interviewed in 1995 and 1999 in the PSID that provided information about their early childhood education experience and at least one measure of health. The sibling sample is the subset of individuals within the entire sample who have at least one sibling in the sample. The Head Start, preschool, and neither samples subsets of individuals within the entire sample and the sibling sample who participated in Head Start; nursery school, a preschool program, or day care center besides Head Start; or none of the above, respectively.

experiences, health outcomes, and individual and family background characteristics of PSID respondents.[35] The entire sample is the sample of black and white individuals ages 18 through 35 who were interviewed in 1995 and 1999 in the PSID and provided information about their early childhood education experience and at least one measure of health. The sibling sample is the subset of individuals within the entire sample who have at least one sibling in the sample. The Head Start, Preschool, and Neither samples include subsets of individuals within the entire sample and the sibling sample who participated in Head Start; nursery school, a preschool program, or day care center besides Head Start; or none of the above, respectively.

The descriptive statistics demonstrate that adults who previously participated in Head Start, in comparison to individuals who attended other forms of preschool or did not attend any form of preschool, are, on average, more likely to report themselves in fair or poor health and more likely to be obese or overweight. Adults who formerly attended Head Start report similar health-related behaviors as other adults, with the exception that Head Start participants are more likely to have ever smoked cigarettes than other adults. Former Head Start participants are also less likely than other adults to have health insurance.

While Head Start participants tend to display worse adult health than other individuals, these descriptive statistics, as well as the targeted nature of the Head Start program, highlight the importance of controlling for the home environment in the

[35] The means and standard errors are weighted by the PSID sample weights to be representative of the national population. These weights account for the initial oversampling of low-income households, changes in family composition, and differential attrition. These weights also reflect the addition of a nationally representative sample of post-1968 immigrant households in the PSID and the poststratification adjustments of the weights to the Current Population Survey by race, metropolitan status, and Census region (Heeringa and Connor, 1999).

empirical model to discern the independent effect of Head Start participation. Former Head Start participants are more likely to have been raised in larger families with less income. These families are also less likely to have had a father present in the home, and parents have less education on average.[36] Additionally, Head Start participants are more likely to be black, less likely to be married, and more likely to be a younger sibling. The descriptive statistics for the sibling sample demonstrate that restricting the analysis to individuals with at least one sibling does not change the overall characteristics of the sample.

Estimates of the Relationship between Head Start Participation and Health

Health Behaviors and Overall Indicators of Health

Tables 8 and 9 display the estimation results that measure the relationship between Head Start participation and health behaviors and overall indicators of health.[37] Estimates of the impact of Head Start and other preschools on these dichotomous measures are obtained from linear probability models.[38] Heteroskedasticity-robust standard errors that allow for family clustering in ordinary least squares models are

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[36] This description of Head Start families is similar to previous demographic studies of the characteristics of Head Start families (McKey et al., 1985).

[37] See tables 14 through 21 in the appendix for complete estimation results of the specifications in Tables 8 and 9.

[38] These estimates are substantively similar to logit and conditional logit estimates and are reported for the ease of the interpretation of the coefficient estimates. The disadvantage of the linear probability model is that the probability that the outcome equals one is not constrained to be in the interval [0,1], while the disadvantage of the conditional logit model is that the estimates drop siblings with the same outcome measure from the sample and do not use the information contained in the explanatory variables for these siblings. Although there are disadvantages to each estimation method, the similarity of the results for each method provides assurance that the conclusions presented are robust to the choice of estimation technique.

Table 8: The Relationship between Head Start Participation and Health Behaviors

	(1)	(2)	(3)	(4)
SMOKE CIGARETTES				
Head Start	-0.010	-0.024	-0.081	-0.124
	(0.026)	(0.032)	(0.050)	(0.075)
Other Preschool	-0.027	-0.011	-0.029	0.049
	(0.021)	(0.022)	(0.033)	(0.051)
Difference (HS-PS)	0.017	-0.013	-0.053	-0.174
	(0.031)	(0.037)	(0.058)	(0.088)
Sample Size	2397	2397	984	984
EVER SMOKED CIGARETTES				
Head Start	-0.061	-0.025	-0.061	-0.096
	(0.028)	(0.034)	(0.053)	(0.085)
Other Preschool	-0.034	-0.020	-0.057	-0.006
	(0.025)	(0.027)	(0.040)	(0.057)
Difference (HS-PS)	-0.027	-0.006	-0.004	-0.090
	(0.036)	(0.042)	(0.066)	(0.100)
Sample Size	2396	2396	984	984
LIGHT EXERCISE				
Head Start	-0.071	-0.101	-0.058	-0.039
	(0.030)	(0.037)	(0.057)	(0.098)
Other Preschool	-0.010	-0.039	-0.055	-0.056
	(0.024)	(0.027)	(0.039)	(0.066)
Difference (HS-PS)	-0.062	-0.062	-0.003	0.017
	(0.037)	(0.045)	(0.068)	(0.115)
Sample Size	2390	2390	980	980
HEAVY EXERCISE				
Head Start	-0.048	-0.009	0.022	0.068
	(0.030)	(0.037)	(0.059)	(0.091)
Other Preschool	0.043	0.015	0.008	0.038
	(0.025)	(0.028)	(0.041)	(0.062)
Difference (HS-PS)	-0.091	-0.024	0.014	0.031
	(0.037)	(0.045)	(0.069)	(0.107)
Sample Size	2384	2384	979	979
Control Variables	No	Yes	Yes	Yes
Fixed Effects	No	No	No	Yes
Sample	Entire Sample		Sibling Sample	

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions. Control variables include age, gender, race, marital status, whether the individual lives in an urban or rural community, birth order, whether the individual is the oldest child, average total family income between ages 3 through 6, the mother's and father's average years of formal schooling completed between ages 3 through 6, the average family size between ages 3 through 6, whether the father was present between ages 3 through 6, whether the individual was a low-birth-weight baby, disability status, whether a Head Start participant was born prior to 1966, and whether a participant of other preschool was born prior to 1966.

reported. Columns 1 and 2 are based on the sample of black and white PSID respondents aged 18 to 35 years old who report early childhood education experiences and health. Column 1 does not control for the observable or unobservable characteristics of individuals; these estimates correspond to equation (1). Column 2 includes control variables that reflect the demographic characteristics and the observable family background measures; these estimates correspond to equation (2). Columns 3 and 4 restrict the sample to respondents with at least one sibling. Column 3 is the same specification as column 2, but with the sibling sample; these estimates correspond to equation (2) for the sibling sample. Column 4 includes a family-specific fixed effect that controls for the unobserved family characteristics that are constant across siblings; these estimates correspond to equation (3).

Estimates of the relationship between Head Start participation and the probability that an individual smokes cigarettes as an adult demonstrate no statistically significant relationship when control variables are excluded from the model. After including observable characteristics in the model, the point estimates for Head Start and other forms of preschool remain negative and the difference between the estimated coefficient for Head Start and other preschools changes from positive to negative but all estimates are statistically insignificant. Including a family-specific fixed effect, which controls for the unobservable family characteristics that are constant across siblings, increases the absolute value of the estimate of the effect of Head Start, but increases the standard error as well. This estimate suggests that Head Start participants are 12.4 percentage points less likely to smoke than individuals who did not attend preschool; however, this estimate is only statistically significant at the ten percent level. On the other hand, the estimate of the effect of other preschools on smoking becomes positive but remains statistically insignificant. Because the unobservable household characteristics that determine the selection decisions associated with early childhood education may not be fixed across siblings, the difference in smoking between Head Start participants and their siblings is compared to the difference in smoking between other preschool participants and their siblings. This reveals a negative and statistically significant effect of Head Start participation on the probability that an individual will smoke cigarettes as an adult. Head Start participants are 17.4 percentage points less likely to smoke cigarettes than individuals who attended other forms of preschool. Additional models that estimated the relationship between early childhood educational experiences and the probability that an individual has ever smoked revealed no statistically significant relationship.

Head Start participants are less likely to engage in the recommended level of light exercise than individuals who attended other forms of preschool or did not attend preschool if control variables or fixed effects are excluded. The negative estimate for the Head Start coefficient remains statistically significant after adding control variables to the model but is not statistically significant after the sample is restricted to individuals with at least one sibling in the sample. After adding a family-specific fixed effect to the model, both the Head Start estimate and the difference estimate remain statistically insignificant, but the difference estimate, which represents the lower bound of the benefits to Head Start participation, becomes positive. There is also no statistically significant effect of Head Start on the probability that an individual participates in heavy exercise.

The results at the top of Table 9 describe the relationship between Head Start participation and being overweight. Head Start participants are more likely to be

Table 9: The Relationship between Head Start Participation and Overall Indicators of Health

	(1)	(2)	(3)	(4)
OVERWEIGHT				
Head Start	0.103	0.041	0.017	-0.045
	(0.029)	(0.035)	(0.055)	(0.083)
Other Preschool	-0.079	-0.034	-0.053	-0.089
	(0.025)	(0.028)	(0.042)	(0.056)
Difference (HS-PS)	0.186	0.075	0.070	0.045
	(0.036)	(0.042)	(0.067)	(0.097)
Sample Size	2362	2362	972	972
HIGH BLOOD PRESSURE				
Head Start	0.020	0.013	0.048	0.062
	(0.018)	(0.022)	(0.041)	(0.052)
Other Preschool	-0.010	0.004	0.017	0.049
	(0.013)	(0.015)	(0.025)	(0.035)
Difference (HS-PS)	0.030	0.010	0.031	0.013
	(0.021)	(0.025)	(0.043)	(0.061)
Sample Size	2397	2397	984	984
FAIR OR POOR SELF-REPORTED HEALTH				
Head Start	0.022	-0.009	-0.008	-0.003
	(0.016)	(0.018)	(0.028)	(0.043)
Other Preschool	-0.028	-0.020	-0.043	-0.045
	(0.010)	(0.011)	(0.013)	(0.029)
Difference (HS-PS)	0 .050	0.011	0.036	0.041
	(0.017)	(0.021)	(0.032)	(0.050)
Sample Size	2397	2397	984	984
HEALTH INSURANCE				
Head Start	-0.101	-0.001	0.073	0.026
	(0.027)	(0.032)	(0.047)	(0.064)
Other Preschool	0.027	0.015	0.019	0.079
	(0.017)	(0.018)	(0.029)	(0.043)
Difference (HS-PS)	-0.129	-0.016	0.054	-0.054
	(0.030)	(0.036)	(0.055)	(0.075)
Sample Size	2397	2397	984	984
Control Variables	No	Yes	Yes	Yes
Fixed Effects	No	No	No	Yes
Sample	Entire Sample		Sibling Sample	

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions. Control variables include age, gender, race, marital status, whether the individual lives in an urban or rural community, birth order, whether the individual is the oldest child, average total family income between ages 3 through 6, the mother's and father's average years of formal schooling completed between ages 3 through 6, the average family size between ages 3 through 6, whether the father was present between ages 3 through 6, whether the individual was a low-birth-weight baby, disability status, whether a Head Start participant was born prior to 1966, and whether a participant of other preschool was born prior to 1966.

overweight, while other preschool participants are less likely to be overweight in comparison to individuals who did not attend preschool; the difference between these two estimates is positive and statistically significant. After controlling for individuals' demographics and childhood family background, only the difference estimate is statistically significant at the ten percent level for the entire sample. The addition of a family-specific fixed effect reveals no statistically significant relationship between Head Start attendance and being overweight.

Although the point estimates for Head Start and the difference estimate are consistently positive across all model specifications, the effect of Head Start participation on the probability that an individual has or has had high blood pressure is not statistically significant in any model.

In the model without control variables or fixed effects, preschool participants in programs besides Head Start are less likely to report their health as fair or poor than individuals who did not attend preschool, while Head Start participants, in comparison to other preschool participants, are more likely to view their health as fair or poor. Other preschool participants remain less likely to report poor or fair health than individuals that did not attend preschool once control variables are included, but this relationship becomes statistically insignificant with the addition of a family-specific fixed effect. There is no relationship between Head Start participation and the probability that individuals report themselves in fair or poor health once the family background and demographics of individuals are included in the model.[39]

[39] Examining each category of self-reported health separately, Head Start participants are more likely to report good health and less likely to report very good health than individuals who did not attend any form of preschool. While self-reported health may be related to objective measures of health such as mortality (Mossey and Shapiro, 1982), because of the potential biases in this measure (Bound, 1991), the

Without controlling for observable characteristics, Head Start participants are less likely to have health insurance as a young adult. However, columns 2 and 3 demonstrate that this relationship can be explained by family background and individual demographics. Including a family-specific fixed effect, Head Start does not affect the probability that a young adult has health insurance.[40,41,42]

Differential Effects According to the Year of Enrollment

To evaluate the possibility that the effects of Head Start participation vary according to the year of enrollment, we include an interaction term between Head Start participation and current age and an interaction term between participation in other

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implications of individuals reporting their health as good compared to very good are unclear. Given the family backgrounds of Head Start participants and the relationship between low socioeconomic status and poor health, we focus on whether or not an individual reports their health in the lower two categories (fair and poor) of the self-reported scale.

[40] Head Start does affect the type of insurance that individuals obtain. Head Start participants are 11.8 percentage points less likely to have Medicaid insurance than individuals who did not attend preschool and 14.9 percentage points less likely than individuals who attended other forms of preschool. White Head Start participants are 20.1 percentage points and 21.9 percentage points less likely to have Medicaid insurance than other white individuals who did not attend preschool or who attended other forms of preschool, respectively. Black Head Start participants are 20.4 percentage points less likely to have Medicaid insurance than other black individuals who attended other forms of preschool; however this result is only statistically significant at the ten percent level. Black Head Start participants are also 20.5 percentage points more likely to have employer-provided health insurance than other black individuals who did not attend preschool; this result is also only statistically significant at the ten percent level. There is no statistically significant relationship between Head Start participation and the likelihood that an individual has privately purchased health insurance or health insurance funded by government sources other than Medicaid. The decrease in Medicaid participation is driven by whites. However, there is not a corresponding increase in other forms of insurance for whites and white Head Start participants are not less likely to have health insurance. An explanation for these relationships between Head Start and insurance categories remains to be determined. These results are available from the authors upon request.

[41] The reported estimates in this section are robust to conditioning on the sample of individuals who were not disabled during childhood and, to capture the impact of any Head Start standards that vary by state, including a set of dummy variables that control for the state of residence at age 4.

[42] While not estimated as a measure of health, there is also the possibility of mortality benefits from Head Start participation that arise because of the associated increased immunization rates (Currie and Thomas, 1995) and reduction in crime (Garces, Thomas, and Currie, 2002). In the data sample, a comparison of mortality rates is not feasible because Head Start participation data are not collected until 1995, while health data are collected in 1999. This results in a sample size that is not large enough to analyze mortality. However, the potential that Head Start participation reduced mortality provides further credibility that our estimates provide a lower bound of the true effect of Head Start on long-term health.

preschools and current age in the fixed effects model. The results are summarized in Table 10; this table displays only the estimates based on the family-specific fixed effects in equation (3).

Table 10: The Importance of the Year of Enrollment in the Relationship between Head Start Participation and Health

	SMOKE CIGARETTES	EVER SMOKED CIGARETTES	LIGHT EXERCISE	HEAVY EXERCISE	OVER-WEIGHT	HIGH BLOOD PRESSURE	FAIR OR POOR SELF-REPORTED HEALTH	HEALTH INSURANCE
Head Start	-0.028	-0.076	-0.309	-0.171	-0.347	0.005	0.126	-0.004
	(0.455)	(0.516)	(0.591)	(0.550)	(0.496)	(0.315)	(0.257)	(0.385)
Head Start x Age	-0.003	-0.001	0.010	0.009	0.011	0.002	-0.005	0.001
	(0.017)	(0.019)	(0.022)	(0.020)	(0.018)	(0.011)	(0.009)	(0.014)
Other Preschool	0.519	-0.011	1.240	-0.698	0.634	0.089	0.184	-0.237
	(0.345)	(0.392)	(0.448)	(0.424)	(0.384)	(0.239)	(0.195)	(0.292)
Other Preschool x Age	-0.017	0.000	-0.047	0.027	-0.026	-0.001	-0.008	0.012
	(0.013)	(0.014)	(0.016)	(0.015)	(0.014)	(0.009)	(0.007)	(0.011)
Sample Size	984	984	980	979	972	984	984	984

Notes: Standard errors in parentheses. Estimates include a mother-specific fixed effect and control variables that include age, gender, marital status, whether the individual lives in an urban or rural community, birth order, whether the individual is the oldest child, average total family income between ages 3 through 6, the mother's and father's average years of formal schooling completed between ages 3 through 6, the average family size between ages 3 through 6, whether the father was present between ages 3 through 6, whether the individual was a low-birth-weight baby, disability status, whether a Head Start participant was born prior to 1966, and whether a participant of other preschool was born prior to 1966.

The relationship between Head Start participation and health does not vary according to an individual's age; however, the relationship between participation in other preschools and health does. Individuals who attended other forms of preschool are more likely to engage in light exercise than individuals who did not attend preschool, although this benefit of early childhood education is smaller for individuals who attended preschool further in the past. Older individuals who attended other preschools are more likely to exercise heavily and less likely to be overweight than individuals who attended other preschools more recently, although both of these relationships are only significant at the 10 percent level.

Differential Effects According to the Length of Participation

The length of participation in Head Start can differ for children, and the difference in exposure to the program can affect the benefits received. For the entire sample of individuals who participated in Head Start, 7.5 percent attended the program for less than three months, 56.9 percent attended the program for three to eleven months, 24.7 percent attended the program for 12 to 23 months, and 10.9 percent attended the program for 24 or more months. For the sibling sample, these numbers change to 11.1 percent, 54.0 percent, 27.4 percent, and 7.5 percent, respectively.[43]

To determine if the variation in program exposure has an effect on the health outcomes of Head Start participation, we include a set of dummy variables in the fixed effects model that controls for the length of attendance in Head Start. Variables that measure participation for less than 3 months, from 12 to 23 months, and for 24 or more months are included; participation from 3 to 11 months is the reference category. Thus, the estimate of the impact of attending Head Start for 3 to 11 months is determined by the value of the Head Start coefficient and the estimate of the impact of attending the program for 12 to 23 months is determined by summing the value of the Head Start coefficient and the coefficient for attending Head Start for 12 to 23 months. These results are reported in Table 11; this table displays only the estimates based on the family-specific fixed effects in equation (3). Similar variables that reflect the length of participation in other preschools are not available in the PSID.

[43] These figures are weighted by the PSID sample weights.

Table 11: The Importance of Length of Attendance in the Relationship between Head Start Participation and Health

	SMOKE CIGARETTES	EVER SMOKED CIGARETTES	LIGHT EXERCISE	HEAVY EXERCISE	OVER-WEIGHT	HIGH BLOOD PRESSURE	FAIR OR POOR SELF-REPORTED HEALTH	HEALTH INSURANCE
Head Start	-0.077	-0.015	-0.036	-0.015	-0.153	0.069	0.000	0.008
	(0.090)	(0.102)	(0.120)	(0.110)	(0.099)	(0.062)	(0.052)	(0.076)
Time in Head Start: 0-3 months	-0.120	-0.426	0.282	0.184	0.386	0.173	-0.011	0.116
	(0.250)	(0.283)	(0.332)	(0.306)	(0.274)	(0.174)	(0.144)	(0.212)
Time in Head Start: 12-23 months	0.014	-0.018	-0.061	0.134	0.203	0.088	0.001	0.01
	(0.121)	(0.138)	(0.164)	(0.149)	(0.133)	(0.084)	(0.070)	(0.103)
Time in Head Start: 24+ months	-0.333	-0.522	0.184	0.098	0.327	0.022	-0.067	-0.129
	(0.165)	(0.187)	(0.220)	(0.203)	(0.181)	(0.115)	(0.095)	(0.140)
Other Preschool	0.052	0.004	-0.062	0.032	-0.096	0.037	-0.044	0.078
	(0.050)	(0.057)	(0.067)	(0.062)	(0.056)	(0.035)	(0.029)	(0.043)
Sample Size	974	974	970	969	962	974	974	974

Notes: Standard errors in parentheses. The reference category for time in Head Start is 3 to 11 months. Estimates include a mother-specific fixed effect and control variables that include age, gender, marital status, whether the individual lives in an urban or rural community, birth order, whether the individual is the oldest child, average total family income between ages 3 through 6, the mother's and father's average years of formal schooling completed between ages 3 through 6, the average family size between ages 3 through 6, whether the father was present between ages 3 through 6, whether the individual was a low-birth-weight baby, disability status, whether a Head Start participant was born prior to 1966, and whether a participant of other preschool was born prior to 1966.

The length of attendance in Head Start impacts the probability that an individual smokes cigarettes or has ever smoked cigarettes, but does not affect the probability that an individual engages in light or heavy exercise. An individual who attended Head Start for two years or more is 33.3 percentage points less likely to smoke cigarettes than an individual who was in the program for 3 to 11 months and 41 percentage points less likely to smoke than an individual who did not attend any form of preschool. A similar pattern is displayed for the probability that an individual has ever smoked cigarettes. An individual who attended Head Start for two years or more is 52.2 percentage points less likely to have ever smoked cigarettes than an individual who was in the program for 3 to

11 months and 53.7 percentage points less likely to have ever smoked cigarettes than an individual who did not attend preschool.

Head Start participants who attended the program for two years or more are 32.7 percentage points more likely than participants enrolled in Head Start for 3 to 11 months to be overweight as young adults, although this relationship is significant only at the ten percent level. No other statistically significant effects are estimated for body composition, high blood pressure, self-reported health, or health insurance.

Differential Effects Across Race

Based on the results reported by Currie and Thomas (1995) and Garces, Thomas, and Currie (2002) that demonstrate a differential impact of Head Start participation for blacks and whites on educational and social outcomes, it is important to examine if the health benefits from Head Start participation differ by race. To estimate if there is a racial difference in the health effect of Head Start participation, we first include interaction terms in the fixed effects model between Head Start, other preschools, and a dummy variable that equals one if the individual is black. Second, we estimate the fixed effects model for each race separately. While the latter method estimates the potentially differential impact of Head Start participation by race with greater flexibility, the decrease in sample size reduces the precision of the estimates. The results of each method are reported in Table 12.

Table 12: Racial Differences in the Relationship between Head Start Participation and Health

HEALTH BEHAVIORS

	SMOKE CIGARETTES			EVER SMOKED CIGARETTES			LIGHT EXERCISE			HEAVY EXERCISE		
	Interaction	Black	White	Interaction	Black	White	Interaction	Black	White	Interaction	Black	White
Head Start	-0.171	-0.012	-0.138	-0.045	-0.036	-0.029	0.000	-0.065	-0.050	0.11	0.111	0.078
	(0.122)	(0.095)	(0.133)	(0.138)	(0.106)	(0.155)	(0.160)	(0.125)	(0.178)	(0.148)	(0.110)	(0.168)
Head Start x Black	0.059			-0.090			-0.062			-0.066		
	(0.144)			(0.163)			(0.189)			(0.175)		
Other Preschool	0.108	0.017	0.081	0.065	-0.071	0.054	-0.043	-0.053	-0.069	0.050	0.044	0.024
	(0.059)	(0.098)	(0.060)	(0.067)	(0.109)	(0.070)	(0.078)	(0.129)	(0.080)	(0.072)	(0.118)	(0.076)
Other Preschool x Black	-0.201			-0.251			-0.049			-0.050		
	(0.109)			(0.124)			(0.145)			(0.138)		
Difference (HS-PS)		-0.029	-0.219		0.035	-0.083		-0.012	0.019		0.067	0.053
		(0.126)	(0.146)		(0.140)	(0.170)		(0.165)	(0.195)		(0.147)	(0.183)
Sample Size	984	282	702	984	282	702	980	280	700	979	279	700

OVERALL INDICATORS OF HEALTH

	OVERWEIGHT			HIGH BLOOD PRESSURE			FAIR OR POOR SELF-REPORTED HEALTH			HEALTH INSURANCE		
	Interaction	Black	White	Interaction	Black	White	Interaction	Black	White	Interaction	Black	White
Head Start	0.062	-0.188	0.052	0.104	0.006	0.133	0.108	-0.074	0.091	0.074	0.05	0.027
	(0.133)	(0.114)	(0.141)	(0.085)	(0.070)	(0.091)	(0.069)	(0.077)	(0.062)	(0.103)	(0.096)	(0.104)
Head Start x Black	-0.153			-0.064			-0.169			-0.077		
	(0.157)			(0.099)			(0.081)			(0.122)		
Other Preschool	-0.129	-0.064	-0.134	0.059	0.036	0.062	-0.035	-0.125	-0.023	0.106	0.021	0.099
	(0.066)	(0.124)	(0.065)	(0.041)	(0.072)	(0.041)	(0.034)	(0.080)	(0.028)	(0.050)	(0.100)	(0.047)
Other Preschool x Black	0.135			-0.036			-0.041			-0.096		
	(0.124)			(0.076)			(0.062)			(0.093)		
Difference (HS-PS)		-0.124	0.185		-0.030	0.071		0.051	0.114		0.029	-0.071
		(0.155)	(0.155)		(0.093)	(0.099)		(0.103)	(0.068)		(0.128)	(0.114)
Sample Size	972	279	693	984	282	702	984	282	702	984	282	702

Notes: Standard errors in parentheses. Estimates include a mother-specific fixed effect and control variables that include age, gender, marital status, whether the individual lives in an urban or rural community, birth order, whether the individual is the oldest child, average total family income between ages 3 through 6, the mother's and father's average years of formal schooling completed between ages 3 through 6, the average family size between ages 3 through 6, whether the father was present between ages 3 through 6, whether the individual was a low-birth-weight baby, disability status, whether a Head Start participant was born prior to 1966, and whether a participant of other preschool was born prior to 1966.

Focusing on the interaction terms between black and Head Start, the relationship between Head Start participation and smoking does not seem to vary according to race. Black participants in other preschools are 25.1 percentage points less likely to have ever smoked and 20.1 percentage points less likely to currently smoke than white participants in other preschools, although the latter relationship is only significant at the ten percent level. Further, white participants in other preschools are more likely to currently smoke than individuals who did not attend preschool, at the ten percent significance level. Examining the relationship between Head Start participation and smoking for blacks and whites separately, there is no statistically significant impact of early childhood education for either race. However, the point estimates for current smoking suggest that the overall results described previously are driven by whites. The lack of statistical significance may be the result of the decrease in sample size that accompanied the stratification of the sample by race.

The relationships between Head Start participation and the probability that an individual exercises (light or heavy), the probability that an individual is overweight, the probability that an individual has or has had high blood pressure, and the probability that an individual has health insurance do display a statistically significant difference by race, regardless of whether interaction terms are included in the model or separate models are estimated for each race. Whites who attended preschool other than Head Start are less likely to be overweight and more likely to have health insurance than whites who did not attend any preschool.

Black Head Start participants are 16.9 percentage points less likely than white Head Start participants to describe their health as fair or poor. Stratifying the sibling sample by race, there is no statistically significant relationship between Head Start participation and the probability that an individual reports fair or poor health for blacks. White Head Start participants are 11.4 percentage points more likely to report fair or poor health than whites who attended other forms of preschool, although this relationship is significant only at the ten percent level.

The Benefits to Siblings of Early Childhood Education

The benefits of Head Start participation may not be confined to the participants in the program. To examine if spillover effects occur, we interact the Head Start and other preschools variables with birth order and oldest child variables and add these interactions to the fixed effects model. The results of these estimates for each health measure for both races together and separately are reported in Table 13; this table displays only the estimates based on the family-specific fixed effects in equation (3).

Older siblings who attended Head Start are 22.9 percentage points more likely to smoke than their younger siblings and older, white siblings who attended Head Start are 64 percentage points less likely to have ever smoked cigarettes than their younger siblings, although both of these relationships are significant only at the ten percent level.

Younger siblings who participated in Head Start are six percentage points more likely than their older siblings to engage in the recommend amount of light exercise. This relationship is found for blacks but not whites and is significant only at the ten percent level. Similar relationships hold for the probability that an individual participates in heavy exercise, although these relationships are statistically significant at the five

Table 13: Sibling Spillovers in the Relationship between Head Start Participation and Health

	HEALTH BEHAVIORS											
	SMOKE CIGARETTES			EVER SMOKED CIGARETTES			LIGHT EXERCISE			HEAVY EXERCISE		
	Both Races	Black	White	Both Races	Black	White	Both Races	Black	White	Both Races	Black	White
Head Start	-0.213	-0.097	0.021	-0.064	-0.086	0.550	-0.304	-0.378	-0.097	-0.224	-0.260	-0.368
	(0.128)	(0.158)	(0.311)	(0.146)	(0.177)	(0.363)	(0.169)	(0.209)	(0.417)	(0.155)	(0.175)	(0.392)
Head Start x Birth Order	0.016	0.013	-0.022	-0.017	0.003	-0.156	0.065	0.067	0.021	0.070	0.085	0.131
	(0.026)	(0.030)	(0.084)	(0.030)	(0.034)	(0.098)	(0.035)	(0.039)	(0.113)	(0.032)	(0.033)	(0.106)
Head Start x Oldest	0.229	0.293	-0.419	0.131	0.234	-0.640	0.263	0.369	0.036	0.169	0.269	0.267
	(0.137)	(0.178)	(0.331)	(0.156)	(0.200)	(0.386)	(0.183)	(0.235)	(0.445)	(0.166)	(0.199)	(0.417)
Other Preschool	0.066	-0.111	0.127	0.036	-0.020	-0.056	-0.117	-0.012	-0.258	0.127	0.358	0.065
	(0.104)	(0.175)	(0.164)	(0.119)	(0.198)	(0.191)	(0.137)	(0.231)	(0.220)	(0.126)	(0.198)	(0.207)
Other Preschool x Birth Order	-0.004	0.023	-0.002	-0.020	-0.023	0.044	0.023	-0.010	0.080	-0.038	-0.064	-0.029
	(0.031)	(0.039)	(0.058)	(0.036)	(0.044)	(0.067)	(0.041)	(0.052)	(0.078)	(0.038)	(0.044)	(0.073)
Other Preschool x Oldest	-0.050	0.298	-0.140	0.009	0.119	0.058	0.023	0.007	0.044	0.036	-0.600	0.096
	(0.095)	(0.217)	(0.124)	(0.108)	(0.244)	(0.144)	(0.124)	(0.285)	(0.166)	(0.115)	(0.245)	(0.156)
Sample Size	984	282	702	984	282	702	980	280	700	979	279	700
	OVERALL INDICATORS OF HEALTH											
	OVERWEIGHT			HIGH BLOOD PRESSURE			FAIR OR POOR SELF-REPORTED HEALTH			HEALTH INSURANCE		
	Both Races	Black	White	Both Races	Black	White	Both Races	Black	White	Both Races	Black	White
Head Start	-0.007	-0.168	-0.202	0.057	-0.059	0.316	0.003	-0.126	0.272	0.073	0.127	0.195
	(0.141)	(0.192)	(0.329)	(0.089)	(0.117)	(0.212)	(0.073)	(0.130)	(0.145)	(0.109)	(0.160)	(0.243)
Head Start x Birth Order	-0.018	-0.011	0.040	0.005	0.018	-0.053	-0.002	0.009	-0.043	-0.012	-0.006	-0.069
	(0.029)	(0.037)	(0.090)	(0.018)	(0.022)	(0.058)	(0.015)	(0.025)	(0.039)	(0.022)	(0.030)	(0.066)
Head Start x Oldest	0.135	0.156	0.765	-0.042	-0.023	-0.140	-0.052	0.035	-0.279	0.004	-0.363	0.161
	(0.151)	(0.217)	(0.350)	(0.095)	(0.133)	(0.226)	(0.078)	(0.147)	(0.154)	(0.117)	(0.180)	(0.259)
Other Preschool	-0.128	-0.196	-0.176	0.078	0.019	0.129	0.026	-0.015	-0.047	0.037	-0.096	0.058
	(0.115)	(0.221)	(0.176)	(0.072)	(0.131)	(0.112)	(0.059)	(0.145)	(0.076)	(0.089)	(0.178)	(0.128)
Other Preschool x Birth Order	0.013	0.019	0.019	-0.002	0.009	-0.016	-0.026	-0.034	0.011	0.014	0.036	0.014
	(0.035)	(0.048)	(0.063)	(0.022)	(0.029)	(0.039)	(0.018)	(0.032)	(0.027)	(0.027)	(0.040)	(0.045)
Other Preschool x Oldest	0.005	0.397	-0.028	-0.095	-0.041	-0.118	-0.025	0.022	0.008	0.02	0.038	0.016
	(0.105)	(0.269)	(0.133)	(0.065)	(0.162)	(0.084)	(0.054)	(0.179)	(0.057)	(0.080)	(0.220)	(0.096)
Sample Size	972	279	693	984	282	702	984	282	702	984	282	702

Notes: Standard errors in parentheses. Estimates include a mother-specific fixed effect and control variables that include age, gender, marital status, whether the individual lives in an urban or rural community, birth order, whether the individual is the oldest child, average total family income between ages 3 through 6, the mother's and father's average years of formal schooling completed between ages 3 through 6, the average family size between ages 3 through 6, whether the father was present between ages 3 through 6, whether the individual was a low-birth-weight baby, disability status, whether a Head Start participant was born prior to 1966, and whether a participant of other preschool was born prior to 1966.

percent level.[44] As older siblings who attend Head Start interact socially with their peers and become for likely to play and exercise, younger siblings may become more active as they imitate and learn from their older siblings. Increased activity at a younger age is likely to encourage children to remain active and exercise as they age.

When the eldest sibling in a black family attended Head Start, these siblings are 76.5 percentage points more likely than their younger siblings to be overweight.[45] This suggests that the benefits of Head Start spill over from older siblings to younger siblings for body composition.[46] This spillover could result from increased parental education about child nutrition in the Head Start program. After the oldest child attends Head Start, this knowledge of nutrition provides a greater benefit to the younger siblings, who are the beneficiaries of the greater parental knowledge at an earlier stage in development. The lasting impact of improved child nutrition is a decrease in the likelihood of being overweight. All younger siblings benefit equally from this spillover since the coefficient on birth order is not statistically significant. This spillover effect explains why no statistically significant effect of Head Start participation is found when comparing sibling outcomes, even though nutrition is a large part of the health component of Head Start. No spillover effects exist for the relationship between early childhood education and high blood pressure. In white families, the eldest child who attended Head Start is 27.9

[44] For blacks, this relationship is robust to a model specification with interactions between early childhood experiences and birth order only.
[45] This result also holds when only interactions between early childhood experiences and the oldest sibling variable are included.
[46] To further verify that this result is a spillover effect benefiting younger siblings, we estimate a model for overweight that includes interaction terms between early childhood education and a dummy variable indicating that the individual is the youngest child. These interactions are negative and statistically significant at the ten percent level suggesting that older siblings do not benefit from the Head Start attendance of the youngest child.

percentage points less likely to report their health as fair or poor; however, this result is only significant at the ten percent level.

In black families, the eldest child who attended Head Start is 36.3 percentage points less likely to have health insurance.[47] No statistically significant relationship exists for whites. Head Start programs work to ensure that a source of health care and funding is available for the participants. Staff members assist families in determining if the Head Start child is eligible for Medicaid, aid families in understanding the guidelines of the Medicaid program, and refer families to health professionals who accept Medicaid patients (Head Start Bureau, 2002). As parents learn about the available health insurance options and the benefits of health insurance, the children are likely to profit from this knowledge and the youngest child seems to benefit the most.

Conclusion

The early childhood investment program Head Start affects the education and health of children who participate in the program. Prior research determined that the cognitive focus of the program resulted in sustained educational benefits. The predicted relationship between educational attainment and adult health, as well as the empirical literature that substantiates this claim, suggest that the cognitive investments of Head Start will translate into lasting health benefits for program participants. Prior research has found evidence that immunizations and physician visits increased among Head Start participants. If the investments in the health and nutrition of the child participants have a

[47] This result also holds when only interactions between early childhood experiences and the oldest sibling variable are included. Additional estimates demonstrate that older siblings in black families are more likely to have health insurance than the youngest sibling who attended Head Start, although this result is only significant at the 10 percent level. This suggests that this spillover benefit does flow from older siblings to younger siblings.

lasting effect on health, then the Head Start program can lead to sustained health benefits for program participants. As a result of the focus of Head Start on children from low-income families, health benefits from Head Start participation can reduce persistent socioeconomic health disparities.

To determine the long-term impact of Head Start participation, we estimated a fixed effects model of health outcomes and health practices. Our results demonstrated that Head Start changed one of the most crucial aspects of health behavior. In adulthood, Head Start participants are 17.4 percentage points less likely to smoke cigarettes than individuals who attended other preschools. However, it is worth noting that Head Start is not shown to have an impact on other health behaviors for participants.

The estimated reduction in smoking due to Head Start participation is indeed substantial. One way of seeing this is to compare Head Start's impact on smoking to the quit rates obtained through traditional smoking cessation programs. It turns out that these rates are quite similar to the 17.4 percentage point figure for Head Start (Anthonisen et al., 2005; Cutler, 2002). In terms of smoking behavior, the impact of attending Head Start is comparable to participating in an intensive smoking cessation program. A second way of interpreting our results is to convert the impact into dollar terms. The estimated annual costs per smoker between 1995 and 1999 amounted to $3,391, which included excess medical expenditures and lost productivity (Center for Disease Control and Prevention, 2002). The present value of a 17.4 percentage point reduction in smoking, assuming a 3 percent real discount rate, is $11,704 per each Head Start participant entering the program at four years of age in 2003.[48] Using a 7 percent real discount rate, the present value becomes $3,756. For comparison purposes, the average cost of each Head Start participant in 2003 was $7,092. The value of the reduction in smoking, then, represents 53 to 165 percent of the costs of Head Start per child. Since this is only one of the outcomes of Head Start, the benefits are relatively large.

Participation in Head Start benefits younger siblings, as well as participants in Head Start on other dimensions of health. Younger siblings of Head Start participants in black families are more likely to exercise heavily than older siblings who attended Head Start. Younger siblings of Head Start participants in white families are less likely to be overweight than the oldest sibling who attended Head Start. Poor diet and physical inactivity combine to form the second leading cause of mortality and were responsible for 400,000 deaths in 2000 (Mokdad et al., 2004).

Younger siblings of Head Start participants in black families are more likely to have health insurance than the oldest sibling who attended Head Start. Sixteen percent of individuals in the United States in 2003 were uninsured and 24 percent of people in households with an annual income of less than $25,000 were uninsured (DeNavas-Walt, Proctor, and Mills, 2004). Because low income individuals are less likely to have health insurance and Head Start targets children from low income families, Head Start provides a pathway for reducing socioeconomic disparities in health insurance coverage. Health insurance encourages individuals to seek medical care by lowering the associated cost of preventive and curative care and can lead to improved health by increasing the consumption of an important input in health production.

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[48] The economic costs are converted into 2003 dollars using the Consumer Price Index of all items for all urban consumers (current series). This calculation assumes that the reduction in smoking begins at age 18 and lasts until death at age 70.

Head Start is associated with health benefits that are likely to persist throughout the participants' life. As the participants age into their later years, information will become available about adult health conditions, including the development of various diseases and mortality. In the future, we will be able to better understand if attending a comprehensive early childhood development program, such as Head Start, can reduce the socioeconomic disparities in health.

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Appendix

This appendix provides the complete results of the estimates displayed in Tables 8 and 9.

Table 14: Smoke Cigarettes

Complete Results of the Specifications in Table 8	(1)	(2)	(3)	(4)
Head Start	-0.010	-0.024	-0.081	-0.124
	(0.026)	(0.032)	(0.050)	(0.075)
Other Preschool	-0.027	-0.011	-0.029	0.049
	(0.021)	(0.022)	(0.033)	(0.051)
Head Start Before 1996		0.065	0.009	0.113
		(0.065)	(0.096)	(0.123)
Other Preschool Before 1996		-0.013	0.081	0.057
		(0.051)	(0.091)	(0.121)
Age		0.001	0.003	0.001
		(0.003)	(0.004)	(0.013)
Female		-0.032	-0.059	-0.033
		(0.017)	(0.028)	(0.036)
Black		-0.114	-0.099	
		(0.027)	(0.046)	
Married		-0.136	-0.148	-0.078
		(0.020)	(0.028)	(0.037)
Urban		-0.062	-0.044	-0.014
		(0.023)	(0.036)	(0.056)
Rural		-0.009	0.057	0.138
		(0.070)	(0.130)	(0.159)
Birth Order		0.008	-0.001	0.001
		(0.008)	(0.012)	(0.035)
Oldest		-0.012	-0.054	-0.064
		(0.025)	(0.034)	(0.042)
Family Income (ln)		-0.037	-0.031	-0.045
		(0.023)	(0.035)	(0.080)
Family Size		-0.005	-0.008	-0.036
		(0.009)	(0.015)	(0.035)
Father Not Present		-0.004	-0.055	-0.032
		(0.036)	(0.044)	(0.083)
Mother's Education		-0.011	-0.011	-0.019
		(0.006)	(0.009)	(0.031)
Father's Education		-0.007	-0.020	-0.034
		(0.005)	(0.008)	(0.024)
Low Birth-weight Baby		-0.021	-0.106	-0.001
		(0.040)	(0.049)	(0.074)
Disabled		0.013	-0.067	-0.123
		(0.052)	(0.079)	(0.090)
Constant	0.254	0.734	0.911	1.246
	(0.012)	(0.121)	(0.174)	(0.804)
Difference (HS-PS)	0.017	-0.013	-0.052	-0.174
	(0.031)	(0.037)	(0.058)	(0.088)
N	2397	2397	984	984
R-squared	0.00	0.05	0.10	0.06

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

Table 15: Ever Smoke Cigarettes

Complete Results of the Specifications in Table 8	(1)	(2)	(3)	(4)
Head Start	-0.061	-0.025	-0.061	-0.096
	(0.028)	(0.034)	(0.053)	(0.085)
Other Preschool	-0.034	-0.020	-0.058	-0.006
	(0.025)	(0.027)	(0.040)	(0.057)
Head Start Before 1996		0.101	0.112	0.272
		(0.071)	(0.109)	(0.140)
Other Preschool Before 1996		-0.016	0.104	0.055
		(0.064)	(0.105)	(0.137)
Age		0.002	0.002	0.000
		(0.003)	(0.005)	(0.015)
Female		-0.026	-0.035	-0.059
		(0.019)	(0.031)	(0.041)
Black		-0.208	-0.198	
		(0.030)	(0.050)	
Married		-0.154	-0.143	-0.072
		(0.022)	(0.032)	(0.042)
Urban		-0.053	-0.03	0.016
		(0.025)	(0.038)	(0.063)
Rural		-0.063	0.051	0.217
		(0.074)	(0.122)	(0.181)
Birth Order		0.013	-0.006	0.002
		(0.009)	(0.014)	(0.039)
Oldest		-0.026	-0.103	-0.091
		(0.028)	(0.039)	(0.048)
Family Income (ln)		-0.001	0.002	-0.091
		(0.026)	(0.038)	(0.091)
Family Size		-0.013	-0.006	-0.007
		(0.010)	(0.017)	(0.040)
Father Not Present		-0.071	-0.098	-0.076
		(0.040)	(0.052)	(0.095)
Mother's Education		-0.016	-0.012	-0.001
		(0.007)	(0.010)	(0.036)
Father's Education		-0.013	-0.025	-0.045
		(0.006)	(0.008)	(0.027)
Low Birth-weight Baby		-0.087	-0.102	0.014
		(0.044)	(0.061)	(0.084)
Disabled		-0.006	0.005	-0.020
		(0.055)	(0.085)	(0.102)
Constant	0.416	0.932	1.052	1.417
	(0.014)	(0.132)	(0.183)	(0.912)
Difference (HS-PS)	-0.027	-0.005	-0.003	-0.090
	(0.036)	(0.042)	(0.066)	(0.100)
N	2396	2396	984	984
R-squared	0.00	0.07	0.09	0.06

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

Table 16: Light Exercise

Complete Results of the Specifications in Table 8	(1)	(2)	(3)	(4)
Head Start	-0.071	-0.101	-0.058	-0.039
	(0.030)	(0.037)	(0.057)	(0.098)
Other Preschool	-0.010	-0.040	-0.056	-0.056
	(0.024)	(0.027)	(0.039)	(0.066)
Head Start Before 1996		0.071	-0.033	-0.039
		(0.068)	(0.121)	(0.163)
Other Preschool Before 1996		0.134	0.027	-0.022
		(0.065)	(0.118)	(0.161)
Age		-0.008	-0.002	-0.003
		(0.003)	(0.004)	(0.017)
Female		-0.012	-0.032	0.015
		(0.019)	(0.032)	(0.048)
Black		-0.042	-0.060	
		(0.031)	(0.051)	
Married		-0.077	-0.096	-0.069
		(0.024)	(0.033)	(0.049)
Urban		0.009	-0.003	0.078
		(0.025)	(0.036)	(0.073)
Rural		0.118	0.126	-0.017
		(0.084)	(0.106)	(0.208)
Birth Order		0.000	-0.007	-0.030
		(0.010)	(0.014)	(0.045)
Oldest		-0.055	-0.051	-0.069
		(0.030)	(0.043)	(0.055)
Family Income (ln)		-0.016	-0.041	-0.038
		(0.027)	(0.036)	(0.106)
Family Size		-0.008	-0.004	-0.013
		(0.010)	(0.016)	(0.046)
Father Not Present		-0.029	0.011	0.098
		(0.040)	(0.054)	(0.111)
Mother's Education		-0.007	-0.001	0.054
		(0.007)	(0.009)	(0.041)
Father's Education		-0.003	-0.006	-0.039
		(0.006)	(0.008)	(0.032)
Low Birth-weight Baby		0.019	0.038	-0.012
		(0.051)	(0.070)	(0.097)
Disabled		0.047	0.099	0.12
		(0.057)	(0.084)	(0.118)
Constant	0.546	1.056	0.967	0.656
	(0.014)	(0.127)	(0.185)	(1.055)
Difference (HS-PS)	-0.062	-0.061	-0.002	0.017
	(0.037)	(0.045)	(0.068)	(0.115)
N	2390	2390	980	980
R-squared	0.00	0.02	0.04	0.04

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

Table 17: Heavy Exercise

Complete Results of the Specifications in Table 8	(1)	(2)	(3)	(4)
Head Start	-0.048	-0.009	0.022	0.068
	(0.030)	(0.037)	(0.059)	(0.091)
Other Preschool	0.043	0.015	0.008	0.038
	(0.025)	(0.028)	(0.041)	(0.062)
Head Start Before 1996		-0.032	0.051	0.145
		(0.066)	(0.122)	(0.151)
Other Preschool Before 1996		0.065	-0.02	-0.012
		(0.066)	(0.110)	(0.149)
Age		-0.001	0.002	0.007
		(0.003)	(0.004)	(0.016)
Female		-0.098	-0.111	-0.115
		(0.021)	(0.033)	(0.044)
Black		-0.047	-0.038	
		(0.030)	(0.052)	
Married		-0.060	-0.088	-0.055
		(0.022)	(0.035)	(0.045)
Urban		-0.007	-0.027	0.094
		(0.025)	(0.039)	(0.067)
Rural		0.083	0.087	-0.148
		(0.091)	(0.113)	(0.200)
Birth Order		0.003	-0.004	-0.022
		(0.010)	(0.014)	(0.042)
Oldest		0.027	0.009	-0.023
		(0.029)	(0.041)	(0.051)
Family Income (ln)		-0.020	-0.007	0.152
		(0.027)	(0.040)	(0.099)
Family Size		0.007	0.003	0.010
		(0.010)	(0.016)	(0.043)
Father Not Present		-0.010	0.048	-0.034
		(0.039)	(0.056)	(0.102)
Mother's Education		0.015	0.017	0.028
		(0.007)	(0.010)	(0.038)
Father's Education		0.003	-0.001	-0.048
		(0.006)	(0.008)	(0.030)
Low Birth-weight Baby		0.024	0.028	0.004
		(0.049)	(0.072)	(0.090)
Disabled		-0.087	-0.099	0.038
		(0.053)	(0.077)	(0.109)
Constant	0.373	0.336	0.289	-0.058
	(0.013)	(0.143)	(0.212)	(0.983)
Difference (HS-PS)	-0.091	-0.024	0.014	0.031
	(0.037)	(0.045)	(0.069)	(0.107)
N	2384	2384	979	979
R-squared	0.00	0.03	0.04	0.05

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

Table 18: Overweight

Complete Results of the Specifications in Table 9	(1)	(2)	(3)	(4)
Head Start	0.103	0.041	0.016	-0.045
	(0.029)	(0.035)	(0.055)	(0.083)
Other Preschool	-0.079	-0.034	-0.053	-0.089
	(0.025)	(0.028)	(0.042)	(0.056)
Head Start Before 1996		-0.083	-0.237	-0.152
		(0.073)	(0.108)	(0.137)
Other Preschool Before 1996		0.074	0.132	-0.039
		(0.061)	(0.092)	(0.139)
Age		0.006	0.010	0.018
		(0.003)	(0.005)	(0.014)
Female		-0.190	-0.172	-0.190
		(0.021)	(0.034)	(0.040)
Black		0.154	0.145	
		(0.031)	(0.051)	
Married		0.049	0.055	0.018
		(0.023)	(0.034)	(0.041)
Urban		-0.014	-0.012	-0.068
		(0.024)	(0.038)	(0.061)
Rural		0.023	-0.080	0.019
		(0.066)	(0.102)	(0.174)
Birth Order		-0.013	-0.015	0.037
		(0.010)	(0.014)	(0.039)
Oldest		0.022	0.023	0.039
		(0.029)	(0.038)	(0.046)
Family Income (ln)		-0.058	-0.085	-0.032
		(0.028)	(0.042)	(0.089)
Family Size		0.017	0.012	-0.060
		(0.010)	(0.015)	(0.039)
Father Not Present		-0.053	-0.082	-0.052
		(0.041)	(0.057)	(0.092)
Mother's Education		-0.010	-0.018	-0.002
		(0.007)	(0.011)	(0.034)
Father's Education		-0.003	-0.002	0.024
		(0.006)	(0.009)	(0.026)
Low Birth-weight Baby		-0.046	-0.033	0.010
		(0.048)	(0.059)	(0.081)
Disabled		0.056	0.027	0.173
		(0.056)	(0.075)	(0.101)
Constant	0.521	0.709	0.816	0.260
	(0.013)	(0.139)	(0.212)	(0.888)
Difference (HS-PS)	0.186	0.075	0.069	0.045
	(0.036)	(0.042)	(0.067)	(0.097)
N	2362	2362	972	972
R-squared	0.01	0.08	0.10	0.11

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

Table 19: High Blood Pressure

Complete Results of the Specifications in Table 9

	(1)	(2)	(3)	(4)
Head Start	0.020	0.013	0.048	0.062
	(0.018)	(0.022)	(0.041)	(0.052)
Other Preschool	-0.010	0.004	0.017	0.049
	(0.013)	(0.015)	(0.025)	(0.035)
Head Start Before 1996		-0.023	-0.054	-0.043
		(0.044)	(0.073)	(0.085)
Other Preschool Before 1996		-0.054	-0.071	-0.081
		(0.025)	(0.056)	(0.084)
Age		0.003	0.005	0.005
		(0.002)	(0.003)	(0.009)
Female		-0.012	0.001	-0.016
		(0.012)	(0.018)	(0.025)
Black		0.020	0.002	
		(0.017)	(0.031)	
Married		-0.012	-0.023	-0.022
		(0.012)	(0.017)	(0.026)
Urban		-0.009	-0.007	0.046
		(0.014)	(0.022)	(0.038)
Rural		-0.063	-0.034	-0.102
		(0.023)	(0.044)	(0.110)
Birth Order		0.003	0.000	0.013
		(0.006)	(0.008)	(0.024)
Oldest		0.026	0.010	0.049
		(0.017)	(0.025)	(0.029)
Family Income (ln)		0.030	0.027	0.010
		(0.015)	(0.022)	(0.055)
Family Size		-0.003	-0.005	-0.009
		(0.005)	(0.007)	(0.024)
Father Not Present		0.038	0.024	0.077
		(0.025)	(0.034)	(0.058)
Mother's Education		-0.004	-0.002	0.022
		(0.004)	(0.005)	(0.022)
Father's Education		-0.005	-0.007	-0.021
		(0.003)	(0.004)	(0.017)
Low Birth-weight Baby		0.004	0.023	0.074
		(0.028)	(0.041)	(0.051)
Disabled		0.081	0.097	0.093
		(0.043)	(0.065)	(0.062)
Constant	0.077	0.000	-0.023	-0.126
	(0.007)	(0.074)	(0.110)	(0.556)
Difference (HS-PS)	0.030	0.010	0.031	0.013
	(0.021)	(0.025)	(0.043)	(0.061)
N	2397	2397	984	984
R-squared	0.00	0.02	0.03	0.05

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

Table 20: Fair or Poor Health

Complete Results of the Specifications in Table 9	(1)	(2)	(3)	(4)
Head Start	0.022	-0.009	-0.008	-0.003
	(0.016)	(0.018)	(0.028)	(0.043)
Other Preschool	-0.028	-0.020	-0.044	-0.045
	(0.010)	(0.011)	(0.013)	(0.029)
Head Start Before 1996		0.011	0.024	0.123
		(0.041)	(0.077)	(0.070)
Other Preschool Before 1996		0.012	0.031	-0.02
		(0.026)	(0.047)	(0.069)
Age		-0.001	0.001	-0.004
		(0.001)	(0.002)	(0.007)
Female		0.012	0.018	0.016
		(0.010)	(0.013)	(0.020)
Black		0.019	0.023	
		(0.014)	(0.023)	
Married		-0.029	-0.021	-0.002
		(0.011)	(0.015)	(0.021)
Urban		-0.017	0.015	-0.018
		(0.011)	(0.015)	(0.031)
Rural		-0.053	-0.041	0.028
		(0.024)	(0.014)	(0.090)
Birth Order		0.004	-0.019	-0.018
		(0.007)	(0.009)	(0.020)
Oldest		0.005	-0.014	-0.015
		(0.014)	(0.019)	(0.024)
Family Income (ln)		-0.016	-0.015	-0.008
		(0.013)	(0.016)	(0.045)
Family Size		0.001	0.017	-0.011
		(0.007)	(0.009)	(0.020)
Father Not Present		0.026	0.019	-0.017
		(0.020)	(0.026)	(0.047)
Mother's Education		0.001	0.001	0.018
		(0.003)	(0.003)	(0.018)
Father's Education		-0.005	-0.002	0.011
		(0.002)	(0.003)	(0.014)
Low Birth-weight Baby		-0.039	-0.020	-0.010
		(0.018)	(0.025)	(0.042)
Disabled		0.109	0.085	0.079
		(0.043)	(0.059)	(0.051)
Constant	0.064	0.180	0.051	-0.013
	(0.006)	(0.069)	(0.082)	(0.455)
Difference (HS-PS)	0.050	0.011	0.036	0.041
	(0.017)	(0.021)	(0.032)	(0.050)
N	2397	2397	984	984
R-squared	0.00	0.03	0.06	0.04

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

Table 21: Health Insurance

Complete Results of the Specifications in Table 9	(1)	(2)	(3)	(4)
Head Start	-0.101	-0.001	0.073	0.026
	(0.027)	(0.032)	(0.047)	(0.064)
Other Preschool	0.027	0.015	0.019	0.079
	(0.017)	(0.018)	(0.029)	(0.043)
Head Start Before 1996		-0.075	-0.094	0.093
		(0.058)	(0.090)	(0.104)
Other Preschool Before 1996		-0.009	0.016	-0.063
		(0.034)	(0.050)	(0.103)
Age		0.006	0.006	-0.015
		(0.002)	(0.003)	(0.011)
Female		0.045	0.036	0.033
		(0.014)	(0.023)	(0.031)
Black		-0.045	-0.016	
		(0.025)	(0.044)	
Married		0.115	0.106	0.137
		(0.017)	(0.024)	(0.031)
Urban		0.023	0.013	0.011
		(0.019)	(0.029)	(0.047)
Rural		-0.09	-0.199	0.126
		(0.069)	(0.104)	(0.135)
Birth Order		-0.007	-0.015	-0.062
		(0.008)	(0.011)	(0.029)
Oldest		0.021	0.014	0.038
		(0.022)	(0.028)	(0.035)
Family Income (ln)		0.078	0.096	0.079
		(0.023)	(0.034)	(0.068)
Family Size		0.001	0.000	-0.001
		(0.008)	(0.011)	(0.030)
Father Not Present		-0.039	-0.048	0.096
		(0.033)	(0.044)	(0.071)
Mother's Education		0.008	0.009	0.046
		(0.006)	(0.008)	(0.027)
Father's Education		0.003	0.002	-0.021
		(0.004)	(0.006)	(0.021)
Low Birth-weight Baby		-0.008	0.024	0.081
		(0.034)	(0.044)	(0.062)
Disabled		0.009	0.031	0.032
		(0.044)	(0.059)	(0.076)
Constant	0.858	0.178	0.14	0.645
	(0.010)	(0.113)	(0.167)	(0.681)
Difference (HS-PS)	-0.129	-0.016	0.054	-0.054
	(0.030)	(0.036)	(0.055)	(0.075)
N	2397	2397	984	984
R-squared	0.01	0.10	0.11	0.09

Notes: Standard errors (in parentheses) allow for household clustering and heteroskedasticity in ordinary least squares regressions.

CHAPTER IV

THE ROLE OF HOMEWORK AND CLASS SIZE IN EDUCATIONAL PRODUCTION

Introduction

Following the dire conclusions of *A Nation at Risk* (National Commission on Excellence in Education, 1983), a variety of education reforms have been proposed to increase student achievement in the United States. One of the most popular reforms is to reduce the number of students per classroom. In 1999, the federal government appropriated $1.2 billion to reduce class sizes, mainly in lower income school districts and districts with the highest overall enrollments.[49] The federal Class-Size Reduction Program, which has since been incorporated into the No Child Left Behind Act, is premised on the belief that smaller classes can increase achievement levels and decrease the socioeconomic and racial disparities in achievement. Additionally, nearly half of the states have enacted class size reduction policies with 12 states amending or establishing new policies since 2000 (Education Commission of the States, 2005).

Reductions in class size are popular among parents, teachers, and policy makers because of the commonly held notion that smaller classes lead to more individualized attention for students and greater achievement. Simply decreasing the number of students in a classroom, however, does not necessarily lead to changes in teachers' or students' behavior. Policy makers have focused on changing teachers' instructional

[49] This amount represented 7.6 percent of the $21 billion federal budget for elementary and secondary expenditures in 1999 (Source: Department of Education, http://www.ed.gov/about/overview/budget/history/edhistory.pdf).

approaches to maximize the effectiveness of class size reduction programs. For example, the federal Class-Size Reduction Program allocates a significant portion of funds for professional development to train teachers to alter their teaching styles and take advantage of the instructional opportunities presented by smaller classes.[50] Academic research has also focused on behavioral changes within the classroom as the primary mechanism for class size reduction policies to impact student achievement.[51]

The process of human capital accumulation, however, occurs both inside and outside of the classroom, involving not only the instructional activities that occur during the school day, but also the effort of the student afterwards. Students' effort consists of the amount of time and intensity spent on assigned homework, on unassigned studying, and on educational activities unrelated to coursework (e.g., leisure reading, etc.). Academic work outside of the classroom is a form of private investment in education undertaken by the student that may be augmented by parental effort.

The greatest benefits from class size reduction policies are realized when the resulting change in incentives does not reduce or crowd out the private investments in education by students. The crowding out of private investment is a common unintended consequence of increases in public investment.[52] Previous research has demonstrated that increases in school resources can reduce parents' effort (Houtenville and Conway, 2005;

[50] In 1999, school districts were permitted to use up to 15 percent of the appropriation for professional development. Funds set aside for professional development were not used to train new teachers. In 2000, up to 25 percent of the funding was available for professional development.

[51] See, for example, Smith and Glass (1980) and the references in the next section. Additional research on the behavioral responses of students to incentives within the school system includes Betts (1998), Bishop and Mane (2001), and Jacob (2001), among others.

[52] For example, Cutler and Gruber (1996) document the reduction in private health insurance expenditure as a result of increased Medicaid expenditure and Roberts (1984) describes how government expenditures on public goods reduce charitable donations.

Kim, 2001)[53], but the academic literature has largely ignored students' responses to changes in school resources – an arguably more important input in educational production, at least for older students.

The increased public investment that leads to smaller classes crowds out students' private investments in education if students respond to smaller classes by decreasing their effort outside of school. If class size reductions increase the quality of instruction in school, then students can reduce effort while enjoying more leisure time without decreasing achievement. An alternative response on the part of students to a decrease in class size would be to complement the increased public investment in their education with an increase in effort outside the classroom. Thus, the overall impact of public investment in smaller classes on achievement depends on students' behavioral response to the investment.

This paper estimates the relationship between class size and student effort using data from the National Education Longitudinal Study of 1988. Student effort is measured by the amount of time spent on homework per week.[54] Previous research has demonstrated that greater amounts of time spent on homework lead to higher levels of achievement.[55] Therefore, estimates of the relationship between class size and homework are relevant for determining the extent to which class size reduction policies crowd out

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[53] Houtenville and Conway (2005) find that increased school resources reduce parents' effort, measured by the extent that parents discuss subjects studied, school activities, and course selection, in high school. On the other hand, Bonesronnig (2004) finds that decreases in class size increase parents' effort, measured by homework assistance, for female students in lower secondary school in Norway.

[54] As recognized above, the amount of time spent on homework is only one component of student effort. However, time spent on homework is likely to be one of the most important determinants of effort, at least for mathematics. Additionally, the use of time spent on homework as a measure of student effort is driven by data considerations.

[55] See, for example, Aksoy and Link (2000) and the references in the next section.

student effort, and hence for determining the actual relationship between class size and student achievement.

Cross-section estimation of the relationship between class size and the amount of time spent on homework will likely lead to biased estimates due to the omission of students' innate ability and, more generally, the potential endogeneity of class size. The endogeneity arises because of the nonrandom assignment of students to classes, the nonrandom allocation of resources across schools, and the nonrandom assignment of teachers to classes. To account for these sources of potential bias, I exploit the longitudinal nature of the data source to estimate a student fixed effects model that also controls for a variety of observable teacher characteristics.

The empirical results suggest that increased public investment in education in the form of smaller classes does not crowd out the private investment of students. On the contrary, the point estimates describe a negative, although statistically insignificant, relationship between class size and the amount of time spent on homework. Examining this relationship by demographic groups reveals that black students respond to smaller classes by spending more time on homework. This finding provides further support for the growing body of research that suggests that smaller classes provide a plausible reform strategy for reducing the black-white achievement gap (Boozer and Rouse, 2001; Krueger and Whitmore, 2001).

Background

The empirical research that attempts to determine if class size affects student outcomes has produced mixed conclusions regarding the effectiveness of class size reductions. Different literature reviews of this substantial body of research arrive at different conclusions. Eric Hanushek's reviews of the literature (1986, 1996, and 1997) conclude that class size has no effect on student achievement. However, applying a different weighting scheme to the studies in Hanushek's 1997 meta-analysis yields the opposite conclusion, leading Krueger (2003) to argue that class size is related to student achievement.

While there are mixed conclusions regarding the overall relationship between class size and students' achievement, smaller classes may lead to increases in achievement for some students (Mishel and Rothstein, 2002). For example, minority students benefit the most from smaller classes (Finn and Achilles, 1999; Krueger, 1999), and smaller classes can substantially decrease racial achievement gaps (Boozer and Rouse, 2001; Krueger and Whitmore, 2002).

To determine how smaller classes might lead to gains in student achievement, Rice (1999) and Betts and Shkolnik (1999) examine the relationship between class size and middle and high school math teachers' instructional activities within the classroom. Both studies find that smaller classes reduce the amount of time that the teacher needs to spend on discipline and increases the amount of time available for instruction.[56,57] Betts and Shkolnik (1999) also estimate that teachers in smaller classes spend more time on individual instruction and less time on group instruction. Decreases in class size reduce

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[56] This view is consistent with Lazear's (2001) model of congestion effects in classroom learning, where disruptive behavior creates a negative externality. In the Lazear model of educational production, output is determined by the value of a unit of learning, the number of students in the school, and the probability that any given student is not disrupting their own or any other students' learning at any moment in time. The latter term accounts for the negative crowding effect associated with classroom education. The key result of this model is that the optimal class size varies inversely with the behavior of students. Further, the effects of class size reductions depend on the size of the class and the behavior of the students. This implies that there are larger benefits from a class size reduction program for worse behaved students.

[57] These results are consistent with the findings of the early literature on class size (Smith and Glass, 1980).

the percentage of classroom time spent on routine administrative matters and increase the percentage of time allocated to review, although these changes are small in magnitude. Class size has no statistically significant effect on the percentage of time allocated to new material or testing or on the percentage of the assigned textbook that is taught. These results suggest that as class sizes are reduced, teachers respond by attempting to improve student understanding through more review and individual attention, as opposed to teaching new material.

Smaller classes may also influence students' behavior. Finn, Pannozzo, and Achilles (2003) argue that a decrease in class size is associated with increased student engagement and that the resulting increase in engagement leads to increased student achievement. Students in smaller class sizes are more academically and socially engaged in the classroom because of an increase in the visibility of the student in a smaller class and an increase in the sense of belonging to the group. With smaller classes, students are under more pressure to participate because of the inability to "hide" or avoid notice in the classroom. Additionally, students in smaller classes develop a closer relationship with the teacher and a more supportive relationship with other students, suggesting that peer effects are stronger in smaller classes.

The results from the studies described above suggest that a reduction in class size does change the classroom environment and is likely to increase student achievement. However, the research that explores how school resources might impact achievement is limited to effects within the classroom and ignores the potential impact on students' effort outside of the classroom. This paper attempts to fill this gap by estimating the impact of class size on students' effort outside the classroom, as measured by the amount of time spent on homework. Additionally, this paper explores the possibility that students' behavior outside of the classroom can explain the contrast between the literature that finds that smaller classes improve the instructional environment of the classroom and the literature that leads to mixed conclusions about the overall impact of class size on student achievement. Further, this paper seeks to determine if students' responses outside of the classroom can partially explain why minority students seem to benefit the most from smaller classes. In general, this paper examines whether student behavior can explain the various results found in the literature relating to the impact of smaller class size.

The amount of time spent on homework is a worthwhile outcome to examine because time spent on homework is related to student achievement. The overall conclusion from the early research on this subject suggests that one extra hour of math homework per week is associated with a 0.39 standard deviation increase in achievement (Cooper, 1989).[58] This research suffers from a variety of methodological problems, such as the failure to adequately control for prior achievement – to reduce the bias from the omission of innate ability – and the use of small samples in non-experimental studies. However, recent research with more sophisticated statistical methods and larger samples reinforces the conclusion that there exists a positive relationship between the amount of time spent on homework and student achievement, albeit at a much smaller magnitude.

[58] Overall, homework is positively correlated with achievement for secondary school students, but not for elementary school students. Muhlenbruck, Cooper and Lindsay (2000) provide evidence that homework is assigned for different purposes in elementary school than in secondary school. Elementary school homework is designed to develop time management skills, which may not translate to higher test scores. Further, elementary school teachers used homework to review class material and discussed homework in class, while secondary school teachers used homework to prepare for and enrich classroom lessons.

Aksoy and Link (2000) estimate the effect of the number of hours per week spent on mathematics homework on math achievement using the National Education Longitudinal Study of 1988 (NELS: 88). Using a student fixed effects framework, the number of hours per week spent on homework has a positive and statistically significant effect on achievement scores. An extra hour of homework per week increases math achievement by 2.9 – 5.5 percent of the standard deviation of the test score distribution. Betts (1997) estimates the effect of hours of math homework assigned per week on math achievement using a value-added specification (including the previous period's test score as a regressor) and individual fixed effects models. Betts reports that the number of hours of math homework assigned has a positive and statistically significant effect on math achievement scores in both the value-added and fixed effects specifications. Each extra hour of homework assigned leads to an increase in achievement of 1.7 – 3.0 percent of the standard deviation. Assigning students an extra 30 minutes of homework each night from grades 7 through 11 is predicted to increase student achievement by roughly two grade equivalents on average and an increase of 15 minutes per night would translate to an increase in achievement of one grade equivalent on average. Based on the results described above, the amount of time spent on homework is an important determinant of achievement.

A Model Describing the Relationship between Class Size and Homework

The relationship between class size and the amount of time students spend on homework is conceptualized within a labor supply model.[59] Let a student's utility U be a function of future consumption C and leisure l, so that $U = U(C, l)$ where utility is assumed to be increasing in each input. Consumption is a composite good that consists of all consumption after the completion of schooling and is determined by each individual's human capital H, such that $C = \alpha H$ where α represents the return to human capital and the extent that an individual utilizes their human capital in the labor market. Leisure consists of all time after school $\overline{L}$ not allocated to homework L, such that $L + l = \overline{L}$. The total endowment of time is divided into time spent in school S and time after school $\overline{L}$.

Human capital is produced both in school and after school according to the function, $H = f(qS, L)$, where S is the amount of time spent in school, L is the amount of time spent on human capital building activities (such as homework) after school and q represents school quality. The amount of time spent in school is fixed from the viewpoint of the student, while L is a choice of the student. School quality is a productivity-shifting parameter that is a function of class size, $q = q(N)$. The objective of the students is to allocate their time to maximize utility subject to the consumption equation, time constraint, and human capital production function.

The change in human capital in response to a change in class size is:

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[59] Similar models that include student effort in the human capital equation are Johnson and Stafford (1996) and Laing (2003). Models that include parental effort are Houtenville and Conway (2005). Kim (2001) includes the amount of time that mothers' spend with their child in a human capital equation.

$$\frac{dH}{dN} = S\frac{\partial f}{\partial q}\frac{dq}{dN} + \frac{\partial f}{\partial L}\frac{\partial L}{\partial q}\frac{dq}{dN}. \quad (1)$$

This derivative can be decomposed into two parts: the change in human capital that results from the effect of class size on school quality and the change in human capital that results from the effect of class size on effort after school, or the amount of time spent on homework. Human capital is assumed to increase as school quality rises $\left(\frac{\partial f}{\partial q} > 0\right)$. If a decrease in class size leads to an increase in school quality $\left(\frac{dq}{dN} < 0\right)$, then the first term on the right hand side of equation (1) is negative. This term represents the direct impact of class size on human capital.

The second term in equation (1) represents the indirect impact of class size on human capital through students' effort. Human capital is assumed to increase as students spend more time on homework $\left(\frac{\partial f}{\partial L} > 0\right)$, which is consistent with the literature that demonstrates a positive relationship between time spent on homework and achievement. The relationship between class size and the amount of time spent on homework is comprised of the relationship between school quality and the amount of time spent on homework $\left(\frac{\partial L}{\partial q}\right)$ and the relationship between school quality and class size $\left(\frac{dq}{dN}\right)$. As suggested by previous research, $\left(\frac{dq}{dN} < 0\right)$. Thus, the sign of the relationship between class size and the amount of time spent on homework, which will be estimated as one change in the empirical section, is based on the relationship between school quality and the amount of time spent on homework. This sign is uncertain, however, because *L* is the result of the choices of students. The sign of this relationship, as well as the magnitudes of the direct and indirect impacts, determines the change in human capital in response to a change in class size.

The sign of the change in time spent on homework with respect to class size is determined by the individual's tradeoff between consumption and leisure. An increase in *L* leads to an increase in human capital and consumption, which increases utility; however, an increase in *L* also decreases leisure, which decreases utility. If the student increases the amount of time spent on homework in smaller classes $\left(\frac{\partial L}{\partial q}\frac{dq}{dN} < 0\right)$, then the student chooses the increase in human capital – since $\left(\frac{dH}{dN} < 0\right)$ – and consumption over the decrease in leisure. Under this scenario, a decrease in class size enhances the productivity of time spent on homework, which complements the direct effect of class size on human capital. If the student decreases the amount of time spent on homework in response to a decrease in class size $\left(\frac{\partial L}{\partial q}\frac{dq}{dN} > 0\right)$, then the student prefers the increase in leisure over the greater potential increase in human capital and consumption. Human capital may still increase under this scenario – it depends on the magnitudes of the negative first term and the positive second term in equation (1) – but the increased leisure dampens the impact of class size on human capital and crowds out the public investment in human capital.

To be more concrete about these ideas, while abstracting from the relationship between class size and school quality, let $H = f(qS, L) = qS + \gamma qL$, where γq represents the human capital return to spending time on homework and $\gamma < 1$. Since $C = \alpha H$,

$C = \alpha qS + \alpha\gamma qL$. Let C_0 denote the level of consumption when the student spends no time on homework (L = 0), $C_0 = \alpha qS$. The slope of the budget line between consumption and leisure is then equal to $-\alpha\gamma q$. An increase in school quality increases C_0, which, similar to an increase in nonlabor income in a traditional labor supply model, leads to an increase in leisure and a decrease in the amount of time spent on homework if leisure is a normal good. Additionally, since school quality influences the productivity of time spent on homework, an increase in school quality changes the slope of the budget line between consumption and leisure. An increase in school quality that shifts the budget line also leads to an increase in leisure if leisure is a normal good through an "income" effect. However, there is also a greater cost to the student of not spending time on homework to increase their human capital, which can lead the student to decrease leisure and increase the amount of time spent on homework. Thus, the impact of school quality and class size on the amount of time spent on homework is theoretically ambiguous. This framework demonstrates the importance of accounting for the change in class size on students' behavior outside of the classroom to understand the effect of a change in class size on human capital.

Methodology

Analysis of the relationship between the amount of time that students devote to homework and class size with non-experimental data requires accounting for the nonrandom assignment of both students and teachers to classes, as well as the nonrandom allocation of resources to schools. As a starting point for estimating this relationship, let the amount of time student *i* in class *j* in school *k* at time *t* spends on homework (*HW*) be defined as a function of class size (*CS*), a vector of individual, teacher, and school variables (*Z*), and a random error term (ε):

$$HW_{ijkt} = \beta_0 + \beta_1 CS_{jkt} + \beta_2 Z_{ijkt} + \varepsilon_{ijkt} \,. \qquad (2)$$

One problem with the estimation of equation (2) is the omission of students' innate ability, which will likely lead to biased estimates of the relationship between class size and homework. Failure to adequately control for students' ability presents a source of bias because students' ability levels may be correlated with class size and the amount of time that a student spends on homework. For example, Akerhielm (1995) and Boozer and Rouse (2001) find that lower ability students are more often assigned to smaller classes than higher ability students. If lower ability students need more time than higher ability students to complete the same amount of homework, then a spurious correlation will exist that links smaller classes to greater amounts of time spent on homework.

Longitudinal data are used to alleviate this potential source of bias. By observing students over time, innate ability and other characteristics that remain constant are controlled for through a student fixed effect (ϕ):[60]

$$HW_{ijkt} = \beta_0 + \beta_1 CS_{jkt} + \beta_2 Z_{ijkt} + \phi_i + \varepsilon_{ijkt} \,. \qquad (3)$$

The impact of class size on homework is now identified by relating changes in class size across grades with changes in the amount of time spent on homework.

[60] In addition to innate ability, the fixed effect controls for motivation, parental influence, attitudes towards homework, and any demographic characteristics which are stable over time. The fixed effect does not control for variations over time in these characteristics. Smaller classes could influence parental effort, which could, in turn, influence the amount of time students spend on homework. Parental assistance with students' homework is unlikely to be a major source of parental effort for high school students (Houtenville and Conway, 2005). Other forms of parental effort, however, may influence student effort. Additionally, smaller classes could change students' motivation and, thus, impact the amount of time students spend on homework. Smaller classes might also influence the quality of homework per unit of time. Thus, the reported results should be interpreted as estimates from a reduced-form model.

An additional source of bias for the estimates of equation (2) is the nonrandom allocation of resources across schools. For example, parents may choose their residence based on the school district and parents who choose to live in a high resource district may systematically spend more or less time in assisting their children with homework, which could influence the amount of time students spend on their homework. To minimize this bias, students will only be included in the sample if they did not change school districts throughout the years of the sample. This restriction, along with the inclusion of the student fixed effect, will control for the constant unobservable characteristics associated with Tiebout sorting. Because of this sample restriction, the student fixed effect also controls for any stable state education policies that influence the determination of class size or the assignment of homework.

The nonrandom assignment of teachers to classes within schools may also create a source of bias for the estimates in equation (2) if the teachers assigned to smaller classes also have a predisposition to assigning more (or less) homework and the amount of time a student spends on homework is influenced by the amount assigned by a teacher. To minimize this potential source of bias, observable teacher characteristics are included in the *Z* vector.[61] Also, equation (3) is estimated with and without controlling for the amount of homework assigned by the teacher. If the coefficient estimate for class size changes when the amount of homework assigned is included in the model, then it is likely that teachers respond to changes in class size by assigning more or less homework. Class size may affect the amount of homework assigned if, for example, teachers assign more homework because a smaller class means that it takes less time to grade the assignment.

[61] An alternative strategy would be to include teacher fixed effects. For this strategy to be plausible, the data set must include multiple classes for each teacher. With the data set used in this analysis, the inclusion of both student and teacher fixed effects for the first three survey waves is not possible.

However, Rice (1999) estimates that class size has no impact on the amount of homework assigned. If this is the case, then the coefficient for class size should be unaffected by the inclusion of the amount of homework assigned in the model and it is likely that the nonrandom assignment of teacher to classes within schools does not cause a large source of bias for the estimates of the relationship between class size and homework.

Data

The National Education Longitudinal Study of 1988 (NELS:88) is used to examine the relationship between class size and the amount of time that students devote to homework. NELS:88 is a longitudinal sample that was nationally representative of eighth-graders when the study began in 1988, surveying approximately 25 students each from 1,000 different schools. Additional data were provided by the students' parents, teachers, and school administrators. Follow-up surveys of these students were conducted in 1990, 1992, 1994, and 2000; this research focuses on students in 8^{th}, 10^{th}, and 12^{th} grades in the first three waves of this survey.

The information collected about students included the amount of time spent on homework each week in mathematics, English, social studies, science, and other subjects. This research focuses on mathematics because of the emphasis on homework in this subject compared to other subjects, because time spent on mathematics homework is more strongly related to achievement than time spent on homework for other subjects (Cooper, 1989), and because of the increasing importance of mathematics achievement in determining adult incomes (Murnane, Willett, and Levy, 1995).[62] The dependent variable of interest is the total amount of time (measured in hours) spent on mathematics homework outside of school each week.[63]

The main benefit of using NELS:88 is the repeated observations of students, which permits the inclusion of a student fixed effect as specified in equation (3). To control for any fluctuations in family background characteristics, an index of socioeconomic status, comprised of parent's education level, parent's occupation, and family income, is also included in the model.[64]

In 1988, two teachers of each student were surveyed, one from each of the subject pairs English/Social Studies and Math/Science.[65] Slightly more than half (51.2 percent) of the students had a math teacher fill out the survey in 1988. If a math teacher was surveyed in 1988, then a math teacher was surveyed again in 1990 and 1992. Class and teacher variables included in the model are class size, the amount of mathematics homework assigned each week (measured by the teacher's estimated average number of

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[62] Additionally, homework in mathematics is often a more tangible assignment than in other subjects (i.e. a problem set compared to a reading assignment). The results for the relationship between class size and time spent on science homework are similar to those reported for mathematics; however, the existing literature has not demonstrated that time spent on science homework is statistically related to science or overall achievement.

[63] In 1990 and 1992, students were asked to report the amount of time spent on homework specifically out of school, while in 1988, students were asked to report the amount of time spent on homework. It is assumed that in 1988 students reported the amount of time spent on homework outside of school. Students responded to these questions by selecting the most appropriate category. Median values of each category, with the exception of the highest category, were used to construct a continuous measure. In 1988, the categories were none, less than 1 hour, 1 hour, 2 hours, 3 hours, 4-6 hours, 7-9 hours, and 10 or more hours. In 1990, the categories were none, 1 hour or less, 2-3 hours, 4-6 hours, 7-9 hours, 10-12 hours, 13-15 hours, and over 15 hours. In 1992, the categories were none, less than 1 hour, 1-3 hours, 4-6 hours, 7-9 hours, 10-12 hours, 13-15 hours, and over 15 hours. The highest categories were coded as 10 in 1988 and 17 in 1990 and 1992.

[64] This index is normalized to have a mean of zero and a standard deviation of 1. This composite index is used instead of each variable separately because the index variable is more likely to fluctuate across the survey years and not be collinear with the student fixed effect.

[65] Only math and science teachers were interviewed in 1992.

hours it takes students to complete the homework)[66], the ability level of the class (low, average, advanced, or differing ability compared to other classes in the grade), the hours per week that the class meets, whether or not the teacher has a certification in mathematics[67], whether or not the teacher has a masters degree or higher, whether or not the teacher has a bachelors or graduate degree in mathematics, and the number of years of experience of the teacher. The percentage of students enrolled in remedial math in the school is also included.[68]

The sample was initially restricted to 8th grade students who remained a part of the survey until 1992 with at least one year of information from a math teacher.[69] An unbalanced panel was created where in each year the sample was restricted to public school students with non-missing data for each variable. As described in the previous section, students who changed school districts between 8th and 12th grade were removed from the sample.[70] Students with exceptionally low or high responses to class size were also removed from the sample. Twenty one students with a reported class size of less than five students and twenty five students with a reported class size of at least ninety

[66] In 1988, the survey asked teachers about the hours and minutes of homework assigned per week. In 1990, the survey asked about the hours and minutes of homework assigned per day. In 1992, the survey asked about the minutes of homework assigned per day. Each year was converted into hours per week assuming 5 days per week.

[67] This includes standard, probationary, and temporary certification in mathematics.

[68] Many other school characteristics are not available in all three waves of the public-release version of the survey. For example the number of students in the school and the percentage of students who receive free or reduced price lunch are not available in 1992. Assuming that the school characteristics in 1992 are the same as those in 1990 and then estimating the model does not affect the results reported below.

[69] This removes students whose math teacher was never interviewed, which would have occurred if the science teacher was interviewed instead or if no math teacher responded to the survey.

[70] Students who moved between 1988 and 1992 and remained in the sample until 1992 have lower test scores, are more likely to be Hispanic and less likely to be white, and have less experienced teachers who are less likely to have a graduate degree in 1992 than students who did not move. Students who moved between 1988 and 1990 are less likely to be white, are in larger classes, and are assigned less homework in 1990 than students who did not move.

students were excluded.[71] The remaining sample included 5,945 students in 8th grade, 2,532 students in 10th grade, and 1,522 students in 12th grade.

The descriptive statistics for the sample are reported in Table 22. From 8th grade to 12th grade, the mean number of hours that students spent on homework per week nearly doubled from 1.3 hours to 2.5 hours, with the biggest increase occurring between 10th and 12th grades. The average class size remained stable at roughly 23.5 students from 8th to 10th grade and then increased to 26.1 students in 12th grade. From 8th to 12th grade, the socioeconomic status of the sample increases by roughly a third of a standard deviation. Further, the proportion of students in a low ability class is reduced in half while the proportion of students in an advanced ability class doubles. Teachers are more experienced, more likely to have a math certification, and better educated in 12th than 8th grade. Additionally, the average math achievement score increases by half of a standard deviation from 8th to 12th grade.[72] The changes in student and teacher characteristics over time reflect the selection of students into math classes – students who enroll in a math class in 12th grade as a non-degree requirement are typically college-bound – and the increase in teacher qualifications needed to teach these courses.

[71] The results described in the next section are not sensitive to this restriction with the exception that including one class that reports a class size of 95 does change the results. However, this class size value is likely to be misreported since the other class for the teacher has 28 students and no other class in the school that is included in the data set has more than 35 students.
[72] The scale of the math achievement score is a mean of 50 and a standard deviation of 10.

Table 22: Descriptive Statistics: Means and Standard Errors (in parentheses)

Variable	8th Grade	10th Grade	12th Grade
Hours of Homework Per Week	1.317	1.558	2.514
	(0.035)	(0.058)	(0.089)
Class Size	23.860	23.455	26.116
	(0.238)	(0.241)	(0.715)
Hours of Homework Assigned Per Week	2.410	3.268	2.980
	(0.060)	(0.066)	(0.053)
Socioeconomic Status Index	-0.117	0.079	0.218
	(0.032)	(0.034)	(0.035)
Low Ability Class	0.197	0.183	0.104
	(0.012)	(0.011)	(0.011)
Average Ability Class	0.393	0.407	0.279
	(0.017)	(0.017)	(0.017)
Advanced Ability Class	0.275	0.306	0.576
	(0.012)	(0.015)	(0.018)
Class Differs by Ability Level	0.136	0.103	0.104
	(0.014)	(0.012)	(0.011)
Hours Spent in Class Per Week	4.523	3.990	3.902
	(0.031)	(0.041)	(0.050)
Teacher Experience	14.752	15.479	18.076
	(0.357)	(0.358)	(0.336)
Certification in Math	0.867	0.992	0.989
	(0.015)	(0.003)	(0.004)
Masters Degree or Higher	0.462	0.505	0.629
	(0.022)	(0.022)	(0.025)
Bachelors Degree in Math	0.728	0.912	0.935
	(0.020)	(0.011)	(0.010)
Graduate Degree in Math	0.157	0.370	0.453
	(0.016)	(0.019)	(0.026)
Pct Students in Remedial Math in the School	0.082	0.083	0.083
	(0.005)	(0.007)	(0.007)
Math Achievement Score	50.018	52.872	55.891
	(0.296)	(0.307)	(0.314)
Sample Size	5945	2532	1522

Notes: These statistics are weighted by the second follow-up student panel weight.
Source: National Education Longitudinal Study of 1988

Table 23 describes the distribution of the amount of time that students spend on homework each week. This table demonstrates that math homework is not an excess burden on students. Throughout 8th, 10th, and 12th grade, the percent of students who spend no time on homework each week varies from 9.9 percent to 15.7 percent. The majority of students spend more than zero, but less than three hours of homework per week, although this amount decreases from 81 to 62 percent as the grades progress. In 8th and 10th grade, more students spend no time on homework than four hours or more per week.

Table 23: Distribution of Hours Spent on Homework Per Week

	8th Grade	10th Grade	12th Grade	Total
0 Hours	9.91	15.72	12.88	11.83
1 Hour or Less	63.65	49.72	23.59	54.02
2-3 Hours	17.61	23.1	37.45	22.02
4-6 Hours	7.06	8.57	16.89	8.94
7-9 Hours	1.11	1.66	5.85	1.97
10 Hours or More	0.66	1.22	3.35	1.21

Notes: These figures represent the percent of students in each grade reporting the corresponding hours spent on homework. The question in 12th grade asks students if they spent less than one hour or 1-3 hours on homework. For this table, the response less than one hour is considered one hour or less and the response 1-3 hours is considered 2-3 hours. Totals may not add do to rounding. These percentages are based on actual sample counts and are not weighted.

Results and Discussion

Table 24 displays the results of the estimation of equation (5). The heteroskedasticity-robust standard errors account for the clustering of students within schools in the sample design. Linear and quadratic class size variables are included in the

Table 24: The Relationship between Class Size and Homework (without controlling for the amount of homework assigned)

	All Students	Low SES	High SES	White	Black
Class Size	-0.013	-0.011	-0.050	-0.002	-0.106
	(0.020)	(0.046)	(0.031)	(0.018)	(0.047)
Class Size Squared	0.009	0.005	0.057	-0.010	0.113
	(0.029)	(0.062)	(0.038)	(0.025)	(0.050)
Socioeconomic Status Index	0.054	0.200	0.389	-0.190	0.767
	(0.308)	(0.632)	(0.672)	(0.368)	(0.741)
Low Ability Class	-0.234	-0.295	0.331	-0.389	0.037
	(0.158)	(0.356)	(0.447)	(0.178)	(0.358)
Average Ability Class	-0.162	-0.189	0.066	-0.198	-0.295
	(0.131)	(0.278)	(0.278)	(0.150)	(0.344)
Advanced Ability Class	0.184	0.174	0.617	0.131	0.226
	(0.151)	(0.349)	(0.292)	(0.171)	(0.450)
Hours Spent in Class Per Week	0.005	-0.109	0.038	0.002	0.141
	(0.048)	(0.104)	(0.101)	(0.055)	(0.145)
Teacher Experience	0.001	-0.007	0.008	0.005	-0.007
	(0.006)	(0.013)	(0.011)	(0.006)	(0.019)
Certification in Math	0.276	0.172	0.547	0.158	0.212
	(0.182)	(0.363)	(0.352)	(0.192)	(0.601)
Masters Degree or Higher	0.019	0.104	0.008	0.023	0.229
	(0.094)	(0.259)	(0.176)	(0.101)	(0.345)
Bachelors Degree in Math	-0.021	-0.112	0.156	-0.057	0.321
	(0.127)	(0.284)	(0.211)	(0.146)	(0.346)
Graduate Degree in Math	-0.032	0.010	-0.036	0.001	-0.066
	(0.118)	(0.301)	(0.188)	(0.127)	(0.397)
Pct Students in Remedial Math	-0.417	-1.278	-0.942	-0.576	-0.120
in the School	(0.523)	(1.065)	(1.109)	(0.658)	(1.376)
Grade 10 Dummy	0.092	0.242	0.128	0.012	0.564
	(0.083)	(0.180)	(0.163)	(0.090)	(0.253)
Grade 12 Dummy	0.990	1.026	0.906	0.889	1.260
	(0.120)	(0.286)	(0.200)	(0.135)	(0.274)
Constant	1.467	2.298	0.961	1.536	2.303
	(0.441)	(1.130)	(1.108)	(0.470)	(1.371)
Observations	9999	2270	2630	7342	885
Students	5945	1558	1390	4239	574

Notes: Standard errors (in parentheses) allow for heteroskedasticity and clustering within schools. Other regressors include individual fixed effects. The coefficients and standard errors for class size squared are multiplied by 100.

Source: National Education Longitudinal Study of 1988

regressions. Column (1) displays the estimates of the relationship between class size and the amount of time spent on homework controlling for various student, teacher, and school characteristics.[73] A one student reduction in class size translates into an increase of 0.013 hours of homework per week (or 0.78 minutes); however, this impact is not statistically different from zero and is close to zero in size. This finding suggests that, overall, public investments in education targeted towards class size reductions do not crowd out students' effort.

Given that the literature examining the relationship between class size and achievement demonstrates varying impacts of class size for various subgroups of the population and that class size reduction policies are mainly targeted towards low-income and high-minority school districts, it is important to examine how the relationship between class size and homework differs according to socioeconomic status and race.[74] Columns (2) and (3) restrict the sample to students in the lowest and highest quartiles of socioeconomic status in 8th grade, respectively. Columns (4) and (5) focus on white and black students, respectively. Similar to the results for all students, the relationship between class size and homework for low socioeconomic status, high socioeconomic status, and white students is negative and statistically insignificant. However, for black students, this relationship is statistically significant at the 5 percent significance level and much larger in magnitude. As the number of students in a classroom increases, the hours

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[73] Including a dummy variable for whether the student works or controlling for the number of hours that a student spends working has no qualitative impact on the results reported in this section. Information about extracurricular activities after school is not available in 1988.

[74] Bonesronning (2004) finds that class size impacts parental effort differently based on the students' gender. Additional analysis of the relationship between class size and homework by gender reveals similar results to the estimates based on the sample of all students. The coefficient estimates for class size are negative and statistically insignificant. The same is true for analysis among quintiles of the achievement distribution (based on mathematics achievement in 8th grade).

that students spend on homework decreases at a diminishing rate.[75] In other words, decreasing class size leads to increases in student effort at an increasing rate. For example, decreasing class size from 30 to 29 students results in an increase of 0.046 hours or 2.76 minutes of homework, while decreasing class size from 15 to 14 students results in an increase of 0.076 hours or 4.56 minutes of homework for black students. Using the weighted sample mean for black students across all grades of 24, a decrease in class size to 17 students – which is a one standard deviation decrease – would translate into an increase of approximately one-third of an hour of homework per week.[76] Given that nearly two-thirds of the sample spends one hour or less on homework per week, an increase of approximately 20 minutes per week would be a sizeable percentage increase for most students. The weighted sample mean for black students is nearly 80 minutes of homework per week; thus, an increase of 20 minutes per week is an increase of 25 percent in the amount of time spent on homework each week.

Table 25 displays the estimation results of models similar to those displayed in the previous table with the inclusion of the amount of homework assigned per week. The relationships described in the previous table are not significantly affected by including the hours of homework assigned per week in the model. This suggests that class size does not affect the amount of time students spend on homework by altering the amount of homework assigned. The relationship between class size and the amount of time spent on

[75] Increasing the number of students in the classroom by one student begins to lead to increases in the amount of homework for class sizes greater than 53 students. Since approximately one percent of black students in the sample are associated with class larger than 53 students, the component of the quadratic relationship with a positive slope is not likely to reflect a true relationship.

[76] Examining the relationship between class size and the amount of time spent on homework for black students among quintiles of the achievement distribution (based on mathematics achievement in 8th grade) suggests that this result is driven by high achieving black students. The estimated coefficients (and their standard errors) for blacks in the top quintile of achievement are -1.40 (0.677) and 0.037 (0.014), respectively. However, these results are based on only 53 observations of 26 students. The standard errors are not adjusted for clustering within schools because of the small sample.

Table 25: The Relationship between Class Size and Homework (controlling for the amount of homework assigned)

	All Students	Low SES	High SES	White	Black
Class Size	-0.011	-0.010	-0.050	-0.001	-0.098
	(0.020)	(0.046)	(0.031)	(0.018)	(0.047)
Class Size Squared	0.007	0.005	0.056	-0.012	0.102
	(0.030)	(0.062)	(0.038)	(0.025)	(0.050)
Hours of Homework Assigned Per Week	0.060	0.071	0.093	0.054	0.126
	(0.027)	(0.049)	(0.048)	(0.031)	(0.086)
Socioeconomic Status Index	0.047	0.180	0.370	-0.199	0.816
	(0.308)	(0.638)	(0.669)	(0.368)	(0.729)
Low Ability Class	-0.221	-0.281	0.313	-0.372	0.056
	(0.157)	(0.353)	(0.439)	(0.177)	(0.358)
Average Ability Class	-0.165	-0.195	0.039	-0.196	-0.337
	(0.132)	(0.278)	(0.280)	(0.151)	(0.339)
Advanced Ability Class	0.170	0.155	0.574	0.124	0.161
	(0.152)	(0.348)	(0.295)	(0.172)	(0.441)
Hours Spent in Class Per Week	0.000	-0.115	0.032	-0.003	0.143
	(0.048)	(0.105)	(0.099)	(0.055)	(0.150)
Teacher Experience	0.001	-0.009	0.008	0.005	-0.005
	(0.006)	(0.013)	(0.011)	(0.006)	(0.019)
Certification in Math	0.283	0.180	0.560	0.174	0.213
	(0.178)	(0.358)	(0.347)	(0.188)	(0.595)
Masters Degree or Higher	0.025	0.128	0.010	0.030	0.262
	(0.094)	(0.265)	(0.175)	(0.101)	(0.343)
Bachelors Degree in Math	-0.019	-0.118	0.154	-0.061	0.312
	(0.127)	(0.285)	(0.206)	(0.146)	(0.345)
Graduate Degree in Math	-0.011	0.035	-0.006	0.019	-0.079
	(0.120)	(0.298)	(0.189)	(0.128)	(0.401)
Pct Students in Remedial Math in the School	-0.392	-1.228	-0.961	-0.548	-0.049
	(0.519)	(1.052)	(1.101)	(0.650)	(1.371)
Grade 10 Dummy	0.034	0.175	0.039	-0.039	0.476
	(0.084)	(0.178)	(0.165)	(0.091)	(0.268)
Grade 12 Dummy	0.951	1.003	0.838	0.851	1.222
	(0.120)	(0.285)	(0.200)	(0.136)	(0.284)
Constant	1.307	2.123	0.774	1.386	1.876
	(0.450)	(1.129)	(1.103)	(0.475)	(1.412)
Observations	9999	2270	2630	7342	885
Students	5945	1558	1390	4239	574

Notes: Standard errors (in parentheses) allow for heteroskedasticity and clustering within schools. Other regressors include individual fixed effects. The coefficients and standard errors for class size squared are multiplied by 100.

Source: National Education Longitudinal Study of 1988

homework remains negative for each specification, but is only statistically significant for black students. This reinforces the earlier result that reductions in class size do not crowd out or reduce the after-school investments in education of students and, on the contrary, black students compliment reductions in class size with increases in the amount of time spent on homework. Although class size does not seem to affect the amount of homework assigned, for all students, there is a positive and statistically significant effect of the amount of homework that teachers' assign on the amount of time that students spend on homework. It is interesting, however, that an extra hour of homework assigned only leads to an extra 0.06 hours or 3.6 minutes per week spent on homework and that this relationship is only statistically significant for high socioeconomic status and white students. Neither the relationship between the amount of homework assigned and the amount of time spent on homework nor the relationship between class size and the amount of time spent on homework is affected by the extent to which the teacher records whether or not the homework was completed, grades the homework, or discusses the homework with the class.[77]

Examining the relationship between class size and the amount of time spent on homework, it is clear that reductions in class size do not reduce students' efforts on homework. An interesting finding that emerges from examining this relationship is that black students, but not other students, increase their time working on homework as the number of students in a classroom decreases. A one standard deviation decrease in class size (from the mean) increases the amount of time spent on homework by roughly one-third of an hour. To describe the significance of this result, based on previous results described earlier, an extra hour spent on homework per week increases math achievement

[77] Estimation results are not shown, but are available from the author upon request.

by roughly 3 percent of a standard deviation. This suggests that a one standard deviation decrease in class size would increase math achievement by about 1 percent of a standard deviation as a result of the indirect effect of class size on time spent on homework for black students. Based on their meta-analysis of the school resources literature, Greenwald, Hedges, and Laine (1996) report that a one standard deviation decrease in the pupil/teacher ratio is related to a 0.03 standard deviation increase in achievement. Therefore, the result that decreases in class size increase the amount of time that black students spend on homework explains approximately 33 percent of the relationship between class size and achievement.[78]

Conclusion

This paper estimates the relationship between class size and the amount of time that students devote to homework. This topic is important because if students decrease their effort outside of the classroom in response to the increase in school quality from smaller classes, then the overall impacts of this popular education reform might be reduced. Alternatively, if students complement the increase in school quality with greater levels of effort, then class size reduction policies should achieve the intended effect of increased achievement.

While the crowding out of private investments is a common response to increases in public spending, this paper finds that decreases in class size are not likely to result in students decreasing their efforts on homework. For black students, class size reductions lead to an increase in the amount of time spent on homework. This finding offers a

[78] This assumes that the pupil/teacher ratio is similar to class size.

partial explanation for the result that decreases in class size has a larger effect on black students than white students.

This paper emphasizes that students are active participants in the production of education. While early education production function research viewed students as agents that translate school inputs into test score outputs, this paper adds to the growing literature that examines students' behavioral responses to incentives within the school system. The contribution of this paper to the literature is to point out that, because educational achievement results from both in-school and out-of-school learning activities, students may respond to changing incentives in the school system by altering their after school educational activities.

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