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Child care subsidies and childhood obesity

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Abstract In this paper, we study the impact of child care subsidy receipt on low-income children's weight outcomes in the fall and spring of kindergarten using data from the Early Childhood Longitudinal Study, Kindergarten Cohort. Our results suggest that subsidy receipt is associated with increases in BMI and a greater likelihood of being overweight and obese. Using quantile regression methods, we find substantial variation in subsidy effects across the BMI distribution. Specifically, child care subsidies have no effect on BMI at the lower end of the distribution, inconsistent effects in the middle of the distribution, and large effects at the top of the distribution. Our results point to the use of non-parental child care, particularly center-based services, as the key mechanism through which subsidies influence children's weight outcomes.

Keywords Obesity · Child care · Subsidy · Body mass index · Quantile regression

JEL Classification I12 · I18 · J13

1 Introduction

Over the past three decades, obesity rates among children increased dramatically. Data from the National Health and Nutrition Examination Survey (NHANES)

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indicate that, since the mid-1970s, the prevalence of obesity grew from 5 to 12% among children ages 2–5 and from 7 to 17% among children ages 6–11.[1] This alarming trend generates concern among health care officials for a number of reasons. Obesity during childhood is highly correlated with weight problems throughout adulthood, and obese children are substantially more likely to develop health problems such as high blood pressure and Type 2 diabetes as early as adolescence (Whitaker et al. 1997; Serdula et al. 1993; Freedman et al. 1999, 2007). Moreover, obesity among children and teenagers is associated with a number of long-term psychological and labor market outcomes ranging from poor self-esteem and depression to discrimination and lower wages (Daniels 2006; Mocan and Tekin 2010; Dietz 1998; Strauss 2000). Many of these problems impose a substantial burden on the health care system. For example, Wang and Dietz (2002) estimate that hospital expenditures related to childhood obesity rose from $35 million in the late-1980s to $127 million (in 2001 constant dollars) in the late-1990s.

Much of the current policy response to the obesity epidemic focuses on children in elementary and middle school, thereby neglecting the 13 million preschool-age children who spend a considerable number of hours each year in non-parental child care arrangements (National Center for Education Statistics 1996).[2] Indeed, about 41% of such children attend child care for at least 35 h each week, and another 25% are in care for 15–34 h (Capizzano and Adams 2000). Much of this care now occurs in increasingly formal arrangements. For example, the enrollment of 3-year-olds in center-based care increased from 8% in 1968 to 39% in 2000, while the enrollment of 4-year-olds increased from 23 to 65% (Bainbridge et al. 2005). Today, the predominant child care setting for preschool-aged children is center care (32%), followed by relatives (24%) and family child care homes (16%) (Smolensky and Gootman 2003).[3]

The growing use of non-parental care has raised awareness among health officials of the critical role that child care settings play in shaping children's eating and activity habits. In particular, given that young children spend considerable time away from their parents, child care providers lay the foundation for food consumption and exercise patterns. Structural and process features of the child care environment can dictate the types of physical activities in which children are engaged (e.g., structured

[1] See http://www.cdc.gov/nccdphp/dnpa/obesity/childhood/index.htm. See Anderson and Butcher (2006) for a review of trends.

[2] Indeed, childhood obesity has been identified as one of the most pressing health problems facing the US (US Department of Health and Human Services 2001) and there are a large number of policy efforts underway to stop or reverse this trend among school-age children. For example, the Child Nutrition and Women Infants and Children (WIC) Reauthorization Act of 2004 requires that all local education agencies participating in the National School Lunch Program create local wellness policies no later than July 2006. The Kids Walk-to-School program developed by the Centers for Disease Control and Prevention (CDC) aims to increase opportunities for daily physical activity by encouraging children to walk to and from school in groups accompanied by adults. An increasing number of schools are limiting access to foods high in fats and sugars by banning soda machines and snack bars in cafeterias and school stores. The School Breakfast and the National School Lunch Programs are two federal entitlement programs that provide nutritionally balanced, low-cost or free breakfasts and lunches to millions of children each school day.

[3] Participation rates in formal child care settings among low-income children now rival those of high-income children (49% compared to 53%) (Magnuson et al. 2007).

or free-play), the number of hours per day in which children are performing these activities, and whether these activities occur primarily in indoor or outdoor spaces. In addition, menu options in child care settings expose children to a variety of new foods and flavors, which can influence food preferences at home and school (Deckelbaum and Williams 2001). Child care providers can also serve as a powerful bridge to aid parents in making healthy food choices in other contexts (Story et al. 2006).

An array of federal and state child care policies can further shape children's weight outcomes. The Child Care and Development Fund (CCDF), which provides employment-based subsidies targeted at current and former welfare recipients, allows parents to purchase virtually any legally-operating child care service at a reduced price.[4] To be eligible for CCDF funds, families must be engaged in a state-defined acceptable work activity (e.g., employment, education, or job training), have incomes below 85% of the state median income (SMI), and have at least one child ages 0–12. Subsidies can influence low-income children's weight outcomes through a number of channels. First, insofar as participation in formal care influences children's weight, one might expect to observe a link between child care subsidies and weight outcomes given that this policy encourages mothers to shift from informal to formal child care modes (Tekin 2005). In particular, child care subsidies reduce the amount of time children spend in parent and relative care while increasing participation in center- and family-based services. However, the extent to which subsidy-induced changes in child care utilization are associated with children's weight outcomes depends on the relative quality of subsidized child care. Second, the CCDF stipulates that mothers must be employed to qualify for a subsidy. A number of recent studies find that children of working mothers are more likely to be overweight and obese, raising concerns about the subsidy system's current emphasis on employment (Anderson et al. 2003; Ruhm 2008; Classen and Hokayem 2005; Fertig et al. 2009; Phipps et al. 2006; Courtemanche 2007; Cawley and Liu 2007). Finally, by defraying expenses associated with child care, subsidies increase disposable income that, in principle, can be spent on healthy foods and extracurricular activities. However, it is unclear whether families spend the additional income on goods that enhance child quality or whether these resources increase the demand for fast food and sedentary activities such as video games.

Despite the potential role for child care subsidies in shaping preschool children's weight outcomes, no previous research focuses on this topic. The purpose of this paper, therefore, is to examine the impact of subsidy receipt in the year before kindergarten on several measures of children's weight during the fall and spring of kindergarten. Using a sample of children living with unmarried women drawn from the Early Childhood Longitudinal Study (ECLS-K), our empirical analysis proceeds in two steps. We begin by estimating standard OLS and fixed effects models of body mass index (BMI) and indicators of overweight and obesity status. Next, we use quantile regression techniques to address the possibility that subsidy receipt has

[4] The CCDF was created by the 1996 welfare reform legislation, which consolidated four preexisting subsidy programs into a single block grant, increased funding for child care funding substantially, and gave individual states greater flexibility in program design and administration (Herbst and Tekin 2010). In 2006, states spent approximately $9.3 billion on child care assistance and served more than 1.7 million children in an average month (Child Care Bureau 2006).

heterogeneous effects on children's weight at different points in the distribution of BMI. This method permits us to analyze whether the impact of child care subsidies is relatively stable throughout the BMI distribution, or whether subsidy receipt is associated with greater changes in BMI in some parts of the distribution. In both cases, we pay careful attention to the role of maternal employment and child care utilization in mediating the relationship between subsidy receipt and children's weight outcomes.

Our main results can be summarized as follows. Child care subsidy receipt is associated with increases in BMI and a greater likelihood of being overweight and obese. We also find substantial heterogeneity in response to child care subsidies. Subsidies have no effect on BMI at the lower end of the distribution, inconsistent effects in the middle of the distribution, and large positive effects at the top of the distribution. Interestingly, center-based care is associated with large and stable increases in BMI throughout the distribution, while the impact of the other non-parental arrangements appears to be concentrated at the tails of the distribution. We provide evidence that the use of non-parental child care, rather than maternal employment, is the key mechanism through which the subsidy effects operate. Indeed, our results indicate that subsidy receipt continues to be associated with children's weight after accounting for mothers' work history, but this relationship disappears when child care arrangements are added to the models.

2 Background

Much of what has been written on childhood obesity focuses on school-aged children and school-based programs, rather than preschool-age children and child care arrangements (Story 1999; Gortmaker et al. 1999; Veugelers and Fitzgerald 2005; Story et al. 2006). This literature generally concludes that school-based programs play a positive role in reducing the prevalence of childhood obesity. However, many of these programs do not explicitly target economically disadvantaged children, who are at a higher risk of obesity (Frisvold 2007). To our knowledge, this is the first study to focus on the role of child care subsidies in influencing low-income children's weight outcomes.

Frisvold (2007) examines the impact of Head Start participation on childhood obesity using data from the Panel Study of Income Dynamics. He finds that participation in Head Start reduces the risk of obesity in late-childhood among black children. Both Head Start and child care subsidies are means-tested, but unlike subsidies, Head Start places substantial emphasis on quality through the provision of comprehensive child development services. In addition, many Head Start classrooms focus explicitly on children's health through nutritional screening, offering healthy and nutritionally balanced meals, and engaging in parental outreach and education (Frisvold 2007).

Hubbard (2008) studies the impact of maternal employment and child care decisions on childhood obesity in a dynamic framework using data from the ECLS-K. She finds that any maternal employment decreases the likelihood of obesity while using non-parental child care increases it. She also finds that working full-time and using non-maternal care increases children's risk of being obese. However, her measure of child care utilization is based on the total number of hours children spend in three types of settings (informal care from a relative, informal care from a baby-sitter, and center care). Using this information, she creates a single binary indicator for whether child care was utilized for more than 5 h per week in these settings. Furthermore, this paper does not focus on any dimension of early care and education policy, including child care subsidies.

A number of descriptive studies assess the nutritional quality of foods offered in child care settings.[5] A review of these studies suggests that the quality of foods offered in center-based care, in particular, typically falls short of the standards recommended by *The Dietary Guidelines for Americans*.[6] For example, Padget and Briley (2005) compare the dietary intake of children attending center-based care with the recommendations of the Food Guide Pyramid for Young Children.[7] The authors find that such children generally do not receive an adequate diet, and the intake at home does not compensate for the insufficient consumption of fresh fruits, vegetables, and grains during the time spent in child care. Furthermore, a number of studies show that preschool-age children in various non-parental child care settings do not meet the recommended guidelines for physical activity (Story et al. 2006).[8] However, research suggests that preschools implementing practices aimed at increasing quality in general and physical activity in particular can be successful at reaching this goal. For example, in a study of 266 preschoolers, Dowda et al. (2004) find that children in high-quality preschools, as measured by child-staff ratios, teacher education, and structural attributes of the facility, participate in greater amounts of moderate to vigorous physical activity.

Motivated by the coincident rise in women's employment and childhood obesity, a number of studies examine the effect of early maternal employment on obesity. Findings from this research generally point to adverse effects of maternal employment on children's weight outcomes (Ruhm 2008; Courtemanche 2007; Anderson et al. 2003; Fertig et al. 2009). For example, Anderson et al. (2003) find that increases in hours of maternal work are associated with increases in the likelihood of childhood obesity. They also find greater effects among children of white mothers, of mothers with more education, and of mothers at higher income levels. Fertig et al. (2009) examine the mechanisms through which maternal employment influences children's weight outcomes. Cawley and Liu (2007) find

[5] Story et al. (2006) provide a comprehensive summary of these studies.

[6] A publication put forth every 5 years by the US Department of Health and Human Services, the *The Dietary Guidelines for Americans* provide authoritative advice for people ages two and over about the relationship between increased healthy dietary habits and the reduction in the risk of major chronic diseases. This publication also serves as the basis for Federal food and nutrition education programs. Additional information may be found here: http://www.health.gov/DietaryGuidelines/.

[7] Information on the revised pyramid can be found here: http://www.cnpp.usda.gov/FGP4Children.htm.

[8] The 2005 *The Dietary Guidelines for Americans* recommend that children and adolescents engage in no less than 60 min of physical activity each day. Furthermore, the National Association for Sport and Physical Education (NASPE) recommends that toddlers receive at least 30 min of structured physical and 60 min of unstructured activity each day. Preschoolers should receive 60 min of structured play and another 60 min of unstructured play each day.

that employed women spend significantly less time eating and playing with their children and are more likely to purchase prepared foods.

Also relevant to the current study is previous research on the impact of child care subsidies and arrangements on other dimensions of child well-being, including cognitive and behavioral development. Using the ECLS-K, a recent study by Herbst and Tekin (in press) find that child care subsidy receipt in the year before kindergarten lowers reading and math test scores, increases externalizing and self-control behavior problems, and decreases interpersonal skills at kindergarten entry. In addition, Baker et al. (2008) analyze the impact of Quebec's "$5 per day child care" program on several child and parent outcomes. Subsidized children were worse off across a variety of behavioral and health dimensions, ranging from increased physical aggression and diminished social skills to increases in common illnesses. The program also led to more hostile parenting, worse parental health, and lower-quality parental relationships. Previous research finds mixed results for the impact of non-parental child care on children's developmental outcomes. A large number of studies find positive effects of child care attendance (e.g., National Institute of Child Health and Human Development (NICHD) 2003a, b), but others find insignificant or negative effects (e.g., Bernal and Keane 2008; Blau 1999). There is more agreement, however, that high-quality center-based care has positive effects on cognitive development among low-income children (e.g., NICHD and Duncan 2003).

3 Data

The data used in this analysis are drawn from the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K), a nationally representative sample of 21,260 children attending kindergarten in the fall of 1998.[9] Children in the ECLS-K are followed through the eighth grade, with detailed parent, child, and teacher interviews conducted in the fall and spring of kindergarten (1998 and 1999) and the spring of first (2000), third (2002), fifth (2004), and eighth (2007) grade. Approximately 20 kindergarteners per school from over 1,200 public and private schools are included in the sample.[10]

Analyses in this study are based on the fall and spring of kindergarten waves of data collection, in which children's height and weight were measured and parents

[9] The ECLS-K is sponsored by the US Department of Education. For more information, see the ECLS-K website at http://nces.ed.gov/ecls/kindergarten.asp.

[10] The ECLS-K used a multistage probability sample design to select the sample of children attending kindergarten in 1998. The primary sampling units (PSUs) were geographic areas consisting of counties or groups of counties. The second stage consisted of public and private schools within sampled PSUs. The final stage units were students within schools. The school frame was freshened in the spring of 1998 to include newly opened schools that were not included in the original sample. Once the sample children were identified, parent contact information was obtained from the school, which was used to locate parents and seek consent for the child assessments and parent interviews. Completion rates (or response rates that are conditioned on earlier stages of data collection) for the fall of kindergarten interviews were high: 89.9% of child assessments were completed, 85.3% of parent interviews were completed, and over 90% of the teacher interviews were completed.

were asked questions about child care attendance in the year prior to kindergarten entry. We limit our sample to children who lived with an unmarried mother as of the fall of kindergarten interview.[11] We focus on single mothers because they constitute about two-thirds of eligible subsidy recipients (Herbst 2008). Exclusions from the sample are made if children were living in two-parent families (14,129) or missing data on BMI (438), child care arrangements (3,070), or child care subsidies (34). We exclude an additional 387 children attending Head Start, since the decision to participate in this early intervention program is not influenced by child care subsidies. Furthermore, the goal of Head Start is to increase school readiness through an array of child and family services, whereas CCDF child care subsidies are aimed at facilitating employment.[12] Rates of item non-response on the remaining child and family variables are low, usually well below 1% of the final sample, and we retain these cases by imputing zeros for the missing values and creating dummy variables to control for the possibility of non-random imputation. Our analysis sample consists of 3,113 children in the fall of kindergarten and 3,007 children in the spring of kindergarten.

Our outcome variables are based on body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared (kg/m^2). In addition to estimating models using BMI expressed in levels and logarithms, we construct binary indicators to represent children who are overweight or obese. For children ages two to 19, BMI values are plotted on growth charts from the Centers for Disease Control (CDC) to determine the corresponding BMI-for-age percentile. Children at or above the 85th percentile of the gender- and age-specific BMI distribution are coded as overweight, while children at or above the 95th percentile of the BMI distribution are coded as obese.[13]

A key independent variable in our analysis is a dummy variable indicating whether a child received subsidized, non-parental child care in the year prior to kindergarten. Parents are asked a series of questions about child care utilization during the past 12 months, including the types of arrangements used, the amount of time that each arrangement was used, whether there was a cost associated with each arrangement, and the amount paid for care. Regarding subsidy receipt, parents were asked the following: "Did any of the following people or organizations help to pay for this … provider to care for {CHILD} the year before {he/she} started

[11] Single mothers are identified in the ECLS-K by using the variable P1HPARNT, which describes the child's living arrangements. We define single mother families as those in which the child lived with the "biological mother only."

[12] Additional minor exclusions from the sample are made due to an inability to match children to the 2000 Census geocoded data (five observations) and mothers with nonsensical ages (three observations).

[13] For additional information on the CDC growth charts, see http://www.cdc.gov/nccdphp/dnpa/growthcharts/resources/growthchart.pdf. Also, see http://www.cdc.gov/growthcharts/. Until recently, this nomenclature differed across children (ages two to 19) and adults. Children with BMIs above the 95th percentile of the gender- and age-specific distribution were considered "overweight," and those above the 85th percentile were considered "at-risk-for-overweight." However, an expert committee convened by the American Medical Association (AMA) in collaboration with the Department of Health and Human Services Health Resources and Services Administration (HRSA) and the CDC recently endorsed the use of "overweight" and "obese" for children. See this link for more information on the adjustment: http://www.ama-assn.org/ama1/pub/upload/mm/433/ped_obesity_recs.pdf.

kindergarten?" Four possible choices were then presented to parents, and we code those answering "a social service agency or welfare office" as receiving a child care subsidy. Similar questions appear in several nationally representative surveys (e.g., National Survey of America's Families and the Survey of Income and Program Participation), and other researchers construct indicators of subsidy receipt based on them (Blau and Tekin 2007; Herbst 2008; Tekin 2007). The US Department of Health and Human Services (1999) finds that between 12 and 15% of eligible families received a CCDF subsidy in 1998. In our ECLS-K sample, 14.5% of children are coded as receiving subsidized care in the same year.[14]

Another key variable is an indicator of early maternal work, defined as a dummy variable that equals unity if a given mother was employed at any point between the child's birth and kindergarten entry. We also create mutually exclusive groupings of child care arrangements. Specifically, we code children as attending relative care (which includes caregiving inside and outside the child's home), non-relative care (nanny, babysitter, or family-based), center-based care (daycare center), or school-based services (prekindergarten, preschool, and nursery school). Children who did not attend any of these services are coded as receiving parent care. A non-trivial number of children received child care from more than one provider, so we create a decision rule to ensure mutually exclusive and exhaustive categories.[15]

We exploit the richness of the ECLS-K to control for a detailed vector of child and family characteristics as of the fall or spring of kindergarten. Key child characteristics include gender, age, race, and birth weight. We capture parental reports of children's health status through a set of dummy variables indicating whether the child is in excellent health, good health, or fair/poor health. Health status is also proxied by an indicator for whether the child experienced a premature birth. Children's physical activity habits are captured through variables denoting the number of hours per day the child watches television, the number of days per week the child experiences vigorous exercise, and whether the child ever participated in athletics. We control for children's eating habits and opportunities to consume healthy meals by incorporating variables for whether the child eats a school-provided breakfast and receives a free/reduced price school lunch. Also of relevance here are controls for the number of days per week the family eats breakfast and dinner together. Parental time and skill inputs are captured by the mother's age, an indicator for whether the child's parents were married at birth, the family's socioeconomic status, and parent's educational expectations for the child. Socio-economic status (SES) is a composite measure incorporating the mother's and father's (or legal guardian's) educational attainment, mother's and father's (or legal

[14] Rates of child care subsidy receipt calculated by researchers using the NSAF match closely our ECLS-K estimate. For example, Tekin (2007) calculates a participation rate of 11.6% for a sample of single mothers, and Herbst (2008) estimates a take-up rate of 13.9%, also from a sample of single mothers.

[15] Our decision rule is constructed so that we drop only those children who receive exclusively Head Start. Therefore, our indicator of subsidy receipt omits those reporting subsidy receipt while participating only in Head Start. A child participating in Head Start along with another service is coded as participating in the non-Head Start service. The remaining tie-breakers are settled as follows: relative and center: center; non-relative and center: center; relative and school: school; non-relative and school: school; non-relative, relative, and center: center; non-relative, relative, and school: school.

guardian's) job occupation, and total household income. We parameterize the SES measure through a set of dummy variables indicating the quintiles of the full ECLS-K distribution. Other parental resources and goods inputs are represented by food stamps participation and the number of children in the household.

Summary statistics are presented in Table 1. The average BMI is 16.5, and approximately 29% of children are overweight as of the fall of kindergarten interview. Fully 13% of children are obese. This figure is consistent with recent data from the CDC, which reports an obesity rate of 12.4% among children ages two to five.[16] As shown in Table 1, the BMIs of children receiving subsidized and unsubsidized care are quite similar for the fall and spring of kindergarten. Rates of overweight are slightly higher for subsidized children at both measurement dates. Fully 31 and 32% of children receiving subsidies are overweight in the fall and spring of kindergarten, respectively, compared to 29 and 30% for unsubsidized children. However, none of these differences are statistically significant. Rates of obesity are also similar across these groups of children.

As previously stated, approximately 15% of the sample received a child care subsidy in the year prior to kindergarten entry. Consistent with previous studies, mothers of subsidized children are more likely to be employed than their unsubsidized counterparts (89% compared to 82%). Participation rates in the various child care arrangements are as follows: 16% of children received exclusively parent care; 22% received care from a relative; 7% received care from a non-relative; 16% participated in center-based care; and 39% participated in a school-based program. As expected, subsidized children are more likely to use center-based care than their unsubsidized counterparts (40% compared to 12%). The use of non-relative care is also significantly greater among subsidy recipients (10% compared to 7%). Non-recipients are substantially more likely to utilize care from parents and relatives. This pattern is consistent with previous research indicating that subsidies effectively shift children from informal child care settings into the formal market (Tekin 2005).

Table 1 also shows that subsidized children are less likely to be white and more likely to be black. Both groups of children are equally likely to be born prematurely and have low birth weights. Parental reports of children's health status reveal that subsidized and unsubsidized children are equally likely to be in excellent health, but subsidized children watch slightly more hours of television each day and are less likely to have participated in organized sports at some point before kindergarten entry. Not surprisingly, a much greater share of subsidized children report eating school-provided breakfast and lunch.

The descriptive results presented in Table 1 suggest that rates of overweight and obesity are equivalent across subsidized and unsubsidized children. Table 2 further explores this issue by comparing children's fall of kindergarten weight outcomes across mothers' work status (Panel A) and the child care arrangements used in the year before kindergarten (Panel B). Looking first at Panel A, we find only minor differences in BMI, overweight, and obesity across subsidized and unsubsidized children, regardless of whether the mother worked since childbirth. Substantially

[16] This figure is based on data from 2003 to 2006. See http://www.cdc.gov/nccdphp/dnpa/obesity/childhood/index.htm.

Table 1 Summary statistics

Variable	Full sample	Subsidy recipient	Non-recipient
Weight outcomes			
BMI, Fall ($N = 3{,}113$)	16.462 (2.397)	16.535 (2.329)	16.449 (2.409)
BMI, Spring ($N = 3{,}007$)	16.624 (2.494)	16.663 (2.430)	16.617 (2.505)
Overweight, Fall (%, $N = 3{,}113$)	0.293 (0.455)	0.312 (0.464)	0.289 (0.454)
Overweight, Spring (%, $N = 3{,}007$)	0.304 (0.460)	0.323 (0.468)	0.301 (0.459)
Obese, Fall (%, $N = 3{,}113$)	0.133 (0.340)	0.137 (0.345)	0.133 (0.339)
Obese, Spring (%, $N = 3{,}007$)	0.134 (0.342)	0.139 (0.347)	0.134 (0.341)
Subsidy receipt, maternal employment, and child care arrangements			
Subsidy recipient (%)	0.145 (0.353)	1.000 (0.000)	0.000 (0.000)
Early maternal work (%)	0.834 (0.372)	0.892 (0.310)	0.824*** (0.381)
Parent child care (omitted, %)	0.159 (0.366)	0.000 (0.000)	0.186*** (0.389)
Relative child care (%)	0.222 (0.416)	0.151 (0.359)	0.234*** (0.423)
Non-relative child care (%)	0.073 (0.260)	0.102 (0.303)	0.068** (0.252)
Center-based child care (%)	0.156 (0.363)	0.399 (0.490)	0.115*** (0.319)
School-based child care (%)	0.391 (0.488)	0.349 (0.477)	0.398* (0.490)
Child characteristics			
Child's age (months, Fall of K)	68.42 (4.46)	68.33 (4.06)	68.44 (4.52)
Boy (%)	0.508 (0.500)	0.509 (0.500)	0.508 (0.500)
White (omitted, %)	0.374 (0.484)	0.325 (0.469)	0.382** (0.486)
Black (%)	0.354 (0.478)	0.418 (0.494)	0.344*** (0.475)
Hispanic (%)	0.202 (0.402)	0.167 (0.373)	0.209** (0.406)
Asian (%)	0.018 (0.133)	0.012 (0.110)	0.019 (0.136)
Other race/ethnicity (%)	0.051 (0.220)	0.076 (0.266)	0.047*** (0.211)
First-time kindergartner (%)	0.946 (0.226)	0.940 (0.237)	0.947 (0.224)
Low birth weight (%)	0.073 (0.261)	0.057 (0.233)	0.076 (0.265)
Premature birth (%)	0.178 (0.383)	0.176 (0.381)	0.179 (0.383)
Only child (omitted, %)	0.293 (0.455)	0.229 (0.421)	0.304** (0.460)
One sibling (%)	0.366 (0.482)	0.351 (0.478)	0.369 (0.483)
Two or more siblings (%)	0.341 (0.474)	0.420 (0.494)	0.327*** (0.469)
Child in excellent/very good health (%)	0.787 (0.409)	0.772 (0.420)	0.790 (0.406)
Child in good health (omitted, %)	0.165 (0.372)	0.177 (0.382)	0.163 (0.370)
Child in fair/poor health (%)	0.047 (0.213)	0.051 (0.221)	0.047 (0.211)
Hours/day child watches TV	2.089 (1.289)	2.238 (1.258)	2.064** (1.293)
Days/week child gets vigorous exercise	3.951 (2.382)	3.968 (2.380)	3.948 (2.383)
Ever participated in athletics (%)	0.324 (0.468)	0.273 (0.446)	0.333** (0.471)
Eats breakfast provided by school (%)	0.357 (0.479)	0.401 (0.491)	0.349*** (0.477)
Receives free/reduced price lunch (%)	0.493 (0.500)	0.554 (0.498)	0.483*** (0.500)
Family characteristics			
Mother's age (years, Fall of K)	30.27 (6.01)	29.04 (5.38)	30.48*** (6.09)
Biological parents married at birth (%)	0.363 (0.481)	0.250 (0.434)	0.383*** (0.486)
Family SES in 1st quintile (%)	0.328 (0.470)	0.310 (0.463)	0.331 (0.471)

Table 1 continued

Variable	Full sample	Subsidy recipient	Non-recipient
Family SES in 2nd quintile (%)	0.246 (0.431)	0.311 (0.463)	0.235*** (0.424)
Family SES in 3rd quintile (%)	0.205 (0.404)	0.203 (0.403)	0.206 (0.404)
Family SES in 4th quintile (%)	0.124 (0.330)	0.125 (0.331)	0.124 (0.330)
Family SES in 5th quintile (omitted, %)	0.096 (0.295)	0.052 (0.222)	0.104*** (0.305)
Food stamp recipient (%)	0.454 (0.498)	0.679 (0.467)	0.416*** (0.493)
Days/week family eats breakfast together	3.781 (2.392)	3.469 (2.310)	3.833*** (2.402)
Days/week family eats dinner together	5.749 (1.781)	5.783 (1.694)	5.742 (1.795)
Parent expects HS or less for child (%)	0.129 (0.335)	0.121 (0.327)	0.130 (0.337)
Parent expects some college for child (%)	0.153 (0.360)	0.207 (0.406)	0.142*** (0.349)
Parent expects BA for child (%)	0.417 (0.493)	0.424 (0.495)	0.417 (0.493)
Parent expects > BA for child (omitted, %)	0.301 (0.459)	0.248 (0.432)	0.310 (0.463)

Note: All means are weighted using the ECLS-K Parent Full Sample weight. Standard deviations are in parentheses. Analyses are conducted on children with non-missing data. *, **, *** indicate that the difference in means for subsidy recipients and non-recipients is statistically significant at the 0.10%, 0.05%, and 0.01% levels, respectively

greater differences emerge when we compare children's weight outcomes across mothers with different work histories. Specifically, children of employed mothers are more likely to be overweight and obese, regardless of subsidy receipt status. Summary statistics for the full sample (shown in the first column) reveal that 30% of children of working mothers are overweight and 14% are obese. The comparable figures for children of non-working mothers are 26 and 12%, respectively.

Turning to the non-parental arrangements (Panel B), we once again find small differences in weight outcomes across subsidized and unsubsidized children. If anything, non-recipients tend to have slightly higher BMIs and are more likely to be overweight and obese. However, the story changes dramatically when we compare the weight outcomes of children in parent care with those receiving subsidies. Subsidized children consistently have higher BMIs, and the prevalence of overweight and obesity is substantially greater. For example, 31% of subsidized children in center-based care are overweight and 14% are obese. Fully 35% of subsidized children attending school-based services are overweight, while 15% are obese. On the other hand, 24% of children in parent care are overweight, and 10% are obese. In fact, based on the summary statistics for the full sample, it appears that children in any non-parental arrangement—regardless of whether it is subsidized—have higher BMIs and are more likely to be overweight and obese than those in parent care.

Together, the results presented in Table 2 highlight the potential for child care subsidies to operate through maternal employment and participation in non-parental child care. By encouraging low-income mothers to work and by creating incentives to shift children into formal child care settings, subsidies place children in environments where the average child is more likely to be overweight and obese. We will investigate these channels more explicitly in the regression analysis that follows.

Table 2 Children's weight outcomes by maternal work status and child care arrangements, fall of kindergarten

Variable	Full sample	Subsidy recipient	Non-recipient
Panel A: early maternal work			
Early maternal work			
BMI	16.500	16.548	16.491
Overweight	0.300	0.322	0.296
Obese	0.137	0.142	0.136
No early maternal work			
BMI	16.268	16.489	16.246
Overweight	0.261	0.267	0.260
Obese	0.119	0.097	0.121
Panel B: child care arrangements			
Parent care			
BMI	16.111	–	16.111
Overweight	0.241	–	0.241
Obese	0.099	–	0.099
Relative care			
BMI	16.584	16.196	16.626
Overweight	0.317	0.289	0.320
Obese	0.143	0.095	0.149
Non-relative care			
BMI	16.618	16.526	16.640
Overweight	0.283	0.255	0.290
Obese	0.140	0.174	0.132
Center-based care			
BMI	16.693	16.678	16.702
Overweight	0.331	0.312	0.342
Obese	0.139	0.136	0.141
School-based care			
BMI	16.413	16.521	16.397
Overweight	0.290	0.349	0.281*
Obese	0.139	0.147	0.138

Note: All means are weighted using the ECLS-K Parent Full Sample weight. *, **, *** indicate that the difference in means for subsidy recipients and non-recipients is statistically significant at the 0.10, 0.05, and 0.01% levels, respectively

4 Empirical model

Our goal is to examine the relationship between child care subsidy receipt in the year prior to kindergarten and children's weight outcomes in the fall and spring of kindergarten. Formally, we can specify this relationship in the context of the following regression model:

$$\mathrm{W}_i = \alpha \mathrm{S}_i + \varphi E_i + \mathbf{C}_i\delta + \mathbf{X}_i\beta + \varepsilon_i, \tag{1}$$

where W is one of four weight outcomes for child i in the ECLS-K; S is a binary indicator for whether a child care subsidy is received by child i; E is a binary indicator of early maternal work; **C** is a matrix of child care arrangements; **X** is a matrix of observable child and family determinants of children's health and development, and ε is an idiosyncratic error term. The α, φ, δ, and β are the estimated parameters. Recall that the four weight outcomes include the level and log of child i's BMI and indicators for whether child i is overweight and obese. For ease of interpretation, (1) is estimated using ordinary least squares (OLS) regression.[17] Coefficients are weighted using the ECLS-K Base Year Parent weight, and standard errors are adjusted for arbitrary heteroskedasticity using robust standard errors.

An obstacle to obtaining an unbiased estimate of α is the potential endogeneity of subsidy receipt. For example, employed mothers who obtain a child care subsidy and utilize non-parental care may be systematically different from those who do not in ways that are not captured by researchers. If high-skilled and physically healthy mothers are more likely to work and use child care, then failing to control for these maternal characteristics would lead to an upward bias of α if these characteristics are positively correlated with those of the children. Another source of endogeneity stems from the possibility that children's health and well-being influence maternal choices regarding work and child care. Mothers with unhealthy children, for example, may decide to remain out of the labor force or place their children in specialized child care settings. If these choices are correlated with unobserved child characteristics and the outcomes of interest, estimates of α will once again be biased.

We attempt to guard against potential endogeneity by adding a rich set of child and family characteristics to (1). In particular, we capture the health status of children through such controls as premature birth, low birth weight, and parental reports of children's well-being. We also remove the differential propensities across children to engage in sedentary activities (e.g., watching television) versus those requiring substantial physical activity (e.g., participation in athletics). Family routines that are correlated with children's weight are proxied by the extent to which families eat meals together, and whether children eat breakfast and lunch at school. Finally, we add controls for family SES and food stamp receipt in order to account for differences across families in the ability to purchase high quality food and support extracurricular activities.

A potential concern is that our extensive set of child and family controls may not sufficiently account for the selection into subsidy receipt. As a result, we estimate models that incorporate county fixed effects. These eliminate bias from unobserved characteristics across children residing in the same jurisdiction. For the purposes of this paper, fixed effects specified at the county-level hold a number of advantages. Given that state-level economic and policy conditions are identical for children in the same county, these factors are automatically controlled for and are not needed in the model. This is particularly important for states' social policy environment, including the flurry of recent welfare reforms, expansions to the Earned Income Tax Credit (EITC), and pre-kindergarten initiatives, all of which may influence mothers'

[17] The least squares estimates of coefficients in linear probability models are consistent estimates of average probability derivatives, but the standard errors are biased as a result of heteroskedasticity (Angrist and Krueger 1999). As we note in the text, we report standard errors that are robust to any form of heteroskedasticity.

work and child care decisions and children's well-being. In addition, to the extent that the availability of fast food restaurants, supermarkets, and parks is unevenly distributed across the states, inclusion of county fixed effects will control for these factors as well. Another advantage is that any sub-state-level variation in families' demographic characteristics, physical activity and food options, or the social policy environment is captured by the county fixed effects. Again, this is particularly important for the food and policy environment in which disadvantaged children are raised. For example, substantial evidence suggests that fast food restaurants tend to be clustered in low-income urban and rural neighborhoods (Block et al. 2004; Morland et al. 2002). In addition, a number of studies find that county administrators of subsidy programs have the authority to shape policy decisions with little oversight (Herbst and Tekin, in press; Blau and Tekin 2007; Layzer and Collins 2000; Blank, et al. 2001; Mitchell et al. 1997). These local-level sources of unobserved heterogeneity are removed by the county fixed effects.[18]

Although the inclusion of early maternal work and child care arrangements in (1) is interesting in its own right, we argue that such controls are crucial for understanding the ways in which subsidies influence children's weight outcomes. In particular, if the impact of subsidy receipt operates through the increase in maternal employment, one might expect little or no change in the subsidy estimates after child care arrangements are included in the model. However, if the impact of subsidies operates through children's attendance in non-parental care, inclusion of the arrangement variables should render the estimates on subsidy receipt statistically insignificant. To test these channels, we begin by estimating models that include just the indicator of subsidy receipt, followed by models that sequentially add controls for maternal employment and child care arrangements.

The primary coefficient of interest in (1) is α, which captures the impact of child care subsidy receipt on children's weight outcomes. For models in which the dependent variable is BMI, the estimated parameter represents the conditional mean effect of subsidy receipt across all children in the sample and over the distribution of BMI.[19] For models specifying overweight and obesity, the coefficient is interpreted as the average partial change in the likelihood of moving to the upper tail of the BMI distribution. In both cases, however, the OLS coefficients mask heterogeneous effects of child care subsidies across children's observable characteristics, including BMI.

Therefore, OLS estimates provide an incomplete picture if, for example, there are a priori reasons to be believe that key variables influence not only the conditional

[18] An alternative approach to obtaining an unbiased estimate of α is through the use of instrumental variables (IV). The IV method requires at least one variable that is correlated with subsidy receipt but uncorrelated with children's weight outcomes. We experiment with models using characteristics of the states' child care subsidies system (e.g., CCDF expenditures per child, reimbursement rates, and eligibility thresholds) as identifying instruments. One concern is that these variables, while being correlated with subsidy receipt, may also reflect the states' generosity or attitude toward assisting children and this may be correlated with weight outcomes. The subsidy coefficients from these models are qualitatively similar to those presented in the paper, but they are much larger in magnitude. Given the concerns about the plausibility of the instruments and the fact that these results are qualitatively similar to the current results, we do not present the IV models.

[19] In other words, OLS assumes that covariates only affect the location of the conditional distribution of the outcomes, not its scale or any other attribute of its distribution (Koenker and Hallock 2001).

mean expectation, but also the expectation at the tails and other policy-relevant points in the outcome distribution. In the current analysis, the distributional effects of child care subsidies are of particular interest. For example, consider the policy implications associated with changes in BMI at the lower and upper tails of the distribution. If child care subsidies lead to increases in BMI among underweight children, one could reasonably argue that this form of assistance may not impose additional health risks on already fragile children. For extremely low-income families that experience frequent food shortages, the introduction of a child care subsidy may improve health and development by allowing children to experience stable and healthy food options in the child care environment. In addition, an increase in disposable income may improve the ability of disadvantaged families to decrease consumption of low-cost, calorie-dense fast food and increase consumption of fresh fruits and vegetables. On the other hand, if parents and child care staff are aware that subsidies increase BMI among overweight children, such information can be used to aid parental decisions about the optimal environment for their children. Child care directors can also use this information to address nutrition and physical activity training for staff, and teachers may restructure daily schedules in a way that maximizes indoor and outdoor physical activity. Finally, state-level child care administrators may encourage child care provider services operating in low-income neighborhoods to increase healthy food options to accommodate children receiving subsidized care.

Based on these considerations, we explore heterogeneous effects of child care subsidies at different points in the distribution of children's BMI. To do so, we utilize quantile regression methods (Hao and Naiman 2007; Koenker and Bassett 1978; Bushinsky 1998). Quantile regression is a semi-parametric technique that is used to characterize the entire conditional distribution of a continuous dependent variable. This is achieved by dividing the cumulative distribution of a random function into equal intervals (e.g., quartiles or deciles). Then, unlike OLS, which derives estimates by minimizing the sum of squared residuals across the entire distribution, quantile regression estimates are derived for each subsection defined by p_n (Koenker and Hallock 2001).[20] Formally, parameter estimates at the nth quantile are calculated by:

$$\min_{k} \sum_{i} p_n[y_i - k(x_i, \beta)], \tag{2}$$

where the function $p_n(\cdot)$ is the "check function," and $k(x_i, \beta)$ is specified as a parametric function in order to generate the estimates.[21] Each coefficient produced

[20] The term "quantile" refers to the general case.

[21] The $p_n(.)$ is called the "check function" because it looks like check-mark when it is plotted (Angrist and Pischke 2008). Specifically,

$$p_n(u) = u(n - I(u<0)) = \begin{cases} n\,x\,u, \; u \geq 0 \\ (n-1)\,x\,u, \; u<0 \end{cases}.$$

To estimate the quantile regression models, we use the ivqte command developed by Frolich and Melly (2008) for STATA 10.1.

by the quantile regression model is interpreted as the partial derivative of the conditional quantile with respect to the observable covariates.[22] In the current study, coefficients on child care subsidies represent the marginal change in the *n*th quantile of BMI due to changes in subsidy receipt status. Insofar as coefficients of varying magnitudes are estimated at each quantile of children's BMI, we can interpret such results as evidence of heterogeneous effects of child care subsidies throughout the distribution of BMI.[23]

5 Estimation results

Discussion of the empirical results proceeds as follows. Table 3 presents the OLS estimates of the impact of child care subsidies on children's weight outcomes in the fall of kindergarten. The odd-numbered columns show the results without county fixed effects, and the even-numbered columns add these controls. To test whether the impact of subsidy receipt operates through maternal employment and/or children's child care arrangements, Table 3 presents results from models that incorporate just the indicator of subsidy receipt (Panel A), subsidy receipt and maternal work (Panel B), subsidy receipt and child care arrangements (Panel C), and all three sets of variables (Panel D). The equivalent results for children's weight outcomes in the spring of kindergarten are presented in Table 4. We then turn our attention to exploring heterogeneous subsidy effects. Table 5 (fall of kindergarten) and Table 6 (spring of kindergarten) show the coefficients from the quantile regression analysis of BMI. To maintain consistency, we begin with models that incorporate just subsidy receipt, then sequentially add maternal employment and child care arrangements.[24]

5.1 OLS and fixed effects results

As shown in Panel A of Table 3, child care subsidy receipt is associated with increases in BMI and a greater likelihood of being overweight and obese. In specifications without county fixed effects, the coefficient on subsidy receipt is consistently positive but not statistically significant. Adding controls for unobserved heterogeneity increases the magnitude and precision of the subsidy estimate in all

[22] Note that quantile regression is not the same as fitting OLS models for subsets of the conditional distribution of BMI. The latter approach is equivalent to estimating a model on samples based on truncated dependent variables, resulting in biased estimates.

[23] Quantile regression methods have been increasingly utilized in economics to study the returns to education (Arias et al. 2001), changes in wage structure and inequality (Buchinsky 1994, 1997; Gonzales and Miles 2001; Garcia et al. 2001), union wage effects (Chamberlain 1994), and birth outcomes (Abrevaya 2001). See *Empirical Economics* vol. 26, no. 1, 2001 for further examples on some of the applications of quantile regressions. We also located a few papers using quantile regression to estimate child and adult correlates of BMI. Examples of this work include: Terry et al. (2007) and Beyerlein et al. (2008).

[24] To economize on space, we only present the coefficients on our key variables. The coefficient estimates from other variables are mostly consistent with our expectations and in line with those in the relevant literature. They are available from the authors upon request.

Table 3 The impact of child care subsidies on children's weight outcomes, fall of kindergarten

Variable	BMI		ln(BMI)		Overweight		Obese	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: omit controls for early maternal work and child care arrangements								
Subsidy recipient	0.208 (0.131)	0.308** (0.139)	0.012* (0.007)	0.017** (0.008)	0.037 (0.026)	0.052* (0.028)	0.024 (0.019)	0.031 (0.020)
Panel B: add control for early maternal work and omit child care arrangements								
Subsidy recipient	0.182 (0.131)	0.280** (0.139)	0.011 (0.007)	0.016** (0.008)	0.033 (0.026)	0.047* (0.028)	0.022 (0.019)	0.028 (0.020)
Early maternal work	0.268** (0.130)	0.269** (0.137)	0.015** (0.007)	0.015** (0.008)	0.049** (0.024)	0.047* (0.025)	0.024 (0.018)	0.027 (0.019)
Panel C: omit control for early maternal work and add child care arrangements								
Subsidy recipient	0.058 (0.139)	0.131 (0.147)	0.004 (0.008)	0.008 (0.008)	0.017 (0.028)	0.029 (0.029)	0.013 (0.020)	0.017 (0.021)
Relative child care	0.471*** (0.142)	0.430*** (0.151)	0.027*** (0.008)	0.024*** (0.009)	0.070** (0.029)	0.069** (0.030)	0.047** (0.020)	0.048** (0.021)
Non-relative child care	0.470** (0.229)	0.386* (0.222)	0.026** (0.013)	0.022* (0.012)	0.036 (0.042)	0.011 (0.044)	0.039 (0.031)	0.031 (0.030)
Center-based child care	0.636*** (0.186)	0.714*** (0.197)	0.035*** (0.010)	0.040*** (0.011)	0.089*** (0.034)	0.099*** (0.035)	0.052** (0.024)	0.060** (0.025)
School-based child care	0.311** (0.137)	0.307** (0.145)	0.017** (0.008)	0.017** (0.008)	0.047* (0.027)	0.047* (0.028)	0.045** (0.019)	0.047** (0.020)
Panel D: add controls for early maternal work and child care arrangements								
Subsidy recipient	0.050 (0.139)	0.123 (0.147)	0.004 (0.008)	0.007 (0.008)	0.016 (0.028)	0.028 (0.029)	0.012 (0.020)	0.016 (0.021)
Early maternal work	0.165 (0.132)	0.175 (0.139)	0.010 (0.007)	0.010 (0.008)	0.036 (0.024)	0.036 (0.025)	0.015 (0.018)	0.019 (0.019)
Relative child care	0.432*** (0.144)	0.391** (0.154)	0.024*** (0.008)	0.022** (0.009)	0.061** (0.029)	0.060** (0.030)	0.044** (0.020)	0.044** (0.021)
Non-relative child care	0.425* (0.229)	0.337 (0.223)	0.024* (0.013)	0.020 (0.012)	0.026 (0.042)	0.001 (0.044)	0.034 (0.031)	0.026 (0.031)
Center-based child care	0.595*** (0.187)	0.672*** (0.196)	0.032*** (0.010)	0.037*** (0.011)	0.080** (0.034)	0.090** (0.036)	0.048** (0.024)	0.055** (0.025)
School-based child care	0.282** (0.137)	0.275* (0.145)	0.015* (0.008)	0.015* (0.008)	0.041 (0.027)	0.041 (0.028)	0.042** (0.019)	0.044** (0.020)
County fixed effects	No	Yes	No	Yes	No	Yes	No	Yes

Note: Robust standard errors are in parentheses. Analyses are weighted using the ECLS-K Base Year Full Sample Parent Weight. $N = 3{,}113$ in all models. The dependent variable in models (1) and (2) is the child's fall of kindergarten BMI. The dependent variable in models (3) and (4) is the log of child's BMI. The dependent variable in models (5) and (6) equals unity if the child's BMI is at or above the 85th percentile of the age- and gender-specific distribution. The dependent variable in models (7) and (8) equals unity if the child's BMI is at or above the 95th percentile of the age- and gender-specific distribution. Unless noted otherwise, all models include the full set of child/family controls in Table 1. All models include dummy variables that equal unity for the child and family controls with missing data. *, **, *** indicate that the coefficient is statistically significant at 0.10, 0.05, and 0.01 levels, respectively

Table 4 The impact of child care subsidies on children's weight outcomes, spring of kindergarten

Variable	BMI		ln(BMI)		Overweight		Obese	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: omit controls for early maternal work and child care arrangements								
Subsidy recipient	0.103 (0.139)	0.205 (0.149)	0.006 (0.008)	0.012 (0.008)	0.026 (0.027)	0.038 (0.029)	0.017 (0.020)	0.022 (0.021)
Panel B: add control for early maternal work and omit child care arrangements								
Subsidy recipient	0.083 (0.139)	0.183 (0.149)	0.005 (0.008)	0.011 (0.008)	0.023 (0.027)	0.035 (0.029)	0.016 (0.020)	0.020 (0.021)
Early maternal work	0.282** (0.133)	0.273* (0.142)	0.015** (0.007)	0.015* (0.008)	0.039 (0.025)	0.041 (0.027)	0.018 (0.018)	0.023 (0.019)
Panel C: omit control for early maternal work and add child care arrangements								
Subsidy recipient	−0.042 (0.147)	0.035 (0.157)	−0.001 (0.008)	0.003 (0.009)	0.017 (0.029)	0.020 (0.030)	0.001 (0.021)	0.004 (0.022)
Relative child care	0.466*** (0.149)	0.423*** (0.158)	0.026*** (0.008)	0.023*** (0.009)	0.036 (0.031)	0.028 (0.032)	0.037* (0.021)	0.048** (0.022)
Non-relative child care	0.456* (0.237)	0.273 (0.238)	0.025* (0.013)	0.015 (0.013)	−0.002 (0.043)	−0.026 (0.043)	0.044 (0.033)	0.032 (0.032)
Center-based child care	0.637*** (0.188)	0.724*** (0.197)	0.034*** (0.010)	0.040*** (0.011)	0.045 (0.036)	0.076** (0.038)	0.065** (0.026)	0.079*** (0.027)
School-based child care	0.283* (0.149)	0.338** (0.157)	0.014* (0.008)	0.017* (0.009)	0.005 (0.029)	0.015 (0.030)	0.034* (0.020)	0.047** (0.021)
Panel D: add controls for early maternal work and child care arrangements								
Subsidy recipient	−0.046 (0.147)	0.029 (0.156)	−0.002 (0.008)	0.002 (0.009)	0.016 (0.029)	0.019 (0.030)	0.001 (0.021)	0.003 (0.022)
Early maternal work	0.186 (0.135)	0.190 (0.143)	0.010 (0.007)	0.010 (0.008)	0.034 (0.025)	0.037 (0.027)	0.009 (0.018)	0.013 (0.019)
Relative child care	0.422*** (0.151)	0.381** (0.162)	0.024*** (0.008)	0.021** (0.009)	0.027 (0.031)	0.020 (0.032)	0.035 (0.021)	0.035 (0.022)
Non-relative child care	0.411* (0.236)	0.229 (0.239)	0.022* (0.013)	0.013 (0.013)	−0.010 (0.043)	−0.034 (0.043)	0.042 (0.033)	0.029 (0.032)
Center-based child care	0.595*** (0.188)	0.681*** (0.197)	0.032*** (0.010)	0.038*** (0.011)	0.037 (0.036)	0.068* (0.038)	0.063** (0.026)	0.076*** (0.027)
School-based child care	0.251* (0.149)	0.305* (0.158)	0.012 (0.008)	0.015* (0.009)	−0.001 (0.029)	0.009 (0.031)	0.033* (0.020)	0.045** (0.021)
County fixed effects	No	Yes	No	Yes	No	Yes	No	Yes

Note: Robust standard errors are in parentheses. Analyses are weighted using the ECLS-K Base Year Full Sample Parent Weight. $N = 3{,}007$ in all models. The dependent variable in models (1) and (2) is the child's spring of kindergarten BMI. The dependent variable in models (3) and (4) is the log of child's BMI. The dependent variable in models (5) and (6) equals unity if the child's BMI is at or above the 85th percentile of the age- and gender-specific distribution. The dependent variable in models (7) and (8) equals unity if the child's BMI is at or above the 95th percentile of the age- and gender-specific distribution. Unless noted otherwise, all models include the full set of child/family controls in Table 1. All models include dummy variables that equal unity for the child and family controls with missing data. *, **, *** indicate that the coefficient is statistically significant at 0.10, 0.05, and 0.01 levels, respectively

Table 5 Quantile regression results for the relationship between child care subsidies and BMI, fall of kindergarten

	Fall of kindergarten BMI quantile								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Panel A: omit controls for early maternal work and child care arrangements									
Subsidy recipient	0.065 (0.110)	0.096 (0.110)	0.160 (0.106)	0.206* (0.109)	0.151 (0.115)	0.290** (0.131)	0.400*** (0.149)	0.420** (0.172)	0.397 (0.254)
Panel B: add control for early maternal work and omit child care arrangements									
Subsidy recipient	0.067 (0.105)	0.098 (0.108)	0.132 (0.108)	0.180* (0.109)	0.158 (0.114)	0.258** (0.131)	0.430*** (0.148)	0.363** (0.174)	0.351 (0.239)
Early maternal work	0.035 (0.094)	0.117 (0.096)	0.224** (0.099)	0.183* (0.107)	0.063 (0.114)	0.132 (0.120)	0.248* (0.136)	0.249 (0.182)	0.196 (0.256)
Panel C: omit control for early maternal work and add child care arrangements									
Subsidy recipient	−0.020 (0.116)	0.033 (0.114)	0.095 (0.116)	0.009 (0.116)	0.037 (0.123)	0.176 (0.140)	0.241 (0.157)	0.263 (0.183)	0.253 (0.252)
Relative child care	0.259** (0.131)	0.208* (0.118)	0.244** (0.116)	0.245** (0.121)	0.157 (0.128)	0.196 (0.138)	0.249 (0.161)	0.245 (0.202)	0.608** (0.264)
Non-relative child care	0.327** (0.162)	0.215 (0.163)	0.193 (0.162)	0.219 (0.160)	0.100 (0.172)	0.068 (0.180)	0.127 (0.191)	0.137 (0.222)	−0.123 (0.288)
Center-based child care	0.330** (0.148)	0.303** (0.138)	0.353** (0.144)	0.491*** (0.146)	0.419*** (0.157)	0.382** (0.165)	0.478** (0.196)	0.548** (0.235)	0.750** (0.301)
School-based child care	0.042 (0.119)	−0.056 (0.109)	0.038 (0.110)	0.089 (0.118)	−0.031 (0.129)	0.031 (0.138)	0.120 (0.159)	0.271 (0.198)	0.585** (0.246)
Panel D: add controls for early maternal work and child care arrangements									
Subsidy recipient	0.014 (0.117)	0.041 (0.114)	0.044 (0.115)	0.034 (0.117)	0.032 (0.124)	0.149 (0.140)	0.227 (0.156)	0.249 (0.177)	0.197 (0.245)
Early maternal work	−0.012 (0.097)	0.079 (0.098)	0.208** (0.100)	0.145 (0.106)	0.049 (0.115)	0.076 (0.118)	0.169 (0.139)	0.176 (0.179)	0.256 (0.273)

Table 5 continued

	Fall of kindergarten BMI quantile								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Relative child care	0.251* (0.130)	0.194* (0.119)	0.184 (0.116)	0.227* (0.122)	0.148 (0.131)	0.232* (0.139)	0.198 (0.165)	0.172 (0.198)	0.597** (0.288)
Non-relative child care	0.312* (0.164)	0.210 (0.162)	0.159 (0.161)	0.169 (0.161)	0.100 (0.173)	0.106 (0.178)	0.135 (0.194)	−0.010 (0.218)	−0.111 (0.288)
Center-based child care	0.349** (0.143)	0.301** (0.138)	0.303** (0.140)	0.451*** (0.146)	0.427*** (0.157)	0.452*** (0.165)	0.434** (0.198)	0.483** (0.230)	0.801** (0.312)
School-based child care	0.047 (0.115)	−0.062 (0.108)	−0.001 (0.111)	0.069 (0.117)	−0.032 (0.130)	0.074 (0.137)	0.088 (0.159)	0.176 (0.196)	0.522** (0.251)

Note: Robust standard errors are in parentheses. Analyses are based on Stata's ivqte command produced by Frolich and Melly (2008). $N = 3{,}113$ in all models. The dependent variable is the child's BMI, measured in the fall of kindergarten. Unless noted otherwise, all models include the full set variables listed in Table 1, as well as county fixed effects. All models include dummy variables that equal unity for the child and family controls with missing data. *, **, *** indicate that the coefficient is statistically significant at 0.10, 0.05, and 0.01 levels, respectively

Table 6 Quantile regression results for the relationship between child care subsidies and bmi, spring of kindergarten

	Spring of kindergarten BMI quantile								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Panel A: omit controls for early maternal work and child care arrangements									
Subsidy recipient	0.021 (0.102)	0.057 (0.112)	0.056 (0.114)	0.086 (0.125)	0.107 (0.135)	0.214 (0.146)	0.472*** (0.176)	0.383* (0.228)	0.537* (0.305)
Panel B: add control for early maternal work and omit child care arrangements									
Subsidy recipient	0.031 (0.100)	0.036 (0.111)	0.025 (0.113)	0.098 (0.124)	0.112 (0.135)	0.221 (0.145)	0.435** (0.174)	0.361 (0.232)	0.512* (0.298)
Early maternal work	−0.010 (0.095)	0.180* (0.105)	0.086 (0.105)	0.093 (0.110)	0.150 (0.120)	0.143 (0.133)	0.263* (0.155)	0.379* (0.206)	0.347 (0.234)
Panel C: omit control for early maternal work and add child care arrangements									
Subsidy recipient	−0.002 (0.111)	−0.061 (0.121)	−0.071 (0.120)	−0.021 (0.133)	0.031 (0.147)	0.021 (0.158)	0.206 (0.191)	0.177 (0.241)	0.287 (0.309)
Relative child care	0.272** (0.123)	0.161 (0.127)	0.107 (0.124)	0.171 (0.134)	0.252* (0.145)	0.225 (0.161)	0.186 (0.184)	0.365 (0.234)	0.635** (0.305)
Non-relative child care	0.253 (0.177)	0.087 (0.175)	0.071 (0.177)	0.077 (0.177)	0.039 (0.190)	−0.034 (0.203)	−0.173 (0.236)	0.156 (0.308)	−0.306 (0.334)
Center-based child care	0.275* (0.148)	0.283* (0.150)	0.402*** (0.149)	0.397** (0.160)	0.531*** (0.173)	0.512*** (0.187)	0.557*** (0.216)	0.732*** (0.249)	0.603* (0.319)
School-based child care	0.056 (0.120)	−0.101 (0.118)	−0.102 (0.117)	0.046 (0.124)	0.142 (0.136)	0.114 (0.151)	−0.006 (0.179)	0.395* (0.228)	0.636** (0.262)
Panel D: add controls for early maternal work and child care arrangements									
Subsidy recipient	0.014 (0.112)	−0.037 (0.120)	−0.048 (0.120)	−0.033 (0.133)	0.026 (0.147)	0.057 (0.158)	0.176 (0.188)	0.185 (0.243)	0.273 (0.308)
Early maternal work	−0.054 (0.096)	0.061 (0.106)	0.056 (0.105)	0.026 (0.112)	0.107 (0.120)	0.201 (0.131)	0.181 (0.161)	0.316 (0.205)	0.220 (0.248)

Table 6 continued

	Spring of kindergarten BMI quantile								
	0.1	0.2	0.3	0.4	0.5	20.6	0.7	0.8	0.9
Relative child care	0.275* (0.128)	0.151 (0.130)	0.076 (0.126)	0.154 (0.136)	0.203 (0.148)	0.212 (0.163)	0.176 (0.185)	0.311 (0.242)	0.613** (0.313)
Non-relative child care	0.254 (0.174)	0.117 (0.175)	0.097 (0.173)	0.080 (0.177)	−0.005 (0.190)	−0.061 (0.204)	−0.157 (0.237)	0.150 (0.314)	−0.320 (0.325)
Center-based child care	0.268* (0.152)	0.255* (0.153)	0.391*** (0.151)	0.402** (0.164)	0.469*** (0.177)	0.490*** (0.188)	0.556** (0.221)	0.719*** (0.247)	0.728** (0.332)
School-based child care	0.078 (0.119)	−0.086 (0.121)	−0.105 (0.117)	0.060 (0.126)	0.091 (0.138)	0.105 (0.150)	−0.010 (0.176)	0.352 (0.231)	0.635** (0.269)

Note: Robust standard errors are in parentheses. Analyses are based on Stata's ivqte command produced by Frolich and Melly (2008). $N = 3{,}007$ in all models. The dependent variable is the child's BMI, measured in the spring of kindergarten. Unless noted otherwise, all models include the full set variables listed in Table 1, as well as county fixed effects. All models include dummy variables that equal unity for the child and family controls with missing data. *, **, *** indicate that the coefficient is statistically significant at 0.10, 0.05, and 0.01 levels, respectively models. This suggests that, if anything, the impact of subsidy receipt is likely to be biased downward. As shown in column (4), subsidy receipt is associated with a 1.7% increase in children's fall of kindergarten BMI. The coefficients in column (6) and (8) suggest that subsidized children are 5.2% points more likely to be overweight and 3.1% points more likely to be obese.

Adding a control for early maternal work (Panel B) leads to only a small reduction in the magnitude of the subsidy coefficients, and the standard errors remain unchanged. Subsidy receipt is now associated with a 4.7% point increase in the likelihood of being overweight and a 2.8% point increase in the likelihood of obesity. Coefficients on maternal work are consistent with previous research. Children whose mothers were employed at some point between birth and kindergarten experience a 1.5% increase in BMI. Such children are also 4.7% points more likely to be overweight and 2.7% points more likely to be obese.

Substituting the vector of child care arrangements for the indicator of maternal work (Panel C) leads to a large reduction in the subsidy coefficients, and renders the estimates statistically insignificant in all models. For example, the coefficient on subsidy receipt is reduced by 53% in the log BMI model and about 44% in the overweight and obesity models compared to the baseline subsidy estimate in Panel A. Coefficients on the child care arrangements, however, imply positive and statistically significant increases in BMI, overweight, and obesity. For example, children participating in relative care are 6.9% points more likely to be overweight and 4.8% points more likely to be obese than their counterparts in parent care. Children attending center-based care experience the largest increases in each outcome. Such children have BMIs that are 4.0% higher, rates of overweight that 9.9% points higher, and rates of obesity that are 6.0% points higher. There is also evidence that participation school-based care is positively associated with children's weight outcomes, although the effect sizes are not as large as those for center-based care. Interestingly, rates of overweight and obesity among children in non-relative care are not significantly different from those in parent care.

When the full model is estimated (Panel D), the coefficients on child care subsidies experience a further drop in magnitude and remain statistically insignificant. It is interesting to note that a similar pattern of results emerges for early maternal employment. Although maternal employment is initially associated with significant increases in children's weight outcomes, these effects attenuate and become imprecisely estimated once the child care controls are added. On the other hand, the estimates for child care arrangements are largely unchanged by the inclusion of maternal work. Participation in center-based care continues to be strongly related to children's weight outcomes. Children attending this mode of care have BMIs that are 3.7% higher, rates of overweight that 9.0% points higher, and rates of obesity that are 5.5% points higher than their counterparts in parent care.

Results presented in Table 3 are consistent with the picture emerging from the descriptive evidence in Tables 1 and 2. Although subsidized children tend to have slightly higher BMIs and are somewhat more likely to be overweight and obese, these differences are not nearly as large as those between children in parental and non-parental child care arrangements. Accounting for the differential participation in child care settings renders the differences in weight outcomes between subsidized and unsubsidized children statistically insignificant. Variation in employment rates, on the other hand, does not appear to be responsible for the subsidy-induced changes in children's weight. Rather, the subsidy effects operate through the shifting of children into non-parental arrangements, where, children have higher BMIs and rates of overweight and obesity. Furthermore, our results indicate that participation in center-based care is primarily responsible for the larger weight outcomes among subsidized children. Two pieces of evidence support this claim. Center-based care is the predominant arrangement among children receiving subsidies, and this child care setting is consistently associated with the largest increases in BMI, overweight, and obesity.[25]

Table 4 examines the persistence of subsidy, maternal work, and child care arrangement effects. Results in Panel A indicate that the impact of subsidy receipt attenuates between the fall and spring of kindergarten. Generally speaking, the subsidy coefficients decrease in magnitude as compared to those from the fall of kindergarten, and none of the coefficients are statistically significant. Adding the controls for maternal employment and child care, as shown in Panels B through D, further reduces the magnitude of the subsidy effects. The impact of early maternal work also attenuates by the spring of kindergarten. Interestingly, strong associations between child care arrangements and children's weight outcomes are still present as of the end of kindergarten. When the full model is estimated (Panel D), participation in relative care is associated with a 2.1% increase in BMI, center-based care is associated with a 3.8% increase in BMI, and school-based care is associated with a 1.5% increase in BMI. Furthermore, center-based care is expected to increase the prevalence of overweight by 6.8% points and obesity by 7.6% points. School-based care also remains significantly related to overweight and obesity.

5.2 Quantile regression results

Having established a relationship between subsidy receipt and children's weight outcomes at the upper tail of BMI, we now turn to the quantile regression results, which characterize the entire distribution of BMI.[26] Table 5 shows the estimates for the fall of kindergarten BMI, and Table 6 shows the estimates for the spring of kindergarten BMI. As previously stated, we begin by including only the measure of child care subsidy receipt, and then we add controls for early maternal work and child care arrangements. All models show coefficients using the level parameterization of BMI across the 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9 quantiles. County fixed effects are incorporated into all models.

[25] We subject this assertion to a more rigorous test. We re-estimate the basic regression of children's weight outcomes on subsidy receipt, but only among children in different child care arrangements. In the model using the log of BMI as the dependent variable, the coefficient on subsidy receipt implies a statistically significant 3.8% increase in BMI among children in center-based and family child care homes. As for the obesity regression, the coefficient on subsidy receipt implies a statistically significant 6.8% point increase in obesity among such children. Across no other arrangement were any of the subsidy coefficients significant.

[26] We also estimated quantile regression models using ln BMI. The results from these models are very similar to those with the BMI in terms of both pattern and significance.

As shown in Panel A of Table 5, we find evidence of substantial heterogeneity in response to child care subsidy receipt. For comparison purposes, it is useful to recall that the average effect of subsidy receipt in the fall of kindergarten is 0.308 BMI points (Table 3, Panel A). When the full distribution of BMI is characterized, the impact of subsidy receipt ranges from 0.065 to 0.420. Generally speaking, the magnitude of subsidy effect increases monotonically as children move to higher BMI quantiles. Throughout the first three quantiles, the coefficient is small in magnitude and statistically insignificant, suggesting that child care subsidies are not associated with increases in BMI at the lower end of the distribution. Subsidy receipt, however, is associated with increasingly large and precisely estimated gains in BMI among children above the median. In particular, we find that BMIs among subsidized children increase from 0.151 points at the 0.5 quantile to 0.397 points at the 0.9 quantile, peaking at 0.420 points at the 0.8 quantile. This shift represents an increase of 163%.

Adding the control for maternal employment (Panel B) reduces somewhat the magnitude of subsidy coefficients across all BMI quantiles, although the qualitative story remains the same. Furthermore, the impact of maternal work does not reveal a consistent pattern over the BMI distribution, and very few of the coefficients are statistically significant. Incorporating the vector of child care arrangements (Panel D) renders statistically insignificant all of the coefficients on subsidy receipt and most of the coefficients on maternal employment.

As shown in Panel D, an interesting story emerges from the estimates on child care arrangements. On the one hand, it appears that center-based care leads to comparatively large and stable increases in BMI throughout most of the distribution. With the exception of the highest BMI quantile, where the effect is 0.801 points, the impact of center care ranges between 0.301 and 0.483 points over the BMI distribution. A relatively stable effect size throughout the distribution of children's BMI amounts to a location shift: as center-based participation increases BMI among children in the middle of the distribution, children located at other points along the distribution experience similar increases in BMI, causing the entire distribution to shift to the right. The remaining child care arrangements exhibit a different pattern, characterized by BMI increases concentrated at the lower and upper tails of the distribution. Participation in relative care, for example, is associated with statistically significant increases in BMI at the 0.1 and 0.2 quantiles, inconsistent effects throughout much of the middle of the distribution, and a large effect at the 0.9 quantile (0.597 BMI points). Similarly, the only quantile at which non-relative care significantly raises BMI is 0.1, with an effect size of 0.312 BMI points. Participation in school-based care significantly increases BMI only among children at the upper tail of the distribution (0.522 BMI points). Across many of the other quantiles, school settings are associated with reductions in BMI, although in no case is the estimate statistically significant.

Quantile regression results based on the spring of kindergarten BMI (Table 6) are quite similar to the pattern established in the fall of kindergarten. Although the effect sizes attenuate, the range of subsidy coefficients in Panel A remains large (from 0.021 to 0.537 BMI points) and most of the coefficients at the upper tail are statistically significant. The relationship between subsidy receipt and BMI continues to be strongly monotonic: For children below the median BMI, subsidy receipt is associated with gains ranging from essentially 0 to 0.0.86 BMI points. For children above the median BMI, the gains range from 0.214 to 0.537 BMI points.

Generally speaking, the pattern of results exhibited in Panel B, C, and D is also broadly consistent with the fall of kindergarten. Parameter estimates suggest that subsidy receipt remains significantly related to BMI at the upper tail even after accounting for early maternal work, but the relationship attenuates after incorporating controls for child care arrangements. Attendance in school-based services continues to increase BMI among children at the upper tail, but some of the significant effects for relative and non-relative care as of the fall of kindergarten are no longer significant in the spring. It is interesting to note that the impact of center care tends to increase in magnitude, become more heterogeneous, and remain highly statistically significant. For children below the median, center care increases BMI between 0.255 and 0.402 points. For children above the median, the effect size increases from 0.490 to 0.728 points. It is difficult to interpret these findings, but we offer two explanations. First, the increased magnitude and heterogeneity reflect the possibility that children in center care are more likely to enroll in kindergarten programs that are less attentive to serving healthy foods and allowing children sufficient time to exercise throughout the day. The other explanation is that any center-induced increase in BMI did not reveal itself in children's weight until the spring of kindergarten.

6 Conclusions

The US child care subsidy system places considerable emphasis on moving welfare recipients into work, and keeping those currently employed out of the welfare system. Indeed, a number of recent studies suggest that a child care subsidy is an effective policy tool for increasing the labor force participation of single mothers (e.g., Blau and Tekin 2007). Furthermore, the principle of "parental choice," in which families are able to use subsidies to purchase virtually any legally operating child care service, is beneficial to low-income families struggling to balance work-life obligations. However, there may be unintended consequences associated with child care subsidies. In particular, there are a number of design features associated with states' CCDF plans that create disincentives for parents to choose high-quality care and for providers to make costly quality-enhancing improvements (Herbst and Tekin, in press). Consequently, a number of observers have become concerned about the implications of child care subsidies for children's health and well-being (e.g., Adams and Rohacek 2002).

In this paper, we seek to understand the relationship between child care subsidies, measured in the year before kindergarten, and children's weight outcomes throughout kindergarten. Our findings suggest that child care subsidy receipt is associated with increases in BMI as well as increases in the likelihood of being overweight and obese. We also find initial support for the claim that the estimated subsidy effects operate through children's participation in non-parental child care settings. Specifically, our results point to enrollments in center-based care as the primary mechanism through which the subsidy effects operate. Children in this type of arrangement have substantially higher BMIs and experience a significantly greater likelihood of being overweight and obese. In light of our results, it is no coincidence that center care is the predominant child care mode among subsidized children. Estimates from the quantile regression models provide evidence of substantial heterogeneity in response to child care subsidy receipt: BMI gains due to subsidized care are dramatically different depending on where children are located in the BMI distribution. Children at the upper end of the distribution experience BMI gains that are greater than the gains among children at the lower end. Once again, our quantile regression results imply that center-based care emerges as a likely candidate to explain the pattern of subsidy effects. Note that our sample consists of children of single mothers only. Therefore, the results should not be generalized to other children.

A possible explanation for these results is that child care subsidies induce mothers to choose formal arrangements that are of questionable quality. As previously stated, the CCDF's principle of "parental choice" allows parents to purchase child care services operating outside states' regulatory regimes. Furthermore, conditioning eligibility for subsidies on employment and income creates challenges for maintaining stable child care arrangements. In particular, if changes in employment and income are related to lapses in subsidy receipt, such instability could undermine child well-being. States' reimbursement rates can also influence quality. If reimbursements are below the federally recommended level, families may not have access to high-quality care, thereby reducing incentives for providers to make important quality enhancements.

Indeed, recent empirical work seems to confirm these critiques. Several studies find that subsidized children receive lower-quality care than other low-income, unsubsidized children (Adams et al. 2001; Jones-Branch et al. 2004; Mocan 2007; Raikes et al. 2005; Queralt et al. 2000; Thornburg et al. 2002; Whitebook et al. 2004; Witt et al. 2000). As summarized in Story et al. (2006), another body of evidence suggests that many child care centers in the US fail to provide children with healthy foods and sufficient opportunities for physical activity. Finally, a recent analysis by Herbst and Tekin (2010) finds that subsidized children perform worse on tests of reading and math ability and teacher's assessments of externalizing behavior problems, self-control, and interpersonal skills.

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References

Abrevaya, J. (2001). The effects of demographics and maternal behavior on the distribution of birth outcomes. *Empirical Economics, 26*, 247–257.

Adams, D., Roach, M., Riley, D., & Edie, D. (2001). *Are program characteristics linked to child care quality? Wisconsin child care research partnership issue brief 3*. Madison, WI: University of Wisconsin-Extension.

Adams, G., & Rohacek, M. (2002). More than a work support? Issues around integrating child development goals into the child care subsidy system. *Early Childhood Research Quarterly, 17*, 418–440.

Anderson, P., & Butcher, K. (2006). Childhood obesity: Trends and potential causes. *The Future of Children, 16*, 19–46.

Anderson, P., Butcher, K., & Levine, P. B. (2003). Maternal employment and overweight children. *Journal of Health Economics, 22*, 477–504.

Angrist, J., & Krueger, A. (1999). Empirical strategies in labor economics. In O. Ashenfelter & D. Card (Eds.), *Handbook of labor economics* (Vol. 3A). Amsterdam: Elsevier.

Angrist, J., & Pischke, J. (2008). *Mostly harmless econometrics: An Empirisist's companion*. Princeton, NJ: Princeton University Press.

Arias, O., Hallock, K., & Sosa-Escudero, W. (2001). Individual heterogeneity in the returns to schooling: Instrumental variables quantile regression using twins data. *Empirical Economics, 26*, 7–40.

Bainbridge, J., Meyers, M., Tanaka, S., & Waldfogel, J. (2005). Who gets an early education? Family income and the enrollment of three- to five-year-olds from 1968 to 2000. *Social Science Quarterly, 86*, 724–745.

Baker, M., Gruber, J., & Milligan, K. (2008). Universal child care, maternal labor supply, and family well-being. *Journal of Political Economy, 116*, 709–745.

Bernal, R. & Keane, M. (2008). *Child care choices and children's cognitive achievement: The case of single mothers*. Universidad de los Andes Working Paper, WP-July 31.

Beyerlein, Andreas, Toschke Andre, M., & von Kries, R. (2008). Breastfeeding and childhood obesity: Shift of the entire BMI distribution or only the upper parts? *Obesity, 16*, 2730–2733.

Blank, H., Behr, A., & Schulman, K. (2001). *State developments in child care, early education, and school age care, 2000*. Washington, DC: Children's Defense Fund.

Blau, D. (1999). The effect of child care characteristics on child development. *Journal of Human Resources, 34*, 786–822.

Blau, D., & Tekin, E. (2007). The determinants and consequences of child care subsidies for single mothers in the USA. *Journal of Population Economics, 20*, 719–741.

Block, J., Scribner, R., & DeSalvo, K. (2004). Fast food, race/ethnicity, and income: A geographic analysis. *American Journal of Preventive Medicine, 27*, 211–217.

Buchinsky, M. (1994). Changes in US wage structure 1963–1987: An application of quantile regression. *Econometrica, 62*, 405–458.

Buchinsky, M. (1997). The dynamics of changes in the female wage distribution in the USA: A quantile regression approach. *Journal of Applied Econometrics, 13*, 1–30.

Bushinsky, M. (1998). Recent advances in quantile regression models: A practical guide for empirical research. *Journal of Human Resources, 33*, 88–126.

Capizzano, J., & Adams, G. (2000). *The hours that children under five spend in child care: Variation across states*. Working paper no. B-8. The Urban Institute, Washington, DC.

Cawley, J., & Liu, F. (2007). *Maternal employment and childhood obesity: A search for mechanisms in time use data*. National Bureau of Economic Research working paper no. 13600.

Chamberlain, G. (1994). Quantile regression, censoring and the structure of wages. In C. Sims (Ed.), *Advances in econometrics* (pp. 171–209). New York: Elsevier.

Child Care Bureau. (2006) *2006 CCDF state expenditure data*. Washington, DC: US Department of Health and Human Services, Administration for Children and Families, Child Care Bureau. http://www.acf.hhs.gov/programs/ccb/data/expenditures/06acf696/toc.htm. Accessed 10 February 2008.

Classen, T., & Hokayem, C. (2005). Childhood influences on youth obesity. *Economics and Human Biology, 3*, 165–187.

Courtemanche, C. (2007). *Working yourself to death? The relationship between work hours and obesity*. Working paper, Washington University of St. Louis.

Daniels, S. R. (2006). The consequence of childhood overweight and obesity. In S. McLanahan (Ed.), *The future of children: Childhood obesity* (pp. 47–68). Princeton, NJ: Princeton University and the Brookings Institution.

Deckelbaum, R., & Williams, C. (2001). Childhood obesity: The health issue. *Obesity Research, 9*, 239S–243S.

Dietz, W. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics, 101*, 518–525.

Dowda, M., Pate, R., Trost, S., Joao, M., Almeida, C., & Sirard, J. (2004). Influences of preschool policies and practices on children's physical activity. *Journal of Community Health, 29*, 183–196.

Fertig, A., Glomm, G., & Tchernis, R. (2009). The connection between maternal employment and childhood obesity: Inspecting the mechanisms. *Review of Economics of the Household*, *7*(3), 227–255.

Freedman, D. S., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (1999). The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa heart study. *Pediatrics, 103*, 1175–1182.

Freedman, D., Mei, Z., Srinivasan, S., Berenson, G., & Dietz, W. (2007). Cardiovascular risk factors and excess adiposity among overweight children and adolescents: The Bogalusa heart study. *Journal of Pediatrics, 150*, 12–17.

Frisvold, D. (2007). *Head start participation and childhood obesity: Does investing in early childhood education reduce obesity?* Working paper, University of Michigan.

Frolich, M., & Melly, B. (2008). *Estimation of quantile treatment effects with STATA*. Mimeo. Avaliable at: http://www.alexandria.unisg.ch/Publikationen/46580 (2009-04-01).

Garcia, J., Hernandez, P., & Lopez-Nicolas, A. (2001). How wide is the gap? An investigation of gender wage differences using quantile regression. *Empirical Economics, 26*, 149–167.

Gonzales, Z., & Miles, D. (2001). Wage inequality in a developing country: Decrease in minimum wage or increase in education returns. *Empirical Economics, 26*, 135–148.

Gortmaker, S., Peterson, K., Wiecha, J., Sobol, A., Dixit, S., Fox, M. K., et al. (1999). Reducing obesity via a school-based interdisciplinary intervention among youth. *Archives of Pediatric and Adolescent Medicine, 153*, 409–418.

Hao, L., & Naiman, D. (2007). *Quantile regression*. Sage Publications.

Herbst, C. (2008). Who are the eligible non-recipients of child care subsidies? *Children and Youth Services Review, 30*, 1037–1054.

Herbst, C., & Tekin, E. (2010). Child care subsidies and child development. *Economics of Education Review* (in press).

Hubbard, M. (2008). *The effect of mothers' employment and child care decisions on the body mass status of young children*. The University of North Carolina at Chapel Hill working paper, November.

Jones-Branch, J., Torquati, J., Raikes, H., & Edwards, C. (2004). Child care subsidy and quality. *Early Education and Development, 15*, 329–341.

Koenker, R., & Bassett, G. (1978). The asymptotic distribution of the least absolute error estimator. *Journal of the American Statistical Association, 73*, 618–622.

Koenker, R., & Hallock, K. (2001). Quantile regression: An introduction. *Journal of Economic Perspectives, 15*, 143–156.

Layzer, J. & Collins, A. (2000). *National study of child care for low-income families, state and community sub-study*. Interim report, executive summary, Abt Associates, November.

Magnuson, K., Meyers, M., & Waldfogel, J. (2007). Public funding and enrollment in formal child care in the 1990s. *Social Service Review, 81*, 47–83.

Mitchell, A., Stoney, L., & Dichter, H. (1997). *Financing child care in the United States: An illustrative catalog of current strategies*. Kansas City, MO: E.M. Kaufman Foundation.

Mocan, N. (2007). Can consumers detect lemons? An empirical analysis of information asymmetry in the market for child care. *Journal of Population Economics, 20*, 743–780.

Mocan, N., & Tekin, E. (2010). Obesity, self-esteem, and wages. In M. Grossman & N. Mocan (Eds.), *Economic aspects of obesity*. University of Chicago Press (forthcoming).

Morland, K., Wing, S., Roux, A., & Poole, C. (2002). Neighborhood characteristics associated with the location of food stores and food services places. *American Journal of Preventive Medicine, 22*, 23–29.

National Center for Education Statistics. (1996). *Child care and early education program participation of infants, toddlers, and preschoolers*. Washington, DC: US Department of Education.

National Institute of Child Health and Human Development (NICHD). (2003a). Does quality of childcare affect child outcomes at age 4 1/2? *Developmental Psychology, 39*, 451–469.

National Institute of Child Health and Human Development (NICHD). (2003b). Does amount of time spent in childcare predict socioemotional adjustment during the transition to kindergarten? *Child Development, 74*, 976–1005.

National Institute of Child Health and Human Development (NICHD), & Duncan, G. (2003). Modeling the impacts of child care quality on children's preschool cognitive development. *Child Development, 74*, 1454–1475.

Padget, A., & Briley, M. (2005). Dietary intakes at child-care centers in central texas fail to meet food guide pyramid recommendations. *Journal of the American Dietetic Association, 105*, 790–793.
Phipps, S., Lethbridge, L., & Burton, P. (2006). Long-run consequences of parental paid work hours for child overweight status in Canada. *Social Science and Medicine, 62*, 977–986.
Queralt, M., Witte, A., & Greisinger, H. (2000). *Championing our children: Changes in quality, price and availability of child care in the welfare reform era*. Working paper 2000-07, Department of Economics, Wellesley College, Wellesley, MA.
Raikes, H., Raikes, A., & Wilcox, B. (2005). Regulation, subsidy receipt and provider characteristics: What predicts quality in child care homes? *Early Childhood Research Quarterly, 20*, 164–184.
Ruhm, C. (2008). Maternal employment and adolescent development. *Labour Economics, 15*, 958–983.
Serdula, M., Ivery, D., Coates, R., Freedman, D., Williamson, D., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*, 167–177.
Smolensky, E., & Gootman, J. (Eds.). (2003). *Working families and growing kids: Caring for children and adolescents*. Washington, DC: National Research Council, National Academies Press.
Story, M. (1999). School-based approaches for preventing and treating obesity. *International Journal of Obesity, 23*, S43–S51.
Story, M., Kaphingst, K., & French, S. (2006). The role of child care settings in obesity prevention. *The Future of Children, 10*, 143–168.
Strauss, R. (2000). Childhood. *Obesity and Self-Esteem. Pediatrics, 105*, E15. Available at: www.pediatrics.org/cgi/content/full/105/1/e15.
Tekin, E. (2005). Child care subsidy receipt, employment, and child care choices of single mothers. *Economics Letters, 89*, 1–6.
Tekin, E. (2007). Child care subsidies, wages, and employment of single mothers. *Journal of Human Resources, 42*, 453–487.
Terry, M. B., Ying, W., & Esserman, D. (2007). Maternal, birth, and early-life influences on adult body size in women. *American Journal of Epidemiology, 166*, 5–13.
Thornburg, K., Scott, J., & Mayfield, W. (2002). *Early childhood program in Missouri: Workforce, quality, and policy-related findings*. Report to the Midwest Child Care Research Consortium. Center for Family and Policy Research, Columbia, MO.
US Department of Health and Human Services. (2001). *The surgeon general's call to action to prevent and decrease overweight and obesity*. Rockville, MD: US Department of Health and Human Services, Public Health Service, Office of the Surgeon General.
US Department of Health and Human Services, Administration for Children and Families. (1999). *Access to child care for low-income working families*. Available at: www.acf.dhhs.gov/programs/ccb/research/ccreport/ccreport.
Veugelers, P., & Fitzgerald, A. (2005). Effectiveness of school programs in preventing childhood obesity: A multilevel comparison. *American Journal of Public Health, 95*, 432–435.
Wang, G., & Dietz, W. (2002). Economic burden of obesity in youths aged 7 to 17 years: 1979–1999. *Pediatrics, 10*, E81.
Whitaker, R., Wright, J., Pepe, M., Seidel, K., & Dietz, W. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine, 37*, 869–873.
Whitebook, M., Phillips, D., Bellm, D., Crowell, N., Almaraz, M., & Jo, J. (2004). *Two ears in early care and education: A community portrait of quality and workforce stability*. Alameda County, California. Berkeley, CA: Center for the Study of Child Care Employment, Institute of Industrial Relations, University of California, Berkeley.
Witt, R., Queralt, M., & Witte, A. (2000). *Changes in the availability, quality, and price of child care in Massachusetts between 1997 and 1999*. Working paper 2000-12. Wellesley, MA: Department of Economics, Wellesley College.