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Inequality in Preschool Education and School Readiness

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Attendance in U.S. preschools has risen substantially in recent decades, but gaps in enrollment between children from advantaged and disadvantaged families remain. Using data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999, we analyze the effect of participation in child care and early education on children's school readiness as measured by early reading and math skills in kindergarten and first grade. We find that children who attended a center or school-based preschool program in the year before school entry perform better on assessments of reading and math skills upon beginning kindergarten, after controlling for a host of family background and other factors that might be associated with selection into early education programs and relatively high academic skills. This advantage persists when children's skills are measured in the spring of kindergarten and first grade, and children who attended early education programs are also less likely to be retained in kindergarten. In most instances, the effects are largest for disadvantaged groups, raising the possibility that policies promoting preschool enrollment of children from disadvantaged families might help to narrow the school readiness gap.

KEYWORDS: child care, early childhood education, inequality, school readiness.

The share of children attending early education programs has risen dramatically in recent years in the United States. In 2001, 66% of all 4-year-olds were enrolled in a center or school-based preschool program, up from 23% 30 years earlier (National Center for Education Statistics [NCES], 2003; U.S. Bureau of the Census, 1970). However, attendance among children from low-income families and with less educated parents remains relatively low. For example, children whose mothers have a college degree are nearly twice

as likely to be in center-based care arrangements as those whose mothers did not complete high school (NCES, 2003).

Does enrollment in preschool matter for school readiness? Do children who attended a preschool enter school with better reading and math skills? Do the benefits vary depending on the type of program attended, or the characteristics of the children? And, if so, are these associations due to preschool, or are they the result of other differences between children who did and did not attend preschool?

The answers to these questions have implications for policymakers as they decide how many and what types of early education programs to support. In 1990, concern about continuing differences in school readiness between children from more and less economically advantaged families led government leaders to endorse the first of eight national educational goals: "By the year 2000, all children should enter school ready to learn." One of the three objectives under this goal was that all children should have access to high-quality and developmentally appropriate preschool programs that help prepare them for school (Committee for Economic Development, 2002). To equalize access to high-quality early education opportunities, there have been numerous calls to expand public support of preschool programs for 3- and 4-year-olds (Bowman, Donovan, & Burns, 2001; Committee for Economic Development, 2002; Wolfe & Scrivner, 2003).

During the 1990s, states and the federal government did expand funding for child care subsidies and preschool programs (Blank, Schulman, & Ewen, 1999; Education Week, 2002). Yet, evidence on the impact of expanded pre-

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school programs for school readiness remains very limited (Gilliam & Zigler, 2001). Although we know a great deal about the effects of model interventions, we know much less about the effects of the types of programs more typically provided to young children. Evidence is particularly lacking on prekindergarten programs, which have grown rapidly in recent years and now serve one in seven 4-year-olds (Gilliam & Zigler, 2001; U.S. General Accounting Office, 2000a, 2000b).

We address these questions using data from the newly available Early Childhood Longitudinal Study—Kindergarten Class of 1998–1999 (ECLS-K). The ECLS-K follows a large, nationally representative sample of children who attended kindergarten in the fall of 1998, collecting data on reading and math skills as well as a rich array of family and school characteristics. Data are available currently through the spring of 2000, when the children completed first grade. We use these data to estimate the effect of preschool enrollment in the year before kindergarten on children's reading and math scores during the fall of kindergarten, spring of kindergarten, and spring of the first grade. We distinguish between several different types of early education, including prekindergarten, and consider whether the effects of these programs differ for children from advantaged and disadvantaged families.

Background

Children from economically disadvantaged families enter school with fewer academic skills than their more advantaged peers (although no less enthusiasm for learning), and substantial gaps in cognitive and academic competencies persist in later school years (Stipek & Ryan, 1997). Differences in children's early childhood experiences play a formative role in shaping school readiness and largely explain the skill gaps at school entry. Early in life, responsive and cognitively stimulating care fosters the language and cognitive skills that facilitate learning (Shonkoff & Phillips, 2000). Families facing economic constraints are limited in the quality and types of learning experiences they can provide for their children. Close to 40% of the associations between economic disadvantage and young children's lower academic performance are explained by the lower quality of home learning environments (Smith, Brooks-Gunn, & Klebanov, 1997).

Differential language learning opportunities in economically disadvantaged households, in particular, may have lasting consequences for children's language development (Hart & Risley, 1995; Hoff, 2003). In their study, Hart and Risley (1995) found that by the age of 3, children in families receiving welfare had vocabularies that were half as large as those of their more affluent peers, and the disparities persisted throughout childhood. The gap in language skills was fully explained by the lower quality and quantity of parental speech in families receiving welfare. Similarly, Hoff (2003) found that differences due to socioeconomic status in vocabulary growth over children's first 3 years of life were fully accounted for by the quality and quantity of vocabulary used by their mothers.

Not only are children from economically disadvantaged families less likely to experience stimulating learning opportunities in their home environments, they are also less likely to be enrolled in early education programs and center-based child care. Indeed, the gap in enrollment between low- and high-income 4-year-old children was close to 25 percentage points in 2000 (50% vs. 75%; Meyers, Rosenbaum, Ruhm, & Waldfogel, in press). The expense of center-based care clearly plays a role in producing these gaps. With the average cost of full-time private preschool or center-based care in recent years estimated at $4,000 to $6,000 per year (Blank et al., 1999), early education or formal child care arrangements are prohibitively expensive for many low-income families, for whom such care would often represent as much as a quarter of their total household income (Blank et al., 1999).

Concerns that children from low-income or less educated families may be "doubly disadvantaged" (Meyers et al., in press) by being less likely to receive stimulating care at home and less likely to be enrolled in educationally oriented care outside the home have led policymakers to fund early education and child care programs targeted toward these children (Adams & Rohacek, 2002; Farran, 2000). One recent response has been the creation of prekindergarten programs, early education programs funded by local school districts (Ripple, Gilliam, Chanana, & Zigler, 1999). Prekindergarten has emerged into an arena that already includes several types of early childhood education and care programs such as Head Start, preschools, nursery schools, and center-based day care centers. Although policymakers treat early education and child care as separate programmatic entities, early childhood experts argue that high-quality care and education involve the same key components: physical safety, warm and responsive child-caregiver interactions, and cognitively stimulating learning opportunities (Adams & Rohacek, 2002). Next, we provide a brief overview of these early education programs, as well as informal child care programs, and discuss what prior research reveals about their impacts on school readiness.

Prekindergarten Programs

Prekindergarten programs provide a year (or two) of education, funded by public schools, prior to entry into kindergarten. They are primarily funded by states and local school districts, although the latter also use federal Title I and disability services funds for these programs. Since 1990, overall state funding for prekindergarten has increased 250% to approximately $1.9 million (Education Week, 2002). However, spending varies widely across states. In 2000, 39 states had prekindergarten initiatives, but fewer have made substantial per capita investments—Connecticut, Georgia, Illinois, Kentucky, Massachusetts, Ohio, and Oklahoma (Education Week, 2002; Ripple et al., 1999; Schulman, Blank, & Ewen, 1999).[1] Nationwide, approximately 14% of 4-year-olds are enrolled in school-based general education prekindergarten programs (Smith, Kleiner, Parsad, Farris, & Green, 2003).

Prekindergarten is usually (but not always) a part-day educational program located within public schools. Typically, some additional services are offered, including meals and transportation, but few programs provide a full array of comprehensive services such as health screenings (Ripple et al., 1999; Schulman et al., 1999). States also directly fund, and school districts may subcontract with, other programs to provide early education. Data on the exact number of children served in local schools are not readily available, but a summary provided by Schulman and colleagues (1999) suggests that the majority of state-funded prekindergarten programs are located in elementary schools, even if state regulations allow multiple agencies to provide services.[2] School-based programs seem to be particularly prevalent in states with substantial investments in prekindergarten. For example, 90% of Illinois children attending prekindergarten are in school-based programs, along with 81% in Ohio and 44% in Georgia. A recent nationally representative study of public elementary schools conducted by NCES (Smith et al., 2003) revealed that 35% of public schools have prekindergarten programs located on their campus.

Nearly all state and local prekindergarten initiatives target children deemed in need of early education owing to their families' economic disadvantage, or other recognized risk factors such as limited English proficiency (Ripple et al., 1999; Schulman et al., 1999). Consequently, public schools with a high proportion of students from ethnic and racial minority groups and children eligible for free or reduced-price lunches, as well as those in large cities, are more likely to have prekindergarten programs than other schools (Smith et al., 2003). However, being eligible does not guarantee access to these programs, with most states serving less than half of their target population (Gilliam & Zigler, 2001). In Georgia, which provides universal prekindergarten to all children wishing to enroll, only 52% of 4-year-olds were in prekindergarten during 2000–2001 (State of Georgia, Office of Educational Accountability, 2003).

One way to judge the quality of an early childhood program is by measuring structural components associated with higher quality caregiving. Child-staff ratios, class sizes, and caregiver education are important determinants of quality of care (National Institute of Child Health and Human Development [NICHD] Early Child Care Research Network, 2002a; Phillips, Mekos, Scarr, McCartney, & Abbott-Shim, 2001). Data on these indicators suggest that prekindergarten appears to provide relatively high-quality care (Ripple et al., 1999). Most state prekindergarten initiatives set guidelines for class size and child-to-caregiver ratios that meet or exceed recommendations of the National Association for the Education of Young Children (NAEYC, a leading group of experts in the field). An NCES study (Smith et al., 2003) of prekindergarten programs in public schools showed that the average size of general education prekindergarten classes was well within NAEYC guidelines. In addition, the study revealed that 86% of school-based prekindergarten teachers had a 4-year college degree, more than twice the rate of college degrees among center-based care program workers. Prekindergarten

teachers' pay was also more likely to be commensurate with that of elementary school teachers (82% received public school teacher salaries) and considerably higher than that of other child care workers (Blau, 2001).

Head Start

Head Start is a federally funded early education program for children from low-income households and children with developmental delays or disabilities. In operation since 1965, Head Start serves primarily 3- and 4-year-old children (although a small Early Head Start program began serving children under age 3 in 1995). In 2002, federal funding of close to $6.3 billion was provided to local community-based Head Start grantees. By the late 1990s, 16 states were providing supplementary funding to Head Start programs (Schulman et al., 1999). In 2001, about 12% of children nationwide were enrolled in Head Start, representing slightly more than half of those eligible (Currie & Neidell, 2003). The vast majority of Head Start programs operate part-time and part-year, but efforts are being made, in coordination with other community services, to provide wrap-around (full-day) care to meet the needs of working parents.

Head Start is unique in its focus on health and nutrition programming, social services, and parent involvement along with educational programming (Ripple et al., 1999). Such a comprehensive approach to service delivery may be key to promoting school readiness across multiple developmental domains for these children (Ripple et al., 1999; Takanishi & DeLeon, 1994; Zigler & Styfco, 1994). Funding of Head Start programs is contingent on meeting set federal performance guidelines. Each center undergoes an on-site review at least once every 3 years based on 24 program performance measures related to the multiple program components. Although about 85% of reviewed centers met the standards of adequate care in 2000 (Head Start Bureau, 2002), experts worry that low pay and low levels of provider education constrain program quality (Ripple et al., 1999; Zigler & Styfco, 1994).

Preschools, Nursery Schools, and Day Care Centers

The primary purpose of traditional preschools and nursery schools is to provide early education experiences to 3- and 4-year-olds. These programs are often part-day and part-week, although with increasing numbers of parents working they are serving children for longer hours and providing wrap-around (full-day) care. Typically, these programs are privately funded for-profit or nonprofit enterprises, and children's participation is based on a fee (Hinkle, 2000). Center-based day care programs, in contrast to preschools, are typically available 9 to 10 hours a day, 5 days a week, and the facilities may serve children of all ages. Like preschools, these programs are usually privately funded for-profit or nonprofit programs, and participation is fee based (Hinkle, 2000).

The federal government does not directly fund preschools or day care centers, but it does subsidize child care costs (including preschool fees) for

families with low incomes. Public support of child care subsidies is intended to promote employment among families with low incomes (Adams & Rohacek, 2002). Federal funding is provided mainly through two block grants, the Child Care and Development Fund (CCDF) and Temporary Assistance for Needy Families (TANF). States are allowed to use CCDF monies to assist working families with incomes up to 85% of the state median income, although most set much lower eligibility thresholds. TANF funds are intended to assist families transitioning off welfare but can also be transferred to CCDF programs. In 2002, total federal and state CCDF funding amounted to $6.8 billion, more than half of which was spent on center-based child care (Child Care Bureau, 2003). However, as with other types of publicly funded early education and care, assistance falls far short of need. In 1998, fewer than 15% of eligible families received federal child care subsidies, and a third of states had waiting lists (Ewen, Blank, Hart, & Schulman, 2002).

The federal government does not regulate these programs, and state regulations vary widely in terms of both stringency and enforcement (Adams & Rohacek, 2002; Helburn & Bergmann, 2002). As noted, one way to measure quality is through structural features of programs such as child-to-staff ratios and teacher education. Quality ranges across settings, but overall indicators of structural features of center-based care suggest that quality is probably just "mediocre" (Helburn & Bergmann, 2002; Smolensky & Gootman, 2003). A second, arguably better method is direct assessment by trained observers who rate the quality of the learning environment and child-caregiver interactions. Using these observational measures, studies have shown that few center-based programs are of high quality and that quality is low for a substantial proportion (for recent reviews, see Blau, 2001; Helburn & Bergmann, 2002; Smolensky & Gootman, 2003). The Cost, Quality, and Child Outcomes Study, conducted in 1993, revealed that only 24% of centers serving preschool-aged children provided good or developmentally appropriate care, while 10% were rated as being of poor quality; positive child-caregiver interactions were observed in fewer than half (Helburn, 1995). Data from the NICHD Study of Early Child Care suggest similarly low rates of positive child-caregiver interactions in center-based care (NICHD Early Child Care Research Network, 2002a, 2002b).

Other Child Care Arrangements for Preschool-Aged Children

The early education and center-based programs described thus far are distinct from many types of informal child care that children may receive prior to school entry. These other settings include care provided by family child care providers, babysitters, or relatives. Informal child care is widely used for children under age 3, but it is still common for 3- and 4-year-olds as well. In the NICHD Study of Early Child Care, 45% of 4-year-olds were in some type of informal care for 10 or more hours a week, and care by grandparents was the most common (17% of children; NICHD Early Child Care Research Network, 2002b). Overall, young children from families in poverty are only slightly

more likely to be in informal care arrangements than children from more affluent families, but these children experience different types of informal care. Children from families with low incomes are more likely to be in a relative's care and less likely to be in the care of a nonrelative (e.g., babysitter or nanny) (34% vs. 24% for relative care; 6% vs. 13% for nonrelative care; Meyers et al., in press).

Informal child care may also be subsidized for low-income families, if they and the providers meet specified eligibility requirements set by states (Blank et al., 1999). As in the formal sector, state regulations and program quality vary widely (for reviews, see Blau, 2001; Helburn & Bergmann, 2002; Smolensky & Gootman, 2003). For example, a study of informal care (relative and family child care) conducted by researchers from the Families and Work Institute showed that only one in 10 providers was rated as providing good care, while about a third offered inadequate care (Galinsky, Howes, Kontos, & Shinn, 1994).

Prior Research on the Effectiveness of Early Education and Care

The extent to which center-based child care programs provide developmentally appropriate educational learning opportunities is difficult to determine. Prior studies typically have categorized different types of preschool and center-based care programs together. The large disparities in quality and design across programs make it difficult to tease out effects for specific types of programs and to generalize from one study to another.

Noting these limitations, what does prior research reveal about the effects of different types of preschool programs? Certainly, the benefits to children's academic outcomes from high-quality intensive early education interventions are well documented. Recent comprehensive reviews of experimental evaluations of high-quality early-childhood education programs provided to children from at-risk groups conclude that these programs improve children's short-term cognitive and language development and long-term academic achievement and reduce special education placement and grade retention (see Barnett, 1995; Brooks-Gunn, 2000; Farran, 2000; Karoly et al., 1998; Schweinhart, Barnes, & Weikart, 1993; Vandell & Wolfe, 2000; Waldfogel, 2002).

Consider the Carolina Abecedarian Project, which provided high-quality care for the first 5 years of children's lives. The program operated full-time and full-year, with exceptionally low child-to-staff ratios and a curriculum that emphasized children's language development. Follow-up studies showed that children in the Abecedarian program outperformed a comparison group of children on IQ tests at ages 8 and 15 (Campbell & Ramey, 1995; Ramey et al., 1999). These effects were substantial, nearly one third of a standard deviation. In addition, by age 21 those in the Abecedarian program were more likely to have gone on to college than those in the comparison group (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002).

Conversely, it is not clear whether more typical early education programs provide benefits to children, particularly children from disadvantaged

backgrounds. Lacking experiments, researchers have used naturally occurring variation in child care arrangements to assess the impacts on child outcomes. These nonexperimental studies have the well-known disadvantage of not being able to control for unobserved factors associated with differential selection into alternative modes of care. Moreover, analyses often include only a few controls for potential selection factors, raising the possibility that the resulting associations are spurious rather than causal (Blau, 2001).

Gilliam and Zigler's (2001) review of 13 evaluations of state preschool programs revealed consistent evidence of a modest positive effect of programs on children's school readiness at kindergarten entry, but not first grade. However, findings from any given review are only as good as the quality of the studies included, and methodological flaws in the state evaluations led Gilliam and Zigler (2001) to suggest that their results add more to an understanding of how the evaluations were conducted than of the effects of the programs.

An exceptionally good study is Reynolds's (1994) evaluation of a school-based publicly funded preschool and early school follow-on program for African American children from families with low incomes in Chicago. The part-day preschool program emphasized early language development and parent involvement and offered comprehensive services such as meals and health screenings. Accumulated evidence points to preschool participation as a factor contributing to the program's large, positive, and long-lasting effects on children's reading and math achievement and subsequent high school graduation (Reynolds, 1994; Reynolds, Temple, Robertson, & Mann, 2001). However, Reynolds (1994) argues that the key to the program's success is the combination of early education and several years of follow-on services.

Nevertheless, the bulk of the evidence suggests that attending center-based care, including preschools, during the third and fourth years of life promotes children's academic outcomes and cognitive development (Barnett, 1995; Meyers et al., in press; Smolensky & Gootman, 2003). Evidence from the NICHD Study of Early Child Care confirms that children who spent a greater proportion of time in center-based care arrangements over the first 5 years of life had higher language and memory skills, even after controlling for the amount and quality of nonmaternal care children experienced (NICHD Early Child Care Research Network, 2002b). More recently, the NICHD Study of Early Child Care demonstrated that center-based care during the third and fourth years of life is particularly beneficial for children's cognitive development and academic skills; furthermore, children with the lowest scores on a measure of cognitive ability gain the most from center-based care (NICHD Early Child Care Research Network, 2003). However, the studies just mentioned did not distinguish between different types of center-based care programs or provide separate estimates for children from disadvantaged backgrounds.

The Head Start program has been extensively studied with nonexperimental research designs. (An experimental evaluation is currently being conducted.) The research typically reveals small academic benefits from Head Start that fade out over time (Barnett, 1995; Lee, Brooks-Gunn, & Schnur, 1988;

Zigler & Styfco, 1994). However, selection bias is a major problem, and given the very disadvantaged nature of the Head Start population, finding an appropriate comparison sample is difficult. Studies that have addressed selection bias tend to show more positive and longer lasting academic benefits. For example, according to the sibling-based analyses of Currie and Thomas (1995) and Garces, Thomas, and Currie (2002), Head Start is associated with higher academic achievement several years after program completion.

Taken together, the prior research suggests that children enrolled in some form of preschool program perform better on academic tests upon school entry. However, questions about selection bias remain, and few studies include large samples of disadvantaged children or test for the differential effects of alternative types of early childhood education programs. These gaps in knowledge are important because studies of model intensive interventions may not generalize to the implementation of larger early education initiatives. In particular, prekindergarten programs, which currently serve a substantial and growing share of preschoolers, have not been analyzed in a rigorous manner.

Our analysis exploits a newly available data set that allows extensive controls for child, family, neighborhood, and school characteristics that may be correlated with preschool enrollment and school readiness. Using these data, we investigate three related questions. First, do children who experience center-based care (including prekindergarten programs and preschool) have higher levels of reading and math skills during kindergarten and first grade, and are they less likely to be retained in kindergarten? Second, are the effects particularly large for children from disadvantaged groups? Finally, are some types of center-based child care more beneficial than others?

Data and Procedure

Data for the present study were derived from the ECLS-K, which, as mentioned, consisted of a nationally representative cohort of children attending kindergarten in the fall of 1998. Designed and carried out by the U.S. Department of Education, the ECLS-K collected data over children's first 2 years of school. We use data from the fall and spring of kindergarten and 1 year later, for most children, the spring of first grade. The study includes assessments of children's academic skills; surveys of parents, teachers, and school administrators; and observational ratings of school environments by study supervisors.

During each wave, a parent survey collected extensive data on child and family background characteristics and neighborhood of residence. Trained interviewers conducted the parent interviews by telephone primarily with the child's mother. If the mother was unavailable to be interviewed, another adult living in the child's household who was knowledgeable about the child's schooling completed the interview. Close to 7% of parent interviews were conducted in a language other than English, most of these in Spanish.

The teacher and administrator surveys were conducted as self-administered surveys; they were distributed and collected by study field supervisors.

In the fall and spring of kindergarten, teachers filled out questionnaires to provide information specific to each child in the study and all students in the classroom, as well as their own attitudes, education, and classroom practices. In the spring of kindergarten, school administrators, principals, or headmasters provided information about the school, student body, and school policies and practices, as well as their own background and training.

The sample analyzed consists of approximately 12,800 children who completed all three assessments and for whom we have parent-reported information about child care experiences in the year before kindergarten. Characteristics are provided in Table 1 for the full sample and separately for children in different types of child care.

Table 1

Selected Sample Characteristics, Mean Academic Skill Scores, and Rates of Grade Retention, Full Sample and by Child Care Arrangements in the Year Before Kindergarten

Child and family characteristics	Full sample (n = 12,804)	Parental care (n = 2,124)	Center-based care (n = 7,760)	Head Start (n = 1,395)	Other non-parental care (n = 1,525)
Math skills (mean)					
Fall kindergarten	51.71	49.55	53.78	45.64	49.73
Spring kindergarten	51.74	50.23	53.55	45.89	50.08
Spring first grade	51.40	50.18	52.93	46.02	50.22
Reading skills (mean)					
Fall kindergarten	51.02	48.74	53.18	45.07	48.62
Spring kindergarten	51.74	49.64	52.95	46.03	49.81
Spring first grade	51.40	50.13	52.91	46.27	50.25
Grade retention (%)	8	10	6	9	10
Black (%)	15	11	12	41	13
Hispanic (%)	12	16	10	15	15
Asian (%)	4	5	4	3	5
Male (%)	51	53	51	48	50
Child age, fall kindergarten (mean)	5.72	5.72	5.71	5.71	5.70
Family income-to-needs ratio (mean)	3.28	2.41	3.93	1.26	2.87
Single-parent household (%)	19	14	17	37	25
Percentage of sample	100	17	61	11	12

Note. Data are for children in the ECLS-K study. Math and reading skills are standardized scores (M = 50, SD = 10). Child care categories are mutually exclusive but sum to more than 100% owing to rounding errors (see text for details). See Table A2 for definitions of sample characteristics.

Measures

Early Childhood Care and Education

During the fall of kindergarten, parents answered survey questions about their child's child care and educational experiences. They were asked whether their child had ever been involved in any of the following: center-based child care, relative care, nonrelative care, and Head Start. For children in these arrangements, parents indicated the age at which the child had first entered this type of care and whether the child participated in this type of care in the year before kindergarten. For child care during the year before kindergarten, parents answered additional detailed questions, such as the number of hours children were in care during a typical week.

From these responses, we created three dummy variables indicating whether the child participated in center-based child care, Head Start, or other nonparental child care in the year before kindergarten. Other nonparental care includes, for example, relative care (in or out of the child's home) and care provided by nonrelative babysitters. Of the children in nonparental care, more than two thirds were in only one type of care arrangement in the year prior to kindergarten (56% of the full sample), whereas less than a third were in two types of nonparental care (26% of the full sample) and about 1% were in all three types of nonparental care (less than 1% of the full sample).

For ease of interpretation and to more clearly isolate the effects of experiences in specific types of center-based care, we constructed mutually exclusive variables. A child who experienced both center-based and other nonparental care was placed in the center-based care category (35% of children in center care also experienced other nonparental care). Similarly, a child who had experienced both Head Start and other nonparental care was coded as having attended Head Start (41% of children in Head Start also experienced other nonparental care). Finally, children in both Head Start and center-based child care were categorized according to the type of care in which they spent the greatest number of hours per week (17% of Head Start children also experienced center-based care).[3]

The distribution of our sample across these child care and early education categories is presented in Table 1. The vast majority of children (83%) received some nonparental care in the year prior to kindergarten. Center-based child care was the most common (61%), with similar proportions of children in Head Start and other nonparental care arrangements (about 11% each).

In analyses, we further distinguish among three types of center-based care. Parents reporting that their children had been in center-based care in the year before kindergarten identified whether the program was primarily a preschool, nursery school, prekindergarten, or day care program (response categories were mutually exclusive). Because only 2.5% of parents reported that their child attended a nursery school program, this category was combined with the preschool category (9.8%). The percentages of children in each type of program are documented in the Appendix (Table A1).

The participation rate in prekindergarten programs (17%) closely matches recent estimates of the percentage of 4-year-old children in prekindergarten programs in public schools (14%) provided by Smith et al. (2003), suggesting that parents correctly reported their children's participation in this type of program. However, parents were not given guidelines in the interview about how they should distinguish between these types of programs. Consequently, we do not know how parents defined the preschool, nursery school, or day care categories or whether parents' definitions were consistent. This uncertainty raises the possibility of measurement error, which would likely attenuate associations between these types of center-based care and children's outcomes.

Reading and Math Skills

During the fall and spring of kindergarten and the spring of first grade, children's math and reading skills were assessed during one-on-one testing sessions. A brief language screener was given to 8% of children who were identified by teachers or school records as having a non-English language background. About 42% of children who completed the screener (3% of the overall sample) scored below the cut point and received a reduced version of the assessments. The sample analyzed is limited to children who passed the screener and completed both the reading and math assessments.

The skills tests were conducted in a two-step process. Children were first given a common set of questions as a routing section with 12–20 items covering a broad range of difficulty. The second set of questions differed in regard to difficulty (high, medium, low), with children administered these sections based on their performance on the first set of questions. This measurement approach maximizes measurement accuracy and minimizes the length of the assessments. Scores were computed only for children who answered at least 10 questions in both sections of the test.

Because children did not answer the same questions, the resulting score was calculated through the use of item response theory, in which patterns of right, wrong, and missing answers as well as the difficulty of questions are used to place each child on a continuous ability scale. The resulting latent score is an estimate of the number of questions that the child would have correctly answered had he or she taken all available items.

The math and reading skill measures used as outcomes are transformations of the latent ability scores into standardized *t* scores with a mean of 50 and a standard deviation of 10 (based on the full sample distribution). Consequently, the scores indicate children's ability relative to their peers, and dividing regression coefficients by 10 creates estimates of program effect sizes. Average math and reading *t* scores at each assessment are reported in Table 1.

The assessments were created specifically for the ECLS-K study by a team of experts, and some items were adapted from existing instruments such as the Peabody Individual Achievement Tests–Revised and the Woodcock-Johnson

Psycho-Educational Battery–Revised. The assessments included both multiple-choice and open-ended questions, and practice items were given for each type of question format. Children were instructed to answer questions verbally or by pointing. Interviewer assessment materials included an easel with small pictures, letters, words, short sentences, numbers, and number problems. Test reliabilities, calculated on the basis of the variance of repeated estimates for the latent scores, were quite high for both the math and reading assessments (between .92 and .95 for all assessments).

The reading test contained 72 questions that assessed knowledge of letters and word recognition, beginning and ending sounds, vocabulary, and passage comprehension. The reading assessments covered five proficiency levels: (a) identifying uppercase and lowercase letters by name, (b) associating letters with sounds at the beginning of words, (c) associating letters with sounds at the end of words, (d) recognizing common words by sight, and (e) reading words in context.

The math test consisted of 64 items that evaluated children's understanding of numbers, geometry, and spatial relations. Similar to the reading assessment, the math assessment covered five levels of proficiency: (a) identifying one-digit numerals, counting up to 10 objects, and recognizing geometric shapes; (b) reading all one-digit numerals, counting beyond 10, recognizing a sequence of patterns, and using nonstandard units of length to compare objects; (c) reading two-digit numerals, recognizing the next number in a sequence, identifying ordinal positions of objects, and solving a simple word problem; (d) solving simple addition and subtraction problems; and (e) solving simple multiplication and division problems and recognizing more complex number patterns.

Grade Retention

Data collected in the fall of 1998 indicated whether the child was in kindergarten for the first time or was repeating kindergarten. In the spring of 2000, data were collected on the child's grade placement. If either source of information indicated that the child had repeated kindergarten rather than progressing directly into first grade, the child was coded as having been retained. Overall, about 7.5% of children were retained in kindergarten: 4% repeated kindergarten in the fall of 1998, and 3% repeated kindergarten in the fall of 1999.

Covariates

Covariates include data from parent, teacher, and administrator surveys as well as a facility checklist completed by the study's field supervisors. These variables are described subsequently, and they are outlined in detail in the Appendix (Table A2). Because values of covariates were sometimes missing, a set of missing data dummy variables was constructed (1 = missing, 0 = not missing), and the missing values were replaced with a value of zero. This procedure allowed children to be included in analyses despite missing values.

Rates of missing data were less than 1% for the demographic, family, and home environment characteristics measured in the fall of kindergarten and approximately 3% for those measured in the spring of kindergarten. Rates of missing data were higher for school and classroom characteristics but generally below 17%. An exception was the percentage of children eligible for free lunch, wherein data were missing for 39% of the sample, which may reduce our ability to adequately measure differences between schools (Phillips & Chin, in press).

Method

We use ordinary least squares (OLS) regressions to estimate the association between children's experiences in different types of child care in the year prior to kindergarten and their math or reading skills as well as grade retention.[4] The basic equation for these analyses is as follows: Child Outcome$_i$ = β_1 + $\beta_2 CC_i + \beta_3 HS_i + \beta_4 OC_i + \beta_5 COV_i + \xi_i$. Child Outcome$_i$ is a measure of academic skills or grade retention for child *i; CC$_i$* is a dummy variable for attending center-based care the prior year; *HS$_i$* is a dummy variable for attending Head Start in the prior year; *OC$_i$* is a dummy variable for receiving other nonparental care in the prior year; and *COV$_i$* is the set of covariates including measures for child, family, and school characteristics described subsequently. Because schools were the primary sampling unit in the survey, in all analyses we correct standard errors for nonindependence of observations within schools.

In OLS estimation, omission of measures of child, family, school, or neighborhood characteristics that determine children's academic skills and are associated with children's care arrangements leads to biased estimates of β_2, β_3, and β_4 (Duncan & Gibson, 2000). What factors are associated with center-based child care and subsequent academic achievement? As Table 1 demonstrates, children who were in center-based care prior to kindergarten are generally more advantaged than those who were not. Some aspects of advantage may be easy to measure, such as parental education or family income. However, other aspects may be more difficult to observe. For example, children participating in enriching center-based care programs may also benefit from other educational opportunities, or they may live in neighborhoods with high-quality schools. Our strategy for dealing with differences in children's advantage is to present results from OLS regressions with increasingly rich levels of controls for characteristics of families and children that measure potential "selection" factors.

The first model includes only the early child care and education variables, without any other covariates. Thus, the coefficients represent the mean differences between children who experienced the particular type of child care (in the year before kindergarten) and those cared for only by their parents. The second model controls for child and family characteristics, including household income-to-needs ratio (parental report of household income relative to the federal poverty line), parents' and grandparents' educational

attainment, region of the country, family structure and size, and home language, as well as child's race and ethnicity, age, gender, birth weight, height, and weight.

The third model adds a vast set of measures of the child's home learning environment and family background created from parental survey data collected in the fall and spring of kindergarten. The home learning environment is proxied by covariates controlling for the extent to which parents engage their children in activities such as reading books and singing songs, children's participation in structured activities outside of the home such as music or athletic lessons, having a home computer, TV watching, number of books in the home, and how often children read or look at picture books. Indicators of the parents' expectations of the child's educational attainment and attitudes about the importance of particular skills before entering school (e.g., counting) are included as well, as are controls for family members' involvement in the child's schooling. We also incorporate variables created from parents' responses to questions about the warmth and affection of their relationship with their child, physical discipline, and parents' depressive symptoms. Finally, several variables measuring the regularity of the family routine were constructed from parents' responses to questions about how often the family eats meals together and at regular times.

The fourth model holds constant the quality of the child's neighborhood and school environment. Measured in the spring of kindergarten, the former is a composite derived from parental reports on prevalence of crime, abandoned buildings, drugs, and safe places for children to play in the family's neighborhood of residence. The composite has high internal consistency (Cronbach $\alpha = .86$).

School characteristics were derived from administrator survey data collected in the spring of kindergarten. Included are covariates indicating whether the school received federal Title I funding (targeted to low-income communities), the proportion of students who are non-Hispanic White, teacher salaries, school safety policies, and perceived problems such as teacher turnover and overcrowding. Finally, composite measures of field supervisor ratings of the school climate and environment (in the spring of kindergarten) and administrator reports of school neighborhood quality are included. The school climate composite consists of items about the orderliness of the classes and hallways, helpfulness of staff, and decor of hallways, whereas school environment items pertain to safety, graffiti, and litter and trash near the school. Both of these scales demonstrated high internal consistency (Cronbach αs = .81 and .96, respectively). Items included in the administrator reports of school neighborhood quality parallel the neighborhood questions asked of parents, and the composite has high internal consistency (Cronbach $\alpha = .81$).

Kindergarten classroom characteristics were derived from the teacher surveys conducted in the fall and spring. Covariates included teachers' level of certification, education, gender, race, number of years teaching at the school, and attitudes toward teaching and students. Regressions also con-

trolled for the proportion of children in the classroom below grade level in reading, whether teachers considered classroom supplies and space to be adequate, and whether the kindergarten was full-day or part-day. The final set of covariates (entered in Model 5) controlled for children's care arrangements during the year in which academic skills were measured, using two mutually exclusive dummy variables that indicated center-based care or other nonparental care during the hours that the child was not in kindergarten or first grade.

Inclusion of a large number of family characteristics, particularly those related to children's home learning environments, is likely to minimize bias from omitted household attributes that may be driving the correlation between early education and children's academic achievement. However, we may be limited in our ability to construct an exhaustive set of controls. First, most measures of the home learning environment and family background were derived from parent surveys. Bias in parental reports might compromise our measurement of these constructs. Second, our measures of children's characteristics prior to entry into child care arrangements are less complete, and, to the extent that children's health, skills, or behavior influence the likelihood of placement into particular types of child care and educational programs, this selection may bias our analyses. The direction of this bias is unclear. It may be upward if children with higher skills or better health are more often placed in educationally oriented programs, or downward if children with lower skills or poorer health are more likely to be placed in such programs.

Family characteristics are largely measured after children have experienced early child care, raising the possibility that some covariates may be partly determined by the type of care chosen. Most of the covariates are unlikely to suffer from this problem. For example, parents are not likely to select their neighborhood of residence based on their child care needs. However, other explanatory variables, particularly those associated with the home learning environment, may be shaped by family experiences with child care and early education providers. For example, parents with children in center-based care may be instructed by staff to read frequently to their child or may be told about the availability of structured activities (e.g., art classes). Including these covariates in our estimation models might understate the effects of care experiences, and this possibility of underestimation deserves attention when interpreting the regression results.

We explore whether center-based care benefits children from disadvantaged families more than the general population by estimating regression models with the sample restricted to subgroups of interest. We also examine whether the effects of center-based arrangements vary according to type of care by separately measuring prekindergarten, preschool, and center-based day care. Finally, we briefly consider differences in the effects of part-time (less than or equal to 20 hours a week) and full-time (greater than 20 hours a week) arrangements.

Results

Effects on Reading and Math Skills

Tables 2 and 3 present results from full sample regressions estimating the effect of child care or education in the year prior to kindergarten on subsequent reading and math skills. In general, results indicate that children attending center-based care in the year before kindergarten perform better than those experiencing only parental care. Adding measures of family and child demographic characteristics to our estimation models (moving from Model 1 to Model 2 in Table 2) reduces the center-based care coefficients by roughly two thirds. Such a reduction occurs because children attending center-based care tend to come from more advantaged families. Once demographic measures are entered, however, including a rich host of other measures related to the child's home learning environment, participation in structured activities, parental educational expectations, and school involvement, as well as school and neighborhood environment (Models 3 and 4), the apparent benefits of center-based care are diminished only slightly.

For example, without control variables, participation in center-based care is associated with a 4.44 higher reading score relative to children who experienced only parental care (Table 2, Model 1). Adding measures of child and family demographic characteristics reduces the coefficient to 1.67 (Model 2), and introducing the additional covariates reduces the coefficient to 1.35 (Model 4). A 1.35 higher reading *t* score represents answering about one more question correctly but would move an average child ranked at the 50th percentile to the 54th percentile. Interestingly, controlling for children's current care arrangements slightly increases the estimated benefit of center-based care to 1.41 (Model 5). (We also estimated models controlling for age of entry into child care, and this specification did not change the results.)

Similarly, the results presented in Tables 2 and 3 indicate that participation in center-based child care prior to school entry is associated with higher levels of math skills. However, the association is somewhat smaller than for reading skills, which is not surprising given that math skills are typically less sensitive than reading skills to variations in family and care environments (Huttenlocher, Levine, & Vevea, 1998; Jordan, Huttenlocher, & Levine, 1992).

The coefficient for center-based care on math skills in the fall of kindergarten was 4.21 in the model without covariates (Table 2, Model 1). Adding family and child demographic characteristics reduces the estimated effect of center-based care on children's math skills to 1.67 (Model 2). Inclusion of covariates for the child's home learning environment, parental expectations, and school involvement, as well as the other family, neighborhood, and school characteristics, results in only small decreases in the predicted effect of center-based care (Models 3 and 4). Holding constant children's current care experiences once again slightly increases the estimated effect (Model 5).

Table 2

Summary of Coefficients From OLS Regressions of Children's Reading and Math Skills in the Fall of Kindergarten on Child Care Experiences in the Year Before Kindergarten (Standard Errors in Parentheses)

	Reading					Math				
Predictor	Model 1	Model 2: Adds demographics	Model 3: Adds home & family	Model 4: Adds neighborhood & school	Model 5: Adds current care	Model 1	Model 2: Adds demographics	Model 3: Adds home & family	Model 4: Adds neighborhood & school	Model 5: Adds current care
Center-based care	4.44**	1.67**	1.39**	1.35**	1.41**	4.21**	1.67**	1.37**	1.31**	1.40**
	(0.26)	(0.23)	(0.22)	(0.21)	(0.22)	(0.26)	(0.22)	(0.21)	(0.21)	(0.21)
Head Start	−3.69**	−0.65*	−0.67*	−0.47	−0.41	−3.95**	−0.37	−0.35	−0.16	0.07
	(0.35)	(0.31)	(0.30)	(0.30)	(0.30)	(0.37)	(0.32)	(0.31)	(0.31)	(0.31)
Other nonparental care	−0.11	−0.32	−0.12	−0.04	0.10	0.18	0.14	0.30	0.34	0.32
	(0.32)	(0.29)	(0.28)	(0.28)	(0.29)	(0.32)	(0.28)	(0.27)	(0.27)	(0.28)
Demographics		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Home & family environment			Yes	Yes	Yes			Yes	Yes	Yes
Neighborhood environment, school & class characteristics				Yes	Yes				Yes	Yes
Current care arrangements					Yes					Yes
R^2	.08	.30	.37	.38	.38	.08	.32	.37	.38	.40

Note. Models have robust standard errors clustered at the school level. Sample size for all regressions is 12,804. The omitted child care category is parental care (no nonparental care). Consequently, coefficients represent the average difference between children in a particular type of care and children who experienced only parental care in the year before kindergarten. A "yes" in a column indicates that the regression includes controls for the set of covariates listed in the row in which the "yes" appears. Additional details about covariates are presented in Table A2.

*$p < .05$; **$p < .01$.

Table 3

Summary of Coefficients From OLS Regressions of Children's Reading and Math Skills in the Spring of Kindergarten and First Grade on Child Care Experiences in the Year Before Kindergarten (Standard Errors in Parentheses)

	Kindergarten spring				First grade spring			
	Reading		Math		Reading		Math	
Predictor	Model 1	Model 4	Model 1	Model 4	Model 1	Model 4	Model 1	Model 4
Center-based care	3.31**	0.76**	3.32**	0.79**	2.77**	0.59**	2.67**	0.56**
	(0.25)	(0.21)	(0.25)	(0.21)	(0.24)	(0.21)	(0.23)	(0.20)
Head Start	−3.63**	−0.50	−4.34**	−0.68*	−3.89**	−0.60	−4.07**	−0.40
	(0.37)	(0.33)	(0.36)	(0.31)	(0.37)	(0.34)	(0.35)	(0.31)
Other nonparental care	0.19	0.28	−0.11	0.05	0.14	0.18	0.04	0.26
	(0.33)	(0.28)	(0.31)	(0.27)	(0.31)	(0.28)	(0.30)	(0.27)
Covariates		Yes		Yes		Yes		Yes
R^2	.06	.34	.07	.34	.06	.28	.07	.34

Note. Models have robust standard errors clustered at the school level. Sample size is 12,800 for reading and math in kindergarten spring and math in first grade spring. Sample size is 12,804 for reading in first grade spring. Model 1 contains no covariates. Model 4 contains covariates for demographics, home and family environment, and neighborhood, school, and class characteristics. Model 4 corresponds to Model 4 in Table 2. A "yes" in a column indicates that the regression includes controls for the set of covariates listed in the row in which the "yes" appears. See notes for Table 2.
*$p < .05$; **$p < .01$.

A comparison of the results in Tables 2 and 3 suggests that the association between center-based care in the year before kindergarten and reading or math achievement declines over time. To illustrate, the predicted benefit of center-based care for reading skills in the fall of kindergarten is 1.35 (Table 2, Model 4), as compared with 0.76 in the spring of kindergarten and 0.59 in the spring of first grade (Table 3, Model 4). The decline in the effects on math was of a similar magnitude. By spring of first grade, effects are reduced by close to 60%. Nevertheless, the effect remains statistically significant and indicates close to one additional question answered correctly.

The models without covariates suggest a negative association between Head Start participation and children's reading or math scores (Tables 2 and 3). For example, Head Start participation was associated with a 3.69 lower *t* score in reading and math during the fall of kindergarten (Table 2, Model 1). Introducing demographic controls reduces these negative coefficients substantially (Model 2), and adding measures of school and neighborhood characteristics further decreases them, such that the Head Start coefficients are statistically insignificant in Model 4.

Our models control for few child characteristics, raising the possibility that we may not be correcting adequately for potential selection effects. For example, children's developmental status (e.g., presence of delays or disabilities) might be associated with placement into particular arrangements. Presence of specific developmental disabilities was measured at kindergarten entry. However, it is difficult to know whether an association between child care arrangements and identification of disabilities reflects a selection process or whether children who attend early education programs are more likely to be diagnosed (because staff have been trained to identify them). In the former case, we would want to control for these conditions; in the latter case, we might not.

To test the sensitivity of our results to the inclusion of children's disabilities as controls, we ran supplemental regressions that included parental reports of children's vision or hearing limitations, receipt of therapeutic services in the year before kindergarten, or professional evaluation for attention, learning, or communication problems. Adding these variables to our models slightly increased the estimated effects of center-based care on reading and math skills in kindergarten and first grade (typically by 0.06 to 0.10 of a point), suggesting that omitted child characteristics are unlikely to produce a substantial upward bias in the estimated effects of center-based child care.

Table 4 focuses on grade retention. The results suggest that retention rates are about 2 percentage points lower for children who attended center-based child care in the year prior to kindergarten (relative to children cared for by their parents). Because about 7.5% of children were retained in kindergarten, this size effect translates into a 27% reduction in grade retention. This association persists even after including a rich set of controls. Interestingly, Head Start is associated with lower grade retention rates as well, but only in the models that control for child and family demographic characteristics.

Table 4

Summary of Coefficients From OLS Regressions of Children's Grade Retention on Child Care Experiences in the Year Before Kindergarten (Standard Errors in Parentheses)

	Grade retention				
Predictor	Model 1	Model 2: Adds demographics	Model 3: Adds home & family	Model 4: Adds neighborhood & school	Model 5: Adds current care
Center-based care	−0.036** (0.007)	−0.022** (0.007)	−0.020** (0.007)	−0.023** (0.007)	−0.023** (0.007)
Head Start	−0.007 (0.011)	−0.024* (0.011)	−0.024* (0.011)	−0.022* (0.011)	−0.022* (0.011)
Other nonparental care	−0.001 (0.010)	0.008 (0.011)	0.008 (0.011)	0.010 (0.011)	0.010 (0.011)
Demographics		Yes	Yes	Yes	Yes
Home & family environment			Yes	Yes	Yes
Neighborhood environment, school & class characteristics				Yes	Yes
Current care arrangements					Yes
R^2	.00	.04	.06	.08	.08

Note. Sample size is 12,747. Models have robust standard errors clustered at the school level. A "yes" in a column indicates that the regression includes controls for the set of covariates listed in the row in which the "yes" appears. See notes for Table 2. Details regarding covariates are presented in Table A2.
*$p < .05$; **$p < .01$.

Thus, once models take into account that Head Start children have different family backgrounds than the general population, Head Start attendance appears to reduce rates of grade retention for these children.

Do Effects Differ by Subgroup?

Table 5 presents estimated effects of center-based care on children's reading and math skills for subgroups of children from disadvantaged backgrounds. These results are based on regressions with the full set of covariates (i.e., Model 4 of Table 2). Model 4, rather than Model 5, is our preferred

Table 5

Summary of Coefficients From OLS Regressions of Children's Reading and Math Skills in the Fall of Kindergarten on Child Care Experiences in the Year Before Kindergarten, Full Sample and by Subgroups (Standard Errors in Parentheses)

Predictor	Reading	Math
Full sample (n = 12,804)		
Center-based care	1.35 (0.21)**	1.31 (0.21)**
Head Start	−0.47 (0.30)	−0.15 (0.31)
Other nonparental care	−0.04 (0.28)	0.34 (0.28)
R^2	.38	.38
Children from families in poverty (n = 2,121)		
Center-based care	1.69 (0.51)**	2.08 (0.53)**
Head Start	−0.03 (0.53)	1.26 (0.55)*
Other nonparental care	0.29 (0.64)	0.80 (0.71)
R^2	.34	.36
Children of mothers with low education (n = 1,228)		
Center-based care	2.31 (0.67)**	2.01 (0.70)**
Head Start	0.93 (0.67)	0.54 (0.71)
Other nonparental care	0.73 (0.87)	0.94 (0.87)
R^2	.36	.39
Children of single parents (n = 2,311)		
Center-based care	2.10 (0.54)**	2.15 (0.61)**
Head Start	0.04 (0.59)	0.50 (0.67)
Other nonparental care	0.25 (0.68)	0.53 (0.69)
R^2	.39	.39
Children of mothers who speak non-English language (n = 2,205)		
Center-based care	1.82 (0.51)**	1.55 (0.49)**
Head Start	−0.27 (0.62)	−0.02 (0.61)
Other nonparental care	0.18 (0.63)	−0.03 (0.61)
R^2	.49	.46

Note. Models have robust standard errors clustered at the school level. Regressions include a full set of controls (Model 4, Table 2). See notes for Table 2 for additional details. Poverty is defined as having a family income below the federal poverty threshold. Low education is defined as not having a high school diploma or equivalent. Single parenthood is defined as having only one biological parent and no nonbiological parents in the household. Speaking a non-English language is defined as speaking a language other than English to the child sometimes, often, or very often. Prekindergarten, preschool, and center-based day care refer to the three main types of center-based care (see text for details).
*p < .05; **p < .01.

specification because the current care arrangements included in Model 5 could potentially have been affected by children's prior experience in child care. For comparison purposes, the first panel shows corresponding coefficients for the full sample.

Are the benefits of center-based care greater for children from disadvantaged groups? We examine this question by defining disadvantage in four ways: (a) living in poverty (household-income-to-needs ratio of less than one), (b) low maternal education (less than high school), (c) single-parent family, and (d) non-English language spoken by mother. The coefficients for center-based care are larger for all four groups of children from disadvantaged families than for the full sample (Table 5).[5] For example, center-based care increases the skills of children of mothers with low education by 2.31 points in reading and 2.01 points in math, corresponding to about one and a half additional questions answered correctly. These score improvements translate into increases from the 30th to the 37th percentile in the distribution of reading skills and from the 30th to the 35th percentile for math skills.

We also analyzed the effects of center-based care on reading and math scores in the spring of first grade (results not shown) and found that the effects among the disadvantaged subgroups generally continued to be larger than among the population as a whole. Resulting coefficients across three of the disadvantaged groups (children in poverty, children of mothers with low levels of education, and children of single parents) were of similar magnitudes, although with slightly differing levels of significance owing to differing sample sizes. For these groups, effects for reading range from 1.11 to 1.22, and effects for math range from 1.23 to 1.68. By the spring of first grade, effects for children of mothers who spoke a non-English language were not substantively different from effects for the full sample.

Do the Effects of Early Child Care and Education Differ by Type of Program?

Table 6 presents results for reading and math (in the fall of kindergarten) with center-based care decomposed into three types: prekindergarten programs, preschool, and center-based day care. Overall, 61% of children were in some type of center-based in the year before kindergarten. About 27% of these children (17% of the full sample) were in prekindergarten programs, 56% (34% of the full sample) were in preschool, and 16% (10% of the full sample) were in other center-based day care. Children participating in any of the three types of center-based care had higher reading and math skills than those cared for exclusively by parents, but the benefits were the largest for children attending prekindergarten programs. For example, prekindergarten was associated with a 1.66 gain in reading skills, preschool attendance was associated with a 1.32 increase, and other center-based day care was associated with a 0.80 gain.[6]

To determine whether the benefits of preschool and prekindergarten programs differ by family disadvantage, we estimated regressions of math and

Table 6

Summary of Coefficients From OLS Regressions of Children's Reading and Math Skills in the Fall of Kindergarten on Child Care Experiences in the Year Before Kindergarten by Type of Center-Based Program, Full Sample and by Subgroups (Standard Errors in Parentheses)

Predictor	Reading	Math
Full sample (n = 12,804)		
Prekindergarten	1.66 (0.27)**	1.59 (0.26)**
Preschool	1.32 (0.23)**	1.22 (0.23)**
Center-based day care	0.80 (0.31)**	1.05 (0.29)**
R^2	.38	.38
Children of families in poverty (n = 2,125)		
Prekindergarten	2.26 (0.71)**	2.59 (0.67)**
Preschool	1.40 (0.61)*	1.88 (0.65)**
Center-based day care	1.41 (0.71)*	2.07 (0.75)**
R^2	.34	.36
Children of mothers with low education (n = 1,228)		
Prekindergarten	3.57 (0.91)**	2.73 (0.92)**
Preschool	1.21 (0.82)	1.19 (0.85)
Center-based day care	2.38 (1.11)*	2.61 (1.15)*
R^2	.36	.39
Children of single parents (n = 2,315)		
Prekindergarten	3.12 (0.65)**	2.83 (0.70)**
Preschool	2.13 (0.62)**	1.96 (0.66)**
Center-based day care	0.97 (0.66)	2.04 (0.69)**
R^2	.39	.39
Children of mothers who speak non-English language (n = 2,205)		
Prekindergarten	2.72 (0.68)**	2.52 (0.64)**
Preschool	1.54 (0.54)**	1.29 (0.53)*
Center-based day care	1.25 (0.88)	1.05 (0.77)
R^2	.49	.46

Note. Models have robust standard errors clustered at the school level. Regressions include a full set of controls (Model 4, Table 2). See notes for Tables 2 and 5 for additional details. Head Start and other nonparental care were included in regression models as predictors, but results are not presented.
*p < .05; **p < .01.

reading skills in the fall of kindergarten on children's preschool experiences for the subgroups (Table 6). As expected, enrollment in prekindergarten or preschool programs provided considerably, although not always significantly, larger benefits for children from disadvantaged families than for other children.[7] For example, the coefficients for prekindergarten attendance on reading skills are 3.57 among children of mothers who have not completed high

Table 7

Summary of Coefficients From OLS Regressions of Children's Grade Retention on Child Care Experiences in the Year Before Kindergarten by Type of Center-Based Child Care, Full Sample and by Subgroups (Standard Errors in Parentheses)

Predictor	Grade retention
Full sample (n = 12,804)	
Prekindergarten	–0.023 (0.009)*
Preschool	–0.029 (0.008)**
Center-based day care	–0.019 (0.010)
Head Start	–0.023 (0.011)*
Other nonparental care	0.008 (0.011)
Children of families in poverty (n = 2,125)	
Prekindergarten	–0.018 (0.027)
Preschool	–0.008 (0.025)
Center-based day care	–0.020 (0.028)
Head Start	–0.022 (0.022)
Other nonparental care	0.039 (0.032)
Children of mothers with low education (n = 1,212)	
Prekindergarten	–0.013 (0.034)
Preschool	–0.006 (0.033)
Center-based day care	–0.061 (0.047)
Head Start	–0.012 (0.028)
Other nonparental care	0.046 (0.041)
Children of single parents (n = 2,299)	
Prekindergarten	–0.021 (0.026)
Preschool	–0.008 (0.024)
Center-based day care	–0.034 (0.024)
Head Start	–0.013 (0.024)
Other nonparental care	0.007 (0.026)
Children of mothers who speak non-English language (n = 2,197)	
Prekindergarten	–0.003 (0.022)
Preschool	–0.017 (0.019)
Center-based day care	–0.035 (0.026)
Head Start	–0.035 (0.020)
Other nonparental care	0.020 (0.024)

Note. Models have robust standard errors clustered at the school level. R^2 values are as follows: .08 for full sample, .18 for children in poverty, .26 for children of mothers with low education, .19 for children of single parents, and .20 for children of non-English-speaking mothers. Regressions include a full set of controls (Model 4, Table 2). See notes for Tables 2 and 5.
*p < .05; **p < .01.

school and 3.12 for those with single parents. Effects of this size for children of a less educated mother represent about two and a half additional questions correct and would raise their average score from the 30th to the 42nd percentile. The predicted effects of preschool programs on reading skills are generally smaller than for prekindergarten programs, but are typically larger than for center-based day care.

The differential effects of preschool, prekindergarten, and center-based day care on children's math skills are less clear, although all of the programs benefit children from disadvantaged families more than other children. Nevertheless, for children in three of the subgroups (living in poverty, living with single parents, and living with mothers who speak a non-English language), enrollment in prekindergarten has more of an effect on math skills than either preschool or center-based day care. In the case of children of single parents, the prekindergarten coefficient is 2.83, as compared with 1.96 for preschool and 2.04 for center-based day care. On average, children of single mothers score at the 42nd percentile in the math distribution; attending a prekindergarten program would improve their rank to the 50th percentile.

We also consider whether different types of center-based care programs have different effects on grade retention. The results, shown in Table 7, suggest that prekindergarten and preschool are associated with lower retention rates (as is Head Start). The effects are similar in magnitude, with coefficients ranging from −.023 for prekindergarten and Head Start to −.029 for preschool. In contrast to the results for test scores, the estimated effects of center-based care on retention are no larger for children from disadvantaged families than for other children.

Finally, we examined whether number of hours in care mattered. We found that even part-time (20 or fewer hours per week) enrollment in prekindergarten, day care, or preschool was associated with higher reading and math scores in the fall of kindergarten (Table 8, p. 142). Attending prekindergarten more than 20 hours per week was associated with better reading and math outcomes than doing so for 20 or fewer hours. However, a similar pattern was not obtained for center-based day care or preschool participation.

Discussion and Conclusions

Do children who attend preschool prior to school entry have better reading and math skills in kindergarten and first grade, and do these effects hold up after controlling for child, family, neighborhood, and school characteristics that might be associated with preschool attendance and with reading and math achievement? After accounting for a very extensive set of potential selection factors, we find that the answer is yes. Children in center-based preschool programs in the year prior to school entry have better reading and math skills, and this advantage persists to the spring of first grade. These children were also less likely to repeat kindergarten.

Table 8

Summary of Coefficients From OLS Regressions of Children's Reading and Math Skills in Fall of Kindergarten on Children's Weekly Hours in Child Care in the Year Before Kindergarten (Standard Errors in Parentheses)

Predictor	Reading	Math
Prekindergarten 1–20 hours per week	1.30 (0.32)**	1.25 (0.31)**
Prekindergarten > 20 hours per week	2.10 (0.35)**	1.88 (0.32)**
Preschool 1–20 hours per week	1.39 (0.24)**	1.24 (0.24)**
Preschool > 20 hours per week	1.10 (0.32)**	0.93 (0.32)**
Center-based day care 1–20 hours per week	1.19 (0.52)*	0.64 (0.46)
Center-based day care > 20 hours per week	0.71 (0.33)*	1.12 (0.32)**
Head Start 1–20 hours per week	−0.89 (0.36)*	−0.23 (0.37)
Head Start > 20 hours per week	−0.06 (0.40)	−0.18 (0.41)
Other nonparental care 1–20 hours per week	−0.51 (0.43)	−0.10 (0.40)
Other nonparental care > 20 hours per week	0.12 (0.30)	0.39 (0.30)

Note. Models have robust standard errors clustered at the school level. The R^2 value for both regressions is .38. Sample size for regressions is 12,804. Regressions include a full set of controls (Model 4, Table 2). See notes for Table 2.
*$p < .05$; **$p < .01$.

The effect magnitudes are generally modest, with effect sizes of approximately .15. Given that the most successful early childhood interventions (e.g., Abecedarian, which provided several years of intensive and high-quality early childhood education to very disadvantaged children) raise test scores by approximately 0.3–0.5 standard deviations, a 0.15-standard-deviation gain from attending some form of center-based care prior to kindergarten is not surprising. Typically, children in our sample were in these programs for fewer years and fewer hours (on average 21 hours per week) than children in the model intervention programs, and presumably they also received fewer ancillary services.

Larger effects were obtained for children from disadvantaged backgrounds, who are most often the target of federal and state policies to promote early education; effect sizes are on the order of .20 for reading skills. We also find evidence of larger gains in academic skills for prekindergarten and preschool attendance than for center-based day care, particularly among children from disadvantaged backgrounds, where the effect sizes associated with prekindergarten and preschool were approximately .30. Because these estimates do not account for program quality, even larger gains may result from uniformly high-quality educationally oriented programs. As noted earlier, it is also possible that some factors we controlled for are influenced by a child's enrollment in center-based care and are associated with better reading and math scores. If so, we might be underestimating the effects of center-based care.

Why might children from disadvantaged backgrounds benefit the most from participating in early education programs? First, they may be less likely to experience environments that facilitate early learning (Bradley, Corwyn, McAdoo, & Garcia Coll, 2001). For example, they may have fewer books at home, spend less time reading with their parents, and have less stimulating verbal interactions with their parents than children from middle-class households (Linver, Brooks-Gunn, & Kohen, 2002). Attending a preschool program that provides a cognitively stimulating environment and opportunities for interactions with a responsive caregiver may compensate for a less stimulating home environment (Bradley, Burchinal, & Casey, 2001; Caughy, DiPietro, & Strobino, 1994; Hubbs-Tait et al., 2002).

Alternatively, children from families who are disadvantaged may be placed in high-quality care more often. Research shows that the distribution of quality of child care across household income is U-shaped, such that children from low-income and high-income households are the most likely to experience better quality care (Phillips, Voran, Kisker, Howes, & Whitebrook, 1994). Governmental subsidies and provision of free or low-cost care to families who are economically disadvantaged may increase their ability to secure high-quality care relative to families with slightly higher incomes who do not qualify for the subsidies. Unfortunately, absence of data on program quality hampers our ability to determine the extent to which quality of care explains the larger benefits of preschool participation observed for children from disadvantaged families.

We focus on academic outcomes, but school readiness and subsequent school success are determined by more than academic skills (Shonkoff & Phillips, 2000). Children's motivation, orientation to learning, and behavior contribute to their later school success (Alexander, Entwisle, & Dauber, 1993; Reynolds, 1989). Likewise, parents' involvement in their children's schooling also promotes children's achievement (Izzo, Weissberg, Kasprow, & Fendrich, 1999; Meidel & Reynolds, 2003). With children's academic trajectories established in the early school years and demonstrating consistency over time (Entwisle & Alexander, 1993; Kowaleski-Jones & Duncan, 1999), programs that improve young children's behavior and orientation to learning or increase parent involvement may have long-lasting effects on children's school outcomes (Ripple et al., 1999). Consequently, further research should examine the effects of preschool education on these and other aspects of school readiness (e.g., mental and physical health). For example, the Head Start program, which we found to have limited effects on math and reading skills, may be important for other domains, such as child health or behavior (Zigler, 1998; Zigler & Styfco, 1994), parenting (Magnuson & Waldfogel, in press), or parent involvement in children's schooling (Ripple et al., 1999).

Future research should also examine the extent to which the effects of preschool are maintained or attenuated over time, and the factors within schools that are associated with persisting gains. Some have argued, for example, that one reason programs such as Head Start have had limited long-term

effects on school achievement is that participants subsequently attend poor-quality schools (Currie & Thomas, 2000; Takanishi & DeLeon, 1994). There is also evidence that the gains from early education may be maintained longer when child and family follow-on programs are provided during the early school years (Reynolds, 1994; Reynolds et al., 2001).

These limitations notwithstanding, our results do have implications for policymakers struggling with tough decisions on how much to invest in early child care and education and what types of programs to support. The present findings suggest that policies promoting center-based care for children in the year prior to kindergarten yield benefits, particularly for children from disadvantaged families. These policies are especially important given the relatively low enrollment rates of these children.

Another implication is that prekindergarten may be particularly beneficial for children's academic skills. Such programs were in place in 39 states in 2000, but with widely varying rates of coverage (Education Week, 2002). Why might prekindergarten yield larger benefits than other types of center-based care? One possible reason is that such programs are often incorporated into public school systems and so are typically governed by the guidelines and standards of public elementary schools. This appears to result in higher quality care, at least along structural dimensions measured by the educational attainment of the caregiver and compensation of the program staff (Ripple et al., 1999; Smith et al., 2003). Finally, in that they are school based, prekindergarten programs may offer a more academically oriented curriculum than other preschool programs.

Key to policymakers' decisions is an accounting of whether the programs represent a worthwhile investment of limited public funds. Cost-benefit analysis provides a means to answer such a question. Although a complete cost-benefit analysis is beyond the scope of this article, there is reason to believe that targeted investments in prekindergarten programs may be cost-effective. Placing a child into a school-day prekindergarten program during the 9-month academic year costs approximately $8,800 (National Institute for Early Education Research, 2002). If the gains observed at kindergarten and first grade persist, prekindergarten enrollment might raise reading and math skills of children from disadvantaged backgrounds by 0.1 of a standard deviation. A gain of this magnitude is estimated to translate into a lifetime earnings increase of approximately $7,600.[8] It would also result in reductions in expenditures associated with grade retention and possible benefits in other areas (e.g., increases in school completion, reductions in teen pregnancy and criminal justice involvement).

These estimates are, of course, speculative. We need to follow these children for longer periods of time and conduct more detailed analyses before we can draw firm conclusions about costs and benefits. Nevertheless, the estimates just outlined do illustrate the potential gains of expanding prekindergarten enrollment and point to the importance of further research in this area.

Notes

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[1]The number of states with state-funded programs varies depending on the criteria used to define a prekindergarten initiative. The Education Commission of the United States (2003) provides an up-to-date summary of state activities in early education.

[2]Authors' calculation of data provided in Schulman et al. (1999, Table 4, p. 52).

[3]We also estimated a set of models wherein the child care categories were not exclusive (e.g., a child could be coded as being in both center-based care and Head Start). The pattern of results was much the same as that reported here.

[4]For grade retention, we present findings from linear probability models, but similar analyses using a logistic regression model did not change the pattern of findings.

[5]We conducted separate regressions with interaction terms (type of care by each disadvantaged subgroup) to determine whether the effects of center-based care and Head Start among disadvantaged subgroups were statistically larger than effects for the full sample. Of the 16 estimated effects of center-based care programs presented in Table 5, 5 were statistically significantly larger for subgroups. In terms of reading skills, the estimated effect of center-based care was larger among children of single parents, and the estimated effect of Head Start was significantly larger among children of mothers with low education. In terms of math skills, the estimated effects of center-based care were significantly larger for both children living in poverty and children of single parents. The estimated effects of Head Start were significantly larger for children in poverty.

[6]This pattern changes over time. By the spring of first grade, the benefit from day care has faded (such that it is no longer significantly different from zero), and children who attended preschool appear to have benefited slightly more from their care experiences than children who attended prekindergarten. Nonetheless, it appears that both preschool and prekindergarten are associated with benefits that last through the spring of first grade, and the differences between their benefits by this stage are slight.

[7]We conducted separate regressions with interaction terms (type of care by each disadvantaged subgroup) to determine whether the effects of center-based care and Head Start among disadvantaged subgroups were statistically larger than effects for the full sample. Of the 24 estimates of the effects of center-based care programs on children's reading and math skills in Table 6, 9 were significantly larger for disadvantaged groups. In terms of prekindergarten, the estimated effects on reading skills were significantly larger for children of single parents and children whose mothers spoke a non-English language, and the estimated effects on math skills were significantly larger for children of single parents. The estimated effects of preschool were significantly larger only in the case of the math skills of children whose mothers did not have a high school diploma. The estimated effects of day care were significantly larger in the case of the math skills of children of single parents and children from families in poverty and the reading skills of children of low-educated mothers. Finally, the effects of participation in Head Start were significantly larger for the math skills of children from families in poverty and the reading skills of children of mothers without a high school diploma.

[8]Alan Krueger (2003) found a 0.2-standard-deviation gain in children's test scores in his study of the Tennessee Class Size Experiment, and he showed that this gain translates into an increase in per pupil lifetime earnings of $15,180, assuming a 4% discount rate and 1% productivity growth rate. Therefore, we assume that a 0.1-standard-deviation gain would translate into a $7,590 earnings gain.

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Appendix
Supplemental Tables

Table A1
Percentage of Sample Participating in Center-Based Care Programs and Head Start: Full Sample and by Subgroups

Type of care arrangement	Full sample (n = 12,804)	Poverty (n = 2,125)	Low maternal education level (n = 1,228)	Single parent (n = 2,315)	Non-English speaking (n = 2,205)
Center-based care	61	34	28	52	51
Preschool	34	13	12	17	28
Prekindergarten	17	10	10	21	15
Day care	10	11	6	14	8
Other nonparental care	12	12	13	15	14
Head Start	11	32	30	21	15
Parental care	17	22	30	12	21

Note. See notes for Tables 1 and 5. Child care categories are mutually exclusive but may sum to more than 100 because of rounding.

Table A2
Definitions, Additional Details, and Notes About Covariates Used in Analyses

Constructs and variables	Definitions, details, and notes
	Demographic characteristics
Child characteristics	
Child age	Continuous variable; child age in months (specific to timing of assessment)
Child gender	Dummy variable (boy = 1, girl = 0)
Birth weight	2 dummy variables for differing weights (1 = yes, 0 = no): <1,500 grams, 1,500–2,500 grams
Premature	2 dummy variables for differing lengths of time (1 = yes, 0 = no): >7 weeks early, 3–7 weeks early
Child weight	Average of two interviewer-assessed measurements in pounds
Child height	Average of two interviewer-assessed measurements in inches
Race/ethnicity	3 dummy variables for different backgrounds (1 = yes, 0 = no): Black, Hispanic, Asian; omitted categories are White, Native American, Pacific Islander, Native Hawaiian, more than one race

Constructs and variables	Definitions, details, and notes
Parental reports of family characteristics, kindergarten fall and spring	
Number of children in household	Ordinal variable; ranges from 1 to 11
Number of adults in household	Ordinal variable; ranges from 1 to 9
Family structure	3 dummy variables for family types (1 = yes, 0 = no): single parent (one biological parent), blended family (one biological and one nonbiological parent), adopted or foster parents; omitted category is two biological parents
Child has lived in four or more places since birth	Dummy variable (1 = yes, 0 = no); constructed from question about number of moves since child's birth
Rural residency	2 dummy variables for different types of localities (1 = yes, 0 = no): city, town; omitted category is rural residency
Region of country	3 dummy variables (1 = yes, 0 = no): north, south, midwest; omitted category is west
Number of grandparents living	Ordinal variable; ranges from 0 to 5
Number of grandparents living nearby	Ordinal variable; ranges from 0 to 5
Early maternal employment	Dummy variable (1 = mother ever employed between child's birth and entry into kindergarten, 0 = mother not employed)
Grandfather and grandmother's education	12 dummy variables (1 = yes, 0 = no) (6 for each grandparent) ranging in level from less than high school to advanced postgraduate degree; omitted category is some college
Father and mother's education	12 dummy variables (1 = yes, 0 = no) (6 for each parent) ranging in level from less than high school to advanced postgraduate degree; omitted category is some college
English only spoken in home	Dummy variable (1 = mother never speaks foreign language to child; 0 = mother sometimes, often, or very often speaks non-English to child)
Mother's age	3 dummy variables for mother's age at kindergarten fall (1 = yes, 0 = no): <25, 25–30, 35–40; omitted category is > 40 years old
Father's employment status	2 dummy variables for different work hours (1 = yes, 0 = no): full- (35 or more hours per week) and part-time work (fewer than 35 hours per week); omitted category is not employed
Mother's employment status	2 dummy variables for different work hours (1 = yes, 0 = no): full- (35 or more hours per week) and part-time work (fewer than 35 hours per week); omitted category is not employed

(continued)

Table A2 (Continued)

Constructs and variables	Definitions, details, and notes
Use of WIC	Dummy variable (1 = mother or child ever participated in WIC nutritional supplement program; 0 = did not participate); families with incomes up to 185% of federal poverty line are eligible for WIC
Household-income-to-needs ratio	9 dummy variables based on 0.5 increments of the ratio of household income to federal poverty hours (1 = yes, 0 = no); omitted category is income-to-needs ratio greater than 4.5
Home and family environment	
Parental reports of educational expectations, kindergarten fall	
Parents' educational expectations for child	4 dummy variables for differing expectations (1 = yes, 0 = no): high school, some postsecondary schooling, college degree, master's degree; omitted category is PhD or equivalent
Importance of child having skills by entrance to kindergarten	5 ordinal variables for skills: counting, sharing, communication, draws, knows letters; responses range from 1 (essential) to 5 (not important)
Parental reports of home learning activities, kindergarten fall	
Parents chose location of home for current school	Dummy variable (1 = yes; 0 = no).
Frequency of learning activities in home	7 ordinal variables for activities: building things, teaching about nature, playing sports, doing art, doing chores, singing songs, playing games; responses range from 1 (not at all) to 4 (every day)
Number of children's books in home	Ordinal variable; ranges from 0 to 200
Number of music tapes, CDs, or records in home	Ordinal variable; ranges from 0 to 100
Frequency of child looking at picture books outside of school	Ordinal variable; responses range from 1 (never) to 4 (every day)
Frequency of child reading books outside of school	Ordinal variable; responses range from 1 (never) to 4 (every day)
Parental reports of school involvement, kindergarten fall	
Family member attended school activities since beginning of school year	4 dummy variables for differing types of involvement (1 = yes, 0 = no): PTA meetings, open houses, parent groups, parent advisory meetings
Family member volunteered at school this school year	Dummy variable (1 = yes, 0 = no)
Family member participated in school fundraiser this school year	Dummy variable (1 = yes, 0 = no)

Constructs and variables	Definitions, details, and notes
Parental reports of parent-child relationship, kindergarten spring	
Parenting stress composite	Continuous variable. Mean of 8 items, such as "I feel trapped by my responsibilities as a parent" and "I am usually too busy to joke and play around with my child." Responses range from 1 (completely true) to 4 (not at all true). Cronbach $\alpha = .64$.
Child likes parent	Ordinal variable; responses range from 1 (completely true) to 4 (not at all true)
When in bad mood, parent shows love to child	Ordinal variable; responses range from 1 (completely true) to 4 (not at all true)
Hard to be warm with child	Ordinal variable; responses range from 1 (completely true) to 4 (not at all true)
Parent physically affectionate with child	Ordinal variable; responses range from 1 (completely true) to 4 (not at all true)
Parental depression composite	Continuous variable; mean of 12 items (e.g., "How often did you feel like you could not shake off the blues even with help from your family or friends?"); responses range from 1 (never) to 4 (most of the time); Cronbach $\alpha = .86$
Whether parent spanked child in past week	Dummy variable (1 = yes, 0 = no)
Frequency of spanking child in past week	Ordinal variable; ranges from 0 to 30
Parental reports of family routines, kindergarten spring	
Number of days in a week family usually eats meals together	2 ordinal variables for different meals: breakfast and dinner; ranges from 0 to 7
Number of days in a week family usually eats meals at a regular time	2 ordinal variables for different meals: breakfast and dinner; ranges from 0 to 7
Parental reports of structured activities and learning opportunities, kindergarten spring	
Family has computer	Dummy variable (1 = yes; 0 = no).
Child does not watch TV on weekdays	Dummy variable (1 = yes; 0 = no).
Number of hours child watches TV on weekdays	Ordinal variable. Ranges from 0 to 20.
Child visited educational settings in past month	4 dummy variables for different settings (1 = yes, 0 = no): zoo, library, museum, concert
Frequency of child looking at picture books outside of school	Ordinal variable; responses range from 1 (never) to 4 (every day)
Frequency of child reading books outside of school	Ordinal variable; responses range from 1 (never) to 4 (every day)
Child ever taken lessons outside of school	5 dummy variables for different types of lessons (1 = yes, 0 = no): art, crafts, music, dance, athletics
Child ever participated in performing arts outside of school	Dummy variable (1 = yes, 0 = no); examples include choir and dance

(continued)

Table A2 (Continued)

Constructs and variables	Definitions, details, and notes
Child ever participated in organized clubs outside of school	Dummy variable (1 = yes, 0 = no); examples include boy scouts and girl scouts
Neighborhood characteristics	
Parental reports of neighborhood quality, kindergarten spring	
Neighborhood quality composite	Continuous variable; mean of 6 items asking about problems in area around family house or apartment such as violent crimes (e.g., drive-by shootings); responses range from 1 (big problem) to 3 (no problem); Cronbach $\alpha = .86$
School characteristics	
Administrator reports of school characteristics, kindergarten spring	
Number of years served as principal	Ordinal variable; ranges from 0 to 30
Public school	Dummy variable (1 = yes, 0 = no)
Highest teacher salary	4 dummy variables (1 = yes, 0 = no): <$25,000, $25,001–$35,000, $35,001–$45,000, $45,001–$60,000; omitted category is > $60,001
Lowest teacher salary	4 dummy variables (1 = yes, 0 = no): <$15,000, $15,001–$20,000, $20,001–$25,000, $25,001–$30,000; omitted category is > $30,001
School receives Title I funding	Dummy variable (1 = yes, 0 = no)
Percentage White students	Ordinal variable; ranges from 0 to 100
Percentage of students eligible for free lunch	Ordinal variable; number of students eligible for free lunch in school divided by number of students in school (range: 0 to 100)
School has security guards	Dummy variable (1 = yes, 0 = no)
School limits use of bathrooms for safety	Dummy variable (1 = yes, 0 = no)
School locks outside doors for safety	Dummy variable (1 = yes, 0 = no)
School climate problems in early grades	3 dummy variables for different problems (1 = agree or strongly agree, 0 = strongly disagree, disagree, and neither agree nor disagree): teacher turnover, overcrowding, child absenteeism
Student mobility increased in past 3 years	Dummy variable (1 = yes, 0 = no)
Reduction in staff or teacher shortage in past 3 years	Dummy variable (1 = yes, 0 = no)
Students' average family incomes declined significantly in past 3 years	Dummy variable (1 = yes, 0 = no)

Constructs and variables	Definitions, details, and notes
Teachers and students experienced violence during current school year	3 dummy variables for different types of violence (1 = yes, 0 = no): student bringing weapon to school, children or teachers being physically attacked or involved in fights, children or teachers having things taken by force or threat of force on way to or from school
School neighborhood quality	Continuous variable; mean of 7 items (e.g., "How much of a problem is crime in the neighborhood in which this school is located?"); responses range from 1 (big problem) to 3 (no problem); Cronbach $\alpha = .81$
Observer rating of school atmosphere composite	Continuous variable; mean of 6 field study supervisor–assessed items such as "the halls are decorated" and "teachers are attentive"; responses range from 1 (strongly agree) to 4 (strongly disagree); Cronbach $\alpha = .96$
Observer rating of school environment composite	Continuous variable; mean of 4 field study supervisor–assessed items such as "litter and trash near school" and "graffiti near school"; responses range from 0 (none) to 3 (a lot); Cronbach $\alpha = 81$
Classroom characteristics	
Teacher reports of classroom characteristics, kindergarten fall and spring	
Teacher gender	Dummy variable (1 = male, 0 = female)
Number of years in current school	Ordinal variable; ranges from 1 to 37
Teacher race/ethnicity	4 dummy variables for different backgrounds (1 = yes, 0 = no): Black, Hispanic, Native American, Asian; omitted categories are White, Native Hawaiian, Pacific Islander
Teacher certification	2 dummy variables for different levels of certification (1 = yes, 0 = no): no certification (including temporary or probationary), highest level of certification available; omitted categories are alternative certification and regular certification
Teacher has master's degree or higher level of educational attainment	Dummy variable (1 = yes, 0 = no)
Teacher beliefs about children and teaching	6 dummy variables (1 = agree or strongly agree, 0 = strongly disagree, disagree, or neither agree nor disagree); each question asked in spring and fall of kindergarten: children's misbehavior interferes with teaching, children not capable of learning material, teacher would choose teaching again

(continued)

Table A2 (Continued)

Constructs and variables	Definitions, details, and notes
Class does not divide into ability groupings for reading and math activities or lessons	Dummy variable (1 = never divides into groupings, 0 = divides into groups once a week or more frequently)
Percentage of children in class classified as gifted and talented	Ordinal variable; number of children in gifted and talented program in class divided by total number of students in class; ranges from 0 to 1
Percentage of children in class below grade level in reading	Continuous variable; number of children below grade in reading in class divided by total number of students in class; ranges from 0 to 1
Percentage of children in class below grade level in math	Continuous variable; number of children below grade in math in class divided by total number of students in class; ranges from 0 to 1
Adequate workbook supplies	Dummy variable (1 = workbook supplies always adequate, 0 = sometimes, often, or never adequate)
Adequate space in classroom	Dummy variable (1 = classroom space always adequate, 0 = sometimes, often, or never adequate)
Part or full-day kindergarten	2 dummy variables for different types of class (1 = yes, 0 = no): child attends part-day program in a.m., child attends part-day program in p.m.; omitted category is full-day kindergarten

Note. Details regarding missing data and missing data dummy variables are available from the authors on request.

Table A3

Sample Characteristics, Full Sample and by Child Care Arrangements in Year Before Kindergarten

Child and family characteristics	Full sample (n = 12,804)	Parental care (n = 2,124)	Center-based care (n = 7,760)	Head Start (n = 1,395)	Other non-parental care (n = 1,525)
Blended family (%)	8	7	7	13	10
Adoptive or foster family (%)	4	3	3	8	3
Early maternal employment (%)	76	56	80	70	92
Residence in city (%)	37	36	38	37	36
Residence in town (%)	40	38	43	27	34
Four or more moves (%)	11	12	9	14	12
WIC use (%)	42	47	30	88	48
Mother speaks only English to child (%)	83	79	86	79	79
Low birth weight (%)	7	6	6	10	7
Very low birth weight (%)	1	1	1	2	1
Premature birth (%)	8	7	9	8	10
Very premature birth (%)	2	2	2	3	3
Mean child height (in inches)	45	44	45	45	44
Mean child weight (in pounds)	46	46	46	47	46
Mean number of living grandparents	3.34	3.26	3.39	3.16	3.38
Mean number of grandparents living close by	2.21	2.04	2.30	1.92	2.24
Mother works full-time (%)	46	25	48	42	66
Mother works part-time (%)	22	20	25	18	17
Father works full-time (%)	73	75	78	44	69
Father works part-time (%)	3	3	2	3	2
Mean number of adults in household	2.02	2.06	2.02	1.92	2.07
Mean number of children in household	2.44	2.78	2.30	2.81	2.36
Northern U.S. (%)	20	19	21	15	20
Southern U.S. (%)	28	23	29	26	28
Midwestern U.S. (%)	34	33	32	43	31
Percentage of sample	100	17	61	11	12

Note. Data are for 12,804 children in the ELCS-K study. Child care categories are mutually exclusive but sum to more than 100% because of rounding errors (see text for details). See Table A2 for additional information about the definition of sample characteristics.