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Impacts of Early Childhood Education on Medium- and Long-Term Educational Outcomes

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Abstract

Despite calls to expand early childhood education (ECE) in the United States, questions remain regarding its medium- and long-term impacts on educational outcomes. We use meta-analysis of 22 high-quality experimental and quasi-experimental studies conducted between 1960 and 2016 to find that on average, participation in ECE leads to statistically significant reductions in special education placement ($d = 0.33$ *SD*, 8.1 percentage points) and grade retention ($d = 0.26$ *SD*, 8.3 percentage points) and increases in high school graduation rates ($d = 0.24$ *SD*, 11.4 percentage points). These results support ECE's utility for reducing education-related expenditures and promoting child well-being.

Keywords

early childhood education; grade retention; high school graduation; meta-analysis; preschool; special education

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As a period of rapid growth in foundational cognitive, social, and emotional skills, early childhood represents a particularly sensitive time for the promotion of children's educational potential (Shonkoff & Philips, 2000). Reflecting this promise, rates of enrollment in state-funded early childhood education (ECE) programs have risen dramatically in recent years, more than doubling between 2002 and 2016 (Barnett et al., 2017; Barnett, Hustedt, Robin, & Schulman, 2003). Despite increased investment in publicly funded ECE programming as a mechanism to promote learning, the ability of ECE to improve children's educational outcomes in middle childhood and adolescence remains uncertain for both methodological and substantive reasons.

In the present study, we conduct a meta-analysis of high- quality research studies to provide an up-to-date estimate of the overall impact of ECE program participation on three distinct medium- and long-term educational outcomes: special education placement, grade retention, and high school graduation. We focus on these outcomes for several reasons. First, previous literature suggests that the skills typically targeted by ECE programming—including cognitive skills in language, literacy, and math as well as socio-emotional capacities in self-regulation, motivation/engagement, and persistence—are likely precursors of children's ability to maintain a positive academic trajectory (Heckman, Pinto, & Savelyev, 2013). As a result, educational outcomes are theoretically relevant as more distal targets of ECE programming. Second, the prevalence and cost of special education, grade retention, and especially high school dropout are large (Levin, Belfield, Muennig, & Rouse, 2007). Because of this, understanding the possible benefits of ECE for mitigating negative educational outcomes such as these is of particular importance to educational policymaking.

Methods

To address several limitations of previous work in this area (see Appendix), we employ data from a comprehensive meta-analytic database of ECE program evaluations published between 1960 and 2007 as well as a supplement to this database covering studies published between 2007 and 2016. All studies met strict inclusion criteria based on study design, attrition, and relevance. From this larger database, we focus on estimates for three educational outcomes (special education placement, grade retention, and high school dropout) and conduct sensitivity analyses probing differences based on model specification and the time between the end of the ECE program and the outcome measurement.

Results

Appendix Table A1 provides detailed information on the 22 studies that met our inclusion criteria. Seven of these studies used experimental designs (i.e., random assignment to ECE vs. a non-ECE control condition), 4 used quasi-experimental designs (i.e., sibling fixed effects, regression discontinuity, and propensity score matching), and 11 compared ECE and control group children who were not randomly assigned to conditions but provided evidence that groups were equivalent on observed characteristics at baseline.

Results of multilevel weighted regression analyses revealed positive and statistically significant average effects of ECE across all three outcomes combined, $b = 0.24$, $SE = 0.04$, $p < .001$ (see Table 1). Specifically, ECE participation led to an average decrease of 0.33 *SD* ($SE = 0.11$, $p < .01$) in special education placement, an average decrease of 0.26 *SD* ($SE = 0.06$, $p < .001$) in grade retention, and average increase of 0.24 *SD* ($SE = 0.07$, $p < .001$) in graduation rates relative to nonparticipation. Based on the subset of observations providing the necessary data, our results show that ECE participation is associated with an 8.09 percentage point ($SE = 3.44$, $p < .05$) decrease in special education placement, 8.29 percentage point ($SE = 2.05$, $p < .01$) decrease in grade retention, and 11.41 percentage point ($SE = 2.40$, $p < .01$) increase in high school graduation (see Figure 1). Results of sensitivity analyses were largely consistent with those from our primary analyses (see Table 1 and Appendix for details) and suggest that effects of ECE on educational outcomes (particularly special education and retention) are larger at longer term follow-up relative to time points close to the end of treatment.

Discussion

These results suggest that classroom-based ECE programs for children under five can lead to significant and substantial decreases in special education placement and grade retention and increases in high school graduation rates. These findings support previous work on the lasting impacts of ECE on children's educational progression, placement, and completion (Aos, Lieb, Mayfield, Miller, & Pennucci, 2004; Camilli, Vargas, Ryan, & Barnett, 2010; Gorey, 2001; Lazar et al., 1982). Importantly, relative to this earlier work, our analyses cover a wider age range, reflect a mix of both historical demonstration projects and more modern large-scale evaluations, and use more rigorous criteria for research design.

These results provide further evidence for the potential individual and societal benefits of expanding ECE programming in the United States. Over the past several years, financial investments in public ECE have risen rapidly, with states spending $7.4 billion in 2016 to support early education for nearly 1.5 million 3- and 4-year-olds (Barnett et al., 2017). At the same time, approximately 6.4 million children are in special education classes, and more than 250,000 are retained each year, with annual per pupil expenditures for special education and retention amounting to more than $8,000 and $12,000, respectively (Chambers, Parrish, & Harr, 2002; Office of Special Education Programs, 2014; U.S. Department of Education, 2015; Warren, Hoffman, & Andrew, 2014). Even more costly is the fact that approximately 373,000 youth in the United States drop out of high school each year, with each dropout leading to an estimated $689,000 reduction in individual lifetime earnings and a $262,000 cost to the broader economy (Chapman, Laird, Ifill, & Kewal-Ramani, 2011; Levin et al., 2007). These negative educational outcomes are much more frequent for children growing up in low- as opposed to higher-income families, and yet more than half of low-income 3- and 4-year-old children remain out of center-based care (Child Trends, 2015; O'Connor & Fernandez, 2006). Given the high costs that special education placement, grade retention, and dropout place on both individuals and taxpayers, our results suggest that further investments in ECE programming may be one avenue for reducing educational and economic burdens and inequities.

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Appendix

Existing Evidence on Impacts of Early Childhood Education

Since the initiation of the Head Start program in the 1960s, a large body of educational and developmental research has focused on understanding the impacts of early childhood education (ECE) programs on children's subsequent well-being. Most of these studies have focused on immediate and often positive gains in the types of cognitive and self-regulatory skills that are associated with children's later academic well-being (Lazar et al., 1982). Building on this work and broader theory regarding developmental cascades, a much smaller set of studies has aimed to quantify ECE's longer term educational benefits (Masten et al., 2005). In particular, the results of two of the most influential model programs in the early childhood literature—Perry Preschool and Abecedarian—are often cited as conclusive evidence for the role of ECE in improving educational attainment (Barnett & Masse, 2007). In addition to demonstrating individual benefits, these studies are also used as exemplars of ECE's potential to generate social benefits far in excess of their costs, with estimates typically surpassing $5 returned for every initial $1 invested in early educational programming (Barnett & Masse, 2007; Belfield, Nores, Barnett, & Schweinhart, 2006; Heckman, Moon, Pinto, Savelyev, & Yavitz, 2010; Karoly, Kilburn, & Cannon, 2006).

Although the results of the Perry and Abecedarian programs support the promise of ECE for delivering both individual and social benefits, it is difficult to draw general conclusions from just two model program evaluations. In an attempt to provide a more comprehensive—and representative—perspective of the longer term benefits of ECE, several studies have used meta-analysis to quantify average effects across multiple evaluations using studies, rather than individuals, as the unit of observation (Cooper & Hedges, 2009). When focusing on educational outcomes like graduation, attainment, special education placement, and grade retention, these meta-analyses have identified positive overall impacts of ECE participation, with effect sizes in the $d = 0.15$ to 0.50 range (Aos, Lieb, Mayfield, Miller, & Pennucci, 2004; Camilli, Vargas, Ryan, & Barnett, 2010; Gorey, 2001; LazQAzar et al., 1982).

Although promising, there are several limitations of this collective body of work that we attempt to address in the present study. First, with the exception of Aos et al. (2004), no meta-analysis has included studies of ECE's impact on educational outcomes published after 2000. In the present study, we review literature published up to 2016 to provide a more up-to-date meta-analytic estimate. In addition, we extend previous work focusing on ECE for 3- and 4-year-old children (e.g., Aos et al., 2004; Camilli et al., 2010) by considering services provided for children in the full 0 to 5 age range.

Second, unlike previous meta-analyses in this area (Aos et al., 2004; Camilli et al., 2010; Lazar et al., 1982), we limit our analyses to focus exclusively on studies meeting a strict set of quality standards. From a methodological standpoint, the quality of a given meta-analysis is largely determined by the quality of the individual studies it covers (Barnett, 1995; Gormley, 2007). When an included study is systematically biased, for example due to problems with nonrandom selection into treatment conditions or selective attrition, the results of the meta-analysis will also be biased (Borenstein, Hedges, Higgins, & Rothstein, 2009). By limiting our analysis to studies using rigorous experimental and quasi-experimental designs that have established baseline equivalence across ECE and comparison groups and reasonable levels of attrition, we aim to ensure that our estimates are as internally valid as possible.

Third, we provide both aggregated and disaggregated estimates of ECE's impacts on three distinct educational outcomes. A common issue within meta-analysis is the collective evaluation of studies that differ fundamentally from one another in one or more ways, otherwise known as the "apples and oranges" problem (Borenstein et al., 2009). In ECE research, previous meta-analyses (e.g., Camilli et al., 2010) have combined special education placement, grade retention, high school completion, and academic attainment into one outcome category despite the fact that these outcomes differ in terms of their relationship with other domains of functioning (Alexander, Entwistle, & Kabbani, 2001; Morgan, Frisco, Farkas, & Hibel, 2010). Although some older meta-analyses have included domain-specific estimates (e.g., Gorey, 2001), no studies in the past decade have estimated the impacts of ECE on the subtypes of educational outcomes that generate important costs to both individuals and societies. We address this problem in the present study by identifying separate estimates for ECE's impact on special education placement, grade retention, and high school graduation.

Detailed Methods

The present study draws from a comprehensive database of early childhood care and education program evaluations conducted in the United States between 1960 and 2007 and compiled by the National Forum on Early Childhood Policy and Programs. Building on several previously existing meta-analytic databases (Camilli et al., 2010; Jacob, Creps, & Boulay, 2004; Shager et al., 2013), the Forum's database was expanded to include ECE programs for children under age 3 and new research through 2007 and narrowed to focus only on studies meeting a strict set of quality-related criteria. For the present study, this database was then expanded once again to include studies published between 2007 and 2016. Studies were identified through systematic literature review, manual searches of leading policy institutes (e.g., Abt, Rand, Mathematica Policy Research, NIEER) and state and federal departments (e.g., U.S. Department of Health and Human Services), and "snowballing" of the reference sections of included studies and reviews.

Studies were included in the database if they (a) evaluated a U.S.-based educational program, policy, or intervention for children ages 0 to 5 years; (b) made use of a comparison group that was shown to be equivalent to the treatment group at baseline; (c) had at least 10 participants in each condition; (d) experienced less than 50% attrition in each condition between initiation of treatment and the follow-up measurement; and (e) had enough information to calculate effect sizes for analysis. Included evaluations made use of experimental designs as well as quasi-experimental designs that included pre-post treatment and control group comparisons and were equivalent on relevant characteristics before initiation of treatment. Full inclusion and exclusion criteria for the complete meta-analytic database can be found in Shager et al. (2013).

Of the more than 10,000 documents reviewed, most were excluded because they were not research studies, did not include an evaluation component, or consisted solely of previously published results. In total, 272 met the aforementioned criteria and were included in the full database. An additional 4 studies focusing exclusively on the outcomes of interest for the present study were also included covering the time period of 2007 to 2016. Data abstraction and coding were completed by doctoral-level research assistants. Coder training took place over a three- to six-month period and ended with reliability checks in which coders were required to achieve an interrater agreement with an expert coder of .80 for all codes with the exception of effect sizes, which were required to be within 10% of the true effect size. The range of interrater reliabilities for all study information was .87 to .96. Coding questions and discrepancies were resolved during weekly, full-team meetings and recorded for future reference in an annotated codebook.

Data were abstracted at multiple levels. *Studies* refer to the distinct investigations of different ECE programs. *Contrasts* are defined as comparisons of groups within a given study that experienced different conditions (e.g., full-time ECE vs. control, part-time ECE vs. control). Finally, *effect sizes* represent the standardized treatment-control difference using different outcome measures at different time points within contrasts.

Effect sizes were coded for special education placement, grade retention, and high school graduation outcomes using Comprehensive Meta-Analysis computer software (Borenstein, Hedges, Higgins, & Rothstein, 2005). Specifically, Hedges g was calculated, which adjusts the standardized mean difference (Cohen's d) to account for bias in the d estimator when sample sizes are small. In the case of dichotomous rate and event data, effect sizes were first calculated as odds ratios before being converted to Hedges g. All effect sizes were coded such that positive numbers indicate more desirable outcomes (i.e., lower special education placement and grade retention, higher high school graduation).

For the present paper, we focused exclusively on studies that compared classroom-based ECE programs to non-ECE conditions for the full study sample. We excluded effect sizes that were not relevant to one of our three focal outcome measures (special education placement, grade retention, and high school graduation), including college participation and years of education completed. After imposing these exclusions, the final analytic sample for the present study included a total of 75 effect sizes taken from 34 contrasts and 22 studies (see Appendix Table A1 for study names and features).

Within our analytic sample, outcome definitions varied in two important ways. First, special education placement and grade retention were coded as either "current" (e.g., being in special education at the time of the data collection) or "cumulative" (e.g., ever having been in special education since the time of the intervention). Second, different studies captured outcomes at different time points. Time between the end of treatment and the measurement of the given outcomes was coded in years and included as a control variable in our sensitivity analyses.

To account for the nested nature of the effect size data, we used a two-level random intercept model with effect sizes at Level 1 nested in contrasts at Level 2. We chose this over a three-level model due to the low levels of nesting of contrasts within studies (average *n* of contrasts within studies = 1.54; range = 1–6). To determine whether ECE participation affected our targeted educational outcomes, we ran four primary models: (1) a model predicting cumulative and current special education effect sizes at all available time points, (2) a model predicting cumulative and current grade retention effect sizes at all available time points, (3) a model predicting high school graduation effect sizes at all available time points, and (4) a model that combines all of the aforementioned effect sizes for a single estimate of overall ECE impact on educational outcomes. We replicated these analyses using available percentage point (rather than effect size) data, which required us to limit our sample to 62 of the original 75 observations as some effect sizes could not be converted to percentage points (e.g., the NLSY79 Head Start regression discontinuity study). Effect sizes were, on average, slightly larger in the 13 observations without available percentage point data (mean effect size = 0.31) than they were in the 62 observations with available percentage point data (mean effect size = 0.28), though this difference was not statistically significant, $t(73) = 0.72$, $p = ns$.

We also ran three supplemental sets of sensitivity analyses using effect size data. The first used an alternative nesting strategy, with effect sizes nested in studies rather than contrasts. The second took the same approach used in the primary analyses but controlled for the amount of time that passed (in years) between the end of the treatment and the observation time point. The third focused on a narrower set of models predicting only "cumulative" outcome definitions taken from the latest available time point.

Because effect sizes are based on varying numbers of cases and are therefore estimated with varying degrees of precision, effect sizes (and estimates of percentage point differences) were weighted by the inverse of the variance of each effect size estimate multiplied by the inverse of the number of effect sizes per contrast (Cooper & Hedges, 2009; Lipsey & Wilson, 2001). Across all models, the primary coefficient of interest was the Level 1 intercept, which reflects the average effect size for the particular outcome across included contrasts (or studies).

Results of Sensitivity Analyses

Results of primary and sensitivity analyses are shown in full in Table 1, as well as in Appendix Figures A1 through A3. Specifically, results of the first set of sensitivity analyses in which effect sizes were nested in studies (rather than contrasts) produced estimates that were relatively comparable (within approximately 0.03 *SD*) to the primary results. In particular, when nesting in studies, the overall effect of ECE on all outcomes was $b = 0.24$ ($SE = 0.04$, $p < .001$), and the effect on special education was $b = 0.30$ ($SE = 0.11$, $p < .05$), grade retention was $b = 0.23$ ($SE = 0.05$, $p < .01$), and graduation rates was $b = 0.27$ ($SE = 0.07$, $p < .001$).

Results of the second set of sensitivity analyses—which included an additional "time since end of treatment" control—produced results that were similar to the primary findings for grade retention, attenuated slightly (by approximately 0.04 *SD*) for graduation and attenuated substantially (by approximately 0.15 *SD*, or nearly 50% of the primary estimate) for special education. In particular, the overall impact of ECE immediately following treatment across all outcomes was $b = 0.16$ ($SE = 0.06$, $p < .01$), whereas the effect of ECE immediately following treatment on special education was $b = 0.17$ ($SE = 0.11$, *ns*), grade retention was $b = 0.26$ ($SE = 0.07$, $p < .05$), and graduation rates was $b = 0.21$ ($SE = 0.08$, $p < .01$). The coefficient for time in years since treatment was significant and positive for all outcomes but graduation, indicating that ECE impacts grew larger each year posttreatment for special education and retention and remained stable over time for graduation. Specifically, ECE effects were found to be significantly larger across time for all outcomes combined ($b = 0.013$, $SE = 0.002$, $p < .001$), special education ($b = 0.022$, $SE = 0.003$, $p < .001$), and grade retention ($b = 0.020$, $SE = 0.001$, $p < .001$). Collectively, these results showing growing ECE effects on special education and retention diverge from prior evidence showing "fade-out" of ECE's benefits for cognitive skills and achievement. Additional research is needed to identify the mechanisms underlying these gains. It is possible, for example, that ECE may benefit children's development of fundamental but often unmeasured skills such as self-regulation, communication, and motivation, and these skills in turn may lead to more favorable educational outcomes over time (Bailey, Duncan, Odgers, & Yu, 2017).

A third set of sensitivity analyses examining only (a) the last time point of data available within a given contrast and (b) cumulative data for special education and grade retention again revealed positive and statistically significant effects of ECE across all three outcomes ($b = 0.28$, $SE = 0.05$, $p < .001$). Relative to the primary results, results of these sensitivity analyses were slightly stronger (by approximately 0.03–0.05 *SD*) for special education and retention and substantially smaller (by approximately 0.14 *SD*) for graduation. In particular, these sensitivity analyses showed that ECE participants were, on average, 0.37 SD ($SE = 0.05$, $p < .001$) lower in special education placement, 0.29 *SD* ($SE = 0.07$, $p < .001$) lower in grade retention, and 0.10 *SD* ($SE = 0.02$, $p < .001$) higher in graduation rates than their control group peers. Follow-up analyses revealed that the substantial drop in average effect size magnitude for graduation rates within this set of sensitivity analyses was attributable to the relatively greater weighting of the NLSY study—which, due to its large sample size, has a very small standard error—within a more limited sample of effect sizes.

Limitations

Research is needed to address several important limitations of the work presented. First and most importantly, circumstances surrounding today's ECE programs differ from those associated with many of the programs included in this analysis. Many programs in this analysis were implemented at a time when alternative care options were limited, mostly targeted particularly high-risk children, often included comprehensive "wrap-around" services and home visiting components, and frequently provided services for multiple years at a time. Although our inclusion of more recent programs (up to 2016) represents an improvement on prior meta-analyses in this area, the degree to which the impacts found in the present analyses are comparable with the potential effects of the types of universal, publicly funded pre-school programs being considered for scale-up today is a needed area of future research (Barnett, 2010). Second, the limited data from the small sample of included studies precludes our ability to test hypotheses of mechanism, impact variation, and relative forms and levels of program quality. In particular, probing the degree to which these effects may be explained by differences in cognitive and/or socio-emotional functioning is of particular use for generating knowledge about intervention impact fadeout and persistence (Bailey et al., 2017). Additional attention is also needed to understand the degree to which ECE's impacts may be stronger—or weaker—for particular subgroups of children (Magnuson et al., 2016). In the Perry program evaluated in this study, for example, improvements in graduation rates and reductions in grade retention were driven entirely by girls, whereas effects on criminal activity, later-life income, and employment were driven by boys (Heckman et al., 2010; Schweinhart et al., 2005). Moving forward, research with a larger number of longitudinal studies is needed to probe these critical, policy-relevant questions of "why" and "for whom."

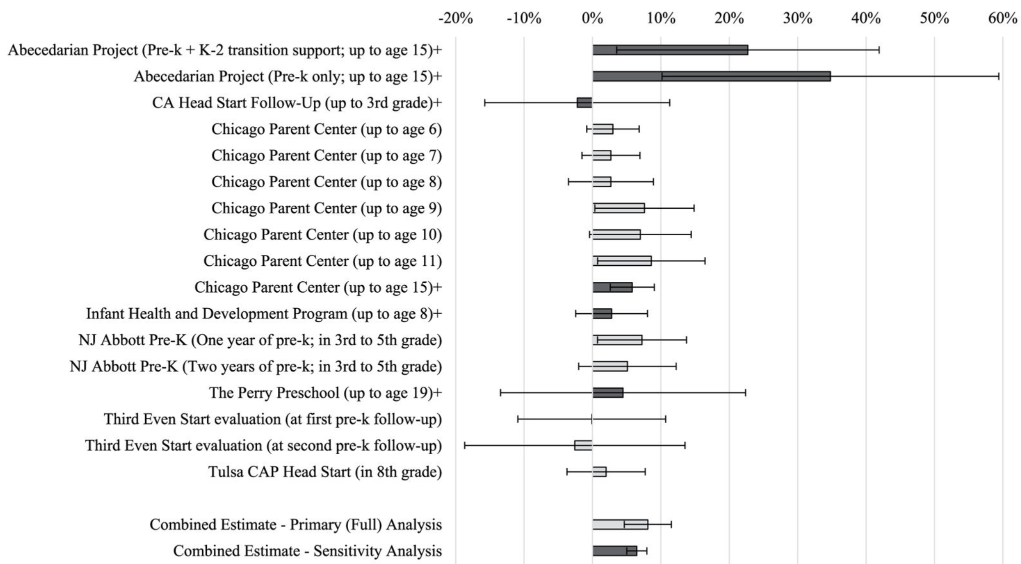

FIGURE A1. Percentage point reduction in special education placement rates (with 95% confidence intervals) for children attending early childhood education versus control group (selected programs with available data)

+ and dark grey bars identify those observations included in sensitivity analyses using a reduced sample. Two additional observations (one from the Yale Child Welfare Research Program and one from the Perry Preschool study) included in primary analyses but not shown due to lack of percentage point data.

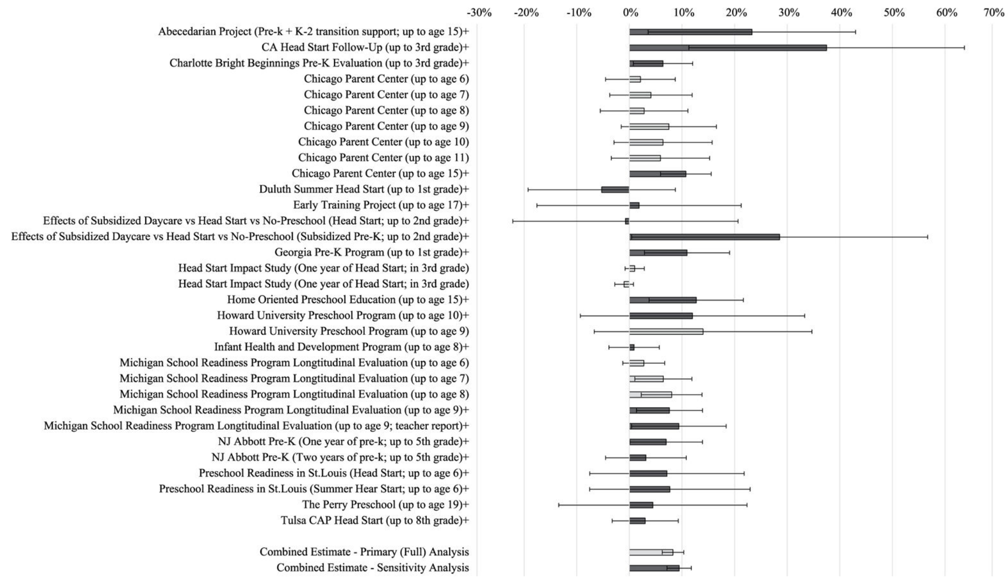

FIGURE A2. Percentage point reduction in grade retention rates (with 95% confidence intervals) for children attending early childhood education versus control group (selected programs with available data)

+ and dark grey bars identify those observations included in sensitivity analyses using a reduced sample. Seven additional observations (six from the Currie and Thomas NLSCM fixed effect study and one from the NLSY79 Head Start regression discontinuity study) included in primary analyses but not shown due to lack of percentage point data.

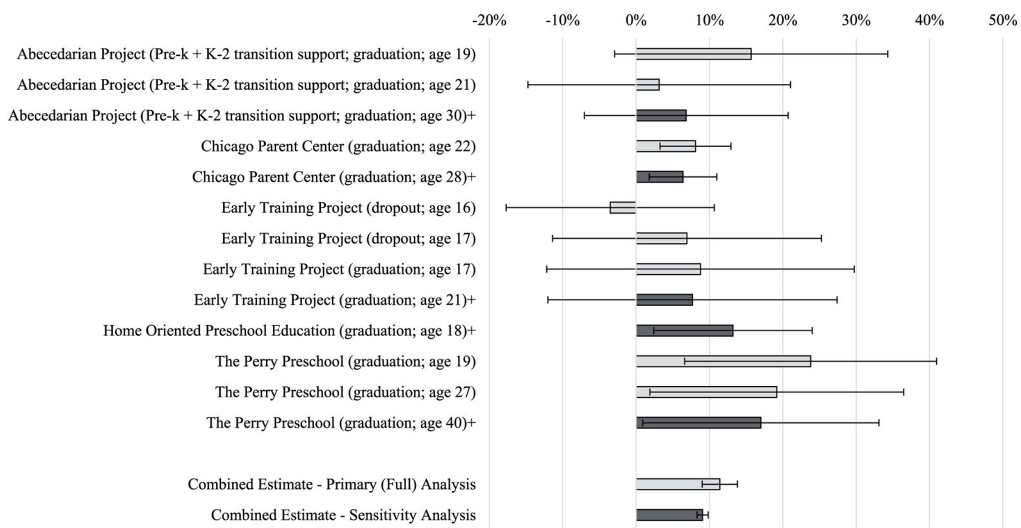

FIGURE A3. Percentage point gain in high school graduation rates (with 95% confidence intervals) for children attending early childhood education versu control group (selected programs with available data)

+ and dark grey bars identify those observations included in sensitivity analyses using a reduced sample. Two additional observations (from the NLSY79 Head Start regression discontinuity study and the OEO Head Start regression discontinuity study) included in primary analyses but not shown due to lack of percentage point data.

Table A1

Summary of Included Studies

						Contrasts		Time Points	Effect Sizes (*N*) High			
Study Name	Citation(s)	Program Description	Study Design	Year	State	*N*	Description	*N*	Special Ed	Grade Retention	School Graduation	Total
Abecedarian Project	Campbell, Ramey, Pungello, Sparling, and Miller-Johnson (2002); Campbell et al (2012); Masse and Barnett (2002); Ramey et al. (2000)	Intensive, full-time preschool services provided for low-income children from birth to age 5, with or without support services for the kindergarten to elementary school transition	Experimental	1972	NC	2	(1) Preschool services only versus no pre-k control; (2) preschool services + K–2 transition supports versus no pre-k control	4	2	1	3	6
CA Head Start Follow-Up	Newton, 2006	Full- and half-day Head Start programs in southern California, with children participating for either 1 or 2 years	Nonrandom assignment to demographically equivalent groups	2003 (est)	CA	1	Head Start versus no pre-k control	1	1	1	0	2
Charlotte Bright Beginnings (CBB) Pre-K Evaluation	Smith, Pellin, and Agruso (2003)	Full-day preschool program for low-income 4-year-olds run by the Charlotte-Mecklenburg Public School System	Nonrandom assignment to demographically equivalent groups	1997	NC	1	CBB pre-k versus no pre-k control	1	0	1	0	1
Chicago Parent Center (CPC)	Reynolds (1995); Reynolds and Ou (2011); Reynolds, Temple, and Ou (2010); Reynolds, Temple, Ou, Arteaga, and White	Half-day (morning) preschool program for 3- and 4-year-old low-income, Black children in Chicago; program provided for either 1 or 2 years	Nonrandom assignment to demographically equivalent groups	1985	IL	1	CPC pre-k (1 or 2 years) versus no pre-k control	7	7	7	2	16
Currie and Thomas NLSCM Fixed Effect Study	Currie and Thomas (1995, 1999)	Existing Head Start and preschool services reported in the National Longitudinal Survey Child-Mother (NLSCM) by mothers participating in the National Longitudinal Survey of Youth (NLSY)	Quasi-experimental (sibling fixed effect models)	1978	National	6	(1) White children in Head Start versus sibling no pre-k control; (2) White children in pre-k versus sibling no pre-k control; (3) Black children in Head Start versus sibling no pre-k control; (4) Black children in pre-k versus sibling no pre-k control; (5) Hispanic children in Head Start versus sibling no pre-k control; (6) Hispanic children in pre-k versus sibling no pre-k control	1	0	6	0	6
Duluth Summer Head Start	Tamminen, Weatherman, and McKain (1967)	Summer Head Start program for low- income, "culturally deprived" children	Nonrandom assignment to demographically equivalent groups	1965	MN	1	Summer Head Start versus no pre-k control	1	0	1	0	1

						Contrasts		Time Points	Effect Sizes (*N*) High			
Study Name	**Citation(s)**	**Program Description**	**Study Design**	**Year**	**State**	***N***	**Description**	***N***	**Special Ed**	**Grade Retention**	**School Graduation**	**Total**
Early Training Project (ETP)	Gray, Ramsey, and Klaus (1982)	10-week, half-day summer pre-k program plus year- round home visiting for low-income children offered for 2 to 3 years	Experimental	1962	TN	1	ETP pre-k versus no ETP pre-k control	3	0	1	4	5
Effects of Subsidized Daycare Versus Head Start Versus No Preschool	Handler (1972)	Existing year-round Head Start and subsidized preschool centers in a single community	Nonrandom assignment to demographically equivalent groups	1966	Unknown	2	(1) Subsidized preschool versus no pre-k control; (2) Head Start versus no pre-k control	1	0	2	0	2
Georgia Pre-k Program	Pilcher and Kaufman-McMurrain (1994)	Universal, state-funded, full- and part-day preschool program for 4-year-olds	Nonrandom assignment to demographically equivalent groups	1993	GA	1	Pre-k versus no pre-k control	1	0	1	0	1
Head Start Impact Study	Puma et al. (2012)	Head Start programs for low-income 3- and 4-year-old children	Experimental	2002	National	2	(1) 3-year-olds in Head Start versus alternative care; (2) 4-year-olds in Head Start versus alternative care	1	0	2	0	2
Home-Oriented Preschool Education (HOPE)	Gotts (1989)	Daily at-home television lessons, weekly home visits, and weekly classroom group lessons for rural children ages 3 to 5	Experimental	1968	WV	1	HOPE program versus television lesson only control	1	0	1	1	2
Howard University Preschool Program	Herzog et al. (1972)	2-year preschool program for low-income, low-IQ 3- and 4-year-old children + 3 years kept together in elementary school	Nonrandom assignment to demographically equivalent groups	1964	DC	1	Howard University pre-k program versus no pre-k control	2	0	2	0	2
Infant Health and Development Program (IHDP)	McCarton et al. (1997)	Home visits, child development center educational services, and parent meetings from birth to age 3 for low birthweight babies	Experimental	1984	8 states	1	IHDP versus no IHDP control	1	1	1	0	2
Michigan School Readiness Program Longitudinal Evaluation	Xiang and Schweinhart (2002)	State-funded, part-day preschool program for 4-year-olds at risk of school failure based on economic and sociodemographic characteristics	Nonrandom assignment to demographically equivalent groups	1995	MI	1	Pre-k versus no pre-k control	4	0	5	0	5
NJ Abbott Pre-K	Barnett, Jung, Youn, and Frede (2013)	High-quality preschool provided in private centers, Head Start centers, and public schools through public-private partnership overseen by public schools	Nonrandom assignment to demographically equivalent groups	2003	NJ	2	(1) 1 year of Abbott pre-k versus alternative care; (2) 2 years of Abbott pre-k versus alternative care	1	2	2	0	4
NLSY79 Head Start Regression Discontinuity Evaluation	Weinstein (2004)	Head Start programs reported in the National Longitudinal Survey of Youth (NLSY)	Quasi-experimental (regression discontinuity design)	1965	National	2	(1) Head Start eligible children (born between 1961 and 1964) versus noneligible	1	0	1	1	2

Study Name	Citation(s)	Program Description	Study Design	Year	State	Contrasts N	Contrasts Description	Time Points N	Effect Sizes (N) High Special Ed	Grade Retention	School Graduation	Total
							controls (born 1957–1960); (2) Head Start eligible children (born between 1960 and 1964) versus noneligible controls (born 1957–1959)					
OEO Head Start Regression Discontinuity Study	Ludwig and Miller (2007)	Head Start funded by the Office of Economic Opportunity (OEO)	Quasi-experimental (regression discontinuity design)	1965	National	2	(1) Counties eligible to receive technical assistance to write Head Start Grants versus noneligible counties (Cohort 1); (2) counties eligible to receive technical assistance to write Head Start Grants versus noneligible counties (Cohort 2)	2	0	0	3	3
Preschool Readiness Centers in St. Louis	Bittner, Rockwell, and Matthews (1968)	Year-long, part-time (half-day, between 2 and 4 days per week) preschool program for low-income children ages 2.5 to 6 and summer Head Start	Nonrandom assignment to demographically equivalent groups	1965	IL	2	(1) Full-year program versus no pre-k control; (2) summer Head Start versus no pre-k control	1	0	2	0	2
The Perry Preschool	Schweinhart and Weikart (2000); Schweinhart, Barnes, and Weikart (1993); Schweinhart et al. (2005); Schweinhart (2013)	Half-day, comprehensive preschool and home visiting program for low-income, Black 3- and 4-year-olds	Experimental	1962	MI	1	Perry pre-k versus no pre-k control	3	2	1	3	6
Third Even Start Evaluation	Ricciuti, St. Pierre, Lee, Parsad, and Rimdzius (2004)	Parent-child literacy activities, parenting education, adult education, and early childhood education for low-income families with children age 0 to 7	Experimental	1999	14 states	1	Even Start services versus no Even Start control	2	2	0	0	2
Tulsa CAP Head Start	Phillips, Gromley, and Anderson (2016)	Full-day Head Start program for low- income 3- and 4-year-old children	Quasi-experimental (propensity score matching)	2005	OK	1	Head Start versus no public pre-k program	1	1	1	0	2
Yale Child Welfare Research Program	Seitz, Rosenbaum, and Apfel (1985)	Home visits, pediatric care, developmental evaluation, and day care and toddler school for 0- to 30-month-old, low- income children	Nonrandom assignment to demographically equivalent groups	1968	CT	1	Yale Child Welfare program versus no program control	1	1	0	0	1
Total						34		41	19	39	17	75

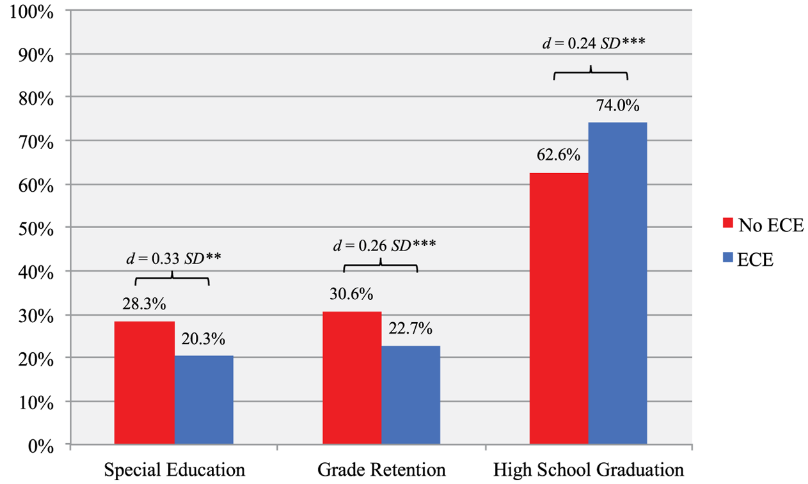

FIGURE 1. Average rates of special education placement, grade retention, and high school graduation for early childhood education participants versus nonparticipants

Effect sizes (*d*) represent results from all available observations ($n = 75$). Percentage point data represent results from a subset of observations ($n = 62$) with available data.

$^{**}p < .01$. $^{***}p < .001$.

Table 1

Estimated Standardized Difference Between ECE and Non-ECE Children Observed From Two-Level Weighted Regression Analyses

	Composite (All Outcomes)			Special Education			Grade Retention			High School Graduation		
	b	***SE***	***p***	***b***	***SE***	***p***	***b***	***SE***	***p***	***b***	***SE***	***p***
Primary models												
Intercept	0.236	0.042	0.000	0.326	0.107	0.002	0.259	0.056	0.000	0.242	0.068	0.000
	N = 22 studies, 34 contrasts, 75 ES			*N* = 9 studies, 11 contrasts, 19 ES			*N* = *19* studies, 28 contrasts, 39 ES			*N* = 7 studies, 8 contrasts, 17 ES		
Sensitivity models: Nesting in studies												
Intercept	0.239	0.039	0.000	0.295	0.114	0.010	0.234	0.045	0.000	0.272	0.070	0.000
	N = 22 studies, 34 contrasts, 75 ES			*N* = 9 studies, 11 contrasts, 19 ES			*N* = 19 studies, 28 contrasts, 39 ES			*N* = 7 studies, 8 contrasts, 17 ES		
Sensitivity models: Controlling for time since treatment												
Intercept	0.159	0.057	0.005	0.171	0.107	0.145	0.258	0.068	0.031	0.205	0.076	0.007
Time	0.013	0.002	0.000	0.022	0.003	0.000	0.020	0.001	0.000	0.002	0.002	0.277
	N = 22 studies, 34 contrasts, 75 ES			*N* = 9 studies, 11 contrasts, 19 ES			*N* = 19 studies, 28 contrasts, 39 ES			*N* = 7 studies, 8 contrasts, 17 ES		
Sensitivity models: Reduced sample with limited outcomes												
Intercept	0.278	0.054	0.000	0.374	0.052	0.000	0.290	0.067	0.000	0.100	0.015	0.000
	N = 19 studies, 30 contrasts, 41 ES			*N* = 5 studies, 6 contrasts, 6 ES			*N* = 18 studies, 26 contrasts, 27 ES			*N* = 7 studies, 8 contrasts, 8 ES		

Note. All models (with the exception of the first set of sensitivity analyses) weighted by the inverse variance of the ES estimates times the inverse of the number of effect sizes per contrast. Primary models include all time points and both current and cumulative representations of special education and grade retention. The first set of sensitivity models nests effect sizes in studies rather than in contrasts. The second set of sensitivity models controls for time (in years) since the end of treatment. The third set of sensitivity models includes a reduced sample of effect sizes reflecting only the latest time point per contrast and only cumulative representations of special education and grade retention. All effect sizes coded such that positive coefficients indicate more desirable outcomes (i.e., lower special education placement, lower grade retention, and higher graduation rates). ECE = early childhood education; ES = effect size.