

Early Childhood Education to Promote Health Equity: A Community Guide Systematic Review

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Context: Children in low-income and racial and ethnic minority families often experience delays in development by 3 years of age and may benefit from center-based early childhood education. **Design:** A meta-analysis on the effects of early childhood education by Kay and Pennucci best met Community Guide criteria and forms the basis of this review. **Results:** There were increases in intervention compared with control children in standardized test scores (median = 0.29 SD) and high school graduation (median = 0.20 SD) and decreases in grade retention (median = 0.23 SD) and special education assignment (median = 0.28 SD). There were decreases in crime (median = 0.23 SD) and teen births (median = 0.46 SD) and increases in emotional self-regulation (median = 0.21 SD) and emotional development (median = 0.04 SD). All effects were favorable, but not all were statistically significant. Effects were also long-lasting. **Conclusions:** Because many programs are designed to increase enrollment for high-risk students and communities, they are likely to advance health equity.

KEY WORDS: early childhood education, health equity, low income, racial/ethnic minority, social determinant

● Context

Income, race and ethnicity, and educational attainment in the United States

Lifelong educational attainment is one of the most important determinants of long-term health.^{1,2} Conversely, incomplete or poor-quality education can jeopardize a child's prospects for health and well-being.

This review investigates the potential of center-based early childhood education (ECE) to foster the larger public health goal of health equity, with a focus on low-income and racial and ethnic minority populations in the United States. The term "health equity" refers to a "widespread, systematic, achievable equality in health and in the major social determinants of health that benefit all principal social divisions of a population" (Community Preventive Services Task Force meeting, September 23-24, 2009, Atlanta, Georgia).

Risk factors for low educational attainment appear even before children enter the educational system. A

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large cohort study of US children entering kindergarten in 1998³ identified a high prevalence of risk factors for poor long-term educational outcomes and differential distribution of these risk factors by race/ethnicity and income. Forty-six percent of children had 1 or more of the following risk factors: a mother with less than a high school education; family use of food stamps or receipt of welfare payments; living in a single-parent household; and having parents whose primary language was not English. Black, Hispanic, and Asian children were 2.5, 2.5, and 2.1 times, respectively, as likely as white children to have 1 or more risk factors. A child's number of risk factors was strongly associated with measures of general knowledge, reading and mathematics abilities, fine motor skills, and social behavior among entering kindergartners. Having even 1 risk factor substantially increased the likelihood of less-than-optimal school readiness. This review assesses the potential of ECE to improve the educational readiness of low-income and minority children.

Documenting the dynamics of the family development process in the early 1980s in the Kansas City region, Hart and Risley⁴ systematically recorded thousands of hours of verbal and nonverbal interactions with caregivers for children of professional parents, working-class parents, or parents who receive government welfare. The researchers' data collection continued on a regular basis for 3 years. By the age of 3 years, children of professionals had twice the vocabulary of children from families on welfare, with children from working-class families between the other 2 groups. Such large differences suggest that low-socioeconomic status (SES) families experience substantial challenges, and their children may experience further challenges when confronted with the interactional and learning demands of formal schooling. Longitudinal data⁵ suggest that these challenges and gaps persist for years. Because of the concentration of school failure among low-income and specific minority populations, the populations of primary interest in this review are blacks, American Indians, Hispanics, Asians, and low-income non-Hispanic white children, the last group making up the largest proportion of low-income children in the United States (52.4% in 2013).⁶

ECE programs, types, and characteristics

For purposes of this review, ECE programs are defined as programs designed to improve the cognitive or social development of 3- and 4-year-old children prior to kindergarten enrollment. Programs must include an educational component that addresses 1 or more of these learning objectives: literacy, numeracy, cognitive development, socioemotional development, and motor skills. Eligible programs may offer additional compo-

nents including recreation, meals, health care, parental supports, and social services. Some programs enroll children younger than 3 years.

Three general types of ECE programs are distinguished in the research literature (Table 1): state and district programs, the federal Head Start program, and model programs such as the Perry Preschool and Abecedarian programs.^{7,8} State and district programs and the federal Head Start program are publicly financed, whereas model programs often have been implemented in well-funded research projects, closely monitored for fidelity of implementation, and staffed by highly trained staff. Although some well-known model programs have served children of low-income families and communities, their costs may make widespread adoption challenging and large-scale implementation with fidelity difficult to achieve.

Community Guide review process

The Community Guide systematic review process^{9,10} was used to assess the effectiveness of ECE programs in advancing the educational, social, and health-related outcomes of low-income and racial/ethnic minority populations in the United States. The review process involved forming a systematic review team of methodology and subject matter experts (the team) from the Centers for Disease Control and Prevention and elsewhere to work with oversight from the nonfederal, independent, unpaid Community Preventive Services Task Force (Task Force) to develop evidence-based recommendations. The rules of evidence used by the Task Force address several aspects of the body of evidence, including the number of studies of different levels of design and execution, consistency of findings among studies, public health importance of the overall effect magnitude, and balance of benefits and harms of the intervention.

Conceptual approach and analytic framework

ECE programs are hypothesized to affect education and health by several interrelated intermediate determinants (Figure 1). The programs can increase motivation and readiness of children for formal schooling by engaging with caring teachers and other same-age children. Engagement with teachers and peers promotes social behaviors that facilitate learning and enhance the long-term life skill of positive social interaction. Teacher contact also increases early identification of social, health, and cognitive challenges of individual children and enables early referral for intervention when needed. Interactions among teachers and ECE parents strengthen parents' capacities, including their ability to reinforce the education and socialization of their

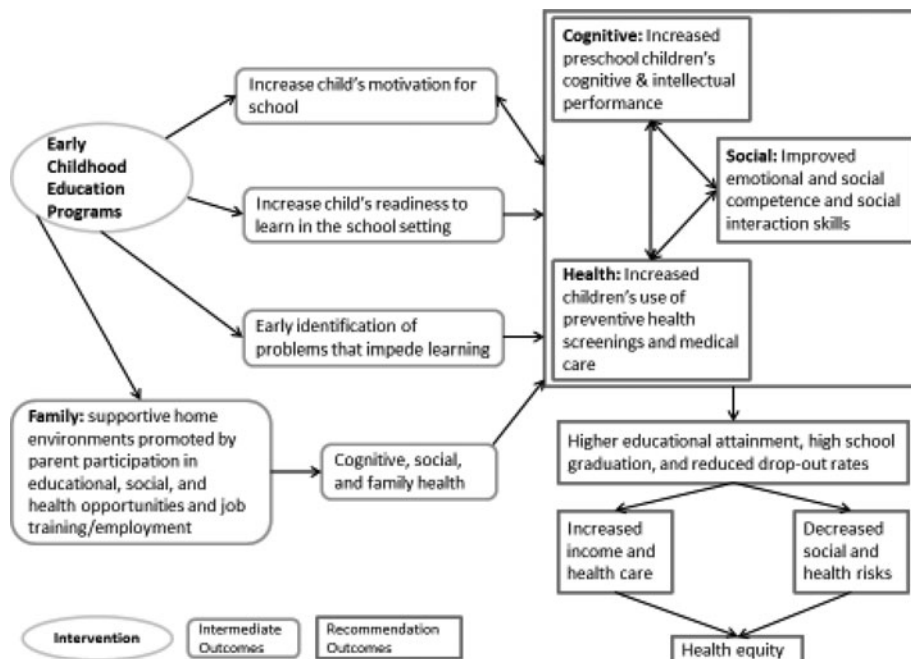
TABLE 1 ● Reported Characteristics of 3 Types of Center-Based Early Childhood Education Programs

	State and District Preschool	Head Start	Model Programs
Student ages	3-4 y (most students were 4-y-old)	3-4 y	Varied by program; some served birth to 5 y and others enrolled students aged 3-4 y
Income limits	Often low-income	Low-income	Low-income
Screening/care provided	Health screening	Health, vision, and dental screening	Health care (in some programs)
Other services provided	Varied	Family support services	Home visits
Teacher training	Most had at least an associate degree in early childhood education	57% of programs required a bachelor's degree	"Highly trained"
Instruction hours per year	320 to >1080 h	57% of programs full-day—1170 h; 74% of programs followed school calendar	Varied
Quality score ^a	7.4	8	10
Annual cost per child (average estimated in 2012 US dollars)	\$6305	\$9332	Not reported

^aAdapted with permission from National Institute for Early Education Research. Available at: www.nieer.org.

children. By enhancing social and educational skills before children enter formal schooling, ECE programs should strengthen the foundation for ongoing learning, with substantial long-term health benefits. ECE programs may be critical for low-income and minority children who have not been exposed to the learning en-

vironments generally more available to higher-income families. High-quality ECE programs that increase participation of low-income and racial and ethnic minority children are expected to improve long-term educational and health outcomes and reduce disparities. Some have found evidence that ECE programs may be

FIGURE 1 ● Analytic Framework: How Center-Based Early Childhood Educational Programs Affect Educational, Social, and Health-Related Outcomes and Health Equity

associated with an increase in externalizing behavior¹¹; other studies indicate that high-quality ECE can compensate for troubled home environments without socioemotional harm, particularly for children who begin ECE at older ages.^{12,13}

● Evidence Acquisition

Search for evidence

This review updates an earlier Community Guide review of ECE.¹⁴ That review assessed only publicly funded US programs, thus excluding model programs. It included 12 studies that provided strong evidence of effectiveness in preventing cognitive delay and increasing readiness to learn, and insufficient evidence of effectiveness on other outcomes.

In the search for literature evaluating ECE programs, 2 recent meta-analyses were located: Leak et al,¹⁵ under auspices of the National Forum on Early Childhood Policy and Programs (the “Forum”), searched the literature up to 2007, and Kay and Pennucci,¹⁶ under auspices of the Washington State Institute for Public Policy, searched the literature up to 2013. Following Community Guide criteria for the use of existing systematic reviews, the review by Kay and Pennucci was chosen as the basis for this review because it included more recent studies and met Community Guide systematic review requirements in terms of intervention definition, range of outcomes assessed, study design and execution evaluation, synthesis of effect estimates, and assessment of long-term effects. That study’s literature search strategy was expedited but is likely to have captured the well-known, high-quality studies in the field.

Study inclusion criteria

To qualify for inclusion in the Community Guide review, a study had to examine programs that closely matched those analyzed by Kay and Pennucci:

- for children aged 3 or 4 years, although children may begin the program at earlier ages;
 - directed at primarily low-income or racial and ethnic minority populations;
 - not exclusively for a population with medical disorders or learning disabilities;
 - not conducted only in the summer; and
 - based on behavioral interventions, excluding medical procedures or medications.
- Studies also had to:
- include an assessment of effects on children’s health, health-related outcomes, or academic outcomes; and

- have a control or comparison population and provide enough data for analysts to calculate effect size and adjust for confounding.

Synthesis methods

Kay and Pennucci¹⁶ used meta-analytic methods to summarize effects across included studies. Effect sizes are presented as standardized mean differences in outcomes among the intervention population compared with the control population. Insofar as data were available, Kay and Pennucci sought to assess effect modification associated with several program features: per pupil funding, staff salaries, staff retention, class size, child-to-teacher ratio, length of instructional day, teacher education levels, and classroom quality. Analyses for the present review were conducted in 2014.

To assess the persistence of improvements in cognitive functioning attributed to ECE programs, Kay and Pennucci¹⁶ included 10 studies that assessed cognitive abilities such as IQ scores in addition to achievement test scores, thus expanding the body of evidence from 49 to 59 studies. They assessed several statistical functions for goodness of fit with the longitudinal data. They also assessed whether the addition of broader cognitive measures alters the assessment of long-term effects based on achievement scores alone.

Kay and Pennucci¹⁶ included a benefit-cost analysis that focused on Washington State programs and did not include model programs. With their collaboration, the Community Guide economics team will publish a separate economic analysis of ECE including programs in other states and model programs.

● Evidence Synthesis

ECE effects

In the studies included in the Kay and Pennucci¹⁶ meta-analysis, some outcomes were assessed shortly after program completion and others were assessed when students were older. For some outcomes, there were no studies to estimate an effect for 1 or more program types. Where data were available, effects for all outcomes were in a favorable direction for each program type but not all effects were statistically significant at the $P < .05$ level (Table 2, which excludes program types without data on given outcomes). Program specific findings were as follows:

- *Standardized achievement tests:* Significant beneficial effects were found for all 3 program types: state and district, 0.32 SD (95% CI, 0.25-0.38); Head Start, 0.17

TABLE 2 ● Effects of Center-Based Early Childhood Education Programs on Educational, Social, and Health-Related Outcomes (Data for All Program Types Combined)

Outcome (Number of Studies; Program Types Included)	Mean Age at Follow-up, y	Standardized Mean Difference (95% CI)	Effect Meaningful?	Consistent Across Body of Evidence?
Test scores (27 studies; all types)	3.7	0.29 (0.23-0.34)	Yes	Yes
High school graduation (7 studies; all types)	20.0	0.20 (0.07-0.33)	Yes	Yes
Grade retention (12 studies; all types)	17.0	− 0.23 (−0.43 to −0.02)	Yes	Yes
Assignment to special education (6 studies; state and district and model programs)	15.5	− 0.28 (−0.49 to −0.08)	Yes	Yes
Crime (5 studies; all types)	25.0	− 0.23 (−0.45 to 0.05)	Yes	No
Teen birth (3 studies; Head Start and model programs)	18.0	− 0.46 (−0.92 to 0.0)	Yes	No
Self-regulation (5 studies; state and district and Head Start programs)	18.0	0.21 (0.14-0.28)	Yes	Yes
Emotional development (7 studies; state and district and Head Start programs)	4.0	0.04 (−0.05 to 0.12)	No	No

SD (95% CI, 0.12-0.23); model, 0.57 SD (95% CI, 0.24-0.81).

- *High school graduation*: A statistically significant positive effect was found for Head Start programs but not for the other program types: Head Start, 0.18 SD (95% CI, 0.03-0.33); state and district, 0.23 SD (95% CI, −0.04 to 0.50); model, 0.31 SD (95% CI, −0.21 to 0.83).
- *Grade retention* (in which children are held back from the next grade because they have not succeeded in required learning): Nonsignificant favorable effects were found for all program types: state and district: −0.39 SD (95% CI, −1.34 to 0.19); Head Start, −0.08 SD (95% CI, −0.34 to 0.19); model: −0.46 SD (95% CI, −0.96 to 0.03).
- *Assignment to special education* (in which children are taken out of the standard learning track and assigned to receive extra attention because of learning difficulties): Nonsignificant favorable effects were found for state and district and model program types; this outcome was not evaluated for Head Start: state and district: −0.12 SD (95% CI, −0.51 to 0.04); model: −0.47 SD (95% CI, −0.99 to 0.05).
- *Crime*: Nonsignificant favorable effects were found for all the program types: state and district, −0.25 SD (95% CI, −0.59 to 0.09); Head Start, −0.18 SD (95% CI, −0.71 to 0.35); model, −0.32 SD (95% CI, −0.74 to 0.10).
- *Teen births*: No data were available for state and district programs, but there were nonsignificant favorable effects for the other 2 program types: Head Start, −0.47 SD (95% CI, −1.04 to 0.11); model, −0.44 SD (95% CI, −1.22 to 0.33).

- *Self-regulation*: A statistically significant effect was found for state and district programs, a nonsignificant effect was shown for Head Start, and this outcome was not assessed for model programs: state and district, 0.23 SD (95% CI, 0.12-0.33); Head Start, 0.16 SD (95% CI, −0.09 to 0.41).
- *Emotional development*: Effects were small and statistically nonsignificant for state and district programs and Head Start programs, and this outcome was not assessed for model programs: state and district, 0.04 SD (95% CI, −0.08 to 0.17); Head Start, 0.03 SD (95% CI, −0.07 to 0.13).

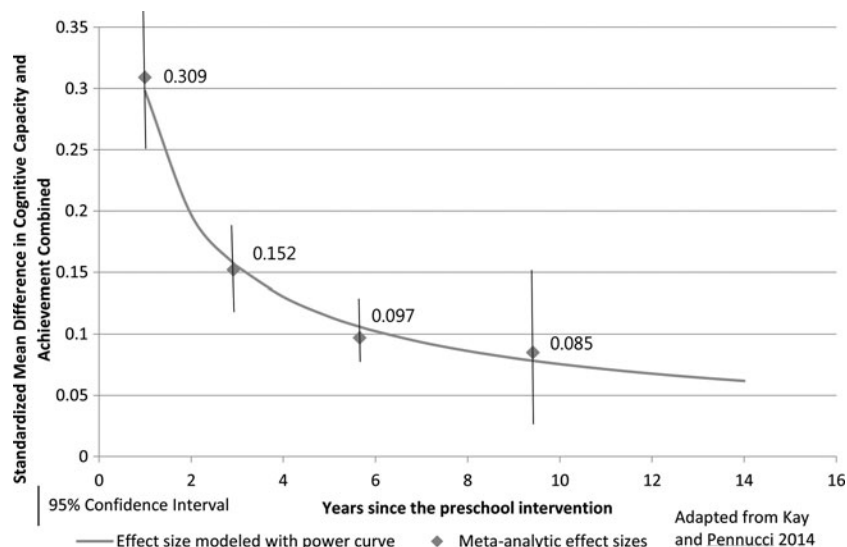
Persistence of ECE effects

Among several statistical functions for the longitudinal relationship between ECE and measures of cognitive abilities, the model that best fit the data was a power function: a rapid decrease of effects followed the end of the program, with a more gradual decline in later years (Figure 2). An assessment of the difference in rates of decline in achievement versus IQ indicated no significant statistical difference (N. Kay, Washington State Institute for Public Policy, oral communication, 2014). Eight years after program conclusion, there remained a statistically significant program benefit ($P < .05$).

Effect modification

Two program characteristics were associated with nonsignificant increases in ECE effects. Programs that hired

FIGURE 2 ● Academic Ability and Performance Fadeout (Combining Achievement and Cognitive Ability), WSIPP Meta-analysis, 2014 Standardized Mean Difference (59 Data Points)^a



^aAdapted with permission from Kay and Pennucci.¹⁶

teachers with at least a bachelor's degree showed greater effects on student standardized achievement, as did programs with higher program quality scores on the Early Childhood Environmental Rating Scale—a scale that includes many evidence-based elements (<http://ers.fpg.unc.edu/>). Data were insufficient to determine the most effective class size, hours, duration, program foci, or the possible benefit of additional components (eg, health care, parental involvement, or meals) because too few studies reported these program characteristics.

● Discussion

Summary of findings

- There is strong evidence that center-based ECE programs improve educational outcomes.
- Program effects on standardized test scores persist following program completion, with declining effect sizes over time.
- There is sufficient evidence that center-based ECE programs improve several long-term social and health outcomes.
- All 3 reviewed program types are effective (state and district programs, Head Start programs, and model programs).

Applicability

Although all studies were conducted in predominantly low-income or racial and ethnic minority communities,

programs attended by children in higher-income families are generally of high quality and therefore are likely to be effective in these populations as well.¹⁷ It is important to note that publicly funded programs such as the federal Head Start are included among those that are effective. For high school graduation, the Head Start program is the only program type that showed statistically significant benefit in the meta-analysis.

Additional benefits and potential harms

- Drawing from studies included in the evidence review, the broader literature, and expert opinion, the team found 1 possible added benefit: creation of additional work-time for parents and subsequent increased family income (implied). The team also noted 2 potential harms: loss of free, recreational time for children (postulated) and loss of family time (implied).

Evidence gaps

To maximize and sustain the benefits of ECE programs, research should address the following questions:

- How old should children be when they enroll in an ECE program?
- What should the teacher-to-student ratio be to ensure program benefits?
- What is the minimum program length (in months or years) required to achieve beneficial and long-lasting effects? How many days a week should programs be offered, and for how many hours each day?

- What are the core components that should be included in program curricula, and how can they best be adapted for different groups and settings?
- What are the independent effects of additional program components such as recreation, meals, health care, parental supports, and social services?
- Why does program effect diminish over time? Are there school, family, or environmental conditions that improve the maintenance of early benefits?

● Conclusions

This review found strong evidence that center-based ECE programs improve educational and health-related outcomes for low-income and minority children aged 3 and 4 years. By improving educational outcomes for low-income and racial and ethnic minority children, these programs can promote long-term educational and health outcomes and increase health equity in countries with high-income economies, such as the United States. All studies included in the meta-analysis used high-quality designs and controlled well for confounding. The number of such studies was large enough to indicate the effects of ECE on a variety of educational and social and health-related outcomes. However, available studies often lacked detailed program descriptions, making it difficult to assess the effects of program components.

Although for reasons noted earlier, the meta-analysis by the Forum¹⁵ was not used to assess the effectiveness of ECE programs in this review, that meta-analysis includes a larger body of evidence and has the statistical power to address questions of interest to readers left unanswered by the Kay and Pennucci¹⁶ meta-analysis. For example, one Forum study¹⁵ indicated that ECE effects following program completion were substantially greater for black and Hispanic participants than for others in the programs. Another Forum study¹⁸ found that programs that involved training parents in child education and the modeling of good instructional practice substantially increased program effectiveness. Awareness of these effect modifiers is critical in designing and targeting programs to promote health equity.

One feature of ECE programs for poor and minority children suggests a possible reason for the decreasing effects of ECE programs as participants mature. Post-ECE educational quality is an important modifier of the long-term effects of ECE itself. Because poor and minority children are likely to live in poor neighborhoods, they are also more likely to attend lower-quality schools, as measured, for example, by average school achievement and school safety.¹⁹⁻²² Because lower-quality elementary schools will independently

lead to lower student achievement, children who attend ECE are likely to have lower achievement growth after ECE even if their achievement has been advanced by ECE. For example, whereas children of high-SES families have mathematics achievement scores at 7 years of age similar to those of low-SES children, they have higher mathematics scores at 16 years of age. The apparent gap between scores is greatly reduced when intervening school quality (measured, for example, by the age at which phonics and mathematics education are initiated and teacher-to-student ratios) is taken into account.¹⁹

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