

Effects of Full-Day Kindergarten on the Long-Term Health Prospects of Children in Low-Income and Racial/Ethnic-Minority Populations

A Community Guide Systematic Review

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Context: Children from low-income and minority families are often behind higher-income and majority children in language, cognitive, and social development even before they enter school. Because educational achievement has been shown to improve long-term health, addressing these delays may foster greater health equity. This systematic review assesses the extent to which full-day kindergarten (FDK), compared with half-day kindergarten (HDK), prepares children, particularly those from low-income and minority families, to succeed in primary and secondary school and improve lifelong health.

Evidence acquisition: A meta-analysis (2010) on the effects of FDK versus HDK among U.S. children measured educational achievement at the end of kindergarten. The meta-analysis was concordant with Community Guide criteria. Findings on the longer-term effects of FDK suggested “fade-out” by third grade. The present review used evidence on the longer-term effects of pre-K education to explore the loss of FDK effects over time.

Evidence synthesis: FDK improved academic achievement by an average of 0.35 SDs (Cohen’s *d*; 95% CI=0.23, 0.46). The effect on verbal achievement was 0.46 (Cohen’s *d*; 95% CI=0.32, 0.61) and that on math achievement was 0.24 (Cohen’s *d*; 95% CI=0.06, 0.43).

Evidence of “fade-out” from pre-K education found that better-designed studies indicated both residual benefits over multiple years and the utility of educational boosters to maintain benefits, suggesting analogous longer-term effects of FDK.

Conclusions: There is strong evidence that FDK improves academic achievement, a predictor of longer-term health benefits. To sustain early benefits, intensive elementary school education is needed. If targeted to low-income and minority communities, FDK can advance health equity.

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Context

Income, Race and Ethnicity, and Educational Attainment

Educational attainment is one of the most important determinants of 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 full-day kindergarten (FDK) to foster the public health goal of health equity, with a focus on low-income and racial/ethnic-minority populations in the U.S.

Risk factors for poor lifelong educational attainment appear even before children enter the formal educational system. A large cohort study of U.S. children entering kindergarten in 1998³ identified a high prevalence of risk factors for poor educational outcomes and differential distribution of these risk factors by race/ethnicity and income. Forty-six percent of children had one or more of the following factors: a mother with less than a high school education, family use of food stamps or receipt of welfare, a single-parent household, and parents whose primary language is not English.

Black, Hispanic, and Asian children were 2.5, 2.5, and 2.1 times, respectively, as likely as white children to have one or more risk factors. The number of risk factors was strongly associated with measures of general knowledge, reading and math abilities, fine motor skills, and social behavior among entering kindergartners. Having even one risk factor negatively affected school readiness. Longitudinal data⁴ suggest that these gaps persist for years.

How Education Affects Health

A substantial body of evidence links educational attainment to lifelong health outcomes through three interrelated pathways—(1) development of psychological and interpersonal strengths, such as a sense of control and social support, which in turn contribute to healthy social interactions; (2) problem-solving abilities and the ability to pursue and maintain productive work and adequate income, and the health benefits they provide; and (3) adoption of healthy behaviors.^{2,5,6}

Standardized tests of academic achievement and school grades assess acquired knowledge and the ability to interact effectively in the classroom setting, reason, and solve problems. Because these abilities have been shown to predict long-term health outcomes,^{2,6–8} they provide a reasonable basis for use as outcomes in Community Guide health equity reviews.

An Overview of U.S. Kindergarten

Funding for public kindergarten in the U.S. began in Ohio in 1935 and had expanded to all states by 1986.⁹ Current public and private kindergarten programs vary in intensity. FDK is a formal program offered in a school or school-like setting during the year prior to entering first grade. It typically lasts 5–6 hours per day for 1 school year. FDK activities are organized, developed, and supervised by at least one adult. Children aged 4–6 years can attend FDK. Half-day kindergarten (HDK) generally lasts about 3 hours per day, and alternating-day full-day kindergarten (ADFDK) lasts about 5–6 hours per day on alternating weekdays. In addition to more instructional time for math and language, there are more teacher-

Table 1. Proportions of programs reporting time spent on daily academic activities in half- and full-day kindergarten, % unless otherwise noted

Academic activity	Half-day kindergarten programs	Full-day kindergarten programs
> 30 minutes/day mathematics instruction	50%	80%
≥ 60 minutes/day reading instruction	37%	68%
Daily reading aloud	62%	79%
Self-selected activities (minutes/day)	32	57

Source: Walston J, West J. Full-day and half-day kindergarten in the United States: findings from the Early Childhood Longitudinal Study, Kindergarten Class of 1998–99 (NCES 2004-078). U.S. Department of Education, National Center for Education Statistics, Institute of Education Sciences. Washington, DC: U.S. Government Printing Office, 2004

guided and independent learning opportunities in FDK than in HDK (Table 1).

Over the past decades, HDK enrollment rates have declined whereas those of FDK have increased.¹⁰ By 2011, 47.8% of children aged 5 years were enrolled in public FDK, 12.0% in public HDK, 5.5% in private FDK, and 2.0% in private HDK; the remainder were either in nursery school (17.7%), elementary school (5.5%), or not formally enrolled in school (7.4%).¹¹ Although attendance in FDK is similar among racial/ethnic-minority populations, blacks are substantially more likely to attend FDK over HDK than other groups (Table 2).¹¹

Evidence Acquisition

The Community Guide systematic review process was used to assess the effectiveness of FDK (vs. HDK/ADFDK) to improve the education-related health outcomes of low-income and racial/ethnic-minority populations.^{12,13} The process involved forming a systematic review team (the team) to work with oversight from the nonfederal, independent Community Preventive Services Task Force (Task Force), to develop evidence-based recommendations.

The rules of evidence under which the Task Force makes its determination address several aspects of the body of evidence, including the number of studies of different levels of design suitability and execution, consistency of the findings among studies, public health importance of the overall effect estimate, and balance of benefits and harms of the intervention.^{12,13}

Conceptual Approach and Analytic Framework

Compared with HDK, FDK has an immediate logical consequence for children who attend: increased in-school time and reduced out-of-school time. The analytic framework (Figure 1) depicts logical and hypothetical links between FDK and downstream outcomes, ending in health and health-related consequences. Increased

Table 2. Participation in private and public full- and half-day kindergarten by 5-year-olds, U.S. 2011

Race/ethnicity ^a	Total population of 5-year-olds (thousands)	Total % enrolled K	Half-day % enrolled	Full-day % enrolled	Total public %	Total private %
White alone	3197	70.0	17.2	52.8	62.0	8.0
Black alone	561	63.3	7.7	55.6	58.3	5.0
Asian alone	196	74.0	15.8	58.2	66.3	7.7
Hispanic of any race	1072	67.5	16.2	51.4	64.3	3.3

Source: U.S. Census Bureau. School enrollment in the U.S.: enrollment status of the population 3 years old and over, by sex, age, race, Hispanic origin, foreign born, and foreign-born parentage: October 2011. www.census.gov/hhes/school/data/cps/2011/tables.html

^aThese racial and ethnic categories are not mutually exclusive

in-school time allows more time for instruction and development of learning skills, which may lead to improved cognition and cognitive skills and provide the foundation for ongoing educational development.¹⁴ Increased in-school time also allows more supervised interaction with peers and opportunities to develop socioemotional skills—elements of mental health.

Improved cognitive and socioemotional skills lead to improved educational outcomes and health behaviors, higher income, and reduced morbidity and mortality.^{2,5,6} FDK also may improve children’s nutrition insofar as healthy meals are provided. Spending more time with trained teachers also may increase the detection of health and learning problems and referral for diagnosis and treatment. Reduced out-of-school time may lower parents’ child care expenses and increase the time available for parents to work. Potential undesirable effects may include increased pressure to learn and decreased recreational time and time with family.

Inclusion Criteria

To qualify for inclusion in this review, a study had to

- evaluate the relative effectiveness of FDK compared with HDK or ADFDK;
- measure and report educational outcomes, including school grades or performance on standardized achievement tests and/or health-related behavioral outcomes reflecting the level of social development;
- be published in English and conducted in a country with a high-income economy.¹⁵

Search for Evidence

During the FDK literature search, the team identified a meta-analysis on this topic reported by Cooper et al.¹⁶ This meta-analysis was assessed and determined to match the goals of the Community Guide review with respect to the interventions and outcomes evaluated, study design, and synthesis and assessment of evidence.

It was accepted by the Task Force as the basis for their findings and recommendations. To determine whether studies published after the cutoff date of the meta-analysis (October 2009) were consistent with its findings, the team conducted a systematic search for new studies using the search criteria of Cooper et al.; no qualifying studies published up to March 2011 were identified.

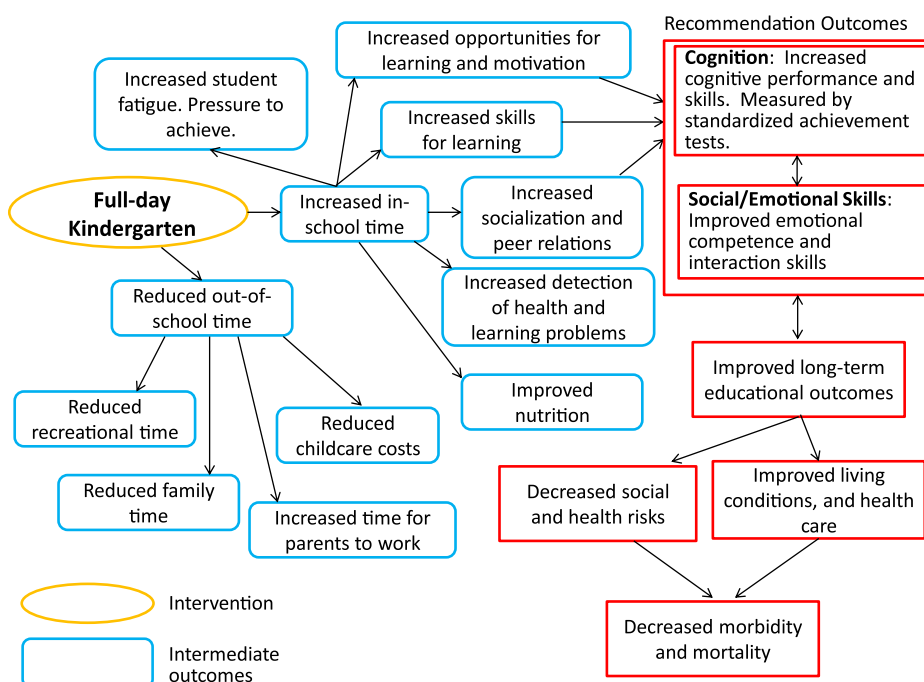


Figure 1. Analytic framework of the effects of full-day kindergarten on distal health and other outcomes

The literature search in the meta-analysis of Cooper et al.¹⁶ included all available years up to October 2009 in the following databases: ERIC, PsycINFO, Sociological Abstracts, Dissertation Abstracts, EconLit, and Google Scholar. In addition, institutions of higher education and other education-related organizations were contacted and asked to submit reports of unpublished studies. References in previous reviews and studies of this topic were scanned for additional studies.

The meta-analysis recorded information on the racial and ethnic composition of the study populations when the population was homogeneous (i.e., “only one ethnicity”) but did not present results by these demographic features. It collected information on the SES of the student population to analyze differential effects for low-income populations but found insufficient data for this stratification, and therefore used a proxy measure. In the absence of detailed results on these issues, the review team examined evidence from other sources, either in studies of the intervention among low-income or minority populations themselves or in studies of the broader populations with results stratified by income and race/ethnicity.

Synthesis Methods

The meta-analysis¹⁶ focused on educational outcomes at the end of kindergarten or at the beginning of first grade, and provided only a summary of findings on longer-term effects.

Effect estimates were calculated using Cohen’s *d*, the standardized mean difference between intervention and control outcomes following the intervention.^{17,18} Both fixed and random effects models were assessed, using a weighted measure to determine the combined effects. The conclusions in the current review are based on the random effects models, because they assume heterogeneity of effects due to study design and/or intervention components.¹⁹

Cooper et al.¹⁶ provided estimates, both unadjusted and adjusted, for baseline achievement measures and for demographic characteristics of intervention and control populations, including age, gender, race/ethnicity, and preschool educational experience. Conclusions of the present review are based on adjusted effect estimates to increase the likelihood that observed effects are attributable to the intervention. The researchers used the *Q*-statistic to assess heterogeneity of combined effect size estimates.¹⁷

As a supplement to their meta-analysis, Cooper and colleagues¹⁶ summarized the results of numerous analyses from the Early Childhood Longitudinal Study—Kindergarten (ECLS-K). In 1998, the National Center for Education Statistics began collecting longitudinal data on a national sample of more than 21,000 entering kindergartners. The children were tested in the fall of 1998, in the following spring, and at the end of third and fifth grade. Because multiple analyses sampled from a single cohort would have had to be represented by a single data point in the meta-analysis, thus masking the range of results, Cooper et al. summarized these studies separately.

The meta-analysis of Cooper et al.¹⁶ found sparse and inconsistent evidence regarding longer-term effects of FDK compared with HDK/ADFDK. In the absence of additional evidence concerning long-term effects of FDK, the Community Guide team assessed the extensive evidence on the longer-term effects of pre-K education programs and identified moderators

of those effects, such as the characteristics of subsequent schooling.

Use of this evidence for inferring the relative effects of FDK rests on (1) the overlap of pre-K and kindergarten curricula and (2) evidence that children in kindergarten and pre-K have similar cognitive processing characteristics. An IOM review of child development indicates gradual and continuous changes in developmental processes in perception, cognition, or language in children between ages 3 and 5 years.¹¹

Similarly, although the notion of “stages” is evolving in the field of developmental psychology, there is support for a phase including children aged 4–5 years.²⁰ Because kindergarten and pre-K programs are similar in content and their attendees have similar psychological characteristics, the team posits that studies of the long-term effects of pre-K programs provide useful information on the long-term effects of FDK.

The study of Cooper and colleagues¹⁶ did not report effects of FDK on assignment to special education and grade retention, the requirement that a child repeat a grade because he/she has not satisfied grade requirements. In addition, differential effects according to SES and race/ethnicity were only partly reported. Evidence on these outcomes from other sources is summarized below.

Evidence Synthesis

Short-Term Effectiveness: FDK Versus HDK/ADFDK Observed at the End of Kindergarten or Beginning of First Grade

In total, Cooper and colleagues¹⁶ examined 655 study reports, and 290 were retrieved as potentially useful. Forty studies were included in the meta-analysis, of which seven were published. The studies assessed 55 “samples,” that is, separate populations. Dissertations and master’s theses accounted for 21 samples, and 16 samples were conference papers, government reports, school district reports, or other unpublished research reports.

The meta-analysis focused on FDK programs (compared with HDK and ADFDK) and their association with academic achievement. For 25 of 55 total samples, achievement outcome effects (measured by standardized achievement tests or teacher-assigned grades) were adjusted for baseline achievement measures. For nine samples, effect estimates were also adjusted for additional characteristics, including gender, age, SES, and ethnicity.

Thirty reports contained 43 samples that compared FDK with HDK; these studies indicated that FDK improved academic achievement by an average of 0.35 SDs, controlling for family income level and racial/ethnic identity (Cohen’s *d*; 95% CI=0.23, 0.46; Table 3). Cohen proposed that a “*d*” value of approximately 0.2 be regarded as “small,” 0.5 as “medium,” and ≥ 0.8 as “large.”²¹ The *d*=0.35 result implies that if a group of children was evenly

Table 3. Outcomes reported in the meta-analysis of Cooper et al.¹⁶

Outcome (no. of effect estimates)	Adjusted ^a <i>d</i> index, random effects model	Conclusion Favoring FDK over HDK/ADFDK (significance of effect estimate)
Academic achievement (35)	<i>d</i> index=0.35 (95% CI=0.23, 0.46)	Significant effect FDK versus HDK
	<i>d</i> index=0.43 (95% CI=0.07, 0.79)	FDK versus ADFDK
Verbal scores (21)	<i>d</i> index=0.24 (95% CI=0.32, 0.61)	Significant effect FDK versus HDK
	<i>d</i> index=0.46 (95% CI=0.06, 0.43)	Significant effect FDK versus HDK
Math scores (9)	<i>d</i> index=1.06 (95% CI=0.63, 1.49)	Significant effect FDK versus HDK
	<i>d</i> index=0.09 (95% CI=-0.32, 0.50)	Nonsignificant effect FDK versus HDK

Source: Cooper H, Batts Allen A, Patail E, Dent AL. Effects of full-day kindergarten on academic achievement and social development. *Rev Educ Res* 2010;80(1):34–70

^aAdjusted for baseline test scores and/or demographics in intervention and control populations
ADFDK, alternate-day full-day kindergarten; FDK, full-day kindergarten; HDK, half-day kindergarten

divided between FDK and HDK, 59% of those in FDK would have test scores above the population median, compared with 41% of those in HDK.²²

Math scores were improved over those of HDK enrollees by 0.24 SDs (Cohen's *d*; 95% CI=0.06, 0.43) and verbal scores by 0.46 SDs (Cohen's *d*; 95% CI=0.32, 0.61). Seven studies comparing achievement scores of FDK with ADFDK students found that FDK scores exceeded ADFDK scores by 0.43 SDs (Cohen's *d*, 95% CI=0.07, 0.79). On the basis of a single study,²³ children in FDK also showed an increased ability to work or play with others, indicative of socioemotional health (*d* =1.06; 95% CI=0.63, 1.49). Another single study²⁴ indicated a nonsignificant increase in school attendance associated with FDK.

Using urbanicity as a proxy for low income, Cooper and colleagues¹⁶ found that the effect of FDK among urban populations (ten studies; *d*=0.49; 95% CI=0.25, 0.72) was substantially greater than in nonurban (suburban and rural, seven studies) populations (*d*=0.18; 95% CI=0.02, 0.35), concluding that FDK programs may be more effective for lower-income children.

However, use of urban/nonurban location as a proxy for child's family income level or poverty is problematic. Although rates of child poverty are generally greater in urban than in suburban settings, urban rates are only slightly higher than rural rates.²⁵ Cooper (H Cooper, Duke University, personal communication, 2013) reports that the nonurban studies in the meta-analysis were conducted in a mixture of suburban and rural settings, which have lower and higher rates of child poverty, respectively, compared with urban rates. Thus, it is likely that the urban/nonurban proxy was inadequate for poverty or SES; inferences using this proxy are likely to be invalid.

Meta-analysis results stratified by race/ethnicity were not reported, perhaps because of the strict requirement that populations be homogeneous in order to be classified as one race or another; a scan of the meta-analysis Appendix database (rer.sagepub.com/supplemental/) suggests that this variable was rarely reported in included studies.

Cooper et al.¹⁶ assessed whether any of several methodologic or programmatic study characteristics were associated with different levels of school achievement following completion of kindergarten, and found no significant differences by publication status or sample size. Unadjusted effect sizes were significantly larger than adjusted effect sizes.

The researchers also assessed effects of specific kindergarten program characteristics on outcomes. One analysis found that kindergarten programs of <360 minutes per day have an effect estimate of *d*=0.07 (95% CI=-0.07, 0.25), whereas those of ≥360 minutes per day have an effect estimate of *d*=0.43 (95% CI=0.18, 0.67), confirming the overall study findings. Results from the ECLS studies²⁶ were consistent with the meta-analysis.¹⁶

Long-Term Effectiveness: FDK During the Grade School Years

To assess the fade-out, or diminution of intervention effects over time, Cooper et al.¹⁶ used findings from the ECLS and studies included in the meta-analysis;^{27–34} findings were inconsistent. Some studies showed increased benefit over time, whereas others, including the ECLS studies, showed decreased benefit. Adjusted for demographic characteristics, the results of these studies are presented in Figures 2 and 3.

Mathematics—Adjusted Effect Estimate

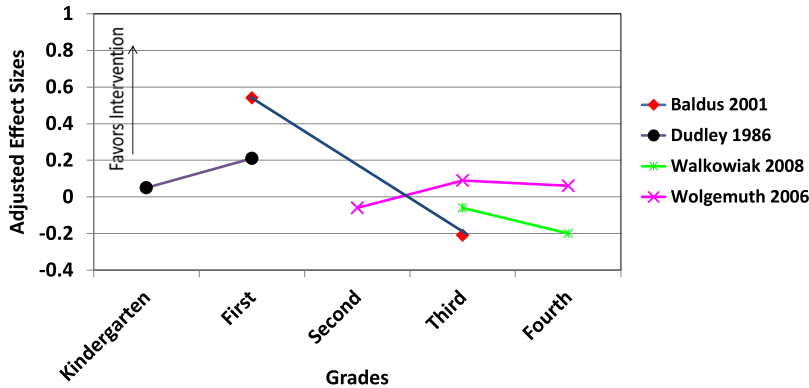


Figure 2. Long-term effects of full-day kindergarten (versus half-day kindergarten) on mathematics achievement

Note: Chart developed from data presented by Cooper et al.¹⁶

None of the studies in the review of Cooper et al. assessed potential benefits of educational boosters in reducing fade-out. (An educational booster is a program enhancement, supplement, or strengthening measure, such as more teachers, better-trained teachers, or additional curricula that might improve the longer-term effect of an earlier intervention.)

Two features of FDK indicate possible reasons for the apparent fade-out of FDK and other early childhood educational programs. First, until recently, poor and minority children were more likely than children in other population segments to attend FDK (rather than HDK). Because poor and minority children are likely to live in poor neighborhoods, they are also more likely to subsequently attend elementary schools of lower quality, as measured, for example, by average school achievement and school safety.^{35,36}

This subsequent lower-quality schooling is the opposite of a booster.³⁴ Because lower-quality elementary

schools will independently lead to lower student achievement, children who attend FDK are likely to have lower achievement growth after FDK even if their achievement has been advanced by FDK. For example, children from high-SES families with math achievement scores similar to those of low-SES children at age 7 years have higher math scores at age 16 years; however, this apparent gap is greatly reduced when intervening school quality is taken into account.³⁷

Second, a nationally representative survey of teachers in 2008 revealed that elementary school

teachers focus on children who are currently having difficulty learning.³⁸ Because children in FDK benefit academically from this program, they are less likely to have difficulty in learning when they begin elementary school and will receive relatively less attention in first through third grade than their classmates who have not attended FDK and are not doing as well.

When compared with others, some of whom have received more individual attention, FDK children may appear to have lost at least part of the FDK benefit over less-intensive kindergarten programs/formats. However, instead of fade-out, low-achieving children in elementary school who did not attend FDK are catching up, exaggerating fade-out among children who have previously benefited from FDK because the comparison population has improved from targeted assistance. It is likely that what has changed is not the benefit of FDK for participants but the improved outcomes for those to whom the FDK participants are compared.

Reading – Adjusted Effect Estimates

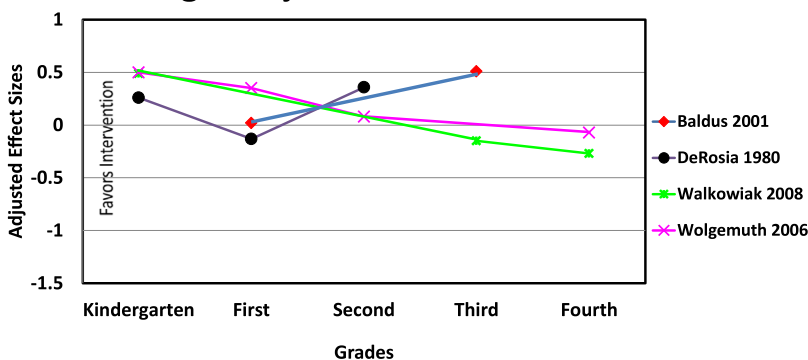


Figure 3. Long-term effects of full-day kindergarten (versus half-day kindergarten) on reading achievement

Note: Chart developed from data presented by Cooper et al.¹⁶

Lessons from Long-Term Evaluations of Pre-K Programs

Do pre-K programs have long-term effects? Evidence on the long-term effects of pre-K educational programs in the U.S. indicates that stronger study designs, such as RCTs, show substantial fade-out³⁹ and substantially greater initial and residual benefits than do studies with weaker designs, such as pre-post observational studies.⁴⁰ Although fade-out occurs, cognitive benefits—a combination of intelligence and reading abilities—remain substantial after 10 years.³⁹ The mean of standardized

mean differences for all studies combined at ages >10 years is 0.20.³⁹

Better-designed studies indicate effects on cognitive outcomes approximately twice this magnitude.⁴⁰ Other research using ECLS data supports this conclusion.⁴¹ Similar findings are reported from a systematic review of pre-K interventions in other nations.⁴² Overall, there is strong evidence that pre-K programs can have substantial and enduring benefits. In the Chicago Child-Parent Center (CPC) pre-K program, additional health benefits were reductions in violent crime and child maltreatment. It is reasonable to expect analogous outcomes for FDK.

Do booster interventions assist in maintaining the initial effects of pre-K programs? Two well-conducted studies of pre-K programs with long-term follow-up provide strong evidence of the effect of differential educational “booster” quality in first through third grade on disadvantaged children exposed to pre-K educational programs.^{43,44}

In the Abecedarian program (1972–1977),⁴³ infants in North Carolina (N=111) with multiple sociodemographic risk factors for poor educational outcomes were randomized into experimental and control groups. At school age, children from the intervention and control groups were matched on cognition scores, and one child in each pair was randomized to receive intensive educational attention for the first 3 years of elementary school or routine schooling.

Thus, four groups of children were randomized to different combinations of pre-K (or not) and intensive elementary school (or not).⁴³ Mathematics and reading achievement were assessed following the elementary school program at age 8, then again at ages 12, 15, and 21 years. Over the entire follow-up period, there was modest fade-out for the effects of pre-K alone, intensive elementary school alone, and for both interventions combined.

There was also substantial residual benefit of each intervention and both combined. At all ages, the effect of pre-K was greater than that of intensive elementary school for both math and reading, but the intensive educational booster program provided a substantial effect beyond that of pre-K alone. Additional health benefits of the Abecedarian program were reductions in teen child-bearing rates and cigarette and other substance abuse.

The second study on the course of pre-K learning during elementary school programs is the CPC program.⁴⁴ During 1985–1986, poor children in Chicago (N=989) were provided a 1- or 2-year pre-K program focused on literacy skills, along with health care. Children with demographics similar to CPC participants were randomly selected from Chicago school districts for the control condition ($n=550$).

Following the pre-K program, intervention and control children were offered special kindergarten and elementary education with smaller classes and enhanced education for 1–3 years. Intervention and control children were followed through K–12 schooling into their late 20s and assessed for multiple outcomes, including health outcomes. This design allowed assessment of the contributions of the separate and combined pre-K and K–3 components of the program, but lack of randomization in this study introduced selection bias and thus causality is unclear.

In general, immediately following the conclusion of the CPC third grade program, there were benefits of both the pre-K and intensive elementary schooling on all outcome measures; at this stage, the larger effect was from the elementary school component, the smaller effect from the pre-K program, and the combination of both showed the greatest benefit.

Two years later, there was a diminished overall benefit: the relative contribution of pre-K was increased, that of elementary school decreased, and the combined effect was again significantly greater than the effect of each alone. Thus, the CPC study also indicates the enduring benefits of an early learning program and the added benefit of subsequent intensive educational boosters. It is reasonable to expect that long-term benefits of FDK will also depend on strong, ongoing primary education.

Outcomes Not Fully Considered in the Meta-Analysis of Cooper et al.

Two categories of outcomes not fully assessed by Cooper et al.¹⁶ were (1) reductions in grade retention and referral to special education and (2) differential effects of FDK by SES and race/ethnicity. Although referral for special education may sometimes be appropriate, it may also be regarded as a failure when remediable problems are not addressed, leading to unnecessary referral. Findings associated with FDK on these outcomes are reported in other studies of FDK and summarized here.

Grade retention is an indicator of ongoing academic problems and a predictor of school dropout.⁴⁵ In addition, both grade retention and referral for special education are costly, the former adding a year’s schooling expense for each retained student, the latter more often adding recurring expense. Several reviews indicate the effectiveness of FDK compared with HDK/ADFDK in reducing grade retention and referral for special education, with estimates of reductions in grade retention ranging from 17% to 75%.^{27,46–49}

Most other reviews of the effects of FDK report greater benefit for lower-income and racial/ethnic-minority students than for middle- and upper-income and white

students.^{50–53} The absence of relative benefit or lower relative benefit is also reported.^{27,28,36,54,55}

Potential Harms, Additional Benefits, and Considerations for Implementation

Full-day kindergarten may have further benefits and harms not evaluated here systematically. Researchers postulate that FDK allows earlier identification of learning problems, improved nutrition, and more time for parents to work outside the home.⁵⁵ The review team also postulates that FDK lowers out-of-pocket child care costs for families. In contrast, some researchers believe that FDK may lead to academic pressure to achieve before a child is ready developmentally and to increased fatigue, irritability, and stress-related and behavioral problems among students, and less planning time for teachers.^{14,56,57}

Preschool programs have been associated with increased behavioral problems among attendees, which may also be found in FDK.^{56,58} Implementation issues in the establishment of FDK include a lack of qualified teachers, rapid teacher turnover, and the reservations of some scholars¹⁶ about “accelerated learning” and reduced time for informal learning. Probably the greatest challenge to the successful implementation of FDK is the need to support the benefits of this intervention with ongoing, high-quality education after kindergarten.

Applicability

Because the focus of this review is increasing health equity by improving educational achievement among socioeconomically disadvantaged children, the applicability of findings across socioeconomic position and race/ethnicity are central issues. Cooper et al.¹⁶ found few study results stratified by these effect modifiers, and the present review noted concerns about their use of urbanicity as a proxy for poverty. However, as noted above, other studies of pre-K education and FDK report greater benefits for poor and minority populations.^{41,59–61}

Relative Economic Efficiency of FDK

The systematic economic review found two journal articles,^{27,28} three reports,^{49,62,63} and one doctoral dissertation⁶⁴ related to FDK and its benefits relative to HDK. Only the study by Aos et al.⁶² was rated as good according to Community Guide quality evaluation criteria.⁶⁵ The others provided only limited information on costs or benefits and were not rated. All monetary figures reported here were converted to 2009 U.S. dollars, using the Consumer Price Index.⁶⁶

Full-day kindergarten is potentially more expensive than HDK and may involve additional start-up costs,

particularly for personnel and equipment. Costs vary widely even among schools in the same district or state. Lee et al.⁴⁹ presented findings from a 1980 study that estimated 20%–24% higher costs for FDK programs over half-day programs during 1981–1983, factoring in the number of teachers, salary and fringe benefits, transportation, instructional materials, library materials, and teacher aides.

Because kindergarten teachers in schools with half-day programs can instruct two sessions per day, full-day programs generally double the number of classrooms and teachers (or teacher time) required. DeCicca²⁸ notes the reduced opportunities in full-day programs for students to share resources such as desks, books, and computers relative to half-day programs. He cites Ohio’s Office of Education Oversight estimates that FDK costs more than 70% above traditional HDK in per-pupil expenditures. Thus, estimates of the marginal cost of FDK range from 20% to more than 70%.

Stone⁶⁴ computed the average cost-effectiveness of FDK relative to HDK programs for Manheim County, Pennsylvania. Costs included teachers’ salaries and benefits, and effectiveness was measured in terms of the number of students scoring proficient on the end-of-year Developmental Reading Assessment (DRA). The county started with one full-day session and nine half-day sessions of kindergarten in 2000–2001, and all ten sessions were converted to FDK by 2003–2004. The initial cost-effectiveness per student scoring proficient was \$2790 for half-day students and \$4745 for full-day students.

As the county increased its FDK offerings over a 3-year period, the difference between HDK and FDK average cost-effectiveness ratios steadily decreased, suggesting that the FDK program became relatively more efficient over time. The percentage of students scoring proficient on the end-of-year DRA in FDK was 92.4% compared with 79.7% in HDK, and FDK cost the school district \$466,594 compared with \$159,575 for HDK. Thus, the cost-effectiveness per student scoring proficient was \$3395 for half-day students and \$4242 for full-day students, indicating that the efficiency of HDK declined substantially, whereas that of FDK increased.

On the basis of analytic modeling, Aos et al.⁶² estimated that FDK in Washington State would cost about \$2778 more per child than HDK in terms of operating and capital expenditures. Operating costs were based on the difference in teacher salaries and capital costs, including the cost of additional classrooms.

Assuming availability of appropriate public policies to sustain early gains in test scores to the end of high school, they estimated the present value of benefits to be \$5958 per student. These benefits included lifetime gains in

earnings and other benefits, including reduced crime, reduced healthcare costs, increased civic participation, and “knowledge spillovers”—the educational advances of one person that improve the capacities of collaborators, thus stimulating general economic growth.

Reductions in grade retention and assignment to special education were not included as benefits in this analysis.⁴⁸ For example, one study⁶⁷ notes additional possible savings over the long run from lower rates of grade retention, providing evidence that Philadelphia’s FDK students were substantially more likely than former HDK students to make it to third grade without repeating a grade; they estimated that the lower retention rates for FDK graduates saved approximately 19% of FDK costs. In addition, in the study of Aos et al.,⁶² to enable calculation of a societal rate of return from investment in FDK, costs of supplemental programs to help maintain initial gains in test scores must be added to the extra costs of FDK over HDK programs.

Evidence Gaps

Whereas prior reviews have indicated that FDK programs are especially effective for lower-income and minority populations,^{50–53,68,69} the meta-analysis by Cooper et al.¹⁶ could only address this issue with a proxy measure. Lack of findings on variations in effect by race/ethnicity may have been a consequence of their seemingly stringent inclusion criterion of population homogeneity (i.e., “only one ethnicity”), which, if taken literally, is rare. Given that low-income and minority populations are often developmentally behind higher-income and majority populations prior to entry into kindergarten, the differential effect of FDK by lower income and minority status is a critical issue.

There is a paucity of studies on the long-term cognitive and social-developmental effects of kindergarten programs with different formats. In the present review, evaluating the relative short-term and longer-term benefits of FDK over less-intensive HDK programs, inferences are drawn from research on the related population and educational intervention, that is, pre-K programs. Studies of kindergarten itself should assess the effects of subsequent schooling, family, and community characteristics to allow better estimation of kindergarten’s long-term effects (independent of subsequent schooling and environment) and to determine the optimal design of effective educational boosters.

Future research on the economic benefits of FDK (versus HDK) should incorporate savings in transportation costs to the school system and child care savings for parents. Other potential benefits that merit additional

study include increased employment opportunities for parents during the kindergarten years associated with children’s FDK attendance; such opportunities could raise household income and tax revenue for society.²⁷ On the other hand, there could be additional costs of FDK programs to consider, such as adopting new curricula and training teachers, principals, and other school staff members.

Discussion

The present review demonstrates that, at least in the short term, children in the general population benefit more from FDK than HDK/ADFDK in academic and social development. Evidence on the long-term benefits of pre-K programs suggests that FDK also may have long-term educational and health benefits, particularly when reinforced by intensive ongoing education programs. Prior reviews suggest greater relative benefits among children in lower-income populations and racial/ethnic-minority populations.^{50–53,68,69}

The effects reported in the present review are based on comparison of FDK and HDK/ADFDK. Assuming that HDK/ADFDK are effective, the estimates made by Cooper et al.¹⁶ and this review therefore underestimate the benefits of FDK compared with no kindergarten. To estimate the effect of FDK compared with no kindergarten at all, one would add the effect estimates reported in this study (i.e., the results of Cooper et al.) to the baseline effect reported for HDK and ADFDK.

Although very few studies report the separate effects of FDK and HDK/ADFDK, these rates are reported in two studies based on the ECLS Kindergarten Class of 1998–1999.^{49,55} This study estimates that HDK/ADFDK improves math and reading achievement scores by 1.00 and 1.05 SDs, respectively. Adding the respective estimated improvements from FDK of 0.24 and 0.46 SDs for math and reading, the benefit of FDK compared with no kindergarten is clearly large.

Given the decline over time in the relative benefits of FDK, it is critical to determine the features of subsequent educational booster programs that effectively maintain early gains.⁷⁰ Several features of effective educational, health, and social service boosters for preschool and kindergarten programs were gleaned from an assessment of the maintenance of pre-K benefits in the CPC and Abecedarian programs.⁷¹

Effective booster programs were characterized by a low student–teacher ratio, a focus on basic skills, teacher training, creation of school–parent liaisons, school meals, provision of transportation to and from school, night courses for parents, healthcare services/referrals, home visitation, and supportive social services. There is

evidence for a benefit of similar features, as well as organization and continuity, in a review of pre-K to third-grade programs and initiatives.⁷¹

Findings from the Cooper meta-analysis¹⁶ have several limitations. Outcomes measured were achievement scores available at the end of kindergarten or beginning of first grade. Adjusted effect estimates controlled for baseline achievement scores. A study³⁴ using the nationally representative ECLS cohort to assess changes in achievement over the kindergarten year found that fall baseline assessments were made as late as December of the school year and that spring ECLS assessments were made prior to the end of the kindergarten year, thus potentially underestimating the absolute achievement of FDK versus HDK for the full kindergarten year, insofar as substantially less than the full kindergarten year exposure was assessed.

In summary, the present review does not demonstrate the specific effectiveness of FDK (versus HDK) for low-income and minority populations, although the body of available studies examined here suggests that these groups likely benefit from FDK. As described above, other studies show that FDK programs are more effective for low-income and minority populations compared to more affluent and majority populations.^{40,41,60}

Researchers may also consider evidence of the intervention's overall effectiveness—without regard to income and minority status, combined with theoretical reasoning on the plausibility of a differential effect by income and minority status. For example, it might be theorized that, given a background of lesser school readiness and fewer environmental learning resources, low-income and minority children may benefit more than others academically from a greater dose/duration educational program.

In the absence of evidence to the contrary, it is reasonable to assume that, if an intervention is effective in the population overall, it is likely to be at least as effective in low-income and minority populations that have greater need. With full utilization of FDK, the general benefits should also apply to these populations and improve their academic outcomes and the long-term health benefits associated with greater educational attainment.

Education before the beginning of formal schooling has the potential to foster greater health equity by redressing educational deprivations commonly suffered by the large proportion of U.S. children who grow up in poverty. Failure to compensate for gaps in language, reasoning, and social and learning skills may lead to lifelong challenges and obstacles in the child's educational career and to subsequent difficulties in employment, income, and health. This review shows that FDK provides benefits that may, in part, address this critical need.

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