

Cost-Effective Early Childhood Development Programs from Preschool to Third Grade

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Abstract

Although findings on the positive effects of early childhood development programs have been widely disseminated, less attention has been given to program impacts across the entire period of early childhood. This review summarizes evidence on the effects and cost-effectiveness of programs and services from ages 3 to 9. The major focus is preschool programs for 3- and 4-year-olds, full-day kindergarten, school-age programs including reduced class sizes, and preschool-to-third-grade interventions. Participation in preschool programs was found to have relatively large and enduring effects on school achievement and child well-being. High-quality programs for children at risk produce strong economic returns ranging from about \$4 per dollar invested to over \$10 per dollar invested. Relative to half-day kindergarten, the positive effects of full-day kindergarten have been found to be relatively small and generally do not last for more than a year. Although no formal economic analyses have been conducted, the economic return per dollar invested would be expected to be close to zero. Among early-school-age programs, preschool plus school-age interventions (PK-3) for children at risk are linked to higher levels of school performance into adolescence. The Child-Parent Center PK-3 Program shows a return of \$6 to \$9 per dollar invested. Class-size reductions show evidence of positive effects, with economic returns of roughly \$3 per dollar invested. The causal mechanisms of long-term effects are discussed. Key principles to promote intervention effectiveness are offered.

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INTRODUCTION

The positive effects of early childhood development programs on school readiness and performance have been documented in hundreds of research studies since the 1960s and in dozens of research syntheses (Karoly et al. 2005, Reynolds et al. 2003, Zigler et al. 2006). In the past decade, findings of the accumulated evidence have been more widely disseminated to practitioners and policy makers (Carroll et al. 2003, Comm. Econ. Dev.

2002, Wallen 2002). During this time, states began to substantially increase investments in preschool programs for both at-risk children and those at lower risk. From 2005 to 2006, state-funded programs in 38 states served 943,000 3- and 4-year-olds at an annual expenditure of \$3.3 billion (Barnett et al. 2007). Nationally, 20% of all 4-year-olds attend state-funded prekindergarten programs. These programs complement the federally funded Head Start program, early childhood

special education, and related investments at the local level. Total government expenditures for programs from birth to age 5 exceed \$22 billion annually (White House 2003).

Increased attention to the early years of life also has sparked greater interest in the transition to school and the experiences in the early grades that can reinforce preschool learning gains and strengthen school achievement and performance (Bogard & Takanishi 2005, Reynolds 2003). Evidence is increasing that school-based programs provide a system that is more likely to contribute long-term benefits for children. Greater interest in kindergarten and early school-age services reflects the importance of policies and practices that enhance the continuity of development. The comparative or added effect of kindergarten programming and early school-age programs and services is of major interest.

REVIEW OF EARLY CHILDHOOD DEVELOPMENT PROGRAMS

In this review, evidence is presented on the effectiveness and cost-effectiveness of early childhood development (ECD) programs for school readiness, school achievement and performance, and long-term life course development. The primary focus is on preschool or prekindergarten programs for 3- and 4-year-olds, full-day kindergarten, and early-school-age programs including prekindergarten to third-grade (PK-3) programs and practices. Three major questions are addressed.

1. What are the effects and economic benefits of preschool programs?
2. What are the effects and economic benefits of kindergarten and school-age programs?
3. Which elements and principles of effectiveness are key to long-term effects?

For this review, early childhood development is defined broadly to include most of the first decade of children's life. Findings from prenatal and infant programs are beyond the

scope of this review, as their family focus differs from the center-based, child development approach covered here. For reviews of prenatal, infant, and home visitation programs, see Olds et al. (2007), Sweet & Appelbaum (2004), and Temple & Reynolds (2007).

Although findings on school readiness and achievement are reported in detail, we emphasize cost-benefit analyses of the effects of programs. There are three reasons for the focus on cost-benefit analyses. First, economic benefits relative to costs are the most relevant indicator for policy development. The value of public investments can be judged, at least in part, on efficiency (Heckman 2000). This is especially true in a time of scarce resources for educational and social programs. Second, in the economic-benefit approach, program effects on multiple outcomes can be converted into the metric of dollars and cents (Levin & McEwan 2001). Other metrics such as standard deviation units or percent change cannot be used across outcomes. Finally, cost-benefit analyses emphasize longer-term effects of programs and practices. A focus on immediate and shorter-term effects, while an important first step, is neither revealing nor unique in evaluation and intervention research. Longer-term effects are a major focus of early childhood programs. Although preschool and kindergarten programs may have important short-term effects, a major question for social policy is whether these short-term effects translate into long-term effects of adaptive life skills and behavior.

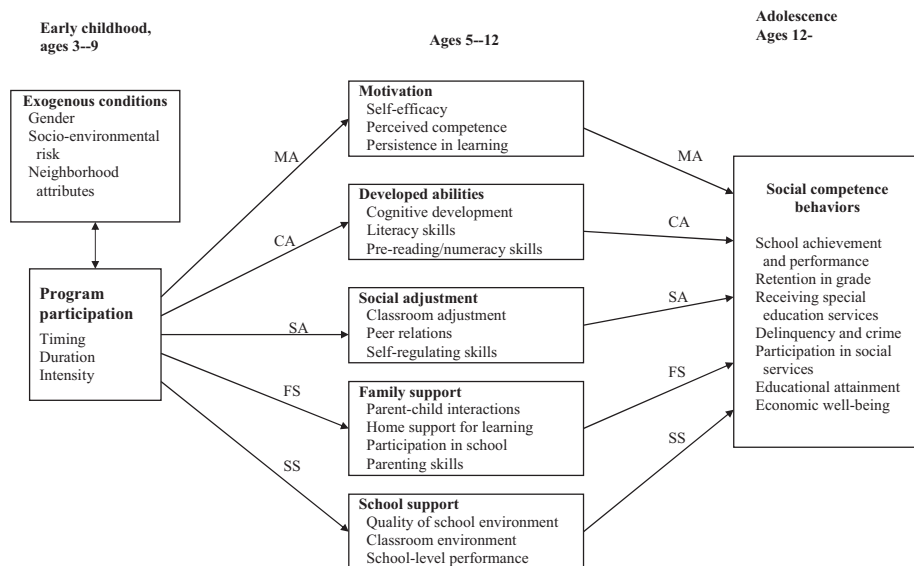
HOW EARLY CHILDHOOD DEVELOPMENT PROGRAMS INFLUENCE OUTCOMES

Considerable research has documented that ECD programs impact later school performance and related outcomes through at least one of five processes or pathways (Reynolds 2000, 2004; Reynolds et al. 2004). In short, these can be viewed as the "active" ingredients contributing to impacts on child development. They have been conceptualized from

Figure 1

Paths from program participation to social competence behavior.

Abbreviations: MA, motivational advantage; CA, cognitive advantage; SA, social adjustment; FS, family support; SS, school support.



the beginning of the early childhood as the primary mechanisms of intervention effects. As shown in **Figure 1**, the cognitive advantage pathway indicates that the longer-term effects of ECD programs are due primarily to the enhancement of cognitive skills, including literacy, school readiness, language, and numeracy.

The family support pathway indicates that impacts on child outcomes derive from greater parental investments in children's development, such as greater parent involvement in education, increased parenting skills, and greater resource supports for parents.

The school support pathway suggests that longer-term effects would occur to the degree that postprogram school experiences reinforce learning gains. Enrollment in higher-quality schools and schools with positive learning environments would strengthen or maintain learning gains, whereas enrollment in schools lower in quality would neutralize earlier learning gains.

The social adjustment and motivational advantage hypotheses indicate that noncognitive skills can be the mechanism of effects of ECD programs, such as increased classroom and peer social skills, positive teacher-child relationships, achievement motivation, and

school commitment. The greater the magnitude of effect of program experiences on a particular pathway or multiple pathways, the more likely that enduring effects would occur.

Notably, programs that provide comprehensive services would be expected to impact several of the pathways simultaneously. This is one explanation for why comprehensive programs have been found to be more likely to have longer-term effects.

CUMULATIVE EVIDENCE ON PRESCHOOL IMPACTS

Given the voluminous knowledge base, the effects of preschool ECD programs are summarized through findings from 19 reviews of preschool impacts published in the past decade (1995–2006). These reviews were selected as among the most thorough in assessing short- and longer-term effects of both model and large-scale programs (contact the author for additional information). **Table 1** includes key characteristics of the reviews such as the number of studies of model, large-scale, and Head Start programs, and the length of follow-ups. The most frequently cited programs are listed in **Table 2** along

Table 1 Reviews of early childhood intervention programs (1995–2006)

Review author	Source	Total	Number of programs studies reviewed				Years studies published	Number of studies in which effects reported (significant)		
			Large public programs	Model programs	Head Start programs			Short	Medium	Long
Chambers et al. 2006	Spodeck & Saracho, eds., <i>Handbook Res. Educ. Young Child.</i>	12	2	7	3		1968–2001	11 (10)	7 (2)	6 (3)
Blok et al. 2005	<i>Int. J. Behav. Dev.</i>	17	2	13	2		1985–2001	None	None	None
Karoly et al. 2005	<i>Early Child. Interventions</i>	20	6	12	2		1970–2004	20 (17)	3 (2)	5 (5)
Anderson et al. 2003	<i>Am. J. Prev. Med.</i>	7	1	4	2		1966–1998	7 (6)	5 (4)	4 (4)
Eckenrode et al. 2003	Lerner et al., eds., <i>Handbook Appl. Dev. Sci.</i>	12	5	7	0		1980–2002	12 (12)	5 (5)	5 (5)
Nelson et al. 2003	<i>Prev. Treat.</i>	30	7	20	3		1970–2000	27 (27)	13 (13)	10 (10)
Currie 2001	<i>J. Econ. Perspect.</i>	12	1	7	4		1983–2000	10 (8)	4 (4)	5 (5)
Gorey 2001	<i>Sch. Psychol. Q.</i>	12	1	10	1		1978–1998	None	None	None
Brooks-Gunn et al. 2000	Shonkoff & Meisels, eds., <i>Handbook Early Child. Int.</i>	31	5	26	0		1979–1999	31 (30)	0 (0)	1 (1)
Farran 2000	Shonkoff & Meisels, eds., <i>Handbook Early Child. Int.</i>	9	3	5	1		1980–1997	9 (9)	4 (4)	2 (2)
Gilliam & Zigler 2001	<i>Early Child. Res. Q.</i>	12	12	0	0		1977–1999	12 (11)	6 (1)	1 (0)
Halpern 2000	Shonkoff & Meisels, eds., <i>Handbook Early Child. Int.</i>	4	3	1	0		1994–1997	4 (1)	1 (0)	0 (0)
Shonkoff & Phillips 2000	Shonkoff & Phillips, eds., <i>Neurons to Neighborhoods</i>	12	1	11	0		1978–1997	12 (10)	4 (4)	4 (4)
Barnett 1998	Barnett & Boocock, eds., <i>Early Care Educ.</i>	35	6	15	14		1969–1998	19 (13)	22 (18)	10 (6)
Karoly et al. 1998	RAND, <i>Investing in Our Children</i>	10	1	8	1		1970–1997	8 (8)	5 (4)	5 (5)
Bryant & Maxwell 1997	Guralnick, ed., <i>Effectiveness Early Int.</i>	12	3	8	1		1977–1994	11 (11)	5 (5)	4 (4)
U.S. Gen. Account. Off. 1997	GAO/HEHS-97-59	21	0	0	21		1978–1996	21 (18)	2 (1)	0 (0)
St. Pierre et al. 1995	Behrman, ed., <i>Future Child.</i>	5	5	0	0		1982–1995	5 (5)	0 (0)	0 (0)
Yoshikawa 1995	Behrman, ed., <i>Future Child.</i>	40	1	33	4		1974–1994	37 (32)	10 (10)	4 (3)

Table 2 Most frequently cited early childhood education programs from research reviews (1995–2006)

Program	Type	Age	Citations
High/Scope Perry Preschool Program	Model	40	19
Chicago Child-Parent Centers	Large scale	21	14
Carolina Abecedarian Project	Model	21	13
Houston Parent-Child Development Center	Model	11	12
Infant and Health Development Program	Model	8	11
Comprehensive Child Development Program	Large scale	5	8
Early Training Project	Model	20	8
Prenatal/Early Infancy Project/Nurse-Family Partnership Program	Model	15	8
Milwaukee Project	Model	14	8
Philadelphia Project	Model	18	7
Consortium for Longitudinal Studies	Model	27	6
Educational Testing Service Head Start Study	Large scale	8	6
New Haven Follow-Through Study	Large scale	17	6
Institute for Developmental Studies	Model	13	5
Louisville Experiment (Head Start)	Model	16	5
Even Start	Large scale	7	4
Harlem Training Project	Model	12	4
Maryland Head Start	Large scale	17	4
Yale Child Welfare Research Project	Model	10	4
Avance Family Support and Education	Large scale	5	3
New York State Experimental Prekindergarten	Large scale	9	3
Panel Study of Income Dynamics Head Start Longitudinal Study	Large scale	25	3

with the last age of follow-up as of 2006. To be included, the programs had to contain a center-based early education or preschool component.

Two major conclusions are evident. First, many programs have assessed long-term effects into adulthood. Three-quarters of the reviews reported effects at five or more years after the end of participation. This is rare for social programs and indicates that impacts on life course development and economic benefits can be accurately assessed. Second, the accumulated evidence includes both model programs, developed for research demonstration, and large-scale programs, developed for routine implementation by schools and other institutions. Consequently, the generalizability of the evidence for policy recommendations is much stronger today than a decade ago.

What are the main findings of the reviews? Of the hundreds of studies synthesized in the reviews, there is substantial evidence that preschool programs mostly for children at risk positively impact cognitive skills, school achievement, social and emotional development as well as educational attainment, employment, and later social behavior. The average effect size on cognitive skills at or near school entry was 0.42 standard deviations (sd), which is roughly equivalent to one-half of a year of growth associated with preschool participation. Average effects were also statistically and practically significant for social and emotional development (0.24 sd), school achievement (0.35 sd), delinquency and crime (–0.22 sd), grade retention (–0.21 sd), special education (–0.46 sd), school completion (0.27 sd), and employment and earnings (0.37 sd). The

breadth of effects suggests positive economic returns.

EFFECTS AND ECONOMIC BENEFITS OF THREE PRESCHOOL PROGRAMS

Based on their prevention focus and strong evidence of enduring effects, three early childhood programs have had extensive cost-benefit analyses: Carolina Abecedarian Project (ABC), High/Scope Perry Preschool Project (PPP), and the Child-Parent Center Program (CPC). **Table 3** summarizes the three preschool programs and studies. In brief, all three programs provided high-quality educational enrichment to children at risk in group settings characterized by

small class sizes, a focus on language and cognitive skills, and well-qualified and compensated teachers (for details, see Reynolds 1999, Reynolds & Temple 2006, Temple & Reynolds 2007). ABC was the most intensive and lengthy, providing full-day, year-round care for five years (Campbell & Ramey 1995, Ramey et al. 1998). PPP provided the most established and organized curriculum, which followed the Piagetian cognitive principle of child-initiated learning (Schweinhart et al. 1993). CPC provided the most comprehensive services by implementing an intensive parent involvement component, outreach services, and attention to health and nutrition (Reynolds 2000, Reynolds et al. 2002, Sullivan 1971). It also is the only program that became established in public schools.

Table 3 Background and characteristics of three preschool programs

Characteristic	High-Scope Perry Preschool Project	Carolina Abecedarian Project	Child-Parent Center Program
Years of operation	1962–1967	1972–1977	1983–1985
City and context	Ypsilanti, MI	Chapel Hill, NC	Chicago, IL
	Urban	Rural	Inner city
Location	Elementary school	University center	Elementary school or adjacent to
Number of sites	1	1	24
Child attributes	Low SES	Low SES	Low SES
	IQs of 70–85	High risk	Reside in Title I area
Race/ethnicity	100% black	96% black	93% black
			7% Hispanic
Entry age	3 years	1–4 months	3 years
Mean duration	1.8 years	5 years	1.6 years
Length of day	Part day	Full day	Part day
Other components	Weekly home visits	Nutrition	Outreach
			Occasional home visits
			Health services
Mean class size	22	12 (infancy)	17
			12 (preschool)
Mean child-to-staff ratio	5.7 to 1	3 to 1 (infancy)	8.5 to 1
		6 to 1 (preschool)	
Curriculum emphasis	Cognitive and social	Language and social	Language and social
	Child-initiated	Traditional	Teacher-directed
Staff compensation	Public school	Competitive with public schools	Public school
School-age services	None	K to grade 2	K, grades 1 to 3

A significant difference among programs was child-to-staff ratios. CPC had 17 children and a certified teacher and aide (8.5 to 1 ratio), which is most consistent with current practice. ABC, implemented in a university-based child-care center, had 12 children and two teachers (6-to-1 ratio), neither of whom were certified. PPP had the most unusual structure with 24 children and 4 master's level certified teachers in the classroom for an average ratio of 5.7 to 1. Moreover, unlike the other programs, PPP children were selected because they had IQ scores of 70 to 85.

PRESCHOOL PARTICIPATION ENHANCES CHILDREN'S WELL-BEING INTO ADULTHOOD

The major long-term findings of the studies leading to economic benefits are shown in **Table 4** (also see Masse & Barnett 2002, Reynolds et al. 2002, Schweinhart et al. 1993). The estimated impacts of the programs are large and occurred 17 to 25 years after the end of preschool participation. Group differences are specific to preschool participation and are adjusted for child and family background differences such as preprogram IQ,

family socioeconomic status (SES), and other factors.

Although the magnitude of estimated effects varied, participation in all three programs was associated with significantly lower rates of special education services up to and including adolescence. The impact on special education was large, as preschool participants had rates of special education that were 40% to 60% lower than the comparison group. Similar reductions in grade retention were observed for the ABC and CPC programs. The Consortium for Longitudinal Studies (1983), a joint project of 13 model preschool and home visiting programs including PPP, showed similar results.

Participation in each program also was linked to significantly higher rates of high school completion up to age 27 as well as more years of education. Preschool participation was associated with about a one-half (CPC and ABC) to full-year increase (PPP) in educational attainment. Program participants also had higher rates of postsecondary and college attendance, with ABC participants showing large differences in attendance at four-year colleges.

Only PPP has shown significant group differences in employment and earnings, but this may reflect the age at follow-up assessment

Table 4 Adjusted means or percentages for program and comparison groups on key outcomes for cost-benefit analysis

Outcome	Perry Preschool	Abecedarian	Child-Parent Centers
Original sample sizes (program, control)	58, 65	57, 54	989, 550
Sample recovery for high school completion (%)	94	95	87
Special education services by age 15/18 (%)	15 vs. 34	25 vs. 48	14 vs. 25
Grade retention by age 15 (%)	ns	31 vs. 55	23 vs. 38
Child maltreatment by age 17	n/a	n/a	7 vs. 14
Arrested by age 19	31 vs. 51	ns	17 vs. 25
Highest grade completed by age 21/27 (mean)	11.9 vs. 11.0	12.2 vs. 11.6	11.3 vs. 10.9
High school completion by age 21/27 (%)	71 vs. 54	70 vs. 67 (graduation)	66 vs. 54
Attend college by age 21/27 (%)	33 vs. 28	36 vs. 14 (four-year)	24 vs. 18
Employed at age 21/27 (%)	71 vs. 59	70 vs. 58 (teen mothers)	n/a
Monthly earnings at age 27 (\$)	1219 vs. 766	n/a	n/a

Note: For Perry, special education is for educable mental impairment (i.e., mental retardation) placement by age 15. Ages for educational attainment and employment are 27 for Perry, 21 for Abecedarian, and 22 for Child-Parent Centers. Abbreviations: ns, not significant; n/a, not available.

(27 versus 21/22 for the ABC and CPC). For ABC, differences in employment were largest for teen mothers of program participants. Employment and earnings are not currently available for CPC. Only CPC demonstrated reductions in substantiated reports of child abuse and neglect (for details, see Reynolds & Robertson 2003).

Finally, both PPP and CPC have demonstrated significant program effects on crime. These effects are large. Participation in PPP was associated with a 40% decrease in arrests by age 19 (from 51% to 31% ever arrested) whereas CPC was associated with a 33% reduction in juvenile petitions by age 18 (from 25% to 17% with one or more petitions). Only PPP has collected data on adult crime, and findings are consistent with those of earlier ages. The lack of crime prevention benefits in ABC may be due to the low base rates of crime in Chapel Hill, North Carolina or, more likely, to the relative absence of family services in the program. Overall, these findings show that the programs enhanced participants' general social competence over the first two decades of life.

Not shown are the substantial effect sizes for program participation on cognitive skills at the time of kindergarten entry and on school achievement through the elementary grades. CPC participation also was associated with higher levels of parent involvement in school.

COST-BENEFIT ANALYSIS IN EARLY CHILDHOOD DEVELOPMENT PROGRAMS

Cost-benefit analysis (CBA) is an economic approach for estimating the value of alternative programs and policies relative to costs. Levin & McEwan (2001) define CBA as the "evaluation of alternatives according to their costs and benefits when each is measured in monetary terms" (p. 11). CBA can be used to rank program and intervention investments according to their effectiveness per dollar of expenditure.

CBA is a major departure from traditional measures of effect size, such as the *d* statistic and percentage change metrics, which take into account only program effects while ignoring their costs. The use of CBA in the field of early childhood development has increased dramatically (Comm. Econ. Dev. 2002, Heckman 2000, Oppenheim & McGregor 2003, Reynolds & Temple 2006, Temple & Reynolds 2007, Wallen 2002).

To illustrate estimation, relative to the control group, participants in the CPC preschool program spent an average of 0.7 fewer years in special education from kindergarten to high school (Reynolds et al. 2001). The effect size is 0.29 *sd*. This translates to an average savings in special education of \$4637 per program participant, which was calculated by multiplying the program effect of 0.7 years by the average annual cost per child of special education services above and beyond regular instruction estimated in 2004 dollars for the Chicago school district in which they were enrolled and discounting the cost at an annual rate of 3% up to age 10 (average age of special education placement; Reynolds et al. 2002).

The major advantage of CBA is that benefits for multiple outcomes can be summarized in dollar terms, either the net return (benefits minus costs) or return per dollar invested (benefits divided by costs). However, the ability to conduct a CBA depends on whether it is possible to reflect program benefits in dollar terms. Estimates are most accurate if outcomes are receipt of services (e.g., special education) or are strongly correlated with them or with future costs of treatment or economic well-being. These may include juvenile arrest, educational attainment, and grade retention. Secondary measures such as achievement test scores or problem behaviors may also be used, but their correlation with income and future crime is more modest. When program outcomes cannot be easily converted to monetary terms, cost-effectiveness analysis is the recommended approach (see Levin & McEwan 2001).

Table 5 Summary of costs and benefits per participant in 2002 dollars for three preschool programs

Costs and benefits	High/Scope Perry Preschool	Chicago Child-Parent Centers	Abecedarian Project
Program costs (\$)			
Average program participant	15,844	7384	35,864
For one year of participation	9759	4856	13,900
Program benefits (\$)			
Total benefits	138,486	74,981	135,546
Net benefits (benefits minus costs)	122,642	67,595	99,682
Total benefit per dollar invested	8.74	10.15	3.78
Public benefit per dollar invested (benefit-cost ratio)	7.16	6.87	2.69

Note: Costs are program expenditures and do not include estimated costs for comparison-group experiences. Ages of study participants for economic analyses were 27, 21, and 22, respectively. The Abecedarian cost is relative to control group. The total cost per participant was \$67,225. Based on the actual costs, total and public benefits of Abecedarian Project per dollar invested are \$2.02 and \$1.44, respectively.

SUMMARY OF RESULTS OF THREE COST-BENEFIT ANALYSES

At a minimum, the economic return should equal the amount invested in the program—a return of at least one dollar per dollar invested. Estimates of economic benefits derive from three sources. Benefits to participants are returned to the child and parent attending the program but do not directly benefit others in society. These benefits include increased earnings capacity in adulthood projected from educational attainment as well as the benefit to parents from the provision of part-day care for children. Benefits to the public include averted expenditures of remedial education and social welfare spending by governments, reduced tangible expenditures to crime victims as a result of lower rates of crime, and increased tax revenues to state and federal governments as a result of higher earnings capacity. Benefits to society include the sum of benefits to program participants and to the general public. Societal benefits are emphasized, which represent the total economic contribution of programs.¹

¹The benefits typically included in CBA are (a) reduced need for future remedial education services, (b) increased educational attainment or increased test scores, (c) reduced future crime costs (administration and treatment), (d) savings to victims of crime (tangible or intangible), (e) reduced

As shown in Table 5, all three programs showed substantial economic returns of preschool into adulthood through government savings in education, justice system, and health expenditures and in increased economic well-being. The values are those reported in the CBAs for each program. All values are the average economic return per program participant in 2002 dollars. The assumptions underlying each CBA were not identical.

Although the costs of the programs are significantly different from each other, the economic returns of each program far exceeded the initial investment. The total economic benefits per participant, both measured and projected over the life course, ranged from \$74,981 to \$138,486. The net economic benefit per participant (benefits minus costs) for PPP was \$122,642 and for ABC was \$99,682. The net economic benefit for the CPC, an established Title I program, was

costs in child welfare services (administration and treatment), and (f) improved health or associated averted medical expenditures. The benefits typically not included are (a) improved social and emotional outcomes, (b) social cohesion (or citizenship), (c) improved health of participant's future spouse and children, (d) increased educational attainment of participant's children, (e) increased savings, (f) increased charitable giving, and (g) increased test scores. (For further information, see Reynolds & Temple 2006, Temple & Reynolds 2007.)

\$67,595. The benefit for ABC is especially salient given its relatively high cost. Despite the cost of full-day year-round care for five years, the program returned per participant nearly \$100,000. Indeed, when using the actual cost of ABC (\$67,225) rather than the marginal cost (actual cost minus the costs of care for the comparison group), benefits substantially exceeded costs.

Table 5 also shows the economic benefits as a ratio of program costs. These ratios can be interpreted as the economic return per dollar invested, which is an indication of program efficiency. Benefit-to-cost ratios index the return on investment, whereby \$2 per dollar invested would be a 100% return. All three programs showed a large return on investment based on data collected into adulthood, ranging from a total societal benefit of \$4 per dollar invested to \$10.15 per dollar invested. These are equivalent to a 278% to 915% return on the dollar. The CPC program showed the highest benefit-cost ratio at \$10.15, reflecting its relatively lower costs. The lower costs are primarily a result of a higher child-to-staff ratio in the classroom (8.5 to 1 for CPC versus less than 6 to 1 for PPP and ABC). Without intangible crime victim benefits, the ratio of benefits to costs for CPC is \$7.14. That a routinely implemented school-based program demonstrates positive returns indicates that wide-scale programs can be cost-effective. The other school-based program, PPP, demonstrated an economic return of \$8.74 per dollar invested as assessed at age 27. Although not included here, the economic return at age 40 follow-up of PPP nearly doubled (see Schweinhart et al. 2005). At \$3.78 per dollar invested, ABC had the lowest benefit-cost ratio. This is not surprising given its high cost. In terms of public benefits alone (i.e., government and crime victim savings), benefit-cost ratios ranged from \$2.69 to \$7.16 per dollar invested.

In summary, the CBA findings show the high returns of investments in preschool education despite the differences in timing, dura-

tion, geography, time period, and content of the three programs. This consistent pattern of results strengthens the generalizability of findings to contemporary programs.

EFFECTS OF CONTEMPORARY STATE-FINANCED PRESCHOOL PROGRAMS

The consistent findings of the economic analyses of the PPP, CPC, and ABC programs, despite their major differences in social context and instructional approach, are encouraging evidence in favor of expanding preschool access. However, the participants of the three programs were almost exclusively low-income, African American children. Although there is no comparable evidence from studies of middle-income families or from more diverse samples, research on the short-term effects of state-funded preschool programs, which include more diverse samples by socioeconomic status and race/ethnicity, provides an indication of the extent to which the findings could provide a similar pattern of effects. Because intensive programs achieve their long-term effects initially from enhancing school readiness skills and because studies of current state-funded programs lack information on longer-term effects, we compare the estimated effect sizes on school readiness between intensive preschool programs with those more routinely implemented state-funded programs (e.g., Gilliam & Zigler 2001).

Findings are reported in **Table 6**. For consistency, the impacts are reported in standard deviation units whereby a value of 0.20 or above is considered an educational meaningful difference in favor of program participants. Gilliam & Zigler (2001) assessed the impact of state-funded preschool on school readiness in preschool and kindergarten in six states and the District of Columbia up to 1998. Although the programs primarily served children at risk, participants were more heterogeneous on family income, race, and ethnicity

Table 6 Effect sizes for state-funded and intensive preschool programs on school readiness (values are standard deviation units)

Program/study	Urbanicity/N of sites	Socioeconomic status (SES) attributes	Language-cognitive skills at age 5
State-funded preschool			
Gilliam & Zigler 2001	Mixed (7 states and cities)	Lower income	0.36
Hustedt et al. 2007	Mixed (New Mexico)	Lower/middle	0.37
Hustedt et al. 2007	Mixed (Arkansas)	Lower/middle	0.30
Frede et al. 2007	Urban (New Jersey)	Lower income	0.32
Lamy et al. 2005	Mixed (Oklahoma)	Lower/middle	0.26
Gormley et al. 2005	Urban (Tulsa, OK)	All SES	0.58
Intensive Preschools			
CPC/Perry Preschool/Abecedarian mean	Mixed/22 sites	Low income	0.66
Consortium for Longitudinal Studies (1983)	Mixed/13 sites	Low income	0.50

Note: Language-cognitive skills was measured by one of following: IQ tests (only Perry, Abecedarian, and Consortium), cognitive, vocabulary/language skills, literacy, or early academic achievement. Age of assessments varies between end of preschool and beginning of kindergarten. Most of state-funded programs were average of receptive vocabulary and math skills.

than were those of intensive programs. They reported an average effect size of 0.36 standard deviations.

Effects sizes for evaluations of state-funded programs implemented from 2002 to 2006 for four-year-olds in New Mexico, Arkansas, New Jersey, and Oklahoma ranged from 0.26 to 0.58. These effect sizes are statistically and educationally meaningful. Note that the effect sizes for language/vocabulary and math skills are averaged, as the assessments were identical across states. The strong effect size for Tulsa was for the universal Oklahoma prekindergarten program (Gormley et al. 2005) that served children from all SES backgrounds.

Although findings are generally limited to short-term effects, recent studies show benefits at the end of kindergarten and beyond for state-funded programs (Frede et al. 2007, Xiang & Schweinhart 2002) and for other large-scale programs (see **Table 1**). First-year findings of the congressionally mandated Head Start impact study (Puma et al. 2005), which includes nearly 5,000 3- and 4-year-olds in 84 nationally representative grantee agencies, indicate modestly positive impacts on prereading skills (0.19 to 0.24 sd units) and on receiving dental care (0.33 sd units). Effects

on social-emotional and parenting skills were less consistent.

In summary, findings of the evaluations consistently show positive and meaningful effects in many states for both universal and targeted programs. Although effects sizes are smaller than for intensive preschool programs, the reach of the state-funded programs is greater.

COST-BENEFIT ANALYSES FROM POLICY SIMULATIONS

Several researchers have estimated the economic benefits of high-quality but routinely implemented preschool programs by conducting cost-benefit simulations that either modify assumptions of actual cost-benefit analyses of longitudinal analyses of model programs or make projections from correlational data linking short-term outcomes such as achievement scores to educational attainment, income, and criminal behavior, which are more easily translated to economic benefits. Three such analyses are summarized below. All indicate that more widely implemented preschool programs for 3- and 4-year-olds would be more likely to

yield benefits than to significantly exceed costs.

Using short- and long-term data from 58 evaluation studies published from 1967 to 2003, Aos et al. (2004) estimated an economic return of \$2.36 per dollar invested for preschool programs for low-income 3- and 4-year-olds. In 2003 dollars, the estimated cost per child was \$7301 (which was based on the CPC program) and societal benefits were \$17,202. It should be noted that the estimates were based on studies that investigated long-term outcomes such as educational attainment and on studies limited to short-term outcomes such as achievement, which were used to make long-term projections. Moreover, although many categories were included in benefit estimates, intangible crime victim savings, mental health outcomes, health insurance, or potential intergenerational effects were not included.

Karoly & Bigelow (2005) estimated the economic benefits of universal access to one year of preschool education at age 4 in California. Based in part on cost-benefit findings from the CPC program and assuming a 70% participation rate, the estimated return to California society at large was \$2.62 per dollar invested. The most conservative estimates were about \$2 return per dollar invested, and the most liberal were about \$4 return per dollar invested. Cost-effectiveness estimates would be significantly higher if intangible crime victim savings, child welfare savings associated with reduced child maltreatment, improvements in health and well-being, and intergenerational effects were included.

A broader national analysis by Lynch (2007) used modified estimates from the cost-benefit analysis of the CPC program (Reynolds et al. 2002) to generalize across states and in the country at large. It was estimated that by the year 2050, a high-quality targeted preschool program for 3- and 4-year-olds would cost \$5700 (2002 dollars) per child and provide a return per tax dollar invested of \$3.18 in government budget savings alone. For a universal access program, the return per

tax dollar invested was estimated at \$2.00 for government budget savings. Considering all societal benefits (budget savings, justice system and child welfare savings, and increased earnings), the long-range annual benefit per tax dollar invested was estimated at \$12.10 for a targeted program and \$8.20 for a universal access program.

THE EFFECTS OF FULL-DAY KINDERGARTEN

The effects of full-day kindergarten (FDK) compared to half-day kindergarten (HDK) are well documented. Many studies have examined achievement gains at the end of kindergarten and in the early school grades. Aos et al. (2007) synthesized the results of 23 well-designed comparison-group studies of the effects of FDK on academic achievement. The studies were published since 1970 and excluded those in which FDK was part of other interventions or the selection into groups was undocumented or uncontrolled. The average effect size of FDK on achievement at the end of kindergarten was 0.18 standard deviations for all children and 0.17 for economically disadvantaged children. This is equivalent to roughly a two-month increase in achievement.

This relatively small advantage largely disappeared by first grade and did not re-emerge later. The average effect size was 0.01 at the end of first grade, 0.048 at second and third grade, and 0.00 at fourth and fifth grade. These findings include analyses of the Early Childhood Longitudinal Study, which tracks a national sample of 20,000 kindergartners from 1998 (Le et al. 2006).

To illustrate the common finding on FDK, **Table 7** shows mean reading achievement test scores for children in the Chicago Longitudinal Study (1999), which investigates the long-term effects of the CPC program described above. As shown, the impact of FDK relative to HDK is small and short-lived. As shown, for both children with and without prior CPC preschool, FDK enrollment was

Table 7 Effects of full-day kindergarten (FDK) and half-day kindergarten (HDK) in the Chicago Longitudinal Study of the Child-Parent Centers on reading achievement

Program participation	Iowa Tests of Basic Skills achievement standard score			Gain in K	Gain K to 1
	Start of K	End of K	End of Gr. 1		
One year of preschool and FDK	47.3	64.9	73.9	17.6*	8.9
One year of preschool and HDK	47.5	61.8	75.4	14.3	13.6**
No preschool and FDK	44.1	59.9	69.7	15.8	9.8

Note: Sample sizes for one-year HDK participants, one-year FDK participants, and the no-preschool FDK comparison group were 273, 182, and 550. Group attrition rates were no more than 10% by the end of first grade.

* Gain score is significantly greater than HDK group.

** Gain score is significantly greater than Child-Parent Center group in FDK.

associated with greater gains during kindergarten on the word analysis subscale of the Iowa Tests of Basic Skills. At the end of first grade, however, FDK was not associated with reading achievement test scores or learning gains since kindergarten. FDK participants with no preschool experience had significantly lower reading scores than did both preschool groups. This pattern of findings was similar for children who had two years of preschool and for the outcome of math achievement. Similarly, Clements, Reynolds, and Hickey (2004) found that FDK was associated with higher reading achievement in kindergarten but not with math achievement or socioemotional outcomes.

Given that the effects of FDK have been found not to endure, formal cost-benefit analyses have not been conducted. Aos et al. (2007) reported that the net annual cost per child (2006 dollars) for implementing FDK in the State of Washington is \$2,611. This cost would be expected to vary by state. Based on the available evidence, the benefit-cost ratio of FDK relative to HDK is close to zero. Assuming no other benefits are achieved, the economic return is likely to be close to zero. However, it should be noted that few studies have investigated effects beyond third grade or social and psychological outcomes. Given the meager short-term findings identified in most studies, it is unlikely long-term effects would emerge. This is partly due to later timing of services, the lack of comprehensive ser-

vices, and the diminishing return of additional services beyond half-day programming.

CLASS SIZE REDUCTIONS

In a recent synthesis of 38 studies of class size reductions, Aos et al. (2007) reported that reducing class sizes in kindergarten through second grade was more cost-effective than reducing class sizes in third through sixth grades, middle school, or in high school. For each additional student by which class size is reduced, the effect size on achievement increases by 0.019 sd for kindergarten to second grade and by 0.007 sd for third to sixth grades. These are relatively small effects. A reduction from 25 to 15 students in kindergarten, for example, increases achievement by 0.19 standard deviations. This one-fifth of a standard deviation improvement (two- to three-month gain in learning) also was found in the Wisconsin Student Achievement Guarantee in Education (SAGE) program for 3000 kindergarten and first graders in 30 schools (Molnar et al. 1999). The corresponding increase in achievement is 0.07 standard deviations for small classes in grades 3 to 6.

Based primarily on the higher test scores of students in smaller classes, Aos and colleagues (2007) estimated that the economic return of small classes in kindergarten through second grade was \$2.79 per dollar invested and \$1.38 for small classes in third through sixth grades. Given the absence of effects,

cost-effectiveness for small classes in later grades was not estimated.

In the most extensive study of class size reduction, Project STAR in Tennessee experimentally investigated the impact of enrollment in class sizes limited to 13 to 17 students from kindergarten to third grade relative to enrollment in class sizes of 22 to 26 students with and without teacher aides. More than 6300 kindergarten students in 79 schools and 46 districts were included. Although one or more years of enrollment in reduced class sizes was associated with higher achievement test scores in the short-term, longer-term effects by eighth grade were found only for students with three or four years of reduced class sizes (Finn et al. 2001). The three-year group had median effect sizes of 0.13 to 0.21 sd in grades 4 to 8. The four-year group had median effects sizes of 0.21 to 0.29 sd, which represents at least one half a year of growth by eighth grade. One year of reduced class size had no long-term effects, and two years had small effects of about 0.10 sd. Minority children and those from low-income families experienced more positive effects. Relative to control groups, only low-income students with three or four years of small classes had higher rates of high school graduation (Finn et al. 2005).

Krueger (2003) found that Project STAR had an economic return of \$2.83 per dollar invested in the program. The source of this benefit is an increase of 0.20 sd in test scores, which is associated with a 1.6% increase in adult earnings. The average economic benefit per participant was \$23,913 (2002 dollars); the average cost per participant was \$8454 for 2.3 years of small classes (Krueger 2003).

Additional evidence on small class sizes comes from the school-age program of the Child-Parent Centers, of which the main program element was a reduction in class sizes from 35 to 1 to 25 to 2 (teacher and aide) during grades 1 to 3. The school-age program also included instructional resources to promote reading and math achievement and family support activities under the direction of a program coordinator. School-age participa-

tion was independently associated with significantly higher levels of reading achievement and with lower rates of grade retention and special education placement. The economic return for two years of school-age intervention was \$2.12 per dollar invested (Reynolds et al. 2002). Although this return per dollar invested is much lower than that of the CPC preschool program, it is within the range of that found for Tennessee's Project STAR.

OTHER SCHOOL-AGE PROGRAMS AND PRACTICES

Given their implications for cost-effectiveness, two additional ECD programs are covered. The Skills, Opportunities and Recognition (SOAR) Program, formerly the Seattle Social Development Project, is designed to promote social and emotional skills (Hawkins et al. 1999). Starting in grade 1 and continuing to grade 6, the supplemental classroom-based program includes cooperative, developmentally appropriate teaching practices and optional parent education classes. Six years after the end of the program, participants had greater attachment to school, higher achievement test scores, lower rates of delinquency, and lower rates of alcohol misuse. With an average program cost of \$4712 per student, estimated economic benefits to society are \$14,810, a return of \$3.14 per dollar invested (Aos et al. 2004, Small et al. 2005).

Reading Recovery is an instructional tutoring program for first-grade students who are having difficulty learning to read. The program provides 30 minutes of one-on-one daily instruction with a teacher outside of the regular school class. Students in the bottom 20% in reading performance are enrolled in the program. In more than 30 studies that have been conducted of Reading Recovery (D'Agostino & Murphy 2004), findings are generally consistent that the program significantly increases participants' reading performance and helps close the gap with more typically performing students (D'Agostino & Murphy 2004,

Shanahan & Barr 1995). Effect sizes at the end of intervention average about 0.75 sd. These drop to under 0.15 sd by third or fourth grade, however.

Reading recovery is a relatively expensive program. In 2002 dollars, the average cost per child was estimated at \$4830 (Shanahan & Barr 1995). Although formal cost-benefit analyses have not been reported, Shanahan & Barr (1995) estimated that the program would, at best, be expected to recover about 30% of its costs through reductions in special education placement as a consequence of the short-term achievement effects. This would be a return of \$0.30 per dollar invested. To the extent that achievement gains would endure, this may be an underestimate.

PRESCHOOL-TO-THIRD-GRADE PROGRAMS

A key rationale for transition programs and practices in the early school-age years is that elementary schools play an important role in sustaining the benefits of early childhood programs and a continuation of programs into the primary grades will promote successful transitions. PK-3 programs are the most comprehensive approaches for enhancing transitions and promoting positive child development. Several extended early childhood programs have provided preschool and school-age services to children and families considered at risk because of economic disadvantage.

The core attributes of PK-3 programs have become evident in recent years, as empirical knowledge is established (Bogard & Takanishi 2005, Reynolds 2003). Four key principles are critical. These programs and practices (a) support continuity, (b) enhance capacity for organization of services, (c) promote instructional practices, and (d) encourage family support behavior and school-family partnerships. To the extent that P-3 programs and practices contribute to these principles, positive impacts on child development are expected. Studies have indicated that the quality and duration of developmentally appropriate early

childhood experiences are strongly linked to later school performance and adjustment into adulthood (Campbell et al. 2002; Ramey et al. 2000; Reynolds et al. 2001, 2004, 2007). Although research supports the efficacy of early intervention, the “fade-out” phenomenon has been linked to enrollment in lower-quality schools.

The four best-known programs are described below. **Table 8** shows their key features.

Carolina Abecedarian Project

The Carolina Abecedarian Project (ABC) served low-income minority children at high risk for cognitive delays or academic problems up to age 8 (only the preschool portion is discussed above). Program-group children received five years of enriched educational day care from age 4 months to 5 years (prior to kindergarten) followed by a school-age intervention for three years, through second grade. A systematic curriculum, including learning activities in cognitive, language, and social-emotional development, was used. The school-age intervention used a family-support model and supported children’s academic development through increasing and enhancing parent involvement in the educational process (Campbell & Ramey 1995). A home school resource teacher offered learning activities and provided materials for parents to use at home with their children (Ramey et al. 1998). These teachers were home/school liaisons on behalf of the student and provided community outreach. In addition, the school-age program included a six-week summer transition program prior to kindergarten entry. ABC was implemented at a single site for yearly cohorts from 1972 through 1977. Of the total sample of 111 children, 25 participated in the PK-3 program through second grade.

Research findings. Evaluations have consistently shown that the preschool program produces greater intellectual and academic outcomes than does the school-age program.

Table 8 Major characteristics of four extended early childhood programs for low-income families

Early intervention programs	Age of entry/length	Organization	Program description	Classroom environment	Parent component	Other services
Carolina Abecedarian Project (1972–1985)	6 weeks to 5 or 8/5 to 8 years	Elementary school Parent program for school-age children Home-school resource teacher	Full-day child care for preschoolers; parent program for school-age children	Limited to activities of home-school teacher	Home visits, school support, outreach	Outreach and referrals Nutrition
Head Start/Follow Through (1968–1996)	5 years/5 years	Elementary school Program coordinator	Kindergarten to third-grade program	Distinct curriculum model Curricular resources Staff inservices	Class volunteers Home visitors Advisory council	Examinations Referrals
Chicago Child-Parent Centers (1967–present)	3 or 4 years/1 to 6 years	One administrative system	Half-day preschool program; half-day or full-day kindergarten program	Individual instruction in language and math Curricular resources Staff inservices	Parent room at each site Coordinator School and home support activities Advisory council	Services of school community representative Outreach and Referrals
Head Start/Public School Early Childhood Transition Demonstration (1991–1998)	5 years/5 years	Elementary school Family service coordinator	Kindergarten to third-grade program	Developmental curricula Inservice training and workshops	Parent resources at each site Home visits School involvement Transgov. board	Nutrition services Family outreach Dental care

Nevertheless, an additional dosage-response effect has been found for children who participate in both preschool and school-age programs. These children have the highest levels of intellectual and scholastic performance at the end of the program at age 8; and the extended intervention group surpassed the performance of the preschool-only group by one-third of a standard deviation (Campbell & Ramey 1995). At the age 15 follow-up, the extended group surpassed the nonextended group only for reading achievement (Ramey

et al. 2000). Although this trend was apparent at the age 21 follow-up, the difference was not statistically significant (Campbell et al. 2002).

Head Start/Follow Through

The Head Start/Follow Through (FT) programs tested the effects of alternative instructional methods on children's educational development in kindergarten to third-grade classrooms. It was implemented as a series of "planned variations" of five instructional

models and mixtures including (a) Parent Education Model, (b) Direct Instruction Model, (c) Behavioral Analysis Model, (d) High/Scope Cognitively Oriented Curriculum Model, and (e) the Bank Street Model of Developmental Interaction. Like Head Start, FT programs included health and social service components, home visits from paraprofessionals who encouraged parents' participation in their child's education, and participation in school advisory councils.

Research findings. A national evaluation showed that substantial modifications in the classroom learning environment in kindergarten and the early primary grades can enhance children's early educational success as well as social and emotional development, thus improving the transition to school (House et al. 1978). However, the instructional models were not equally effective in promoting student achievement. The Direct Instruction and Behavioral Analysis models were most consistently associated with higher achievement test scores. Studies based on the High/Scope, Bank Street, and Direct Instruction models found that Head Start with FT was associated with higher school achievement in the short term, but these effects were generally reduced over time (Seitz et al. 1983). Effect sizes were 0.39 and 0.29, respectively, for reading and math achievement at age 9 for the High/Scope FT program group compared with same-school controls (Schweinhart & Wallgren 1993).

Chicago Child-Parent Center and Expansion Program

The Chicago Child-Parent Center (CPC) and Expansion Program was developed to promote academic success among low-income children (only the preschool component of the program is discussed above). The CPC program was established in 1967 through funding from Title I of the Elementary and Secondary Education Act. The program includes three components: a child-centered fo-

cus on the development of reading/language skills, parental involvement, and comprehensive services (Reynolds 2000).

CPC included a half-day preschool program for three- and four-year-olds (described in the previous section), a half-day or an all-day kindergarten program, and two or three years of school-age intervention in colocated elementary schools. The center operates on the nine-month school-year calendar. An eight-week summer program is also provided. Parents were expected to be involved in the center at least one half-day per week. The comprehensive services include (a) attending to children's nutritional and health needs (i.e., free breakfasts and lunches and health screening), (b) coordinated adult supervision, including a CPC head teacher, a parent resource teacher, a school-community representative, and a teacher aide for each class, (c) funds for centralized inservice teacher training in child development as well as instructional supplies, and (d) emphasis on reading readiness through reduced class size, reading and writing activities in the learning center, and reinforcement and feedback.

The expansion or school-age program encouraged parent involvement and continued to provide parents with a parent resource room and a community representative. The program was designed to enrich the primary-grade classroom experience. In each grade, class sizes were reduced to a maximum of 25 children, and each teacher was provided with a teacher aide. Like the CPC head teacher, the curriculum parent resource teacher provides inservice training to classroom teachers and aides in the expansion classrooms.

Research findings. Participation in the CPC program is significantly associated with higher levels of academic achievement and parent involvement in children's education (Reynolds 2000). Children participating in the preschool plus follow-on services had higher academic achievement in comparison with children receiving only the preschool or follow-on programs (Conrad & Eash 1983).

Children with extended program participation (four or more years of services) had higher achievement in the eighth grade and better high school graduation rates than did children with no intervention (Fuerst & Fuerst 1993). In addition, CPC participation through second grade was associated with a seven-month advantage in reading and math achievement, lower rates of grade retention, and lower rates of special education placement (Reynolds 1994). Students participating through the third grade fared even better, and the benefits persisted up to age 15. Extended program participation was also associated with lower rates of school remedial services (grade retention by age 15 and special education placement by age 18), and with lower rates of delinquency infractions (Reynolds et al. 2002). At the age 24 follow-up, extended program participation was associated with higher rates of high school completion and full-time employment and lower rates of Medicaid receipt and arrests for violence (Reynolds et al. 2007).

National Head Start/Public School Early Childhood Transition Demonstration Project

The Head Start/Public School Transition (HST) Project tested the value of extending comprehensive, Head Start–like supports through the first four years of elementary school. This program provides a range of Head Start–like family services to assist in the transition from Head Start to public schools, help families with health issues, and improve children’s school performance. A total of 7515 former Head Start children and families were recruited at 31 sites to participate in the national study in 1992/93 and 1993/94. Approximately 12,000 children participated, however, since supports and educational enhancements were offered to all children and families in the classrooms. Program enrollment was based on random assignment of schools to a transition demonstration group. There were differences across sites in whether schools or school districts were randomly assigned.

Four key features comprise the HST program (Ramey et al. 2000). First, families participating in the HST were encouraged to participate in their children’s schooling and were provided with a number of educational resources. Second is educational enhancement, especially to promote use of developmentally appropriate curricula and practices and continuity in children’s educational experiences. Third, family social support services were provided to help facilitate positive family-school interactions and to assist in securing and coordinating services across agencies. Finally, health and nutrition services and activities were provided to ensure the physical and mental health of the entire family. Most local sites had plans for promoting the inclusion of children with disabilities, addressing cultural and linguistic diversity, and developing individualized transition plans for each child.

Research findings. To date, evaluations of HST have indicated no overall effect (Ramey et al. 2004). There is no difference on academic achievement or social development between children in the HST schools and children in the control groups. This was attributed to the implementations of the programs. Only about 20% of the sites implemented very strong programs. Moreover, many comparison schools adopted these features and supported them through other resources or funding.

Nevertheless, the findings indicate although these former Head Start children entered school below other children nationally, they showed significant gains in reading and math in early elementary school and quickly rose to perform close to the national averages by third grade. Furthermore, HST participants demonstrated typical levels of growth in social skills and were rated by their teachers and parents as socially and behaviorally well adjusted to school. The majority of HST children also reported positive experiences at schools (Ramey et al. 2000). One study found that participation in the HST was associated with lower rates of mental retardation and

emotional disturbance, but an opposite effect was found in the category of speech or language impairment (Redden et al. 2001).

COST-BENEFIT ANALYSES OF PRESCHOOL-TO-THIRD- GRADE PROGRAMS

Only the CPC extended intervention program has been the subject of cost-benefit analysis. Compared to participation in less extensive CPC services (0 to 3 years of intervention), the CPC extended program returned \$9.05 per dollar invested through reduced remedial education and child maltreatment, lower juvenile arrest for violence, and higher levels of educational attainment. Exclusive of intangible crime victim savings, the return was \$6.11 per dollar invested.

The school-age program alone demonstrated a return of \$2.12 per dollar invested, primarily through participants requiring fewer remedial education services (Reynolds et al. 2002). The return per dollar invested was \$1.66 without intangible crime victim savings. The main components of the school-age services were reduced class sizes, family services, and instructional support to classrooms.

CHARACTERISTICS OF EFFECTIVE PROGRAMS

The evidence described in this section shows that extended early childhood programs can promote more successful transitions to school than can preschool interventions alone. Although more longitudinal data are needed, several characteristics of successful programs can be drawn from this review. First, programs that focus on language-based school readiness skills appear to be more beneficial to children. Second, multiple years of services are associated with successful transition to schools. Third, using schools as the single administrative system for early and extended childhood interventions can strengthen the continuity of services to children and avoid disjointedness

between preschool and school-age programs. Fourth, it is important for programs to have an intensive family support component that facilitates parental involvement and commitment to the child's education and promotes parents' personal growth. Finally, it is beneficial to children to add teacher aides in the classroom to reduce class sizes and student-teacher ratios so that children can receive individualized attention and more individual learning opportunities. Programs should be tailored to the needs of children across the entire first decade of life. Because many children are now entering schools at a higher risk than that of students entering 10 years ago, continuous services across the first decade of children's lives provide the optimal level of support for their learning and development and do not presume that intervention at any stage of development (infancy, preschool, school-age) alone can prevent children from future underachievement.

SUMMARY OF COST- EFFECTIVENESS

Table 9 summarizes the economic returns of ECD programs from preschool to third grade. Preschool for 4-year-olds has demonstrated the highest returns across many programs in different contexts, decades, service systems, and curricular philosophy. New evidence from state pre-K programs shows positive effects on school readiness.

Small classes in the early grades show positive returns from test score gains (Krueger 2003), but long-term effects were limited to low-income children with three or four years of enrollment (Finn et al. 2005). Substantial reductions in class sizes (i.e., from 25 to 15) are needed to meaningfully improve achievement (Aos et al. 2007).

The CPC PK-3 intervention shows substantial benefits above and beyond earlier intervention. The SOAR social skills program also has demonstrated positive long-term effects leading to cost-effectiveness. Neither Reading Recovery nor FDK findings are

Table 9 Cost-effectiveness estimates for early childhood programs, preschool to third grade

Developmental stage	Focus	Location	2002 dollars			
			Benefits	Costs	B – C	Ratio
Preschool						
Child-Parent Centers	Targeted	20 Chicago sites	74,981	7384	67,595	10.15
Perry Preschool	Targeted	1 Ypsilanti site	138,486	15,844	122,642	8.74
Abecedarian Project	Targeted	1 NC site	135,546	67,225	68,321	2.02
RAND study of preschool in CA	Universal	State of CA	11,375	4339	7036	2.62
National PreK	Targeted	National	18,126	5700	12,426	3.18
Synthesis for 2050 (Lynch 2007)	Universal	National	11,400	5700	5700	2.00
Synthesis study (Aos et al. 2004)	Targeted	58 programs	17,202	7301	9901	2.36
Kindergarten						
Full-day K* synthesis	Universal	23 programs	close to 0	2343	Negative	<0
School-age						
Tennessee STAR, small classes, K-3	Universal	79 schools	23,913	8454	15,459	2.83
K–2 synthesis of small classes (25 to 15)	Universal	38 studies	6054	2170	3886	2.79
Grade 3–6 synthesis of small classes (25 to 15)	Universal	38 studies	2995	2170	825	1.38
Child-Parent Centers school-age	Targeted	20 sites	6928	3268	3660	2.12
School-age						
Reading Recovery*	Targeted first graders	General	1610	4830	–3220	0.30
Skills, Opportunities, and Recognition	Universal	Seattle schools	14,810	4712	10,098	3.14
PK-3 intervention						
Child-Parent Centers	Targeted	20 sites	40,245	4447	35,798	9.05

Note: Lynch's (2007) estimates were the most conservative. Total benefits relative to costs were \$12.10 and \$8.20 for targeted and universal programs. Using the relative program cost for the Abecedarian Project, the ratio of benefits to costs was \$3.78. Full-day kindergarten cost is relative to half-day kindergarten in Washington State (Aos et al. 2007) and is converted to 2002 dollars. Estimates from syntheses of small classes (Aos et al. 2007) based on a reduction from 25 to 15 students per class.

* Estimates are not based on formal cost-benefit analyses.

suggestive of cost-effectiveness. Across many studies, the average effect of FDK is not detectable after the end of kindergarten.

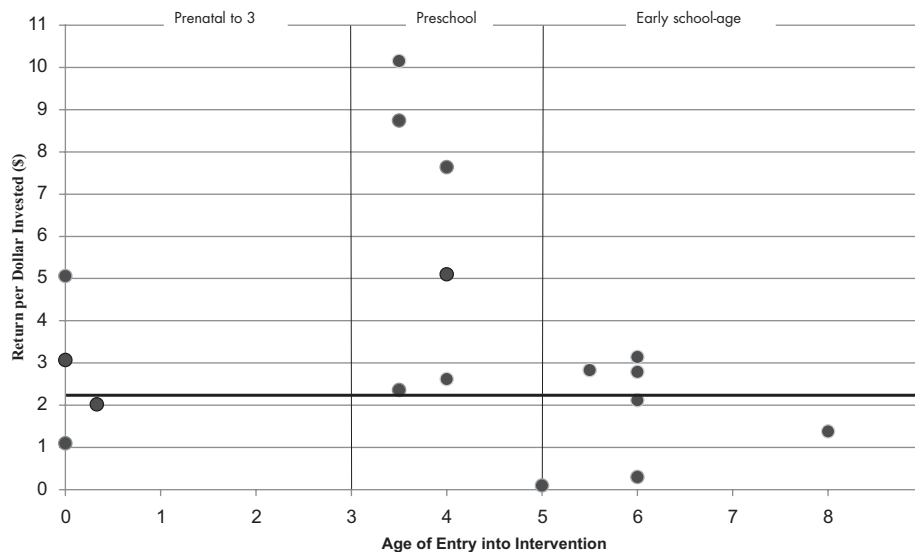
For completeness, CBA estimates are available for select prenatal and home visitation programs in the first three years of life. The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) provides nutrition education, referrals to social services, and a variety of food supplements to low-income families. A meta-analysis of 15 studies in different states by Avruch & Cackley (1995) found that WIC participation was associated with a 25% reduction in the rate of low birth-weight infants, which significantly reduced hospital costs paid

by insurers in the first year of life. The economic return in savings was estimated to be \$3.07 per dollar invested.

The Nurse-Family Partnership (Olds et al. 1997) is an intensive nurse home visitation program for young mothers having their first child. For the high-risk sample (unmarried and low-income mothers having their first child), Karoly et al. (1998) found that participation from prenatal development to age 2 was associated with lower rates of criminal behavior for both mothers and target children, lower rates of substantiated child maltreatment, higher earnings capacity for the mothers, and increased tax revenues projected into adulthood. The estimated economic return

Figure 2

Return per dollar invested by age of entry into intervention.



was \$5.06 for every dollar invested. For the lower-risk sample, the economic return was \$1.10 per dollar invested.

In summary, findings show that a variety of ECD investments are associated with positive economic returns. Preschool programs for 3- and 4-year-olds have had the most research and generally show the highest returns. This is illustrated in **Figure 2** as the economic return per dollar invested for the accumulated research as a function of the age of entry into intervention. Age 0 corresponds with prenatal development (WIC and the Nurse-Family Partnership program). Early school-age programs show positive returns of close to \$3 per dollar invested (Tennessee STAR). Combinations of programs such as PK-3 are not represented in the figure. These other synergies warrant further investigation. Nevertheless, cost-effectiveness is one of many criteria for prioritizing investments. Social importance, feasibility, and capacity for sustainability also are important to consider in policy making.

ASSESSMENT OF CAUSAL MECHANISMS

Although there is now a critical mass of evidence in support of long-term effects on

educational attainment, the causal mechanisms that account for these findings are not well understood. Among the studies that have assessed long-term effects, comprehensive models have rarely been tested (Ou & Reynolds 2004, Reynolds et al. 2004). Early studies emphasized the cognitive advantage hypothesis as the major initiator of long-term effects (Berreuta-Clement et al. 1984, Consortium for Longitudinal Studies 1983). This is illustrated in the top section of **Figure 3**. As reported by the Consortium for Longitudinal Studies (1983), the long-term effects of preschool came about largely as a function of the initial cognitive advantage. Social and motivational factors were not directly assessed.

The second phase of studies added one or two hypothesized mechanisms such as family support and social adjustment (Barnett et al. 1998, Reynolds et al. 1996, Schweinhart et al. 1993). These studies generally found strong support for the cognitive advantage but also found that family support behavior, motivation, and social adjustment contributed either directly or indirectly. This is represented in the second section of **Figure 3**. Barnett and colleagues (1998) found that the initial cognitive advantage of participation helped create later advantages through greater motivation

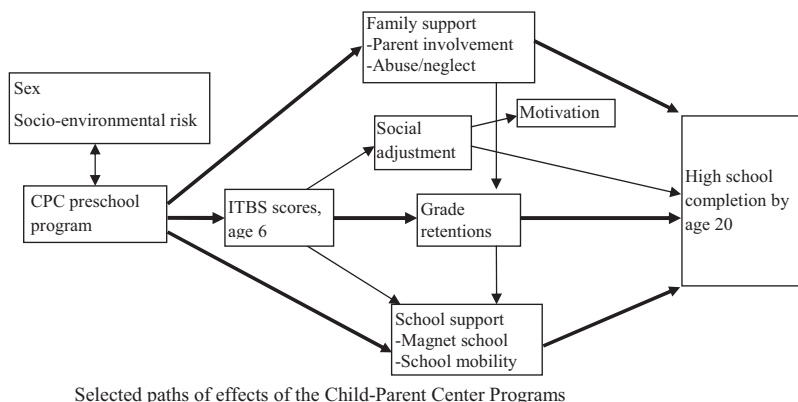
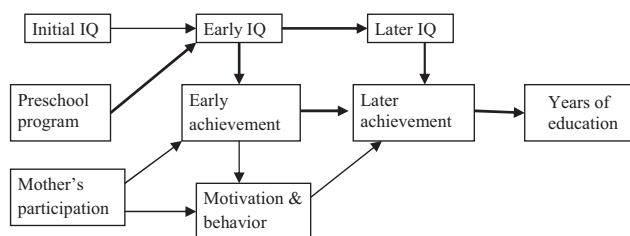
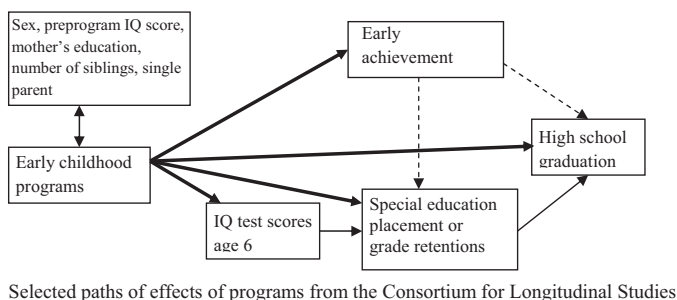


Figure 3

Paths of effects of preschool in three phases of studies. CPC, Child-Parent Center Program; ITBS, Iowa Tests of Basic Skills. Thicker lines denote stronger effects; thinner lines are weaker but notable effects, and dashed lines significant effects in which direction of influence is less certain.

and social adjustment, thus accounting for the long-term effects of preschool in the PPP.

These and related findings led to the development of the five-hypotheses model of the effects of early childhood intervention (Reynolds 2000, 2004). Derived from the accumulated research on preschool effects over four decades, the model, depicted in the lower section of **Figure 3**, posits that the effects of intervention are explained by indicators of five general paths of influence: cognitive advantage, motivational advantage, social adjustment, family support behavior, and school support behavior. Moreover, in

the five-hypothesis model, the contribution of any one hypothesis can be accurately assessed only in conjunction with the others. Previous studies have found, based on structural equation modeling, that all five hypotheses contribute to the explanation of the links between CPC preschool and later outcomes, including school achievement in adolescence, high school completion (Ou 2003, Reynolds et al. 2004), and delinquency prevention (Reynolds et al. 2004). This model should be tested across a wider range of studies and programs.

Reynolds et al. (2004), for example, found that the five hypotheses together accounted

for 58% of the main effect of CPC preschool participation on high school completion and 79% of the main effect of preschool on juvenile arrest. In order of contribution to the model of high school completion, cognitive advantage accounted for 32% of the indirect effect of preschool, school support behavior 28%, and family support behavior 26%. Motivation, measured by school commitment, and social adjustment, measured by teacher ratings of classroom adjustment, accounted for less than 2% of the indirect effect. Nevertheless, the structural model that best fit the observed data included indicators of all five hypotheses.

As documented in the confirmatory impact evaluation approach (Reynolds 1998, 2004, 2005), the identification of mechanisms advances knowledge in three ways. First, causal inferences are strengthened. The identified mechanisms account for, at least in part, the main effect and are the “active” ingredients of change. Since the length of time between the end of the program and outcome assessment is more than 15 years, documenting the process of change is especially important. Even in well-controlled studies, there are many intervening events and experiences after the program that challenge the capacity to infer causality. If the identified mechanisms lead to a coherent explanation of the main-effect relation, causal inference is strengthened. Second, the identification of mechanisms increases generalizability of findings. To the extent that findings across studies share a common mechanism, program replication and expansion in different contexts would be more likely to be successful. Finally, clarification of mechanisms of impact helps prioritize program improvement efforts. Program modifications consistent with the identified mechanisms would be supported. For example, if the family support hypothesis is identified as an important mechanism of effects, greater attention to parental involvement and the provision of family services would be one strategy of program improvement.

KEY PRINCIPLES OF EFFECTIVENESS OF EARLY CHILDHOOD DEVELOPMENT PROGRAMS

Findings summarized in this review indicate that greater investments in high-quality preschool and school transition programs are warranted. Since relatively large percentages of children do not enroll in center-based preschool programs (Barnett et al. 2007), and the quality of services that many receive is not high, the ECD programs summarized in the review provide effective models to be used in the design of coordinated early childhood systems. Attention to the causal mechanisms of change reviewed above also can help strengthen program effectiveness. Research on three major programs reviewed (ABC, PPP, and CPC) and many others suggest five major principles that can enhance the effectiveness of early childhood development programs and increase long-term economic benefits.

The first principle is that a coordinated system of early education should be in place beginning at age 3 and continuing to the early school grades. Program implementation within a single administrative system in partnerships with communities can promote stability in children’s learning environment, which can provide smooth transitions from preschool to kindergarten and from kindergarten to the early grades. The three major programs we reviewed were either housed in elementary schools or provided continuity of services between preschool and formal schooling. This is a first-decade strategy of promoting child development. Today, most preschool programs are not integrated within public schools and children usually change schools more than once by the early grades. In the movement to universal access to early education, schools could take a leadership role in partnership with community agencies. More generally, programs that provide coordinated or wrap-around services may be more effective under a centralized leadership structure

rather than under a case-management framework. The CPC program, for example, is an established program in the third largest school system in the nation. Findings from the cost-benefit analysis of a complete cohort CPC participants give a good indication of the size of effects that could be possible in public schools, the largest administrative system of any universal access program.

Among the recommendations that are consistent with this principle of system coordination are (a) to increase the amount of Title I funds that go to preschool (less than 5% of the \$13 billion annually allocated to schools under Title I goes to preschool; U.S. Gen. Account. Off. 2000); (b) to increase the number of Head Start programs administered by public schools (only about one-third of Head Start grantees are schools); and (c) to expand the availability of full-day preschool programs and transition programs to promote early school success. Research in the CPC and Abecedarian programs indicates that as program length increases, children's school performance improves (see also Zigler & Styfco 1993).

A second major principle of effective ECD programs is that the teaching staff should be well trained, preferably with earned bachelor's degrees and certification in early childhood, and compensated with competitive salaries. These characteristics are much more likely under a public school model of universal access, notwithstanding the need for established partnerships with community child-care agencies. It is no coincidence that the three major programs reviewed above followed this principle. Being located in public schools, the Perry and CPC programs were implemented by teachers with at least bachelor's degrees and appropriate certification in early childhood. They were paid on the public school salary scale, and Perry teachers received a 10% bonus for working in the program. In the Abecedarian program, teachers were compensated at a level that was highly competitive with public schools. Turnover

was low in all three programs. In most other early education programs, from child care to Head Start, staff do not have this level of education, training, and compensation, and turnover is significantly higher.

Third, educational content should be responsive to all of children's learning needs, but special emphasis should be given to cognitive and school readiness skills through a structured but diverse set of learning activities. All of the cost-effective programs reviewed had a strong emphasis on the development of cognitive and language skills necessary to do well in school within a responsive learning environment. Child-staff ratios of less than 9 to 1 in preschool help as well. The curriculum appeared to less important since the programs spanned from Perry's child-initiated approach to Chicago's blended, teacher-directed approach. These findings indicate that preschool and other social programs are more likely to have enduring effects if they provide services that are intensive and are dedicated to the enhancement of educational and social skills.

A fourth principle of effectiveness is that comprehensive family services should be provided to meet the different needs of children. Because they are child development programs, the preschool, kindergarten, and school-age programs must be tailored to family circumstances and thus provide opportunities for positive learning experiences in school and at home. Those with special needs or those who are most at risk will benefit from intensive and comprehensive services. Each of the cost-effective preschool programs discussed above provided family services. Abecedarian provided medical and nutritional services. The Perry preschool included weekly home visits by teachers. In the CPC program, parent involvement is more intensive: Each center has a parent resource room run by a certified teacher and provides school-community outreach. Parents' own educational and personal development is an important program goal.

Finally, greater commitment to ongoing evaluations of effectiveness and cost-effectiveness is needed. Even today, cost-benefit analyses are rarely conducted. This state of affairs limits full consideration of the effects of alternative programs. Paramount in conducting cost-benefit analyses is the availability of longitudinal studies of programs for children and youths. These studies are more likely to assess accurately the total impact of program participation. In addition, more studies are needed that address the differential effects of participation across a range of child, family, and program attributes. As discussed above, the identification of causal mechanisms and related processes that promote enduring effects also is a high priority.

Knowledge would be advanced faster if greater investments were made in research and development (R & D). The National Science and Technology Council (1997) estimated that of the total annual expenditures of social programs for young people, only one-third of 1% goes to R & D. In comparison, national R & D investments in energy, biomedical sciences, and transportation average 2% to 3% of total expenditures (estimated by gross domestic product).

CONCLUSION

The amount of evidence on the positive and enduring effects of high-quality preschool programs is unprecedented, especially for children at risk. There is not only a critical

mass of evidence from long-term cost-benefit analyses, but increasingly strong evidence from state-financed prekindergarten that participation is associated with sizeable increases in school readiness and transition to elementary school. These demonstrated increases in many programs are critical to the emergence of enduring effects. Economic analyses of the likely economic effects of upscaled and sustained programs consistently show that even under modest assumptions, prekindergarten programs for 4-year-olds would be expected to return more than \$2 per dollar invested. Considering a wider spectrum of effects that have been tested in other programs such as CPC, the return is likely to be more than \$4 per dollar invested.

Based on the accumulated research evidence, greater investments are warranted in ensuring that programs and interventions strategies are high in quality following the key principles of effectiveness found in the most cost-effective programs. Among these are the provision of services that (*a*) are of sufficient length or duration, (*b*) have high intensity, (*c*) have low class sizes and ratios of children to teachers, (*d*) are comprehensive in scope, and (*e*) are implemented by well-trained and well-compensated staff. Although adhering to these principles increases program costs, the benefits that follow in improved child well-being can be considerable. Assessment of longer-term effects of programs that vary in the use of these principles also is needed, as are the causal mechanisms through which effects are achieved.

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DISCLOSURE STATEMENT

The authors are not aware of any biases that might be perceived as affecting the objectivity of this review.

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