Cost-Effective Early Childhood Development Programs: A Synthesis of Evidence in the First Decade of Life

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Running head: ECD programs

Abstract

In recent years, greater attention has been given to promoting child well-being throughout the entire period of early childhood. We summarize evidence on the effects and cost-effectiveness of early childhood development programs from birth to age 10. Findings from17 estimates of 16 programs were emphasized. Birth to age 3 interventions including nutritional education and home visitation show family, health and social benefits ranging from $1 to $5 per dollar invested. Participation in preschool programs for 3 and 4-year olds has been found to have relatively large and enduring effects on child well-being. Across many studies, economic -returns range from $2 per dollar invested to over $10 per dollar invested with an average of $6. In kindergarten and the early school-age years, programs that combine services across ages can enhance well-being. The Child-Parent Center preschool to third grade program shows a return of $6 to $9 per dollar invested above and beyond lesser intervention. Class size reductions beginning in kindergarten and social skills training show evidence of positive effects with economic returns of $2 to $3 per dollar invested. Reading Recovery and class size reductions after kindergarten show low cost-effectiveness. The causal mechanisms and key principles for promoting enduring effects are described as well as future directions for cost-effectiveness studies.

The positive effects of early childhood development (ECD) programs on well-being have been documented in hundreds of studies and reviews since the 1960s (Karoly et al., 2005; Reynolds, Wang, & Walberg, 2003; Zigler, Gilliam, & Jones, 2006). Advances in scientific knowledge have contributed not only to the establishment of early childhood programs but have helped spur recent expansion of programs and services in states and localities (Barnett et al., 2007; Gormley, 2007; Reynolds & Temple, 2008; Zigler et al., 2006). 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 gains and strengthen school achievement (Bogard & Takanishi, 2005; Reynolds et al., 2003). The creation of early childhood systems and practices that enhance the continuity of development over the first decade of life is increasingly viewed as fundamental to shaping children's well-being.

Scope of Review

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

1. What are the effects and economic benefits of ECD programs implemented in the first decade of children's life?

2. Is there consistent evidence of comparatively greater economic benefits by age or intervention approach?

3. Which elements and principles of effectiveness are key to long-term effects?

We define ECD broadly to include the first decade of life, including prenatal and infancy, early education and preschool, kindergarten, and early school-age programs. Although findings on achievement and other short-term outcomes are reported, we emphasize the results of cost-benefit analysis (CBA). There are three reasons for the focus on CBA.

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 to assess cumulative effects, and they do not account for costs to achieve benefits.

Finally, CBAs emphasize longer-term effects of programs and practices. A focus on immediate and shorter-term effects, while an important first step, is not the ultimate program goal. Longer-term effects are a major focus of early childhood programs. A major question for social policy is whether 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 well-being through at least one of five processes or pathways (Reynolds, 2000; Reynolds et al., in press; Reynolds, Ou & Topitzes, 2004; Schweinhart et al., 1993). These can be viewed as the "active" ingredients of impacts on child development. They have been conceptualized from the beginning of research on early learning programs as primary mechanisms (Bronfenbrenner, 1975; Zigler & Berman, 1983). As shown by the five-hypothesis model in Figure 1, the cognitive advantage pathway, which 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.

Insert Figure 1 here

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 post-program school experiences reinforce learning gains. Enrollment in higher-quality schools and schools with positive learning environments would strengthen or maintain learning gains while 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. This principle as well as intensity and dosage are consistent with ecological (Bronfenbrenner, 1989; Bronfenbrenner & Morris, 1998) and human capital (Becker, 1964; Heckman, 2003) theories of development and learning.

Cumulative Evidence of Effects

Given the size of the knowledge base, the effects of ECD programs are summarized through findings from 19 reviews of impacts published in the past decade (1995-2006; Reynolds & Temple, 2008). These reviews were selected as among the most thorough in assessing short- and longer-term effects of both model and large-scale programs. Table 1 shows the most frequently cited programs demonstrating beneficial effects along with the last age of follow-up. Two major conclusions are evident. First, many programs have assessed long-term effects into adulthood. Three quarters of the reviews reported effects at 5 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.

Insert Table 1 here

What are the main findings of the reviews? Of the hundreds of studies synthesized (see also Karoly et al., 2005; Gormley, 2007; Zigler et al., 2006), there is substantial evidence that ECD programs for mostly 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 participation. Average effects were also statistically and practically significant for social and emotional development (.24 sd), school achievement (.35 sd), delinquency and crime (-.22 sd), grade retention (-.21 sd), special education (-.46 sd), school completion (.27 sd), and employment and earnings (0.37 sd). Because a number of these significant outcomes can be translated to dollar terms, CBA is well-suited for analyzing the net benefits to society of these programs.

Cost-Benefit Analysis in ECD Programs

CBA is an economic approach for estimating the value of alternative programs and policies relative to costs. Levin and McEwan (2001) define CBA as the "evaluation of alternatives according to their costs and benefits when each is measured in monetary terms" (p. 11). Program and intervention investments can be ranked according to their effectiveness per dollar of expenditure. The most frequently used outcome measures in CBA and their data sources are shown in Table 2.

Insert Table 2 here

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. Growth in economic analysis of ECD programs is due to the identified long-term effects in many studies, and to attention to translating evidence for public policy decisions (Duncan & Magnuson, 2007; Temple & Reynolds, 2007). To illustrate estimation, relative to the control group, participants

in the Child-Parent Center (CPC) preschool program spent an average of 0.7 fewer years in special education from kindergarten to high school. The effect size is .29 standard deviations. This translates to an average savings in special education of $5,317 per program participant (2007 dollars), which was calculated by multiplying the program effect of 0.7 years by the average annual cost per child for special education services above and beyond regular instruction for the school district in which they were enrolled. and discounting the cost to age 3 by 3% annually (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 or not it is possible to reflect program benefits in dollar terms. Researchers have a long tradition of estimating the benefits of increased graduation rates and reductions in crime (Karoly et al., 1998). Often program budgets contribute information used to create estimates of the benefits of reductions in services such as special education or child welfare. It is more difficult to monetize the benefits of higher test scores or problem behaviors because relatively few studies link test scores or behavior to the more monetizable outcomes of higher future incomes or fewer crimes. When program outcomes cannot be easily converted to monetary terms, cost-effectiveness analysis is recommended (see Levin & McEwan, 2001).

Evidence on Economic Benefits for Programs in Children's First Decade

At a minimum, the economic return should equal the amount invested in the program--a return of at least one dollar per dollar invested. Although not all program impacts can be translated to economic benefits and many criteria of program "worth" should be considered, CBA findings are an important metric of efficiency of investment.

Cost-benefit analyses illustrate the distribution of the benefits across different segments of society. 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 general 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 at large include the sum of benefits to program participants and to the general public. While societal benefits frequently are emphasized, benefits to the general public (not including the program participants) often are used to justify government investment.

Below we summarize the societal benefits of programs that have conducted economic analyses by age of program entry. 17 CBA estimates of 16 programs are included. For programs in which there are multiple studies, the most representative and comprehensive estimates from a single study are reported. Typically, these are from the research team of the program study. Table 3 provides a summary of the major findings.

Insert Table 3 here

Prenatal and Infant Programs

Home visitation, health, and child care programs in the earliest years of life are associated with positive child development and parenting behaviors but few long-term behavioral effects have been demonstrated (Reynolds, Mathieson, & Topitzes, 2009; Sweet & Applebaum, 2004). CBA estimates are available for two prenatal and home visitation programs in the first three years. 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 and Cackley (1995) found that WIC participation was associated with a 25% reduction in the rate of low birth-weight births, 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. Devaney (in press) provides a broader review of evidence on WIC, and suggests this return may be an upper bound.

The Nurse-Family Partnership (Olds et al., 1993) 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), Glazner et al. (2004) 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 was $5.01 for every dollar invested. For the lower-risk sample, the economic return was $1.51 per dollar invested (See Karoly et al., 1998, 2005, for additional analyses yielding similar returns of $5.01 and $1.10, respectively). Although no CBAs have been conducted for infant and child care programs with extensive longitudinal data, including Syracuse Family Development Research Program, Houston Parent-Child Development Center, and Infant Health and Development Program, the pattern of findings are suggestive of lower economic returns than NFP (see Aos et al., 2004; Karoly et al., 2005).

Center-based Preschool Programs

Although short- and longer-term effects have been documented for a large number of programs for 3- and 4-year-olds (Gormley, 2007; Karoly et al., 2005), three studies have investigated comprehensively life course impacts and economic returns into adulthood with strong research designs and low attrition. The Child-Parent Centers (CPC), Carolina Abecedarian Project (ABC), and the High/Scope Perry Preschool (PPP) all 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. ABC was the most intensive and lengthy, providing full-day, year round care for five years (Campbell & Ramey, 1995; Campbell et al., 2002). PPP provided the most established and organized curriculum, which followed the Piagetian principle of child-initiated learning (Schweinhart et al., 1993). CPC provides 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). It also is the only program that became established in public schools and is still in existence. The major long-term findings of the studies generating economic benefits are shown in Table 4 (see also Reynolds & Temple, 2008).

Insert Tables 4 and 5 here

As shown in Table 5, all three programs showed substantial economic returns into adulthood through government savings in education, justice system, and health expenditures and in increased economic well-being (Masse & Barnett, 2002; Reynolds et al., 2002; Schweinhart et al., 1993). Although the costs are significantly different from each other, the returns of each program far exceeded the initial investment. As a ratio of benefits to costs, all three programs showed a large return on investment based on data collected into adulthood. The CPC program showed the highest benefit-cost ratio at $10.15, in part 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 versus less than 6 to 1 for PPP and ABC).That a routinely implemented school-based program demonstrates positive returns indicates that wide-scale programs can be cost-effective. PPP showed the highest net present value per child (benefits minus costs) of $141,350 (see Belfield et al., 2006 and Schweinhart et al., 2005 for age 40 findings).

The consistent findings of the economic analyses of the PPP, CPC, and ABC, despite their differences in approaches, are encouraging for the generalization of preschool effects. Nevertheless, the participants of the three programs were almost exclusively low-income, African American children. While 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, find positive impacts. For example, effects sizes on school readiness (average of reading and math scores) of state prekindergarten programs for 4-year-olds implemented from 2002 to 2006 in New Mexico, Arkansas, New Jersey, and Oklahoma ranged from .26 to .58. These are statistically and educationally meaningful (for details, see Reynolds & Temple, 2008).

Cost-Benefit Analyses from Policy Simulations

To estimate the economic benefits of high-quality but routinely implemented preschool programs, several researchers have conducted cost-benefit simulations that either (1) modify assumptions of existing cost-benefit analyses from longitudinal analyses of model programs such as CPC or Perry programs or (2) make projections of benefits from predicted changes in educational attainment, income, or criminal behavior using information from other studies that have shown

correlations between these adult outcomes and the observed short-term outcomes such as achievement scores. These analyses indicate that more widely implemented preschool programs for 3- and 4-year olds would be likely to yield benefits that significantly exceed costs (also see Reynolds & Temple, 2008).

Synthesizing 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 return per dollar invested for preschool programs for low-income 3- and 4-year-olds. Karoly and Bigelow (2005) estimated economic benefits of $2.62 per dollar invested (range of $2 to 4 dollars) for universal access to one year of preschool education at age 4 in California.

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 $6,479 (2007 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, 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.

Full-Day Kindergarten

The effects of full-day kindergarten (FDK) compared to half-day kindergarten 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 studies of FDK for academic achievement. The studies included only those that were well documented and controlled. The average effect size of FDK on achievement at the end of kindergarten was .18 standard deviations for all children and .17 for economically disadvantaged children. This is equivalent to a 2-month achievement gain.

This relatively small advantage largely disappeared by first grade and did not re-emerge later. The average effect size was .01 at the end of first grade, .048 at second to third grade, and .00 at fourth and fifth grade. Additional studies support this pattern (see Reynolds & Temple, 2008).

Although no formal cost-effectiveness studies have been done, the lack of long-term achievement gains would be expected to yield a benefit-cost ratio close to zero.

Class Size Reductions

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. A total of over 6,300 kindergarten students in 79 schools were included. Although one or more years in small classes was associated with higher achievement 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 .17 standard deviations in grades 4 to 8. The four-year group had median effects sizes of .25. Relative to control groups, only low-income students with 3 or 4 years of small classes had higher rates of high school graduation (Finn et al., 2005). Based on Krueger (2003), Project STAR was found to have an economic return of $2.83 per dollar invested in the program. The source of this benefit is an increase of 0.2 standard deviations in test scores, which is associated with a 1.6% increase in adult earnings.

These findings are consistent with a synthesis of 38 studies of small classes (Aos et al., 2007). 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. A reduction from 25 to 15 students in kindergarten, for example, was found to increase achievement by .19 standard deviations. Based on higher test scores, Aos et al. 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.

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. The economic return for two years of school-age intervention was $2.13 per dollar invested (Reynolds et al., 2002).

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, and lower rates of delinquency, and lower rates of alcohol misuse. The economic return was $3.14 per dollar invested.

Reading Recovery, an instructional tutoring program for first-grade students who are having difficulty learning to read, 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 increases participants reading performance and helps close the gap with more typically performing students but the benefit is reduced substantially by fourth grade. Although formal cost-benefit analyses have not been reported, Shanahan and Barr (1995) estimated that the program would, at best, be expected to return about 30% (or $0.30 per dollar invested) of its costs through reductions in special education placement as a consequence of the short-term achievement effects.

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. Preschool-to-third grade (PK-3) programs are the most comprehensive approaches for enhancing transitions and promoting positive child development. Four extended early childhood programs have shown evidence of positive effects on school achievement and child well-being above and beyond that of preschool participation. These are the Head Start/Follow Through Program, National Head Start/Public School Transition Demonstration Project, Abecedarian Project, and the Child-Parent

Center extended intervention program.

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 $9.11per 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.

Summary of Benefits and Costs

In summary, findings show that most of the ECD investments are associated with positive economic returns. This is illustrated in Figure 2 as the economic return per dollar invested for the reviewed programs as a function of the age of entry into intervention. Age 0 corresponds with prenatal development (WIC and NFP). Preschool programs for 3- and 4-year-olds have had the most research, and generally show the highest returns from both cohort studies and economic simulations. The variability of contexts, service systems, and curriculum philosophy strengthens this evidence. Ratios ranged from $2 dollars per dollar invested to over $10 dollars per dollar invested. The average return was $6 per dollar invested. Programs beginning prenatally or in early infancy ranged from $1 to $5 returned per dollar invested and an average of $3 per dollar invested. Early school-age programs varied substantially, with small classes and social skills training showing the highest returns at $2 to $3 per dollar invested. The returns of small classes were highest for low-income children enrolling for 3 or 4 years (Finn et al., 2005). Neither Reading Recovery or full-day kindergarten have findings suggestive of cost-effectiveness. As further shown in Figure 2, the pattern of findings based on net program benefits (benefits minus costs) is similar: preschool programs for 3- and 4-year-olds show the largest benefits.

Insert Figure 2 here

A number of qualifications to these findings are notable. Relatively few studies of economic benefits have been conducted , especially using program cohort studies. Consequently, the CBA ratios do not necessarily define the benefits of particular intervention types (e.g., home visitation, prenatal nutrition). Returns would be expected to vary by the quality of program implementation and intensity of services as well as population characteristics.

Second, the assumptions and approaches to economic analyses varied considerably across studies. This was especially true for length of assessments, scope of measured outcomes, and the balance of projected versus actual benefits. Findings from WIC, for example, were based only on medical savings in the first year of life linked to lower rates of low birth-weight births. Benefit estimates for class size reductions, social skills training, and preschool policy simulations relied almost exclusively on projections from shorter-term outcomes.

A third qualification is that the possible benefits of combining programs such as PK-3, prenatal to preschool, and preschool and small classes in the early grades have not been fully investigated. These and other synergies warrant further effectiveness and cost-effectiveness studies. Interventions across ages should be viewed as complementary.

Finally, cost-effectiveness or CBA is one of many criteria for prioritizing programs for public investment. Social importance, program cost, feasibility, and capacity for sustainability also are important to consider in policy making.

Key Principles of Effectiveness of ECD Programs

Findings summarized in this review indicate that greater investments in high-quality ECD programs can lead to positive long-term effects and economic returns. 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 cross-age programs we assessed provide effective models to be used in the design of coordinated early childhood systems. As shown in Figure 1, attention to the causal mechanisms of change also can strengthen program effectiveness.

The accumulated research suggests five major principles that can enhance the effectiveness of early childhood development programs and to increase economic returns. These principles are consistent with others in early childhood (Ramey & Ramey, 1998) and the broader prevention field (Durlak, 1997; Nation et al., 2003).

The first principle is that a coordinated system is in place no later than preschool and continues to the early school grades. 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 preschool 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. The CPC program, for example, was established in the third largest school system in the nation. Findings from the cost-benefit analysis of a complete cohort of participants gives a good indication of the size of effects that could be possible in public schools.

A second major principle of effective ECD programs is that the teaching staff should be trained and compensated well, preferably with earned bachelor's degrees, certification in early childhood, and competitive salaries. It is no coincidence that most programs with high returns 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. NFP home visitors were public health nurses. In the Abecedarian program, teachers were compensated at levels that were highly competitive with public schools. 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 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 emphasized multiple domains of

child development within responsive and nurturing learning environments. Child to staff ratios of less than 9 to 1 in center-based preschool help as well. Class size reductions were more beneficial if they were large and continued for 3 or more years. The curriculum appeared to less important since programs varied widely in approaches. Extrapolating these findings, early childhood 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. As child development programs, infant, preschool, kindergarten, and school-age services must be tailored to family circumstances and provide opportunities for positive learning experiences in school and at home. Those with special needs or who are most at risk benefit from intensive and comprehensive services. Each of the cost-effective programs provided family services. WIC and NFP provided prenatal nutrition and education. Abecedarian provided medical and nutritional services. SOAR had family and instructional activities. 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.

Finally, greater commitment to research on 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 cohort studies that prospectively assess a wide variety of program benefits using multiple sources of data. Only 4 of the studies we reviewed had these attributes and they are most likely to accurately assess the total impact of participation. In addition, more studies are needed that address differential effects across a range of child, family, and program attributes. This will require larger sample sizes than those of most previous studies. Although less comprehensive than cohort studies, research syntheses and economic simulations provide complementary evidence that can strengthen generalizability of findings. The dissemination of cost-effective interventions also will advance as registries of effective programs include costs and benefits as inclusion criteria. Most registries treat such evidence as supplemental to study design and traditional effectiveness data (Kellam & Langevin, 2003). Efficiency is a major goal to which all programs should subscribe.

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Table 1.
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 (CPC)	Large Scale	24	14
Carolina Abecedarian Project	Model	21	13
Houston Parent-Child Development Center (PCDC)	Model	11	12
Infant and Health Development Program	Model	18	11
Comprehensive Child Development Program (CCDP)	Large Scale	5	8
Early Training Project	Model	20	8
Prenatal/ Early Infancy Project (PEIP)/Nurse-Family Partnership Program(NFP)	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
Advance Family Support and Education	Large Scale	5	3
New York State Experimental Prekindergarten	Large Scale	9	3
PSID Head Start Longitudinal Study	Large Scale	25	3

Table 2.

Examples of Monetized Benefits Reported in Cost-Benefit Analyses of Early Childhood Programs

Benefit Category	Treatment Effect	Estimate
Grade retention	Reduced rates of grade retention	Expenditure for one year of school
Special education	Fewer years of special education services	Weighted average annual cost for various categories of special education services
Childcare expenditures	Average duration of program participation	Annual opportunity cost of parent's (typically mother's) time
Child Maltreatment	Fewer incidences of child abuse/neglect	Weighted average annual cost for in-home services and out-of-home care, including administrative and investigation costs
Public Assistance	Fewer months of public assistance participation	Average monthly payment for AFDC, Food Stamps, and Medicaid, including administrative costs
Adult Health	Lower rates of tobacco use	Value of additional years of life [1]
Lifetime earnings	Higher rates of high school completion, including GED	Projected increase in lifetime earnings associated with high school completion
Juvenile crime	Fewer petitions to juvenile court	Weighted average expenditures per petition to juvenile court [2]
Adult crime	Fewer incidences of adult arrest, conviction, and/or incarceration [3]	Cost of an adult criminal career [2, 4]

[1] Estimates generally exclude benefits associated with reduce morbidity (illness prior to death).

[2] Estimates typically include criminal justice system expenditures for incarceration, probation and parole, as well as victim costs. Tangible victim costs (e.g., productivity loss, mental health care expenditures, property loss) and intangible victim costs (e.g., pain and suffering) can be estimated separately

[3] Treatment effects may be estimated using adult crime data from administrative records and self reports or projected from measures of juvenile delinquency.

[4] The average duration of adult criminal career is approximately 26 years (from age 19 through 44).

Table 3.

Cost-Effectiveness Estimates for Early Childhood Programs, Birth to Third Grade

Development Stage	Source	Focus	Location	2007 Dollars [1] Benefits	Costs	B-C	B/C
Birth to age 3							
WIC [2]	Avruch & Cackley (1995)	Targeted	National	1,206	393	813	3.07
NFP, Low SES	Glazner et al. (2004)	Targeted	Elmira, NY	83,850	16,727	67,123	5.01
NFP, Higher SES	Glazner et al. (2004)	Targeted	Elmira, NY	25,317	16,727	8,590	1.51
Preschool							
Child Parent Centers	Reynolds et al. (2002)	Targeted	20 Chicago sites	86,401	8,512	77,889	10.15
Perry Preschool	Barnett (1996)	Targeted	1 Ypsilanti site	159,610	18,260	141,350	8.74
Abecedarian [3]	Barnett & Masse (2007)	Targeted	1 NC site	182,422	73,159	109,263	2.49
RAND study of Preschool in CA	Karoly et al. (2005)	Universal	State of CA	12,818	4,889	7,929	2.62
National Pre-K synthesis for 2050 [4]	Lynch (2007)	Targeted	National	20,603	6,479	14,124	3.18
	Lynch (2007)	Universal	National	12,958	6,479	6,479	2.00
Synthesis study	Aos et al. (2004)	Targeted	58 programs	19,826	8,415	11,411	2.36
Kindergarten							
Full-Day K synthesis [5, 6]	Aos et al. (2007)	Universal	23 programs	0	2,685	-2,685	0
School-Age							
Tennessee STAR (class size reduction, K-3)	Krueger (2003)	Universal	79 schools	27,561	9,744	17,817	2.83
Synthesis of reduced class sizes, K-2 [5, 7]	Aos et al. (2007)	Universal	38 studies	6,847	2,454	4,393	2.79
Synthesis of reduced class sizes, grade 3-6 [5, 7]	Aos et al. (2007)	Universal	38 studies	3,387	2,454	933	1.38
Child Parent Centers School-Age Program	Reynolds et al. (2002)	Targeted	20 Chicago sites	8,089	3,792	4,297	2.13
Reading Recovery [5]	Shanahan & Barr (1995)	Targeted	General	1,679	5,596	-3,151	0.30
Skills, Opportunities and Recognition	Aos et al. (2004)	Universal	Seattle schools	16,256	5,172	11,084	3.14
PK-3 Intervention							
Child-Parent Centers Extended Program	Reynolds et al. (2002)	Targeted	20 Chicago sites	47,161	5,175	41,986	9.11

[1] All estimates are converted to 2007 dollars using the Consumer Price Index for All Urban Consumers (CPI-U).

[2] Estimates are based on a meta-analysis of studies investigating the effects of WIC.

[3] The cost for the Abecedarian Program represents the total costs of the intervention.

[4] Estimates for Lynch's (2007) synthesis of targeted and universal preschool represent annual per pupil program costs and associated annul government budget benefits. Total accrued benefits to government, the general public, and program participants and their parents relative to costs are $12.10:1 and $8.20:1 for the targeted and universal programs, respectively.

[5] Estimates are not based on formal cost-benefit analyses.

[6] The cost of full-day kindergarten is relative to the cost of half-day kindergarten in Washington State.

[7] Estimates from syntheses of reduced class sizes assume a reduction from 25 to 15 pupils per class.

Table 4.
Outcomes for Program and Comparison Groups on Key Measures for Cost-Benefit Analysis

Outcome	Perry Preschool	Abecedarian	Child-Parent Centers
Original sample sizes (Program, Comparison)	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 v. 48	14 v. 25
Grade retention by age 15, %	ns	31 v. 55	23 v. 38
Child maltreatment by age 17, %	n/a	n/a	7 v. 14
Arrested by age 19, %	31 v. 51	ns	17 v. 25
Highest grade completed by age 21/27	11.9 v. 11.0	12.2 v. 11.6	11.3 v. 10.9
High school completion by age 21/27, %	71 v. 54	70 v. 67 (graduation)	66 v. 54
Attended college by age 21/27, %	33 v. 28	36 v. 14 (4-year college)	24 v. 18
Employed at age 21-27, %	71 v. 59	70 v. 58	ns
Monthly earnings at age 27	$1,219 v. $766	n/a	n/a

Note. For the Perry Preschool Study, special education is for EMI placements by age 15. Ages for educational attainment and employment are 27 for Perry, 21 for Abecedarian, and 22 for the Chicago. Employment for Chicago is full-time employment.
ns = not significant; n/a = not available.

Table 5.

Summary of Costs and Benefits per Participant in 2007 Dollars for Three Early Interventions

	High/Scope Perry Preschool	Chicago Child-Parent Centers	Abecedarian Project
Average cost per participant	$18,260	$8,512	$73,159
Cost For one year of participation	10,283	5,434	16,020
Total benefits	159,610	86,400	182,422
Net benefits (benefits – cost)	141,350	77,899	109,263
Public benefits	130,690	58,476	36,429
Net public benefits	112,430	49,964	(36,730)
Total benefit per dollar invested	8.74	10.15	2.49
Public benefit per dollar invested	7.16	6.87	0.50

Note: Costs are program expenditures and do not include estimated costs for comparison-group experiences. Ages of study participants for economic analysis of the Perry Preschool Program, Chicago CPC Program, and the Abecedarian Project are 27, 21, and 22 respectively. The public benefit of the Abecedarian Project is estimated by assuming that 25% of the reported earnings benefit to participants, parents, and future generations is government tax revenues. In addition, the public is assumed to be responsible for two thirds of the cost associated with increased college attendance.

Figure 1. *Pathways from Early Childhood Programs to Long-Term Outcomes*

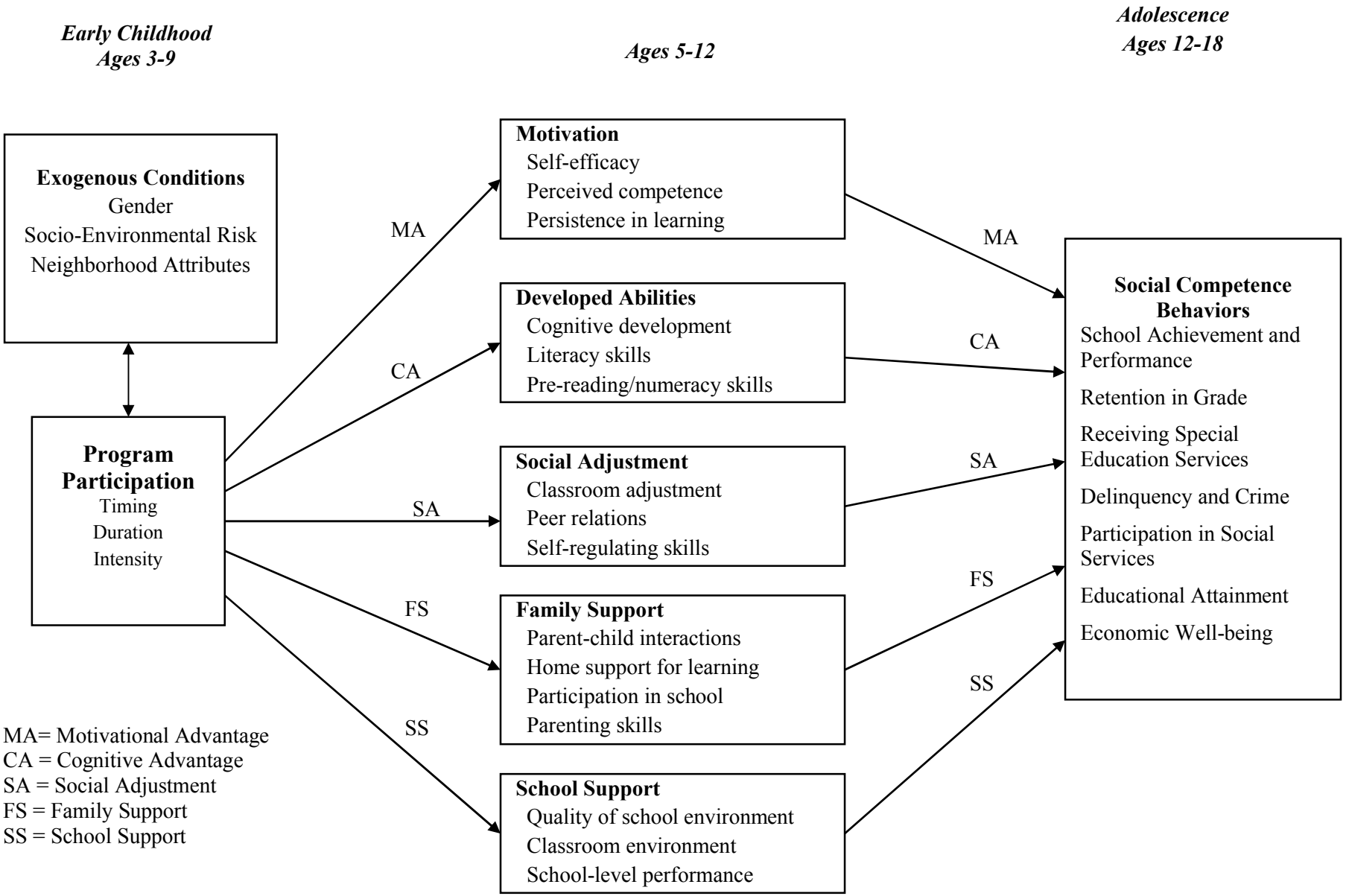

Figure 2a. *Return per Dollar Invested by Age of Entry into Intervention*

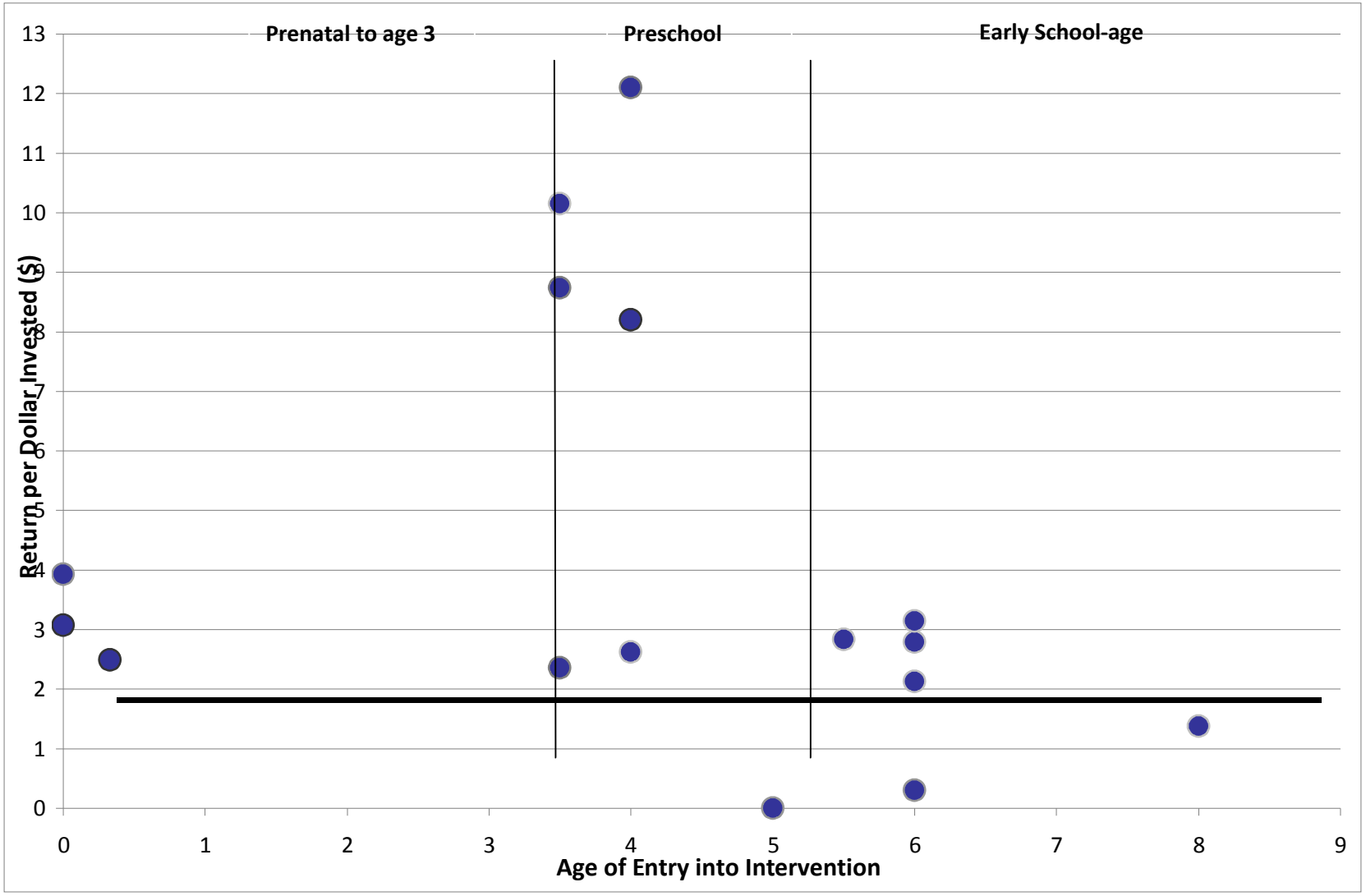

Figure 2b. *Net Present Value (Benefits – Costs) Per Child by Age of Entry into Intervention*