Adult Outcomes as a Function of an Early Childhood Educational Program: An Abecedarian Project Follow-Up

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Abstract

Adult (age 30) educational, economic, and social-emotional adjustment outcomes were investigated for participants in the Abecedarian Project, a randomized controlled trial of early childhood education for children from low-income families. Of the original 111 infants enrolled (98% African American), 101 took part in the age-30 follow-up. Primary indicators of educational level, economic status, and social-adjustment were examined as a function of early childhood treatment. Treated individuals attained significantly more years of education, but income-to-needs ratios and criminal involvement did not vary significantly as a function of early treatment. A number of other indicators were described for each domain. Overall, the findings provide strong

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evidence for educational benefits, mixed evidence for economic benefits and little evidence for social-adjustment outcomes. Implications for public policy are discussed.

Keywords

Abecedarian Project; Early Childhood Education; Poverty; Adult Outcomes; Education; Employment

The present article is the latest in a series of longitudinal reports from the Abecedarian Project, a randomized controlled trial of intensive early childhood education for children who were at risk of developmental delays or academic failure based on their family's low-income status. Children were randomly assigned either to attend a research-based educational child care program from infancy up to kindergarten entry or to a control condition (Ramey et al., 1976). The early childhood program significantly enhanced cognitive development during the treatment years (Ramey & Campbell, 1984) with positive impacts on cognitive and academic skills continuing through the primary grades (Ramey & Campbell, 1991). Subsequent follow-up studies showed that these effects persisted up to age 15 (Campbell & Ramey, 1994, 1995), and further, positive effects on educational, occupational, and social-emotional outcomes were still evident in young adulthood (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Campbell & Ramey, 2007). Specifically, those with early childhood treatment had acquired more years of education and were more likely to be enrolled in college at age 21 (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002). These outcomes were encouraging, but it was important to discover whether, in later adulthood, the promise of better life success inherent in the young adult educational attainment, was borne out. For example, those who were enrolled in college at age 21, even if they progressed through at the typical 4-year rate, would not yet have graduated. Therefore, a follow-up at age 30, when the study participants would have had time to complete their educations and establish careers, was needed to learn if positive effects of the Abecedarian intensive early childhood program extended well into adulthood.

Few well-controlled studies exist where children from poverty backgrounds have been provided with early childhood educational programs and subsequently followed up into their adult years (i.e., aged 25–40 years) to learn the extent to which the early programs might be linked to enduring life-enhancing benefits. Insofar as treatment outcomes at earlier life stages are concerned, a number of early childhood programs found that their treated children showed moderate to large gains in intellectual test scores during the preschool years (Garber, 1988; Royce, Darlington, & Murray, 1983; Ramey & Campbell, 1984) and improved academic scores, reduced special education placements, and fewer grade retentions in grammar school (Lazar, Darlington, Murray, Royce, & Snipper, 1982; Reynolds, 2000; Campbell & Ramey, 1994). Previously published young adult findings, including some from Head Start (Garces, Thomas, & Currie, 2002 and Deming, 2009) have included increased rates of high school graduation (Berrueta-Clement, Schweinhart, Barnett, Epstein, & Weikart, 1984; Garces et al., 2002; Reynolds et al., 2007), an increased likelihood of attending college (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson,

2002; Garces et al., 2002; Reynolds et al., 2007) and somewhat better economic circumstances (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Berrueta-Clement et al., 1984; Deming, 2009; Graces et al., 2002; Reynolds et al., 2007). Some studies reported lower rates of crime (Berrueta-Clement et al., 1984; Deming, 2009; Reynolds et al., 2007) and also reductions in teenaged parenthood (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Deming, 2009).

Most pertinent for comparison of the Abecedarian long-term outcomes are three other well-controlled "model" programs wherein poor children were provided early childhood educational experiences and subsequently followed up their samples past the college years. Although two were not prospective randomized trials, their quasi-experimental designs allow comparisons of adult outcomes for children who did or did not receive their early childhood treatment. The Brookline Early Educational Project (BEEP), a quasi-experimental study, provided 5 years of home visiting and/or child care services that began at age 2 to 169 primarily European-American children who varied in terms of level of poverty; a subsequent long-term follow-up was conducted when their participants were 25 years of age (Palfrey et al., 2005). No effects of BEEP were found for the lower-risk, suburban group. In contrast, for the higher-risk urban group, BEEP was related to more years of education, higher incomes, less depression, and more perceived competence when compared with samples of demographically similar adults (Palfrey et al., 2005).

The Chicago Longitudinal Study (CLS), another quasi-experimental study, evaluated outcomes of the Chicago Child-Parent Centers (CCPC) preschool programs located either within or next to public schools in low-income neighborhoods. The CCPC offered preschool with a focus on parental involvement for two years to some children and for one year to others, kindergarten to all, and additional educational supports in grades 1–3 to some. Comparison groups from similar circumstances provided estimates of treatment effects (Reynolds, 2000). Over the years, treatment effects have been reported by Chicago investigators for participants at elementary school, high school and post-high school age (e.g., Reynolds et al., 2007); most recently, outcomes for treated and comparison groups at age 28 have been published (Reynolds, Temple, Ou, Arteaga, & White, 2011). Significant effects for having attended the preschool program were found for highest grade completed (12.15 v. 11.88 years), SES score of 4 or higher (35.9% v. 30.3%), higher annual incomes ($11,582 v. $10,796), and lower rates of crime (27% lower). No difference was found for rates of employment or the use of welfare.

In terms of having a randomized controlled design, the program most closely comparable to the Abecedarian study is the Perry Preschool Project, in which children from low-income backgrounds attended a half-day preschool program or were in a control group. The participants were most recently followed up at age 40 (Schweinhart et al., 2005). The project enrolled 123 children (100% African American) into a 1 or 2-year preschool program for children aged 3 to 5, with 58 assigned to the treatment group and 65 controls. The preschool operated during the traditional 9-month school year, with families having weekly home visits in the afternoons. In addition to low family income, all admitted children had entry level IQs between 65 and 90. Previous publications by the High/Scope Foundation detail findings from the Perry Preschool study over the years (e.g., Weikart, Bond, & McNeil,

1978; Schweinhart & Weikart, 1980; Berrueta-Clement et al., 1984; Schweinhart, Barnes, & Weikart, 1993). In adulthood, those who attended the preschool program were more likely to graduate from high school by age 27 (71% vs. 57%, *p* = .055) (Schweinhart et al., 1993); and at age 40, they earned significantly more money and were less likely to have been arrested for crime 5 or more times (Schweinhart et al., 2005). The findings from this program have heavily influenced research and policy in the field of early childhood educational intervention for poor children. Moreover, of the three programs reviewed above, only the Perry Preschool employed a design that eliminates *a priori* differences between the treated and comparison children that could account for apparent treatment differences.

In sum, although the service delivery models varied across the three studies, all found significant benefits in adulthood for high-risk individuals in the treated groups. The BEEP and CLS found significant effects for total years of education, CLS and Perry Preschool reported higher high school graduation rates, and the Perry Preschool study showed higher rates for obtaining an Associate or college degree. For economic indicators, both the BEEP and Perry Preschool reported positive benefits for income, while the CLS reported both higher incomes and higher SES scores. For social-emotional adjustment, the BEEP and CLS found reduced depression in the high-risk treated group, and CLS and Perry Preschool studies reported reduced rates for criminal activity.

The Current Study: The Abecedarian Project

The Abecedarian Project was a prospective randomized trial designed to learn the extent to which intensive early childhood education could overcome the odds of developmental delays and academic failure for children born into low-income families. Educational activities (or learning "games") were provided from early infancy within a full-time child care facility that operated year round. Treated children attended the center from as young as 6 weeks (mean entry age was 4.4 months) until they entered public school kindergarten at age 5 years. Thus, it was the most intensive of the studies that have long-term follow-up data. The early childhood educational activities were designed to develop age-appropriate language, cognitive, socio-emotional, and gross and fine motor skills across the infant, toddler, and preschool years (Sparling & Lewis, 1979; Ramey & Campbell, 1981, 1984, 2007; Ramey, Campbell, & Wasik, 1982). Numerous previous publications detail early childhood through middle adolescent findings (Ramey & Campbell, 1984, 1991; Campbell & Ramey, 1994, 1995). At age 21, the treated group had maintained statistically significant advantages both in intellectual test performance and in scores on academic tests of reading and mathematics (Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey 2001). Concerning educational attainment, the treated group had attained more years of education at age 21, and although no significant group difference was found for the percent completing high school by that age, those who received the early treatment were more likely to attend a 4-year college or university (35% of the treated group compared to 14% of the control group). Those with early childhood treatment were also more likely either to be in school or to have a skilled job, or both. Concerning social-emotional outcomes, treated individuals were less likely to be teen parents, less likely to smoke marijuana (Campbell et al., 2002), and less likely to report depressive symptoms (Campbell & Ramey, 2007) when compared to individuals in the control group.

Given these encouraging findings from early adulthood, the current age-30 follow-up study of the Abecedarian Project was designed to investigate treatment effects on educational, economic and social-emotional outcomes later in adulthood. The key educational outcome tested was years of education completed, the key economic indicator compared was income-to-needs ratio, and the key social-emotional outcome examined was criminal activity. Follow-up measures were included to explore other outcomes within each of the key domains as well. Specifically, high school graduation and college graduation rates were examined for educational outcomes; employment, use of welfare, earned income, job prestige, being head of a household, and avoiding the need for welfare support were examined for economic outcomes; and marital status and child bearing, mental health as reflected in internalizing and externalizing problems, substance use, and perceptions of physical health were included as social-emotional outcomes.

Method

Study Sample

Recruitment for the Abecedarian study began in the summer of 1972. Eligibility for enrollment was based on scores from a High Risk Index (Ramey & Campbell, 1977) that contained indices of socio-demographic risk, chiefly weighted scores reflecting low parental education and low family income and, to a lesser degree, such factors as parental marital status, indications of learning problems in other family members, parental IQ level, and the use of welfare. One hundred-twenty eligible families agreed to consider enrollment. Eight families declined their random assignment, and one child was replaced due to a biomedical condition. In addition, two children were administratively assigned to the child care condition; these cases did not contribute data to the study outcomes. Ultimately, 109 families accepted their random assignment, and their child participated at least minimally. The 109 families had 111 children (one set of twins, one sibling pair). These infants, born between 1972 and 1977, were admitted to the study in four cohorts. The base sample thus consisted of 57 infants randomly assigned to treatment and 54 assigned to the control group.

Of the original 109 families, 107 (98%) were African American, and 2 were White. At study entry, 76% of the children lived in female-headed households, and 66% of the mothers did not have high school diplomas. By age five, the number of children had been reduced to 105. Four were deceased, one was withdrawn, and a second child proved to be ineligible due to a biological condition not apparent at birth.

The early childhood treatment and control groups were re-randomized when children entered public school at age five, with half of each early childhood group assigned to receive intervention for the first three school years (grades K-2, unless a child was retained). Thus, early childhood intervention could range from a high of eight years combining early childhood and the primary grades, to five years in early childhood only, to three years in the primary grades only, to no systematic intervention. Further details about the early recruitment and randomization are found in previous publications (e.g., Ramey, Collier, Sparling, Loda, Campbell, Ingram, & Finkelstein, 1976; Ramey & Campbell, 1981; Campbell & Ramey, 1994). Because data from middle childhood and later indicated that the independent effects of the early childhood treatment, as opposed to the school-age program,

predicted adolescent cognitive and academic scores, the outcomes of the age-21 follow-up were compared as a function of early childhood treatment or control group status alone. At age 21, all 105 living and eligible study participants were located, and 104 were successfully recruited for the young adult follow-up (Campbell et al., 2002).

Follow-up assessments for age-30 took place between 2003 and 2009. Between the age-21 and age-30 follow-up periods, two study participants died, reducing to 103 the possible number of recruits for age 30. Of these, 101 agreed to participate (98% of those living and eligible). Thus, 91% of those enrolled as infants provided data for this adult follow-up, and the percentage of African Americans (98%) duplicated that in the original sample. Table 1 summarizes the numbers of female and male infants originally assigned to the treated and control groups and of the adults who participated at age 30. Table 2 gives baseline means and standard deviations for maternal age, maternal education and maternal intellectual test scores for the current participants, as collected when they were originally assigned to early childhood treated and control groups. For this follow-up, all participants were seen as close to the date of their thirtieth birthday as possible to ensure that all had comparable life intervals to accomplish adult goals. Participant age averaged 30 years and 8 months when seen, with a range from 29 years-11 months to 36 years-6 months. For the treated group, mean age = 30.56 years, SD = 0.64; for the control group, mean age = 30.78 years, SD = 1.13 (t = 1.24, p = .23). Approximately 40% of the participants fell within the target range of 1 month before or after the 30th birthday. Of the remainder, 34% were between 30 years-2 months and 30 years-11 months old, 21 % were 31 when assessed, and 5% were 32. Only one individual was older than 32 when interviewed.

Procedures

The study's Family Coordinator contacted the original participants by letter or telephone to inform them of the adult follow-up and invite them to take part. A total of 74 persons still lived either in the hometown or within a 50 mile radius of it; 10 others lived within the same state and 17 lived out of state. Data collection was carried out during face-to-face appointments at the University with the exception of the special arrangements for those incarcerated or when circumstances precluded travel to the data collection site. In those cases, interviews were by telephone and questionnaires were collected by surface mail. Individuals were compensated $125 for the time required to complete the age-30 protocol, and the cost of travel by public conveyance or by personal car in excess of 100 miles round-trip was reimbursed.

Data collection consisted of a semi-structured interview and several questionnaires. Trained interviewers collected data using computer-assisted interviews that assessed educational, economic, and social-emotional outcomes and questionnaires measuring mental health and risk taking behavior (described below). Data for the use of TANF/Work Force funds were obtained from the administrative records of the North Carolina Department of Health and Human Services, covering the receipt of such funds between January, 1995 and August, 2009.

Measures

Given the small sample size, a single key outcome was selected for inferential analysis within each domain to guard against Type I error. Secondary outcomes were examined descriptively. The particular educational measure, years of education completed, and economic indicator, income to needs ratio (INR), were selected because they were judged most fully to encompass the aims of early educational intervention for poor children: i.e., to increase the likelihood of their obtaining sufficient education to become self-supporting adults. Rate of involvement in crime was selected as the most meaningful index for socio-emotional adjustment. Other longitudinal studies of early education have found the avoidance of criminal activity to be a key outcome, especially for cost effectiveness (Schweinhart, et al., 1993), hence it was selected as the key social-emotional outcome for the Abecedarian age 30 study as well.

Education Outcomes

Primary Outcome

Years of education: Derived from individual responses to interview questions, a continuous measure of educational attainment was created based on the number of years associated with the final degree obtained, with numbers assigned as follows: If the participant did not graduate from high school or obtain a GED, the score was the highest grade completed; a score of 12 was assigned for High School graduation or a GED; 14 indicated completion of some college or an associate's degree from a community college; 16 denoted a Bachelor's degree; 18 a Master's degree; 20 for a doctorate.

Secondary Outcomes

Graduation rates: Two binary indices were created as well: High school graduation/GED (yes =1, no = 0) and college degree (Bachelor's or higher, yes = 1, no = 0).

Economic Indicators

Primary Outcome

Income to needs ratio: A series of interview questions assessed total income from a variety of sources. The income to needs ratio (INR) calculated for each person compared the income resources for his or her family to the size of the household being supported. The total for the financial resources of the household was derived based on the interviewee's self-reported total income (salary and wages from all jobs plus tips, bonuses, or commissions, if applicable), as well as income from a spouse, if any, plus that reported from any other source (e.g., alimony, social security, welfare benefits). The INR score was calculated by dividing the total reported household income by the poverty threshold relevant to its household size and the given interview year. A score of 1.00 indicates 100% of the poverty threshold, that is, being just at poverty, whereas 3.00 indicates middle class status. For persons who were incarcerated or homeless when interviewed at age 30, an INR score of zero was assigned.

Secondary Outcomes

Employment: Vocational status was measured based on interview questions covering current job status and past employment over the previous two years. In accordance with Duncan and Petersen's (2001) emphasis on assessing the consistency of working over an extended period, a score was created reflecting the proportion of the preceding 24 months each participant was fully employed (30+ hours/week). A binary measure was created such that individuals who reported full time employment for 2/3 (67%) of that period were considered fully employed; others were not.

Job Prestige: For each individual, a prestige score was assigned to the primary job he or she reported, derived from the 1989 Socioeconomic Index for the 1980 Census Occupational Classification (Nakao & Treas, 1990). These numbers can range from 0 to 100 but, in general, a score below 35 is considered relatively low-status (truck driver, assembly line worker, short-order cook), scores between 36 and 41 reflect modest status (electrical technicians, hairdresser), those from 42 to 55 are considered moderate (owner of day care center, computer programmer, pharmacy technician), and scores above 55 are considered relatively high-status positions (x-ray technician, police personnel, speech therapist) (Nakoa & Treas, 1990; Reynolds, Temple, Ou, & White, 2009). Persons who were not working, either because they had no job or because they were incarcerated at the time, were not assigned a job prestige score (n = 26), limiting this outcome to persons who were working at the time of the interview.

Earned income: Based on information self-reported during the interviews, a total score reflecting current annualized earned income was calculated based on salary and wages from all jobs plus tips, bonuses, or commissions, if applicable. If the respondent gave hourly, weekly, or monthly rates, the numbers were converted to a 12-month equivalent. The unemployed and those incarcerated were assigned scores of zero for this variable.

Use of public assistance: Data from the administrative records of the NC Department of Health and Human Services provided a binary indicator of receipt of public welfare funds for each month between January, 1995 and August, 2009 (yes = 1, no = 0 for each month). To allow exact comparisons among individuals and groups, a standard interval of 89 months was searched for each case, defined as the period between the ages of 22 years 7 months and 30 years. This time span was dictated by the age of the oldest Abecedarian participant at the beginning date of the available data. The score for each person comprised the total months of service used during that period. Because relatively few individuals had entries in this data base, a variable was created to reflect a meaningful difference in welfare use between the treated and control groups; this variable defined "extensive" use of services as welfare receipt greater than 10% of the time span.

Of necessity, this data base included only persons living in North Carolina during the data window. Eighty four of the 101 individuals in the study sample met this criterion. Persons living within the state whose ID did not appear on the administrative data list would have made no use of these services during the reported interval, thereby constituting the cases not using services. Persons who lived in another state during the entire data window covered by

these records would not be represented, thus 17 cases could not be included in this particular analyses. The likelihood of not living in North Carolina at age 30 and therefore not contributing data to the analysis did not vary as a function of having had early childhood treatment (χ^2 (1, N =101) = 1.43, p =.23).

Head of household: The subject interview contained a question as to whether the individual was financially responsible for his or her own housing at age 30. Participants who either owned or rented their current dwelling were coded as head of household = 1, not = 0.

Social- Emotional Outcomes

Primary Outcome

Criminal behavior: Data on criminal involvement were self-reported during the interview. Binary variables examined for the current analysis included a history of any conviction for a misdemeanor or for a felony, and whether or not the individual was currently incarcerated. For this report, convictions for a misdemeanor or felony were combined to show the percent who reported criminal activity as a function of early childhood treatment.

Secondary Outcomes

Marriage and children: Questions in the participant interview also covered marital status, parenthood, indication of multiple children outside wedlock, and age when one's first child was born.

Mental health and social adjustment: Mental health was measured using the Achenbach System of Empirically Based Assessment (ASEBA) Adult Self Report and Adult Behavior Checklist (Achenbach & Rescorla, 2003). The measure is designed for individuals from 18–59 years of age. The scales were normed using data from a nationally representative survey of 1,435 "non-referred" persons whose data were collected in 1999. The norms included 8% African Americans and 31% low SES individuals. Test-retest reliabilities ranged from .71 to .85 for the Adaptive Functioning scores and from .79 to .94 for the clinical scales (Achenbach & Roscorla, 2003). The clinical range for T scores is T > 63 for the Externalizing and Internalizing scores.

Substance use: Items describing the use of alcohol, tobacco, and drugs were taken from the Behavioral Risk Factor Surveillance System Questionnaire published by the Center for Disease Control (Centers for Disease Control, 2001). The individual read and marked these items in private, with the data collector nearby to answer any questions. Prison rules disallowed asking about current drug use, thus the items had to be re-framed to describe pre-incarceration habits for affected individuals.

Health status: Health status was estimated from the individual's self-rating of his or her current health. The subject interview contained a 5-point scale ranging from Excellent (5) to Poor (1). A binary variable was created with Good health being assumed if the person checked either Excellent or Very Good on this scale; checking Good, Fair, or Poor was construed as less than optimal health status.

Data Analysis

Intent-to-treat (ITT) analyses were conducted to estimate the adult impacts of the early childhood intervention. This involved comparing all individuals randomly assigned to the infant/preschool treatment group with those randomly assigned to the control group using analyses of variance (ANOVA) for continuous outcomes and logistic regression for categorical outcomes. Gender and a gender×treatment interaction were included as covariates for the key outcomes. These terms were dropped from all models when they proved to nonsignificant. Effect sizes (Cohen's *d* (Cohen, 1988) or Odds Ratio (*OR*)) were calculated for each outcome to allow the treatment effects to be compared in the same metric. As described above, to guard against Type I error, one primary outcome was selected to indicate effects in each domain (educational, economic, social-emotional). Secondary analyses descriptively compared the treatment and control groups on the other variables assessed within each domain.

Results

Educational

Table 3 summarizes the educational outcomes for the treated and control groups.

Primary Outcome—The Abecedarian early childhood program was associated with significant and moderately large educational gains up to age 30. Educational level (degree years completed) for treated individuals averaged 13.46 years, whereas for those in the control group averaged 12.31 years $F(1, 99) = 9.60$, $p < .01$. $d = .62$.

Secondary Outcomes—Descriptively, high school graduation rates were similar across the two groups, with 89% and 82% for the treated and control groups respectively obtaining a high school diploma or GED, $\chi^2 (1) = .91$, $p = .34$, $OR = 1.73$. The majority of high school credential holders obtained a high school diploma rather than a GED (83% in the treatment group and 72% in the control group). In contrast, in the group with early childhood intervention, 23% had earned a Bachelor's degree or higher, compared to 6% of the control group, $\chi^2(1) = 5.03$, $p = .03$, $OR = 4.60$. In other words, those in the treated group were more than 4 times more likely to be college graduates or higher at age 30. Descriptively, 12 individuals in the treated group earned a 4-year degree; 2 of the 12 had also earned graduate degrees, and 2 others were working toward advanced degrees at the time of the interview. In contrast, 3 in the control group had earned a 4-year degree, and none was pursuing an advanced degree by age 30.

Economic Outcomes

Table 4 summarizes the economic outcomes for the treated and control groups.

Selected Primary Outcome

Income-to-needs ratio: The average income-to-needs ratio favored the treated group, but the effect size was small and the difference was not statistically significant $F(1, 99) = 1.61$, $p = .21$, $d = .25$.

Secondary Outcomes

Employment: Comparing the percentage of the treated and control groups who worked full time for at least 2/3 of the preceding 24 months showed that the odds of being employed for those in the treated group were more than twice the odds for those in the control group, $\chi^2(1) = 5.16$, $p = .02$, $OR = 2.65$. Overall, 75% of the treated group worked full-time while 53% of the control group worked full time.

Earned income: Compared to the control group, the early childhood treated group reported modestly higher earned income, $F(1, 99) = 2.60$, $p = .1$, $d = .32$. The data for this outcome were positively skewed with more scores falling toward the low end of the curve. In addition, one outlier in the treated group reported an annual income more than double the next closest figure given by anyone else, thereby inflating the mean in the treated group. Neither removing the outlier nor using a log-transformation to more nearly normalize the data altered the outcome.

Job prestige: The early childhood treated group had slightly higher job prestige scores than the control group, $F(1\ 99) = 2.60$, $p = .1$, $d = .38$.

Head of household: The odds of being the head of one's own household were almost twice as high for the treated group, $\chi^2(1) = 2.27$, $p = .1$, $OR = 1.98$.

Use of public assistance: Administrative data on welfare funds showed that, within the 89-month time window where usage was compared, individuals in the control group were 6 times more likely to receive benefits 10% of the time or greater, $\chi^2(1) = 5.35$, $p = .02$, $OR = .16$. Inverting the OR showed that the probability of needing public welfare was over 6 times more likely for the control group than for the treated group.

Table 5 summarizes the social adjustment, social/emotional and health outcomes for the treated and control groups.

Primary Outcome

Criminal activity: The selected key outcome for the social-emotional domain was whether the individual had been convicted of a crime. No evidence emerged indicating treatment differences in criminal activity. The percentages within the treated and control groups were virtually identical: 27.45% and 28.27% for the treated and control groups respectively, $\chi^2(1) = .02$, $p = .90$, $OR = .95$.

Secondary Outcomes

Marriage and parenthood: By age 30, approximately a quarter of each group had married: 28% for treated versus 24% for controls, $\chi^2(1) = .24$, $p = .62$, $OR = 1.25$. Having multiple children outside marriage was slightly more likely for individuals in the early childhood control group, $\chi^2(1) = 1.60$, $p = .21$, $OR = .58$. A positive finding was that the mean age at first parity was higher (almost two years) for those with early childhood treatment $F(1, 99) = 4.97$, $p = .03$, $d = .52$.

Substance abuse: Among the 30-year olds, self-reported substance use or abuse did not differ as a function of early childhood educational experience. Reported rates of smoking tobacco, $\chi^2(1) = .44$, $p = .51$, $OR = 1.31$, binge drinking, $\chi^2(1) = .00$, $p = .99$, $OR = .99$, or recent use of marijuana $\chi^2(1) = .88$, $p = .35$, $OR = .63$, were all similar in the treated and control groups.

Mental health: According to the number and severity of the social adaptation and emotional/mental health problem behaviors they endorsed, few of these individuals were experiencing mental health concerns that scored in the clinical range (T>63). For Internalizing problems (Anxious/Depressed, Withdrawn, Somatic Complaints), $\chi^2(1) = .42$, $p = .52$, $OR = .63$, and for Externalizing Behaviors (Aggressive, Rule Breaking, Intrusive), $\chi^2(1) = .03$, $p = .85$, $OR = 1.12$.

Physical health: A higher percentage of individuals in the treated group ranked their own health as either Excellent or Very Good at age 30: 69% of the treated group compared with 59% of the controls. This difference slightly favored the treated group: $\chi^2(1) = 1.10$, $p = .29$, $OR = 1.55$

Discussion

The main goal of the experimental Abecedarian Project was to learn whether an intensive early childhood educational experience could enhance the cognitive development of children being raised in poverty, and, in turn, improve their school progress. Early results during program implementation as well as those from follow-ups through young adulthood showed that the answer to this scientific question was clearly affirmative. The present examination of outcome at age 30 shows that the effect of early treatment on educational attainment extends well into adulthood. Although the strong educational benefit was not reflected in an equally strong gain in the average income to needs ratios for the treated and control groups, several of the secondary economic indicators were positive. Little evidence supporting long-term effects on social-emotional outcomes emerged.

An overarching goal of all the early childhood programs reviewed here was to increase the likelihood of school success for children at risk for academic failure. The number of degree years attained by age 30 comprised the key educational measure on which the Abecedarian treated and control groups were compared; the treated group significantly excelled the control group in this regard with an effect size in the moderate range. Further, the treated participants were four times more likely to have earned college degrees by age 30. The college graduation rate for the treated group (23.5%) approximates the rate reported in the year 2000 US Census for college graduates in the United States as a whole (24%), and clearly exceeds that year's rate for African Americans (14%) (US Census, 2003; 2005).

The educational findings are consistent with those of the other adult follow-up studies of early educational experience for children in poverty, but comparing effect sizes across studies is somewhat problematic The mean difference in years of education attained is very similar for the BEEP, PPS, Perry Preschool, and Abecedarian studies (about one year), while the CLS found the lowest mean years attained and the smallest gap between treated and

control groups (.27 years, Reynolds et al., 2011). However, converting the treatment/control differences into d values requires knowing standard deviations, which were available only for the Abecedarian and BEEP studies. Odds ratios for high school graduation ranged from OR = 2.10 for the PPS, 1.73 for Abecedarian, and 1.42 for the CLS. The BEEP did not report this outcome, but comparing the d values for total years of education showed d = .62 for the Abecedarian study and d = .75 for the BEEP, both moderate effects. The reported odds for college attendance showed that, for the PPS, OR = 1.36 for attending college, compared to OR = 4.60 for earning a Bachelor's degree in the Abecedarian study. Comparable figures were not available for the CLS and the BEEP, and moreover, how the findings with respect to college were operationalized varied across studies with the PPS reporting college attendance in terms of having earned an Associate's degree or 4-year college degree, Abecedarian reporting rates of actually earning Bachelor's degrees or higher, whereas the CLS described college attendance and the BEEP not reporting this outcome per se. Going beyond high school is a critical outcome because college graduation has life-long implications in terms of income, job prestige and community status (Jeynes, 2007).

In contrast to the uniformly stronger educational outcomes, less evidence was found to support effects on economic outcomes in the Abecedarian sample. Despite a small positive effect of treatment on the primary outcome, i.e., income-to-needs ratio, it did not differ significantly between the treated and control groups. However, across the primary and secondary measures findings were mixed. Descriptively, treated individuals were more likely to have worked steadily over the past two years and less likely to need public assistance to meet basic needs than individuals in the control group. Self-reported earned incomes were higher for the treated group, but the difference was not statistically reliable. Given the strong evidence of educational gains in the treated group, higher incomes for that group were also expected. Why a stronger, more direct effect of better education on earnings did not emerge is unclear, but economists have noted that the association between educational level and income is complex and subject to a number of influences outside the control of the individual (e.g., Card, 1999). Recent downturns in the economy leading to fluctuations in local job markets, as well as idiosyncratic personal circumstances, could have negatively impacted earnings at any given time. Research that extends further into the lives of the study participants will be needed to understand more fully the vicissitudes of economic outcomes within this vulnerable population, particularly in light of current downturns in economic expectations affecting all levels of society.

Comparing economic findings across studies in terms of d statistics or ORs was not attempted because even more variation existed in how each study operationalized these outcomes. For the Abecedarian study, self-reported earnings from all sources were combined and annualized to arrive at annualized income figures for age 30. The CLS reported average annual income at age 24 as "four quarters of earned income exceeding $3,000" (i.e., earnings above the poverty line) (Reynolds et al, 2007, p. 733)and at age 28 as average annual earned income (Reynolds et al., 2011). The PPS reported median earned income for its program and no-program groups at age 27 and age 40. The BEEP study used yet another metric to compare monetary attainments among its study participants, reporting the percentage of each group whose current income was "low", i.e., less than $20,000

(interval not specified). Schweinhart et al., (2005) and the BEEP study (Palfrey et al., 2005) both reported significant treatment effects for earned income in adulthood, but it is difficult to compare them directly because the BEEP investigators did not indicate whether their less than $20,000 figure represents a mean or a median income.

Concerning other economic indicators, results here are generally consistent with the other longitudinal studies for employment but inconsistent for use of welfare. Significant long-term effects on adult employment rates were also found in the CLS and the PPS, while the BEEP did not find an employment benefit. Concerning use of welfare, the PPS reported a trend for a reduction in usage rates for their treated group up to age 40, while the CLS and BEEP found no clear trend for a reduction in welfare dependence.

As for social-emotional outcomes, neither the analyses of the primary indicator, criminal involvement, nor the descriptions of the secondary outcomes indicated strong effects of the Abecedarian early childhood treatment within this domain. Among the programs compared here, the Abecedarian Project was unique in that it was primarily a child-centered treatment that began its child-care-based educational program in early infancy. While highly concerned with the physical health, emotional well-being, and security of its young participants, the child care center treatment also focused on cognitive and language development, shown to have mediated the treatment effect on academic skills in young adulthood (Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey, 2001). Of the three other programs, only the BEEP began intervention in infancy and the BEEP's first intervention was primarily focused on pediatric care and parent support. The BEEP children had "drop-in" child care support and periodic play groups in the toddler years and they were provided preschool from ages 3–5, similar to the preschool models used in the CCDP and the PPS. Thus, the systematic child-centered educational program offered for Abecedarian treated participants within a full-time child care setting was by far the most intensive of all four programs, at least in terms of educator-child contact over an extended period of time. Whatever the underlying mechanism, at age 30, the greatest long-term impact of the Abecedarian treatment was on educational outcomes in contrast to socio-emotional adjustment. Although at age 21 young adult outcomes included a treatment-related reduction in self-reported depressive symptoms (Campbell & Ramey, 2007), such a reduction was not found at age 30. Whether this difference was due to the use of a different screening instrument at age 30 or was related to the increased maturity of the individuals is not clear.

Differences among the four programs in reductions in histories of law breaking are even more puzzling. An earlier study of lawbreaking (up to age 18) among Abecedarian participants, based on data located in public records of the administrative office of the courts, showed no difference in citation rates for the treated and control groups (Clark & Campbell, 1998). Similarly, at age 30, self-reported rates of criminal involvement (convictions for misdemeanors, felonies, or incarcerations) did not vary as a function of early childhood treatment. In both groups, just over a quarter of the individuals reported one or another of these events. In contrast to this Abecedarian outcome, a reduction in criminal behavior has been widely publicized as one of the more important benefits accruing to the PPS (Schweinhart & Weikart, 1980; Berrueta-Clement et al., 1984; Schweinhart et al., 1993; Schweinhart et al., 2005). The authors of its age-40 report asserted "The study presents

strong evidence of a lifetime effect of the High/Scope Perry Preschool Project in preventing total arrests and arrests for violent, property, and drug crimes and subsequent prison or jail sentences" (Schweinhart et al., 2005, p. 85). Likewise, in their age 28 follow-up (Reynolds et al., 2011), the CLS found a significant reduction in crime. The BEEP study found a difference in the rate of arrests as a function of the community, with the suburban group having fewer, but no treatment effect for having BEEP in either location (Palfrey et al., 2005). Taken together, one might speculate that programs with more emphasis on parent involvement were more effective in the prevention of later crime in poor children because both the PPS and the CCPP had more systematic parent programs than did the Abecedarian project. Arguing against this supposition, however, is that the BEEP had a strong parent component but found no reduction in arrests for its lower-income urban group. Whether the variations in crime reduction can be tied to differences in early childhood program features or to the demographics of the various communities involved in the four studies compared here remains an open question.

Optimally, all the comparative outcomes considered here must be supplemented with cost-benefit analyses to learn the extent to which the investments in early childhood programs ultimately saved money in terms of more productive lives in adulthood. Based on outcomes at age 27 and age 40, the PPS appears to have been well worth its costs. The relative return of the PPS at age 27 was calculated at $7.16 saved for each dollar spent on early childhood program, while at age 40, this figure was $17.07. In contrast, based on findings at age 21, the Abecedarian program was estimated to save $2.50 for every dollar spent on the early childhood program. The comparable figures for outcomes at age 30 are not yet available for the Abecedarian study, and were not located for the other two programs reviewed. Therefore, further research is necessary to establish reliable comparative estimates of the relative benefits of these programs.

Caveats for this study of Abecedarian outcomes include the small sample size which limits power to detect effects that may truly be related to the early treatment. A sample size of 101 provides 80% power to detect d-type effect sizes as small as .56, generally considered a moderate effect in the population. In this regard, the sample size available for these analyses was insufficient to allow small to modest differences to attain statistical significance. Neither could gender differences or gender by treatment interactions be detected reliably (Demidenko, 2008). Another caveat is that much of what is presented here is based on self-reported outcomes derived from interviewing the individuals face-to-face, and some persons may have embellished their reports of accomplishments. On the other hand, this study is characterized by major strengths, including its randomized control trial design and its low attrition, with contact being maintained with over 90% of the original participants over thirty years, contributing to the validity of the outcomes.

The findings presented here generalize to individuals from low-income, primarily minority families. The findings of the Abecedarian Project at age 30 reinforce the importance of the first five years of life as a key stage during which cognitive skills that provide a foundation for future success are acquired. The present data address neither the feasibility of taking the program to scale nor specific questions about quality child care. Their strength is that they answer a critical question about whether the developmental trajectory of children at risk can

be changed in a way that has implications for their adult lives. The answer is affirmative. A very intensive early educational program provided for full-days, year-round within a quality child care stetting, starting within the first six months of life, was associated with positive outcomes 25 years after participants completed the program. Many children born into poverty are in need of full-time child care, especially given the work requirements now tied to qualifying for welfare benefits. For children growing up in economically poor families who need out-of-home care from infancy, very early child care provides a vital opportunity to enhance development. Other factors in the lives of the Abecedarian participants, including families, communities, schools, and the individuals themselves, also contributed to the positive adult outcomes seen here, but it is clear that the educational advantages seen in the adults who took part in the Abecedarian study would have been less likely without their early childhood educational experience.

Acknowledgments

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Table 1

Number of Infants Originally Assigned to Abecedarian Early Childhood Treatment and Control Groups and Number Followed Up at Age Thirty by Gender

| | | Group | | |
		Treated	Control	Total
Infancy	Females	28	31	59
	Males	29	23	52
Total		57	54	111
Age 30	Females	25	28	53
	Males	27	21	48
Total		52	49	101

Table 2

Baseline Characteristics for Adult Sample Contributing Data at Age 30 Years

	Mean		Standard Deviation			
	Treated	Control	Treated	Control	t-Test	p
Maternal Full Scale IQ	85.44	84.49	12.71	10.08	0.42	.68
Maternal Age at Birth	19.62	20.31	3.92	5.78	0.40	.48
Maternal Education (years)	10.50	10.02	1.63	1.89	1.35	.18
Number original infants	57	54				
Number in Age 30 Study	52	49				

Note. For the t statistics, df = 99.

Table 3

Educational Outcomes for Abecedarian Adults at Age 30 by Preschool Group

Variable		Group Treated (*n* = 52)	Control (*n* = 49)	*O.R.*	95% Conf. Interval	*d*
Years of education	**Mean**	**13.46**	**12.31**		**(0.42, 1.90)**	**.62**[**]
	SD	**2.02**	**1.70**			
HS grad/GED %	%	88.46	81.63	1.73	(0.57, 5.27)	
College graduate %.	%	23.08	6.12	4.60[*]	(1.21, 17.47)	

Note. For the *F* statistic, *df* = 1, 99.

For *d* values, ** indicates *p* for the *F* test <.01. For Chi square statistics, *df* = 1.

For the O.R. value, * indicates for the Chi Square *p* <.05.

d values are standardized effect sizes calculated by dividing the mean treated/control group difference by their pooled standard deviations. For this statistic, a *d* of .20 is considered small. .50 is considered moderate, and .80 is considered large. Odds Ratios are effect sizes for tests of proportions indicating the difference in the odds of occurrence in the treated group compared to the control group. Bolded first row indicates the primary outcome for the educational domain.

Table 4

Economic and Occupational Outcomes for Abecedarian Adults at Age 30 by Preschool Group

Variable		Group		O.R.	95% Conf. Interval	d
		Treated (n = 52)	Control (n = 49)			
Income/needs ratio	Mean	**3.11**	**2.22**		**(−0.50, 2.28)**	**.25**
	S.D.	**4.37**	**2.29**			
Earned income (annual)	Mean	$33,437.13	$20,705.76			.32
	S.D.	$50,807.42	$22,246.66			
Proportion employed 2/3 of past 24 months	Mean	.75	.59		(−0.00, 0.32)	.39*
	SD	.40	.42			
Job prestige (working only)	Mean	44.85	39.43		(−1.28, 12.11)	.38
	SD	15.28	12.76			
Used public aid > 10% time frame	%	3.85	20.41	16*	(0.03, 0.75)	
Head of household	%	78.85	65.31	1.98	(0.82, 4.81)	

Note. For the F statistic, df = 1, 99.

For d values, * indicates p for the F test <.05. For Chi square statistics, df = 1.

For the Chi square statistic, * by the O.R. indicates p <.05.

d values are standardized effect sizes calculated by dividing the mean treated/control group difference by their pooled standard deviations. For this statistic, a d of .20 is considered small. .50 is considered moderate, and .80 is considered large. Odds Ratios are effect sizes for tests of proportions indicating the difference in the odds of occurrence in the treated group compared to the control group. Bolded first row indicates primary economic outcome.

Table 5

Social Adjustment, Mental and Physical Health, Substance Use, and Family Demographics for Abecedarian Adults at Age 30 Years by Preschool Group

Variable		Group		O.R.	95% CI
		Treated (n = 52)	Control (n = 49)		
Criminal conviction	%	**27.45**	**28.57**	**.95**	**(0.40, 2.27)**
Clinical range internalizing	%	9.62	6.12	1.63	(0.37, 7.22)
Clinical range externalizing	%	13.46	12.24	1.12	(0.35, 3.58)
Health excellent/very good	%	69.23	59.18	1.55	(0.68, 3.52)
Binge drink 30 days	%	26.92	27.08	.99	(0.4, −2.40)
Used MJ 30 days	%	17.31	25.00	.63	(0.24, 1.66)
Smoked Cig. 30 days	%	46.15	39.58	1.31	(0.59, 2.90)
Married	%	28.85	24.49	1.25	(0.53, 3.03)
Unmarried, 2 + children	%	26.92	38.78	.58	(0.25, 1.35)
Age at first parity	Mean	21.78	19.95		
	SD	3.63	3.34	$d = .52^*$	(0.19, 3.45)

Note. For the Chi Square statistic, $df = 1$. Bolded first row indicates the primary outcome for the social adjustment domain.