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

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

Keywords: Abecedarian Project, early childhood education, poverty, adult outcomes

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 a research-based educational child care program that they attended from infancy 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). Further, positive effects on educational, occupational, and social–emotional outcomes were still evident in young adulthood (Campbell & Ramey, 2007, 2010; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002). 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 et al., 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 have been subsequently followed up into their adult years (i.e., ages 25–40 years) to learn the extent to which the early

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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; Ramey & Campbell, 1984; Royce, Darlington, & Murray, 1983), improved academic scores, reduced special education placements, and fewer grade retentions in grammar school (Campbell & Ramey, 1994; Lazar, Darlington, Murray, Royce, & Snipper, 1982; Reynolds, 2000). Previously published young adult findings, including some from Head Start (Deming, 2009; Garces, Thomas, & Currie, 2002), 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 et al., 2002; Garces et al., 2002; Reynolds et al., 2007), and somewhat better economic circumstances (Berrueta-Clement et al., 1984; Campbell et al., 2002; Deming, 2009; Garces 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 reductions in teenaged parenthood (Campbell et al., 2002; Deming, 2009).

Most pertinent for comparison with the Abecedarian long-term outcomes are three other well-controlled model programs wherein poor children were provided with early childhood educational experiences and subsequently followed up 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 quasiexperimental study located in the Boston area, 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 quasiexperimental study, evaluated outcomes of the Chicago Child-Parent Centers preschool programs located either within or next to public schools in low-income neighborhoods. The Chicago Child-Parent Centers offered preschool with a focus on parental involvement for 2 years to some children and for 1 year to others, kindergarten to all, and additional educational supports in Grades 1 through 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 vs. 11.88 years), socioeconomic status (SES) score of four or higher (35.9% vs. 30.3%), higher annual incomes (\$11,582 vs. \$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 Study (PPS), in which children from low-income backgrounds living in an industrialized Midwestern community 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 ages 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 HighScope Foundation detail findings from the PPS over the years (e.g., Berrueta-Clement et al., 1984; Schweinhart, Barnes, & Weikart, 1993; Schweinhart & Weikart, 1980; Weikart, Bond, & McNeil, 1978). 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 five 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, only the PPS used a design that eliminated 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, the CLS and PPS reported higher high school graduation rates, and the PPS showed higher rates for obtaining an associate or college degree. For economic indicators, both the BEEP and PPS 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 the CLS and PPS 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, socioemotional, and gross and fine motor skills across the infant, toddler, and preschool years (Sparling & Lewis, 1979, 1984). Numerous previous publications detail early childhood through middle adolescent findings (Campbell & Ramey, 1994, 1995; Ramey & Campbell, 1981, 1984, 1991; Ramey, Campbell, & Wasik, 1982). 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 percentage 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 with 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 (McLaughlin, Campbell, Pungello, & Skinner, 2007) when compared with 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 (INR), 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 & Smith, 1977) that contained indices of sociodemographic 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 because of 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 two 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 5, the number of children had been reduced to 105. Four were deceased, one was withdrawn, and a second child proved to be ineligible because of a biological condition not apparent at birth.

The early childhood treatment and control groups were rerandomized when children entered public school at age 5, with half of each early childhood group assigned to receive intervention for the first 3 school years (kindergarten through Grade 2, unless a child was retained). Thus, early childhood intervention could range from a high of 8 years combining early childhood and the primary grades, to 5 years in early childhood only, to 3 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., Campbell & Ramey, 1994; Ramey & Campbell, 1981; Ramey et al., 1976). 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 the number of 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 30th 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,

Table 1
Number of Infants Originally Assigned to Abecedarian Early Childhood Treatment and Control Groups and Number Followed Up at Age 30 by Gender

Variable	Group		Total
	Treated	Control	
Infants			
Girls	28	31	59
Boys	29	23	52
Total	57	54	111
Age 30			
Women	25	28	53
Men	27	21	48
Total	52	49	101

Table 2
Baseline Characteristics for Adult Sample Contributing Data at Age 30 Years

Variable	<i>M</i>		<i>SD</i>		<i>t</i>	<i>p</i>
	Treated	Control	Treated	Control		
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
No. of infants enrolled	57	54				
No. in age 30 study	52	49				

Note. For the *t* statistics, *df* = 99.

mean age was 30.56 years (*SD* = 0.64); for the control group, mean age was 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 semistructured 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 later). Data for the use of Temporary Assistance for Needy Families/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 the economic indicator (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 socioemotional adjustment. Other longitudi-

nal 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 Project 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 on the basis of 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 general equivalency diploma (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 indicated a master's degree; 20 denoted 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.

INR. A series of interview questions assessed total income from a variety of sources. The 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 on the basis of 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 income reported from any other source (e.g., alimony, social security, welfare benefits). The INR was calculated by dividing the total reported household income by the poverty threshold relevant to its household size and the given interview year. A ratio 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 of zero was assigned.

Secondary outcomes.

Employment. Vocational status was measured on the basis of interview questions covering current job status and past employment over the previous 2 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+ hr/week). A binary measure was created such that individuals who reported full-time employment for two thirds (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; Nakao & 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. On the basis of information self-reported during the interviews, a total score reflecting current annualized earned income was calculated on the basis of 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 North Carolina 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 database, 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 database 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, of not contributing data to the analysis did not vary as a function of having had early childhood treatment, $\chi^2(1, N = 101) = 1.43, p = .23$.

Head of household. The subject interview contained a question about 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 (head of household = 1, not head of household = 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 percentage 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 with the Achenbach System of Empirically Based Assessment Adult Self Report and Adult Behavior Checklist (Achenbach & Rescorla, 2003). The measure is designed for individuals from 18 to 59 years of age. The scales were normed with data from a nationally representative survey of 1,435 nonreferred 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 Centers for Disease Control and Prevention (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 reframed to describe preincarceration 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 5 (*excellent*) to 1 (*poor*). 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 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 (ANOVAs) for continuous outcomes and logistic regression for categorical outcomes. Gender and a Gender \times Treatment interaction were included as covariates for the key outcomes. These terms were dropped from all models when they proved to be 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 earlier, to guard against Type I error, one primary outcome was selected to indicate effects in each domain (educational, economic, social-emotional). Secondary analyses compared the treatment and control groups on the other variables assessed within each domain. Alpha levels were set at $p < .05$, but the What Works Clearinghouse's (2011) criterion of $d > .25$ was also reported to indicate interesting treatment effects where statistical power was inadequate.

Results

Educational Outcomes

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 educational level averaged 12.31 years.

Secondary outcomes. High school graduation rates, combining those who earned diplomas and GEDs, were similar across the two groups: 89% of the treated group and 82% of the control group obtained one or the other. Examination of the data showed that most of the participants with such credentials had earned high school diplomas rather than GEDs (83% in the treatment group and 72% in the control group). In contrast to the similar rates of high school completion, college graduation significantly favored those with early childhood intervention: 23% of this group had earned a bachelor's degree or higher by age 30 compared with 6% of the control group. Specifically, 12 individuals in the treated group had earned a 4-year degree; two of the 12 had also earned graduate degrees, and two others were working toward advanced degrees at the time of their interview. In contrast, three individuals in the control group had earned a 4-year degree, and none were pursuing an advanced degree by age 30.

Economic Outcomes

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

Selected primary outcome.

INR. The average INR did not differ reliably between the two groups, but the effect size indicated that the treated group had nonsignificantly higher INRs than the control group.

Secondary outcomes.

Employment. Comparing the percentage of the treated and control groups who worked full time for at least two thirds of the preceding 24 months showed that the odds of being consistently employed were more than twice as high for those in the treated group as for those in the control group. Overall, 75% of the treated group worked full time, whereas 53% of the control group worked full time.

Earned income. Consistent with the outcome for the INRs, the two groups did not differ significantly in terms of self-reported earned income, but the effect size suggested that, on average, the treated group had nonsignificantly higher incomes. 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 treatment group did not differ significantly from the control group in terms of job prestige, but the effect size suggested that the treated group had somewhat higher job prestige scores than the control group.

Head of household. Despite apparent differences favoring the treatment group for this outcome, no reliable differences were observed in the proportion of individuals who were head of their household at age 30.

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 for at least 10% of that 7-year period than those in the treated group. The obtained *OR* was inverted to calculate the odds of needing help in the control group compared with the treated group.

Table 3
Educational Outcomes for Abecedarian Adults at Age 30 by Preschool Group

Variable	Group		<i>F</i> , χ^2	<i>p</i>	95% CI	<i>OR</i>	<i>d</i>
	Treated (<i>n</i> = 52)	Control (<i>n</i> = 49)					
Years of education			9.60	.01**	[0.42, 1.90]		.62
<i>M</i>	13.46	12.31					
<i>SD</i>	2.02	1.70					
HS graduate/GED (%)	88.46	81.63	0.91	.34	[0.57, 5.27]	1.73	
College graduate (%)	23.08	6.12	5.03	.03*	[1.21, 17.47]	4.60	

Note. Where outcomes were based on continuous variables means and standard deviations for the treated and control groups are reported, *F* statistics ($df = 1, 99$) were calculated. Where outcomes represent percentages of the treated and control groups, chi-square ($df = 1$) is reported. For the *F* statistic, Cohen's *d* values were 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. For the chi-square statistic, odds ratios (*ORs*) are tests of proportions indicating the difference in the odds of occurrence in the treated group compared with the control group. The bolded rows indicate the primary outcome for the educational domain. HS = high school; GED = general equivalency diploma.

* $p < .05$. ** $p < .01$.

Table 4
Economic and Occupational Outcomes for Abecedarian Adults at Age 30 by Preschool Group

Variable	Group		F, χ^2	p	95% CI	OR	d
	Treated (n = 52)	Control (n = 49)					
INR			1.61	.21	[-0.50, 2.28]		.25
<i>M</i>	3.11	2.22					
<i>SD</i>	4.37	2.29					
Annual earned income (in thousands of dollars)			2.60	.11	[-2.73, 28.20]		.32
<i>M</i>	33.44	20.71					
<i>SD</i>	50.81	22.25					
Job prestige (working only)			2.60	.11	[-1.28, 12.11]		.38
<i>M</i>	44.85	39.43					
<i>SD</i>	15.28	12.76					
Proportion employed two thirds of past 24 months (%)	75	53	5.16	.02*	[1.14, 6.16]	2.65	
Used public aid more than 10% of time frame (%)	3.85	20.41	5.35	.02*	[0.03, 0.75]	0.16 ^a	
Head of household (%)	78.85	65.31	2.27	.13	[0.82, 4.81]	1.98	

Note. Where outcomes were based on continuous variables means and standard deviations for the treated and control groups are reported, *F* statistics (*df* = 1, 99) were calculated. Where outcomes represent percentages of the treated and control groups, chi-square (*df* = 1) is reported. For the *F* statistic, Cohen’s *d* values were 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. For the chi-square statistic, odds ratios (*ORs*) are tests of proportions indicating the difference in the odds of occurrence in the treated group compared with the control group. The bolded rows indicate the primary outcome for the economic domain. INR = income-to-needs ratio.

^a The probability of the control group being higher than the treated group is the inverse of this figure, *OR* = 6.40.

* *p* < .05.

Social Adjustment, Social-Emotional, and Health Outcomes

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% and 28% for the treated and control groups, respectively.

Secondary outcomes.

Marriage and parenthood. A positive outcome associated with early childhood treatment was that the mean age at first parity was higher (almost 2 years) for those with early childhood treatment. By age 30, approximately a quarter of each group had married: 28% for treated versus 24% for controls; in this instance,

Table 5
Social Adjustment, Mental and Physical Health, Substance Use, and Family Demographics for Abecedarian Participants at Age 30 Years by Preschool Group

Variable	Group		F, χ^2	p	95% CI	OR	d
	Treated (n = 52)	Control (n = 49)					
Criminal conviction (%)	27.45	28.57	0.02	.90	[0.40, 2.27]	0.95	
Clinical range internalizing (%)	9.62	6.12	0.42	.52	[0.37, 7.22]	1.63	
Clinical range externalizing (%)	13.46	12.24	0.03	.85	[0.35, 3.58]	1.21	
Health excellent/very good (%)	69.23	59.18	1.10	.29	[0.68, 3.52]	1.55	
Binge drinking in past 30 days (%)	26.92	27.08	0.00	.99	[0.40, -2.40]	0.29	
Marijuana use in past 30 days (%)	17.31	25.00	0.88	.35	[0.24, 1.66]	0.63	
Cigarettes use in past 30 days (%)	46.15	39.58	0.44	.50	[0.59, 2.90]	1.31	
Married (%)	28.85	24.49	1.25	.27	[0.53, 3.03]		
Unmarried, 2+ children (%)	26.92	38.78	1.60	.21	[0.25, 1.35]	0.58	
Age at first parity			4.97	.03*	[0.19, 3.45]		.52
<i>M</i>	21.78	19.95					
<i>SD</i>	3.63	3.34					

Note. The means and standard deviations for the continuous variable reported in this table were compared using the *F* statistic (*df* = 1, 99). For the outcomes represented as percentages of the treated and control groups, chi-square (*df* = 1) was reported. For the *F* statistic, Cohen’s *d* values were 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. For the chi-square statistic, odds ratios (*ORs*) are tests of proportions indicating the difference in the odds of occurrence in the treated group compared with the control group. The bolded first row indicates the primary outcome for the social-emotional adjustment domain.

* *p* < .05.

no difference was associated with early childhood treatment. Similarly, no reliable differences emerged when the proportions of individuals who had multiple children outside marriage were compared.

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, binge drinking, or recent use of marijuana 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 the Abecedarian study participants were experiencing mental health concerns that scored in the clinical range ($T > 63$), and the proportions did not reliably differ by treatment group. For internalizing problems (anxious/depressed, withdrawn, somatic complaints), fewer than 10% of either the treated or the control group scored in this range, and for externalizing behaviors (aggressive, rule breaking, intrusive), fewer than 15% of either scored in the clinical range.

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 was not statistically significant.

Discussion

The 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, positively affect their school progress. Early results during program implementation and those from follow-up assessments at early adolescence, middle adolescence, and young adulthood confirmed that such enhancements were possible. The present examination of outcomes at age 30 now shows that the effect of early treatment on educational attainment has extended well into adulthood. Although the strong educational benefit seen at age 30 was not matched by equally strong gains in economic circumstances as reflected in the INRs for the treated and control groups, some of the secondary economic indicators did show positive treatment effects. In contrast, little evidence supporting long-term program 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. Such success would consist of, at minimum, completion of high school. Consistent with findings from the other studies being compared here, the Abecedarian Project's treated group significantly excelled over the control group in educational attainment at age 30. The standardized effect size was moderately large. Unexpectedly, however, the Abecedarian early treatment was not associated with a higher rate of high school graduation, but rather with going beyond high school. Prior analysis examining the predictors of young adult education suggested that family factors were relatively more influential insofar as completing high school was concerned, whereas early childhood intervention was strongly related to going on to college (Pungello et al., 2010). At age 30, the treated Abecedarian participants were 4.6 times more likely than the control participants to have earned college degrees. The college graduation rate for the treated group

(23.5%) approximates the rate reported in the year 2000 U.S. Census for college graduates in the United States as a whole (24%) and clearly exceeds that year's rate for African Americans (14%) (U.S. Census Bureau, 2003, 2005, 2008).

In contrast to the significant and moderately large Abecedarian treatment effect on age 30 educational attainment, however, the chosen primary economic indicator, the INR, did not differ significantly as a function of early childhood treatment. Although the mean INR was slightly higher for the treated group, the F test did not attain the $p < .05$ level. Similarly, the means for self-reported earned incomes were considerably higher for the treated group, but the variance in the treatment group exceeded the mean, and the difference in earned income was not statistically reliable. It should be noted, however, that treated individuals had significantly better scores on two of the five secondary economic measures examined here. Compared with those in the control group, those who attended the early childhood program were more likely to have worked steadily over the past 2 years and were less likely to have used public assistance to meet basic needs.

It is unclear why such a large treatment impact on educational gains in the 30-year-olds was not matched by a direct program effect on earnings. However, 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; Duncan & Petersen, 2001). 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.

As for social-emotional outcomes, the analyses of the primary indicator of social-emotional adjustment—criminal involvement—showed no positive effect for early childhood treatment. In addition, with the exception of a significant tendency to delay parenthood, none of the other social-emotional secondary outcomes, such as self-rated mental health, substance use or abuse, and self-rated health, showed strong effects of the Abecedarian early childhood treatment. Although a treatment-related reduction in self-reported depressive symptoms was found at age 21 (McLaughlin et al., 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, was related to the increased maturity of the individuals, or reflects a real improvement in outlook is not clear.

The Abecedarian educational findings are consistent with those of other long-term follow-up studies of early childhood programs for children in poverty. The BEEP, CLS, and PPS all reported the average educational attainment for their treated individuals to be slightly better than high school graduation (Palfrey et al., 2005; Reynolds et al., 2011; Schweinhart et al., 2005). A more important benchmark for adult educational attainment, however, is college graduation because this achievement has lifelong implications in terms of income, job prestige, and community status (Jeynes, 2007). Within the studies compared here, only the Abecedarian investigators can distinguish between having unspecified college credentials and earning bachelor's degrees, and the Abecedarian

advantage found here is striking: 23% of the treated adults assessed at age 30 had bachelor's degrees or higher compared with 6% of the control participants. In contrast, 5% of the program group from the PPS were reported as having an "associate or higher degree" at age 40 (Schweinhart et al., 2005). Comparisons with the other long-term follow-up studies are difficult; the CLS (Reynolds et al., 2011) reported that 14% of the preschool group had attended a 4-year college but did not give figures for graduations, and the BEEP did not report figures for college attendance or graduation.

Although the specific measure of income varied across the four studies being compared here, all except the Abecedarian project reported significantly better incomes for their treated individuals (Palfrey et al., 2005; Reynolds et al., 2011; Schweinhart et al., 2005). However, interpreting this outcome across studies is difficult given variation in how this variable was operationalized across the studies (e.g., Abecedarian calculated INR, whereas the others used other methods to compare income and earnings). Concerning other economic indicators, the Abecedarian, CLS, and PPS all found significant long-term effects on adult employment rates, whereas the BEEP did not find an employment benefit. The Abecedarian reduction in welfare use is consistent with PPS's reported trend toward a reduction in usage rates for their treated group up to age 40. Neither the CLS nor the BEEP found a clear trend for a reduction in welfare dependence.

On the basis of self-reports at age 30, no reduction in lawbreaking (convictions for misdemeanors, felonies, or incarcerations) was found for the individuals who had the Abecedarian early childhood treatment. Similarly, an earlier study of lawbreaking (up to age 18) among Abecedarian participants, which was 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 (Clarke & Campbell, 1998). At age 30, just over a quarter of the individuals in both groups reported convictions or incarcerations. 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 (Berrueta-Clement et al., 1984; Schweinhart et al., 1993; Schweinhart et al., 2005; Schweinhart & Weikart, 1980). Likewise, in their age 28 follow-up, the CLS found a significant reduction in crime (Reynolds et al., 2011). The BEEP study found a difference in the rate of arrests as a function of the community, with the suburban group having fewer arrests, but found 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 treated participants. 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.

In sum, the Abecedarian advantage in college graduation rate compares most favorably with the other programs whose adult outcomes were described here, but all programs reported higher levels of adult education for their at-risk child participants relative to controls, and economic circumstances were generally better as

well. The four programs differed markedly in the demography of their home communities in terms of school systems and economic opportunities. In part, the fact that the Abecedarian study was located in a university-centered community and the fact that most of the study's participants attended highly competitive local public schools could have affected their continuing to seek education. No other study community was so single-mindedly focused on higher education. Further, PPS children were selected on the basis of standardized test scores suggesting possible lags in cognitive development by age 3. Besides the Abecedarian program, only the BEEP began intervention in infancy, and the BEEP's first intervention was primarily focused on pediatric care and parent support. The PPS and CLS were preschools with strong foci on parent involvement. Thus, the systematic child-centered educational treatment program offered for Abecedarian participants within a full-time child care setting was by far the most intensive of all four programs in terms of educator-child contact over an extended period of time.

Optimally, all the comparative outcomes considered here can 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. On the basis of 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 the early childhood program, while at age 40, this figure was \$17.07. On the basis of 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 \times 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. The extent to which this introduced a positive bias on outcomes is unknown, but any such tendencies could apply equally to individuals in both groups. 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 30 years, contributing to the validity of the outcomes.

The findings generalize to individuals from low-income, primarily minority families. The findings of the Abecedarian Project at age 30 reinforce the importance of the first 5 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. The strength of the present data 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. As noted earlier, the answer is affirmative. A very intensive early educational program provided for full days, year-round within a quality child care setting, starting within the first 6 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.

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