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Young adult outcomes of the Abecedarian and CARE early childhood educational interventions

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ABSTRACT

Adult benefits for participants in Project CARE were compared with those of the Abecedarian Project, a closely related randomized study of early childhood educational intervention for children from low-income families who were at risk of developmental delays and school failure. CARE replicated Abecedarian's young adult treatment-related educational and vocational attainment gains. CARE data also supported the Abecedarian reduction in marijuana use. Treated individuals in both studies reported adopting a more active life style. The average age at birth of a first child, the number of children, and the proportion of teen parents were positively affected in the Abecedarian sample but not in CARE. Finding significant educational and vocational gains lasting into young adulthood in the CARE study reinforces Abecedarian young adult findings and strengthens the case for early childhood intervention for children from low-income families.

1. Introduction

Many early childhood educational programs have been provided for children from poor families in an effort to support their early development and improve their chances for success in school. In general, scientific evaluations of such programs have shown that they enhance young children's intellectual test scores and elementary school academic performance (Bryant & Maxwell, 1997; Johnson & Walker, 1991). When the Consortium for Longitudinal Studies followed up a number of well-controlled studies at least 10 years post intervention, they found that intellectual test score benefits generally eroded shortly after public school entry, but academic gains were maintained somewhat longer. The Consortium's most robust finding was that early intervention led to fewer placements into special education and better attitudes toward school (Lazar, Darlington, Murry, Royce, & Snipper, 1982). Subsequent longer term follow-up studies of early childhood programs have shown that positive gains in intellectual development and academic skills sometimes persisted into adolescence (Campbell & Ramey, 1995; Reynolds, 1994; Woodhead, 1988). However, few investigators of early childhood programs have followed participants into adulthood. Exceptions include the Early Training Project (Gray, Ramsey, & Klaus, 1982), the High/Scope Perry Preschool Project (Schweinhart, Barnes, & Weikart, 1993; Schweinhart et al., 2005) and the Chicago Child-Parent Centers (Reynolds, 2000; Reynolds et al., 2007). All three programs were implemented in the 1960s and 1970s and offered some form of preschool experience; they also all served samples that were entirely or predominantly African American. A fourth randomized study

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of early childhood educational intervention with late adolescent follow-up outcomes is the Infant Health and Development Program [IHDP] (1990), although it differs in several important ways from the first three, being implemented in the 1980s, focusing on low-birth-weight infants, not being restricted to low-income families, and having a more racially diverse sample. Together, these four studies provide evidence concerning the very long-term effects of early educational intervention programs for children considered at risk due to a variety of factors.

The first, the Early Training Project, was located in the "upper South" and offered half-day preschool experiences during the summer months for 88 African American children from poor families. All study children were born in 1958: some entered the summer program as four-year-olds in 1962, giving them two summers' experience prior to school entry (into first grade). The others entered as five-year-olds in 1963 and therefore had only one summer's exposure. Parent home visits were conducted during the winter months following each summer preschool experience and also during the child's first grade year.

In contrast, the High/Scope Perry Preschool Program in Michigan operated for half days during the school year (7.5 months) for children who entered either as three-year olds or four-year-olds in the first "wave" admitted in 1962. Four subsequent waves of three-year-olds entered each fall up through 1965, with a total of 123 children being admitted. All three-year-olds had two years of treatment. In addition to preschool, the intervention called for weekly home visits for each child and family. Intervention ended after public school entry.

The Chicago Child-Parent Center (CPC) program offered half-day preschool programs beginning with three-year-olds or four-year-olds, starting at 4 sites in 1967, expanding over the years to 25 sites, and on-going. Study sites were located close to or within public schools where the children were expected to enroll. The CPCs operated during the regular school year, with treatment extended through kindergarten which was offered in either full-day or half-day classrooms. Thereafter, extra services and personnel were provided from first through third grade. Parents had on-site resources and were expected to participate both in parent programs and in the classrooms. The Chicago Longitudinal Study that evaluated effectiveness of the CPCs was begun in 1986, enrolling children who entered 20 target CPCs in that year. Its design is the most complex of the three programs, with different treatment combinations across the experimental groups. Some Chicago children experienced treatment from age three up through third grade, a second group had preschool through kindergarten intervention but no intervention after kindergarten, others had school-age intervention only. Children from similar backgrounds who lacked CPC experience served as controls. The number of children who participated in this evaluation (1539 in the original sample) is much larger than the other two studies (Reynolds, 2000).

The Infant Health and Development Program (IHDP, 1990) was conducted at 8 sites nationwide, enrolling a total of 985 low-birth-weight infants of which 362 were "heavier" (2100–2500 g), and 632 were "lighter" (<2000 g). The proportion of African Americans varied from 31% to 96% across groups and sites. Intervention began in infancy via home visiting for the first year with center-based care combined with home visiting provided in the second and third years. Treatment ended when children were age three.

The Early Training Project, the High/Scope Perry Preschool Program, and the Chicago Child-Parent Center program have follow-up data on their participants to age 20 or beyond; IHDP reports outcomes at age 18. Outcomes investigated included educational attainment, employment, marriage, parenthood, health-related behaviors, and social difficulties such as criminal behavior. In terms of later educational accomplishments of the treated and comparison participants, treated individuals in the High/Scope Perry Preschool Project (Berrueta-Clement, Schweinhart, Barnett, Epstein, & Weikart, 1984) and the Chicago Child-Parent Centers program (Reynolds, Temple, Robertson, & Mann, 2001) were more likely to graduate from high school, an outcome found only for females treated in the Early Training Project (Gray et al., 1982). Chicago investigators also found higher rates of four-year college attendance by age 24 (Reynolds et al., 2007). At age 18, the heavier weight intervention infants showed higher math achievement and higher Peabody Picture Vocabulary Test scores but no differences in school dropout rates (McCormick et al., 2006).

The Perry Preschool treated group showed better rates of employment and lower rates of lawbreaking (Schweinhart et al., 1993), benefits that persisted through middle age (Schweinhart et al., 2005). The Chicago Child-Parent Centers also found lower rates of crime up to age 20 (Reynolds et al., 2007). A non-significant trend was seen for females treated in the Perry Preschool to delay childbearing (Schweinhart et al., 1993). Neither the Early Training Project (Gray et al., 1982) nor the Chicago program (Reynolds et al., 2007) found significant reductions in teen pregnancies. IHDP found no differences between the treated and follow-up groups in problem behavior scores or health-related outcomes in late adolescence (McCormick et al., 2006). In sum, although long-term outcomes from all these programs differed in domains and degrees, they all affirmed some enduring benefits of early childhood intervention.

None of these programs provided an early childhood intervention program as intense as that offered in the Abecedarian Project, a randomized trial where treated children had year-round, full-day intervention in a child care setting from early infancy until kindergarten entry at age five (Ramey et al., 1976). The rationale for beginning treatment so early was based on several lines of research suggesting that cognitive development might be most malleable in the very young (e.g., Bloom, 1964; Hunt, 1961; Kessen, 1979). Promising early reports from a then on-going study, where infants from very high risk backgrounds (low IQ mothers and poverty) were being given a very intense educational experience starting by 6 months of age, suggested that very large gains in intellectual test performance, on the order of 20 points, could be achieved through early treatment (Garber, 1988). Another incentive was that the early scientific evaluations of Project Head Start's benefits had been disappointing (e.g., Westinghouse Learning Corporation, 1969), implying that its intervention was ephemeral. Scientists questioned if Head Start came too late in the child's life.

The Abecedarian study found positive early childhood and adolescent intellectual and academic outcomes (see below). The question regarding enduring benefits in adulthood remained, however. A follow-up at age 21 showed that Abecedarian treatment group participants still had significantly higher scores on intellectual and academic measures compared with control group participants (Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey, 2001). Moreover, on average, they had attained more years of education, were more likely to have skilled jobs, more likely to attend a four-year college, and less likely to be teen parents than control group participants (Campbell, Ramey, Pungello, Miller-Johnson, & Sparling, 2002). Reports of these long-term outcomes were widely cited as important evidence of the significant benefits of early childhood programs (Broder, 2002; Brooks-Gunn & McCormick, 2006; Starr, 2002).

A closely related second study, the Carolina Approach to Responsive Education (CARE), expanded the Abecedarian research by comparing the efficacy of two service delivery models that varied from that of the Abecedarian study in two ways. The Abecedarian study had randomly assigned children to two groups in infancy: a center-based intervention group and a control group (Ramey et al., 1976). In CARE, the intervention protocol for one group was for children to receive a similar center-based treatment and for the family also to have weekly home visits from their child's teacher. In addition, CARE had a second treatment model in which home visitors made weekly visits but center-based child care was not offered. Thus, Project CARE randomly assigned children to three groups in infancy: a center-based intervention group to which a family education (home visit) program was added, a family education only group, and a control group (Wasik, Ramey, Bryant, & Sparling, 1990).

The two studies were quite similar in other ways. Both studies had prospective randomized designs. The same High Risk Index measuring sociodemographic factors associated with developmental delays or academic failure (Ramey & Smith, 1977) was used in both to screen prospective participants. Background characteristics such as maternal IQ, the early family environment, and child gender are comparable for the two studies (Burchinal, Campbell, Bryant, Wasik, & Ramey, 1997). The studies were conducted at the same site: a small university town in a southeastern state. The town's population consisted primarily of faculty, students, local business proprietors, and a stable community of African American families. The latter represented a range of socioeconomic backgrounds but many filled relatively low-paid service jobs within the university and the town.

The decade between 1970 and 1980, the period of participant recruitment, was a time of social change in the area where the studies took place. Local schools had been desegregated only a few years prior to the beginning of the Abecedarian study. The region was undergoing a growth spurt related to the opening nearby of a large research and development complex that brought new employment opportunities. During the eight-year time span separating the beginning of recruitment for the Abecedarian study and the end of recruitment for Project CARE, a slight improvement in the poverty rate for African American families occurred. In 1970 the local rate for African Americans families below the poverty line was 26% (US Census, 1970); the comparable percent for the 1980 census was 20% (Federal Agency Data, LINC Report, 2007).

1.1. Center-based intervention

The center-based early educational intervention in each study was provided in the same child care setting. The center operated for full days, 5 days/week, year round from infancy until kindergarten entry. A broad-spectrum curriculum (Sparling, 1989) called *Learningames* that targeted language, cognitive, motor, and social-emotional development was used in both center-based programs (Sparling & Lewis, 1978, 1984; see Sparling & Lewis, 2000, 2001, 2002, 2003, 2004 for updated versions), supplemented with other curricula materials after the infancy period (Ramey & Campbell, 1984, 1991; Ramey, McGinness, Cross, Collier, & Barrie-Blackley, 1982). Children also received primary pediatric care at the center.

1.2. Family education

The family education component consisted of home visits for families to provide them the same curriculum materials used within the child care center program, with the goal of having parents engage their children in the learning activities at home. For children in the CARE center-based plus family education group, their caregivers or teachers conducted these home visits. In the family-education-alone group, the visits were conducted by other trained personnel. Home visitors also helped parents learn a problem-solving approach to everyday concerns, and offered consultation on child management (Wasik & Bryant, 2001; Wasik et al., 1990). Children in the family-education-alone group may or may not have attended other child care facilities, in accordance with family decisions.

1.3. Control groups

Both studies included a group of children randomly assigned to serve as untreated controls. The identical developmental outcomes were assessed on the same schedule for treatment and control participants. Control families were supplied free infant formula for the first 15 months to rule out treatment effects related to early nutrition; they also had free disposable diapers as an incentive to participate in the study. Low-cost pediatric care was available to them within the community. Children in the Abecedarian and CARE control groups may have attended family-based or community center-based child care, again, depending upon family decisions.

1.4. School-age phase

In the Abecedarian study, half of the preschool experimental group and half the preschool control group were randomly assigned to receive a primary school follow-on intervention for the first three years in public school. All children in the two CARE preschool treatment groups had this primary school intervention as well. Analyses conducted with the Abecedarian sample indicated that the center-based early educational intervention had far stronger effects than the school-age treatment on children's intellectual and academic outcomes through middle adolescence (Campbell & Ramey, 1994, 1995). Accordingly, the school-age treatment component was not analyzed separately in the current report of findings from long-term follow-up.

1.5. Early childhood and primary school findings

Center-based early educational intervention significantly enhanced children's early childhood intellectual test performance in both the Abecedarian and CARE studies (Burchinal et al., 1997; Campbell & Ramey, 1994, 1995; Martin, Ramey, & Ramey, 1990; Wasik et al., 1990). No intellectual test score gains were found for the children in CARE's family education alone relative to CARE's controls (Wasik et al., 1990). Later childhood and adolescent findings have been published for the Abecedarian study including outcomes at age 8 (Ramey & Campbell, 1991), age 12 (Campbell & Ramey, 1994), and age 15 (Campbell & Ramey, 1995). Intellectual and academic outcomes for CARE per se have not been reported beyond age 54 months (Wasik et al., 1990) although intellectual and academic outcomes for CARE combined with the Abecedarian sample have been reported through age 8, showing positive treatment effects on these outcomes for the two studies combined (Burchinal et al., 1997).

1.6. Current study

As described above, the long-term findings from the Abecedarian study found life success benefits for young adults who received the center-based early educational intervention compared to those in the control group (Campbell et al., 2002). The current study examined the long-term outcomes for CARE to determine if the center-based intervention in Project CARE replicated the Abecedarian outcomes. Educational (e.g., years of education, college attendance), vocational (e.g., obtaining employment, skilled employment), and health-related (e.g., smoking, drug use) outcomes were examined. Furthermore, effects of early treatment on young adult health-related outcomes not previously reported for the Abecedarian program (e.g., diet and exercise) were also examined.

2. Method

2.1. Participants

The Abecedarian study admitted four cohorts of healthy infants born between the spring of 1972 and late summer of 1977 whose families met the criteria for having children at risk for school failure. In all, 111 infants born to 109 families were enrolled: 57 infants randomly assigned to the center-based intervention group (one set of twins, one sibling pair) and 54 to the control group.

Project CARE's two cohorts of participants were born between the spring of 1978 and early 1980. To achieve greater diversity within the child care center during the CARE program, half of the child care spaces were set aside for infants from low-risk families. This policy resulted in fewer infants from high-risk families enrolled in the CARE center-based plus family education treatment group, $n = 16$, in contrast to the 57 assigned to early educational intervention in the Abecedarian study. CARE had 25 families (two sets of twins) randomly assigned to the family education only group ($n = 27$), and 23 families assigned to the CARE control group.

Table 1 summarizes entry level family characteristics for the two studies arrayed by study and treatment group. To learn if these background factors differed significantly across studies or groups, linear models for numerical outcomes (e.g., maternal age at birth, maternal years of education at birth) or logistic regressions for binary characteristics (e.g., high school graduate, teen mother, marital status) were tested. Of the 12 variables examined, only one differed among the groups: on average, CARE mothers had more years of education than did Abecedarian mothers when they enrolled their children in the program ($t = -2.49$, $p < .02$). Otherwise there were no significant differences between the Abecedarian and CARE samples, nor between the treated and control groups. Across groups, 31–68% of the mothers were teen parents (<20 years of age). Ethnicity was not a selection factor, but 98% of the families in the Abecedarian study were African American as were 91% of the CARE families, reflecting the demographics of low-income families in the local community.

Attrition was low for both studies. For the Abecedarian Project, 104 young adults out of the original 111 infants (93.7%) and for CARE, 60 of 66 original enrollees (90.9%) were assessed as young adults.[1] Of these, 53 with early childhood treatment

[1] Attrition in this group included 4 children who were deceased, one who was withdrawn from the study and one who proved unqualified for inclusion because of congenital mental retardation not immediately diagnosed. Of the remaining 105 individuals who might have participated in a young adult follow-up, all were located and 104 participated. For CARE, of the original 66 enrollees, one child died and one was withdrawn during the early years. Of

Table 1
Entry demographics for Abecedarian (ABC) and CARE samples

Maternal characteristics	ABC center based			ABC control			CARE center based			CARE control			CARE family education		
	$n = 54$			$n = 55$			$n = 16$			$n = 23$			$n = 25$		
	M	S.D.	Range	*M*	S.D.	Range	*M*	S.D.	Range	*M*	S.D.	Range	*M*	S.D.	Range
Age in years	19.6	3.8	14–37	20.3	5.8	13–44	21.8	4.7	15–34	21.5	4.9	15–31	20.4	4.7	13–35
Full scale IQ (Wechsler)	85.5	12.4	49–124	84.2	10.7	59–111	86.7	10.5	70–115	87.5	7.7	69–102	86.8	10.6	70–110
Education	10.4	1.8	6–15	10.0	1.9	6–14	10.9	1.6	8–13	11.2	1.3	8–14	10.6	1.7	7–13
% Less than high school	60			72			56			43			60		
% High school graduate	40			28			44			57			40		
% More than high school	4			4			12			4			4		
Marital status															
% Married	16			24			25			13			16		
% Single, never married	78			72			56			74			84		
% Divorced or separated	5			4			19			13			0		
Percent teen mother (age < 20)	62			57			31			52			68		
Percent male infants	51			43			56			61			68		
Percent African American	96			100			94			83			96		

and 51 controls took part in the Abecedarian young adulthood follow-up; 14 of 16 CARE center-based treatment cases took part, 25 of 27 children from the Family Education group were assessed and 21 of the original CARE control group of 23 were followed up. Age when followed up as young adults ranged from 20 to 25 years: $M = 21.1$ years, S.D. = .60 years for Abecedarian participants; $M = 22.5$ years, S.D. = .71 years for CARE. Across both studies, young adult follow-up data were collected between 1993 and 2003.

2.2. Procedures and measures

2.2.1. Young adult interview

A semi-structured interview covered demographic facts such as educational attainments, vocational history, marital status, parenthood, and lawbreaking. Interviewers were graduate students blind with respect to early childhood intervention status. Educational measures derived from these data included indices of high school graduation, post high school education of any kind, being in school when interviewed, and attending a four year college. Employment data were coded using Hollingshead's Index of Social Status (Hollingshead, 1975). Current employment was noted, as well as the level of the job. Jobs rated 4 or higher on the Hollingshead Index (Hollingshead, 1975) were defined as skilled employment. An index of Upward Mobility was derived by combining current enrollment in school and/or having a job rated 4 or higher on the Hollingshead Index. Marriage and parenthood were assessed through questions about marital status and the number of children reported. Age at birth of a first child was noted; young adults who reported having a child before age 19 were categorized as teen parents.

2.2.2. Health-related behaviors

After the interview, the participants responded to a selection of items from the Youth Risk Taking Survey (Centers for Disease Control, 2001) covering behaviors affecting the health of young people (Kolbe, 1990). Healthy life styles were indexed according to reports of healthy diets, being physically active, using automobile seat belts, avoiding substance abuse, and avoiding anti-social behaviors. Good diet was defined as consuming fruit and/or vegetables once or twice within the past 24 h. Active life style required reporting exercising 3 or more days within the past week. Non-smoking was based on never being a regular smoker. Illegal drug use was scored positively if the individual admitted to any use of marijuana or harder drugs. Anti-social behavior was defined as violence, scored if the person admitted carrying a weapon and/or getting into a physical fight within the past 30 days.

Although CARE participants were assessed with an abbreviated protocol that included only the young adult interview and two psychological inventories, the interview questions and the two psychological instruments were the same for both samples. The interview concentrated on the major indices of real-life, young adult accomplishments leading toward a self-sufficient existence: education, vocation, family establishment, and health/safety practices. CARE participants did not receive standardized measures of intelligence or academic skills, nor did they have the full range of self-report measures used with the Abecedarian young adults. These changes were necessitated by practical considerations rather than lack of interest in the other domains covered for Abecedarian participants.

2.3. Analysis plan

An intent-to-treat model provided the most powerful test of center-based intervention effects because it allowed the data for all young adult participants to be included. Five distinct groups were defined: (1) Abecedarian control; (2) Abecedarian center-based treatment; (3) CARE control; (4) CARE center-based plus family education treatment; and (5) CARE family education treatment alone. ANOVAs (for continuous outcomes) and logistic regressions (for dichotomous outcomes), with gender and age as covariates, were used to test the questions of interest. Four contrast models were estimated. One tested for main effects of center-based treatment by comparing center-based treated (Abecedarian center-based combined with CARE center-based) and control groups (Abecedarian combined with CARE). A second set of models tested for a study effect by comparing all Abecedarian participants (center-based and control combined) to all CARE participants (center-based plus family education, family education only, and control combined). A third set of models tested if the center-based effects differed between the two studies by testing a treatment $\times$ study interaction (comparing the magnitude of the difference between the Abecedarian center-based intervention and control groups to the magnitude of the difference between the CARE center-based plus family education and control groups). This test was included because early childhood data indicated that, overall, CARE participants scored higher on early cognitive tests than did Abecedarian participants. The final set of models tested for a family-education-alone effect by comparing the CARE family-education-alone group to the CARE control group. All models controlled for participant gender and the age of the young adult when interviewed.

Effect sizes for all estimable contrasts are reported in Tables 2–4: *d*-type effect sizes for linear outcomes and odds ratios for binary outcomes. Effect sizes for significant contrasts are indicated by symbols, and the related *p*-values are reported in the table notes. For *d*-type effect sizes, .20 indicates a small effect, .50 indicates a medium effect, and .80 indicates a

the remaining 64 individuals, one moved away very early. This individual and two others could not be located for the young adult study, and one person declined to participate in it, leaving 60 cases with young adult data.

Table 2
Young Adult educational and vocational outcomes for Abecedarian (ABC) and CARE studies

	Group						Group comparisons			
	1	2	3	4	5		Center (2,4) vs. control (1,3)	ABC (1,2) vs. CARE (3,4,5)	Treatment-by-study	Family ed. (5) vs. CARE control (3)
	ABC control $n = 51$	ABC center based $n = 53$	CARE control $n = 21$	CARE center based $n = 14$	CARE family ed. $n = 25$					
Educational attainment (years), *M* (S.D.)	11.58 (1.40)	12.25 (1.54)	11.71 (1.65)	12.40 (1.71)	11.75 (1.98)	*d*	.43*	−.11	.00	.02
High school graduate (%)	67	70	71	79	64	O.R.	1.29	1.17	1.12	.68
Any post secondary education (%)	39	59	57	71	56	O.R.	2.09+	.52	.92	.95
In school now (%)	20	42	5	43	16	O.R.	7.06**	.91	2.34	[a]
Four-year college (%)	14	36	14	43	20	O.R.	3.99**	1.40	1.12	1.42
Currently employed (%)	50	64	71	79	60	O.R.	1.70	.35	.90	.63
Skilled job (%)	27	47	19	43	28	O.R.	2.95*	.92	1.13	1.72
Upward mobility (%)	41	67	24	64	36	O.R.	4.44**	.83	1.42	1.96

Note: Group comparisons are based on *F* tests where means and S.D.s are given, Chi Square where percentages of groups are compared. Values in comparison columns are effect sizes: odds ratios for Chi Square tests and *d*-type effect sizes for mean comparisons underlying the *F* tests.
* $p < .05$; ** $p < .01$; + $p < .10$ reflect underlying *F* tests or Chi Square statistics.
[a] Small cell sizes prohibited reliable estimation of comparisons.

Table 3
Marriage and parenthood in Abecedarian (ABC) and CARE study young adults

	Group						Group comparisons			
	1	2	3	4	5		Center (2,4) vs. control (1,3)	ABC (1,2) vs. CARE (3,4,5)	Treatment-by-study	Family ed. (5) vs. CARE control (3)
	ABC control $n = 51$	ABC center based $n = 53$	CARE control $n = 21$	CARE center based $n = 14$	CARE family ed. $n = 25$					
Married (%)	10	4	10	14	12	O.R.	.50	[f]	2.54	1.03
Has a child by age 21 (%)	49	40	29	36	36	O.R.	.92	6.72*	1.39	1.20
Number of children, *M* (S.D.)	.75 (.89)	.49 (.67)	.43 (.75)	.43 (.65)	.80 (1.26)	*d*	−.18	.68*	.13	-.42
Age first child born, *M* (S.D.)	17.7[a] (1.5)	19.1[b] (2.1)	20.8c[c] (2.0)	19.6[d] (2.1)	18.8[e] (2.0)	*d*	−.18	−.36	.82*	.19
Teen parent (<19 years)[f] (%)	45	26	5	21	32	O.R.	1.07	11.99**	2.79	[f]

Note: Group comparisons are based on *F* tests where means and S.D.s are given, Chi Square where percentages of groups are compared. Values in group comparison columns are effect sizes: odds ratios for Chi Square statistics and *d*-type effect sizes for mean comparisons underlying the *F* tests.

* $p < .05$; ** $p < .01$; + $p < .10$ reflect underlying *F* tests or Chi Square statistics.

[a] $n = 25$.

[b] $n = 21$.

[c] $n = 6$.

[d] $n = 5$.

[e] $n = 9$, representing those who actually had children.

[f] Small cell sizes prohibited reliable estimation of comparisons.

Table 4
Health, safety, and social maladjustment as a function of early childhood treatment status in the Abecedarian (ABC) and CARE young adult studies

	Group						Group comparisons			
	1	2	3	4	5		Center (2,4) vs. Control (1,3)	ABC (1,2) v. CARE (3,4,5)	Treatment × study	FE (5) vs. CARE control (3)
	ABC control $n = 51$	ABC center based[a] $n = 51$	CARE control $n = 21$	CARE center based $n = 14$	CARE family ed. $n = 25$					
Active lifestyle[b] (%)	33	43	19	71	28	O.R.	3.92**	3.78	2.85*	1.57
Seat-belt use (%)	51	59	52	36	60	O.R.	.78	4.54+	.56	1.20
Regular smoker[c] (%)	55	39	45	64	56	O.R.	1.03	2.43	2.06+	1.39
Marijuana use[c] (%)	39	18	43	36	36	O.R.	.48+	.43	1.55	.79

Note: Group comparisons are based on *F* tests where means and S.D.s are given, Chi Square where percentages of groups are compared. Values in group comparison columns are effect sizes: odds ratios for Chi Square statistics and *d*-type effect sizes for mean comparisons underlying the *F* tests.

* $p < .05$; ** $p < .01$; + $p < .10$ for underlying *F* tests or Chi Square statistics.

[a] Two males in this group did not complete the Risk Taking Survey from which the data in Table 4 are derived, $n = 50$.

[b] Based on reporting exercise 3 or more days/week.

[c] Small cell sizes prohibited reliable estimation of comparisons.

large effect (Cohen, 1992). Significant interaction contrasts indicate that the effect of intervention for the Abecedarian group was not identical to the effect of intervention for the CARE group. Tabled means and percentages describe the direction and magnitude of group differences. Because logistic regression with sparse data (small cell sizes) can produce unreliable odds ratio estimates (Breslow, 1981; Goodwin et al., 2004; Greenland, 2000; Jewell, 1984), it has been recommended that researchers not report odds ratios computed on small cells. In cases where this occurred in the present data, such ratios are not reported; superscripts within each table indicate these instances.

3. Results

Tables 2–4 contain means and standard deviations for linear outcomes (e.g., years of education attained) and group percents for binary outcomes (e.g., high school graduation) arrayed by treatment groups for each study, along with the relevant effect sizes (i.e., *d*-type and odds ratios) for group comparisons.

3.1. Education and employment

As shown in Table 2, CARE replicated the Abecedarian finding of enhanced educational outcomes for those with center-based treatment. Significantly better educational outcomes were seen in the groups with the full five years of early childhood intervention (see the comparisons column marked Center vs. Control). Years of education attained showed a moderate treatment effect. The odds of being in any kind of educational program when interviewed as a young adult were 7.06 times greater for treated than for control participants, and the odds of attending a baccalaureate college were 3.99 times greater for individuals who had the center-based educational intervention compared to those in control groups. Note that, across groups, no significant effect on high school graduation was found; the differences seen were in educational attainment post high school.

Comparing vocational outcomes showed that from 50% to 79% of all participants were working at some sort of job in their early twenties, irrespective of early childhood treatment. The odds of having skilled employment, however, were 1.95 times greater for those who had center-based early intervention compared with controls. Moreover, the odds of being upwardly mobile, that is, of currently being in school and/or having a skilled job, were more than 4.44 times greater for those who had the center-based early childhood intervention program. No significant educational or vocational benefits were seen for the family-education group compared with CARE controls.

No significant treatment-by-study interactions were found for these educational and vocational indices of young adult accomplishment, thus, there was no evidence that CARE treatment yielded a different effect for these outcomes, either in direction or magnitude, than the ABC program did. No gender effects were seen for any of the educational or vocational outcomes considered here. Males and females had similar results.

3.2. Marriage and parenthood

As seen in Table 3, few of the individuals in either sample were married in their early twenties and fewer than half in any group reported having a child. Three significant overall study differences in child bearing were found. For Abecedarian participants (treatment and control groups combined), the odds of having a child by young adulthood increased by a factor close to six compared to CARE participants. They also had a greater number of children ($d = .68$, a moderate effect), and their odds of being a teen parent were 11.99 times greater compared to CARE. However, given that the number of individuals in the CARE center-based treatment and control groups who had children as teenagers (aged less than 19) was so small ($n = 1$ in the CARE control group and $n = 2$ in the CARE treatment group), the teen parent replication test (a study by treatment interaction) was unreliable. The raw numbers, however, clearly suggest a difference between the two studies. In addition, for this outcome, gender effects were seen with females being more likely to report having children in young adulthood, and to have children at younger ages as well as to be teen parents.

3.3. Health-related behaviors and social maladjustment

Table 4 contains results of self-reported young adult behaviors related to health, safety, and social maladjustment. Such health-related behaviors as regular exercise, consuming a healthy diet, and using automobile seat belts had not previously been examined in the Abecedarian study. The most striking set of findings in this domain concerned active lifestyle defined by regular exercise. For participants who received the center-based treatment, the odds of reporting an active lifestyle in young adulthood were 3.92 times greater compared to participants from the control groups. The treatment-by-study interaction was also significant, with the size of the treatment/control group difference being greater in CARE (by 52 percentage points) than in the Abecedarian study (10 percentage points). Males were more likely than females to describe themselves as being physically active. For automobile seat-belt use, no center-based treatment/control difference was found, but the logistic regression indicated a trend toward an overall study difference, with the Abecedarian participants tending to report higher percentages of use. Females were more likely than males to report using seat belts. No treatment-related effects were found for good dietary habits.

Previous analyses of Abecedarian data alone found a trend for fewer individuals who had early childhood intervention to report being regular smokers in young adulthood compared with controls (Campbell et al., 2002). In contrast, the present study found that the CARE treated group reported the highest raw percentage of smokers of all the groups. Also in previous research, Abecedarian young adults showed a significant treatment-related reduction in reports of using marijuana (Campbell et al., 2002). In this current investigation with treated groups from ABC and CARE combined, there was a trend toward the same reduction in reported use of marijuana by individuals with early childhood center-based treatment ($p < .10$). Females were less likely than males to report using marijuana. There were no significant treatment, study, or treatment-by-study differences in the extent of self-reported binge drinking, driving after drinking, violence, or breaking the law. Males were more likely to report law breaking.

4. Discussion

Young adult educational and vocational benefits found for participants in the Abecedarian early childhood program (Campbell et al., 2002) were replicated in a second randomized study of early educational intervention, Project CARE. In both studies, full-time center-based intervention from infancy to age five was associated with attaining more years of education by young adulthood, with an increased likelihood of obtaining education beyond high school, and an increased likelihood of attending a four-year college. In addition, the center-based early childhood program was associated with having a skilled job and being more upwardly mobile in young adulthood. The results of both studies best generalize to low-income African American families living in a small town or semi-rural environment.

These long-term positive benefits compare favorably with those reported by four other well-controlled studies of early childhood educational intervention for children at high risk for poor outcomes. Outcomes for Abecedarian/CARE compare favorably with those for the Perry Preschool and the Chicago study. Reynolds et al. (2007) found significant differences for high school graduation, highest grade attained, and college attendance. The Perry Preschool follow-up also found significantly more high school graduates for its treated individuals, females in particular. They did not find a significant effect on college attendance (Schweinhart et al., 2005). Similarly, the Early Training Project found that significantly more treated females graduated from high school, but no such effect for males (Gray et al., 1982). All these programs show high school graduation rates between 70% and 75% for those with preschool treatment. With the exception of the untreated individuals in the Early Training Project, whose high school graduation rates ranged between 58% and 20% across males and females in the study's two control groups (Gray et al., 1982), high school graduation rates tended to be around 60% in all other early childhood programs we considered here. IHDP reported dropout rates for its 18-year-olds rather than graduation rates, finding from 8% to 12% across the treated and follow-up only groups for the lighter and heavier infants—not significantly different (McCormick et al., 2006). Thus, by late adolescence, no effect on school progress was demonstrated within that study.

The Abecedarian and CARE young adult findings with respect to college attendance are particularly striking. The percentage of those with center-based intervention who attended college (37% for Abecedarian and CARE center-based treatment groups combined) matched the overall 1992 North Carolina statewide average for being in college at age 19 (34%) and exceeded the 20% statewide rate for African Americans (Marks, 1995). The 34% statewide rate for college attendance in North Carolina is irrespective of economic resources. Here, a comparable rate was found for individuals from low-income, minority families when intervention was provided. In contrast, the college rate for the Abecedarian and CARE controls was 14%.

Of the other studies considered here, only the Chicago study found a significant difference in the percent of individuals with preschool intervention who attended a four-year college: 14.7% of those with preschool intervention did so compared with 10% of their comparison group (Reynolds et al., 2007). It is interesting that the rate of college attendance for individuals who participated in the Chicago preschool program is comparable to the untreated Abecedarian and CARE control groups (around 14%). Thus, the college attendance rate for Abecedarian and CARE center-based treated groups (36% and 43%) is considerably higher than the rate for individuals treated in the Chicago study.

In contrast to differential educational attainment for males and females reported by the Perry Preschool study and the Early Training Project, the combined Abecedarian and Care samples do not find gender effects for high school graduation or college attendance. However, for the Abecedarian study alone, a significant treatment by gender interaction was seen for total years of education at age 21, with treated females having significantly more years of education than control females whereas no such treatment/control difference was seen for males (Campbell et al., 2002). This effect was not found for CARE, but the small size of the CARE center-based treatment group precludes a definitive test of the question.

The mean age at first birth of a child differed for the Abecedarian and CARE studies, with the Abecedarian sample being younger than were CARE participants when they first became parents. In addition, the Abecedarian participants were much more likely to have children while still in their teens. Although no clear explanation for these findings is apparent, the results do mirror national statistics which show a general downward trend in teen births after 1960, with a brief, but steep, upward reversal around 1990, followed by a sharp decrease since then (Ventura, Matthews, & Hamilton, 2001). The Abecedarian participants began to have babies in the late 1980s, corresponding with the national upturn in the teenaged birth rate; CARE teens began having children at a point in time that coincided with the national downturn. Locally, initiatives by health departments and schools targeted reduced teen pregnancies while the Abecedarian and CARE child participants were growing up, years that saw decreased teen births in the local state. As noted above, this outcome did show gender effects, with females more likely to be parents, and more likely to be teen parents.

Adopting healthy life styles, such as engaging in regular exercise, using automobile seat belts, or including vegetables and fruit in one's diet had not previously been examined in the Abecedarian study. A positive center-based intervention effect was seen for active life styles. A study by treatment interaction for this outcome indicated that the size of the center-based intervention/control difference was larger in CARE than in Abecedarian. The two studies tended to differ with respect to seat-belt use, with treated individuals in the Abecedarian study reporting a higher rate of use than the Abecedarian controls. In contrast, the Family Education and the CARE control group both reported usage levels approximately the same as that for the Abecedarian treatment group. The small size of the CARE center-based treatment group cautions against over interpreting these findings. Despite this, however, one may speculate that, given the educational and vocational gains shown by those with early childhood center-based treatment, young adults who had such benefits may be more aware of the importance of adopting healthier, more responsible life styles such as exercising and using auto seat belts. A similar trend was seen in the treated group in the Perry Preschool (Schweinhart et al., 1993). The seat-belt usage rates reported by the Abecedarian and CARE participants are lower than the overall usage rate currently reported for state overall (88.5%) (Governor's Highway Safety Program [GHSP], 2007). Pertinent to finding an effect of preschool treatment on engaging in regular exercise in young adulthood, it may be that this outcome is associated with economic gains. Given better economic circumstances, individuals may be more able to devote time to regular exercise.

The significant treatment-related reduction in reported use of marijuana found for the Abecedarian study was not upheld when the two studies were considered together, although the center-based treatment-related reduction in percents reporting this behavior was also seen in CARE. If inverted, the odds ratio obtained for this outcome suggests that those in the early childhood control groups were twice as likely to engage in this form of illegal drug use as young adults. A gender effect emerged for this outcome as well: females were less likely to report smoking pot. Reported use of this recreational drug was higher in the Abecedarian/CARE young adult groups, varying from 18% to 39% across groups, compared to the 20% rate reported by the high school students who responded to the Youth Risk Behavior Surveillance Survey in 2005 (Eaton et al., 2006). The trend for Abecedarian participants with early childhood treatment to report lower rates of regular cigarette smoking was not seen in CARE, where the center-based treatment group had the highest proportion of all five groups (64%) reporting they were regular smokers. Again, the small size of the CARE center-based treatment group cautions against over interpreting these findings. Both the Perry Preschool (Schweinhart et al., 2005) and the Chicago study (Reynolds et al., 2007) reported slight, but non-significant, reductions in smoking among those who had preschool intervention. Notably, the reported percentages of regular smokers across the five Abecedarian and CARE groups are considerably higher (39–64%) than the overall national average reported for black adults which was 25.7% (Carmona et al., 2004). Almost the identical rate (25%) was found for African American adults residing in the study state in a 1992–93 survey (Poldenak & King, 1999), so the answer to the high rates of smoking found in the present study appears not to lie in lower local prices and taxes for tobacco products.

Not reported in Table 4 were the outcomes related to dietary habits within the two studies. No reliable differences were found for reports of good dietary habits, but it is noteworthy that very small percentages, less than 20%, in any group, responded positively to these questions (i.e., described their own diets as low in fats and sugars). Given the health problems associated with poor diets, this finding could be a matter deserving further study within this demographic group.

The standardized intellectual and academic measures collected for the Abecedarian young adults are not available for CARE. However data from the IHDP did find higher PPVT and mathematics achievement scores at age 18 in its sample (McCormick et al., 2006), an outcome consistent with the Abecedarian finding of significantly higher long-term IQ scores and higher academic test scores for those in the early childhood treatment group (Campbell et al., 2001). Comparable standardized test data are not available for CARE.

Why might the effects of early childhood educational intervention persist into young adulthood? The investigators of both the Perry Preschool and the Chicago study have addressed this question within their own data. Investigators of the Perry Preschool examined different explanatory models to learn if cognitive advantage (i.e., abilities enhanced through the preschool experience) or enhanced motivation, or changes in parental expectations of success were responsible for later academic gains found in treated individuals. Of these, the cognitive advantage model seemed best to explain the data (Barnett, Young, & Schweinhart, 1998), a model that also seemed the best fit for the data from the Consortium for Longitudinal Data (Lazar et al., 1982). Within the Chicago study, researchers found that early intervention led to better school achievement in middle childhood which in turn was associated with better achievement in adolescence, thus "the cognitive advantage hypothesis provided the best single explanation for the relationship between program participation and later school achievement" (Reynolds, 2000, p. 150). Within the Abecedarian study, the effects of early childhood treatment on young adult academic test scores appeared to be mediated through early childhood cognitive test scores (Campbell et al., 2001). In earlier work using data from both the Abecedarian and CARE studies, Burchinal et al. (1997) found that enhanced responsiveness to people and objects mediated the effects of infant and toddler intervention on cognitive test performance up to age 8. Other analyses concerned solely with young adult intellectual test performance of the Abecedarian sample found that early intervention best predicted longitudinal test performance over the years, but that much of the advantage in test performance was related to verbal development. In fact, by age 21, verbal development wholly accounted for the effect of early intervention on long-term intellectual test performance (Campbell & Burchinal, 2008).

Why the family education treatment model appeared to be relatively ineffective is of concern, given the wide-spread use of home visiting as a strategy for parenting education to enhance children's school readiness. It is possible that the

family-based intervention implemented via home visiting in CARE was not as intensive or comprehensive as was needed to bring about change. Recognizing this problem, IHDP adapted the CARE home visiting approach in an effort to improve implementation (Wasik, Bryant, Lyons, Sparling, & Ramey, 1997). However, the design of IHDP, which combined home visiting alone in the first year with center-based plus home visiting services in the second and third years, does not permit us to draw conclusions about the long-term effectiveness of home visiting by itself. Indeed, there is some discussion in the field about whether home visiting by itself can ever yield long-term outcomes as consistently as do center-based services (Gomby, Culross, & Behrman, 1999) and might only be effective when combined with center-based services.

We believe that home visiting might be effective by itself but the goals and expectations need to be very clear. For example, if family literacy is the desired outcome, the content of the home visiting needs specifically to focus on early literacy and language skills of children and provide parents with specific strategies, such as dialogic reading, for helping their children (see Bryant & Wasik, 2004). The outcomes of center-based programs may be enhanced with the addition of home visiting, particularly for children from the most needy families, but research to support this conclusion is currently lacking.

A caveat for the study is the fact that the number of individuals from the CARE center-based intervention group for whom young adult data were available is very small ($n = 14$). This results in reduced power to test the study by treatment interactions in the model. Nevertheless, because the CARE center-based group did have five full years of early educational intervention, having the additional CARE cases increases analytic power for assessing long-term benefits of this intensive treatment model for young children from poverty backgrounds.

In sum, the present study affirms the relative effectiveness of child-centered early education in leading to higher levels of education and better jobs in young adulthood. The results show that early childhood programs can make a lasting difference in the lives of poor children, supporting the use of resources for high quality educational child care. Indications of less use of illegal drugs and more physical activity imply cost savings in terms of healthier life styles for those who had the early childhood program. Examining the CARE outcomes in light of the earlier findings from the Abecedarian study affirms the key findings of better educational and vocational outcomes for young adults in both groups. However, the earlier striking results with respect to a reduction in teenaged parenthood were not replicated, nor was the strong trend for persons with early childhood treatment to smoke less. Even though the small size of the CARE treatment group raises questions about the reliability of results based on 14 cases compared with those based on 53 cases, these inconsistencies do indicate the need to examine these questions with larger samples.

Full-time center-based child care is expensive. Cost benefit analyses have been conducted for the Perry Preschool study and the Abecedarian study. For the Abecedarian study, economists have estimated that the program should return approximately $3.66 for every dollar spent on the preschool program. These savings are based on estimates of higher life time earnings for treated individuals, savings in costs for special education, reductions in health costs related to smoking, and higher projected parental earnings because they benefited from five years of free child care, and can vary depending upon the discount rate used to estimate them (Masse & Barnett, 2002). When Perry Preschool participants were slightly older (age 27) the cost:benefit ratio was calculated to be $7 for every dollar spent (Schweinhart et al., 1993). This calculation includes the significant reduction in law breaking reported for the Perry Preschool in addition to the kinds of educational savings and higher projected earnings found for the Abecedarian study. Later figures for the Perry Preschool, based on savings through the age of 40, showed that every dollar invested saves $17, largely because of reduced costs of crime, savings in educational costs, and increased taxes from earnings (Schweinhart et al., 2005). The cost-to-savings ratios in these studies support the same policy implication: money spent on quality early childhood education for poor children pays off with long-term educational and vocational benefits.

Since the landmark Abecedarian and CARE studies were initiated the field has seen a considerable expansion in the expectations for preschool and kindergarten children's language and literacy development. There is also an increased emphasis on the importance of parents and teachers in promoting these early skills (Bowman, Donovan, & Burns, 2001). Teachers of the very young should be fully aware of the importance of their task. What they do in their classrooms can have long-term positive effects on the lives of the children in their care, especially for children who are growing up in low-income households. The Abecedarian and CARE studies have not only served as a foundation for increased funding for preschool programs, their long-term positive outcomes provide essential support for such practices. These longitudinal studies demonstrate that some of the most important societal gains to be realized from early childhood programs may not be seen until late adolescence or early adulthood. They not only show the importance of early childhood education, but the necessity for long-term research that can demonstrate its sustained value.

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