

The Prevention of Intellectual Impairment in Children of Impoverished Families: Findings of a Randomized Trial of Educational Day Care

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Abstract: We estimated the effects of an experimental educational day care program on the intellectual development of preschoolers from 86 high-risk families in a randomly allocated longitudinal study. At six through 54 months of age, the IQs of experimental program children ranged from 7.9 to 20.1 points higher than those of control children when maternal mental retardation and home envi-

ronment effects were controlled; at every age, a greater proportion of the experimental program children had normal range IQs (> 84). In 13 children with retarded mothers, none of six experimental program children, but six of seven control children, had IQ scores below normal. (*Am J Public Health* 1990; 80:844-847.)

Introduction

Mild mental retardation is more prevalent among lower socioeconomic groups, unlike moderate, severe, and profound mental retardation which are fairly evenly distributed across socioeconomic groups.¹ Family and social problems of many low income families (e.g., low education, unemployment) have been associated with impaired intellectual functioning in general, and mild mental retardation in particular.^{2,3} These findings, in combination with those of national surveys showing that 25 percent of the nation's preschool age children live in poverty,⁴ suggest that mild mental retardation should be an important public health concern.

Preschool programs designed to enhance the intellectual development of high-risk children have generally been associated with positive outcomes; however, the intellectual gains associated with the programs are often of limited duration.⁵

The goal of this report is to evaluate simultaneously the effects of an educational day care program (i.e., the Carolina Abecedarian Project) and familial factors, specifically maternal retardation and home environment, on the intellectual development of high-risk children throughout their first four and a half years of life. Previous investigation of this sample found that educational day care led to improved intellectual functioning;^{6*} however, the impact of multiple potentially confounding factors was not evaluated.

Methods

Intervention Procedures

The Carolina Abecedarian Project is a randomly allocated, controlled, longitudinal investigation of the effectiveness of educational day care in enhancing the intellectual ability of children from impoverished multi-problem families. Children assigned to the experimental condition entered day care between 6 and 12 weeks of age, and remained in care for

five days a week, 50 weeks a year. The program was designed to promote social and cognitive growth in an orderly, friendly environment.^{7,8}

Sample Selection

A total of 120 pregnant women whose unborn children (the target children) were at high-risk for intellectual impairment were identified by public health agencies and hospitals. High-risk status was defined by an index score composed of 14 risk factors for intellectual impairment.⁹ Of the 120 families randomly assigned to either the experimental or control group, 107 continued participation for at least 54 months.⁶ This report focuses on 86 (80 percent) of these 107 families for whom complete follow-up information is available (41 experimentals and 45 controls). No statistically significant differences were detected between the 86 families with complete information and the 21 families with incomplete information in terms of condition assignment, maternal IQ, or maternal education.

Table 1 shows the sociodemographic comparability of the experimental and control groups at study enrollment. Study families were primarily Black, low-income, single parent families. Mothers tended to be young and to have low IQs and low education levels. Target children were predominantly firstborns.

Assessment Instruments

The intellectual development of the children was evaluated using three standardized developmental and IQ tests.

TABLE 1—Characteristics of the Families at Study Enrollment

Characteristics	Control Group (n = 45)	Experimental Group (n = 41)
	n (%)	n (%)
Race		
Black	45 (100)	39 (95)
White	0 (0)	2 (5)
Firstborn		
Yes	27 (60)	28 (68)
No	18 (40)	13 (32)
Marital Status		
Single	31 (69)	31 (76)
Other	14 (31)	10 (24)
	\bar{X} (SD)	\bar{X} (SD)
Maternal age (years)	21 (6)	20 (4)
Maternal IQ (mean)	84 (11)	85 (13)
Maternal education (years)	10 (2)	10 (2)

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The Mental Development Index of the Bayley Scales of Infant Development¹⁰ was used for assessments at 6, 12, and 18 months of age, the Stanford-Binet Intelligence Scale¹¹ for ages 24, 36, and 48 months, and the McCarthy Scales of Children's Ability¹² for ages 42 and 54 months.

For some analyses, children were classified into one of three groups on the basis of their IQ scores. Employing standard clinical cutpoints,^{13,14} children with IQs of 70 or less were categorized within the mentally retarded range of intellectual ability, children with IQs between 71 and 84 fell within the borderline intellectual functioning range, and children who scored 85 or more fell within the normal range of intellectual ability; children could move across groups dependent upon their test scores at particular ages.

The Home Observation for Measurement of the Environment (HOME)¹⁵ was employed to quantify the degree to which each child's home surroundings provided an age-appropriate, potentially stimulating environment. The 45-item infant version HOME was administered at 6, 18, and 30 months, and the 80-item child version at 42 and 54 months. The mean HOME scores of the experimental and control groups were comparable at each of the five assessments and evidenced little within-family variation over time.¹⁶ Therefore, the five evaluations were summed to create a HOME-SUM score representative of each child's home environment throughout the follow-up. For purposes of analysis, the study homes were categorized into two groups: "more stimulating" homes (i.e., homes at or above this sample's mean HOME-SUM score), and "less stimulating" homes (i.e., homes below this sample's mean HOME-SUM score). Twenty-two (54 percent) of the experimental families were classified as having more stimulating homes, as were 19 (42 percent) of the control families.

Analyses

Descriptive statistics were calculated to compare the experimental and control children in terms of their mean IQ scores and the proportion of children who fell within the mentally retarded, borderline, and normal IQ ranges. A repeated measures multivariate analysis of variance procedure¹⁷ was employed to evaluate the effects of the experimental day care on the IQ scores of the study children across time, while controlling for, and examining the impact of, familial factors. The children's IQs were modeled using the following predictor variables: experimental educational day care (yes or no); maternal mental retardation (yes or no); home environment (more or less stimulating); annual family income; maternal age; maternal education level; maternal marital status; and the number of siblings. Using a backward elimination modeling strategy,¹⁸ the full model was reduced

to a smaller final model containing educational day care, maternal retardation, and home environment. The Wilks Lambda criterion (with a type I error rate of .05) was used to evaluate all multivariate tests. Effect sizes were measured using estimated regression coefficients, and 95% confidence intervals were calculated.

Results

Table 2 shows that the mean IQ scores of the experimental program children were above the general population average of 100 at all but one assessment, unlike that of the controls. At all time points, a greater percentage of experimentals than controls fell within the normal range of intellectual ability. Furthermore, at all ages except 24 months, a greater percentage of controls fell within the mentally retarded range of intellectual ability. At 54 months, 93 percent of the experimentals vs 69 percent of the controls had IQs within the normal range.

The 13 children of mentally retarded mothers were examined in detail. At 6 and 12 months, the mean IQ scores of the six experimental program children of retarded mothers were comparable to those of the seven control children of retarded mothers, with all mean scores being slightly above 100. However, by the 54-month assessment, the mean IQ of the experimental program children of retarded mothers was 22 points higher than that of the control children of retarded mothers (95 vs 73). The IQ scores of six (86 percent) of the seven control children of retarded mothers fell below the normal IQ range at 54 months (three within the mentally retarded range and three within the borderline intellectual functioning range). However, the IQ scores of all of the six experimental program children of retarded mothers were within the normal IQ range at the final assessment.

The repeated measures multivariate analysis of the entire sample found that the experimental and control groups differed significantly in their overall level of IQ averaged over time when the effects of maternal retardation and home environment were controlled ($F_{(1,82)} = 49.12, p = .0001$), with the experimental group having a greater grand mean than the comparison group. The two groups also differed in their patterns of change in IQ across time ($F_{(7,76)} = 4.76, p = .0002$). Stepdown contrasts examining the differences in IQ between successive time periods found that the groups differed significantly on all comparisons except for those assessing change between the 6 and 12 month assessments and the 42 and 48 month assessments.

As shown in Table 3, positive educational day care effects were found at all ages, with the mean IQ of the experimental children averaging from 7.9 to 20.1 points

TABLE 2—Mean IQ, Standard Deviation, and the Number and Percentage of Children in the Mentally Retarded (IQ < 71), Borderline Intellectual Functioning (70 < IQ < 85), and Normal (IQ > 84) IQ Ranges at 6 through 54 Months of Age

Age (years)	Control Group (n = 45)				Experimental Group (n = 41)			
	Mean(SD)	Retarded(%)	Border(%)	Normal(%)	Mean(SD)	Retarded(%)	Border(%)	Normal(%)
6	101 (14)	1 (2)	2 (4)	42 (93)	110 (14)	0 (0)	0 (0)	41 (100)
12	105 (15)	1 (2)	3 (7)	41 (91)	114 (13)	0 (0)	0 (0)	41 (100)
18	90 (13)	4 (9)	6 (78)	35 (78)	111 (12)	0 (0)	0 (0)	41 (100)
24	85 (9)	0 (0)	24 (53)	21 (47)	98 (11)	0 (0)	3 (7)	38 (93)
36	84 (14)	6 (13)	17 (38)	22 (49)	104 (13)	0 (0)	2 (5)	39 (95)
42	93 (13)	2 (4)	10 (22)	33 (73)	104 (11)	0 (0)	2 (5)	39 (95)
48	89 (14)	6 (13)	13 (29)	26 (58)	103 (12)	1 (2)	1 (2)	39 (95)
54	91 (14)	4 (9)	10 (22)	31 (69)	101 (11)	1 (2)	2 (5)	38 (93)

TABLE 3—Estimated Regression Coefficients and Associated 95% Confidence Intervals

Age in months	Regression Coefficients (95% CI)		
	Educational Day Care	Maternal Retardation	Home Environment
6	8.2 (2.2,14.1)	1.7 (-6.9,10.3)	4.8 (-1.4,11.0)
12	7.9 (2.0,13.7)	1.0 (-7.4,9.4)	4.9 (-1.2,10.9)
18	20.1 (15.0,25.2)	-3.3 (-10.6,4.1)	6.6 (1.3,10.9)
24	12.7 (8.9,16.7)	-4.3 (-9.9,1.5)	5.1 (0.9,9.3)
36	18.6 (13.5,23.7)	-8.2 (-15.6,-0.8)	8.6 (3.2,13.9)
42	10.2 (5.8,14.7)	-12.2 (-18.6,-5.8)	5.3 (0.7,9.9)
48	13.2 (8.5,17.9)	-11.7 (-18.5,-4.9)	8.9 (4.0,13.8)
54	9.1 (4.5,13.8)	-11.8 (-18.5,-5.1)	7.9 (3.0,12.7)

Note that for the multivariate analysis: educational day care was coded as 1 if experimental, 0 if control; maternal retardation was coded as 1 if retarded (IQ < 71), 0 if not retarded (IQ > 70); and home environment was coded as 1 if more stimulating (HOME-SUM scores above the mean), 0 if less stimulating (HOME-SUM scores below the mean).

higher than that of the control children when the effects of maternal retardation and home environment were controlled. The estimated effects of maternal retardation vary with the age of the children, the coefficients being small and positive at 6 and 12 months, but negative and progressively larger from 18 months onward. By 54 months, children with retarded mothers had IQ scores which averaged 11.8 points lower than children with non-retarded mothers, when the effects of educational day care and home environment were controlled. The effects of a more stimulating home environment were positive at every time point and increased over time. By the final assessment, children with more stimulating homes had IQ scores which averaged 7.9 points higher than did the children with less stimulating homes, controlling for the effects of educational day care and maternal retardation.

Discussion

The findings suggest that educational day care, maternal intelligence, and home environment each contributes to the developmental course of children's intellectual abilities. However, some cautionary comments and explanations are in order.

First, since the IQ scores of the experimental program children were consistently greater than those of the controls, one may ask whether the intellectual advantage of the experimental group was the result of the educational day care or the initial allocation procedure (i.e., were the children most at risk for intellectual impairment disproportionately allocated to the control group?). The facts that random allocation procedures were employed to assign families to groups, that known risk factors were evenly distributed between the groups, and that the experimental children had been in day care for at least three months prior to the initial IQ assessment, argue for the IQ differences being attributable to the educational day care program. Furthermore, the initial similarity of the IQ scores of the experimental and control group children of retarded mothers (i.e., all scored within the normal IQ range at 6 and 12 months of age) and the later dissimilarity of their scores (i.e., only 14 percent of the controls were in the normal IQ range at 54 months of age, compared to all of the experimentals) supports the notion that the educational day care resulted in improved intellectual functioning.

Second, issues arise concerning the patterns of change in IQ seen in the experimental and control groups over time.

The decline in IQ seen in both groups after 12 months of age may be the result of at least two factors. The norms for the 12-month Bayley may be outdated, resulting in over-estimation of the true abilities of some children.¹⁹ If the assessments at 6 and 12 months are inflated estimates of the children's functioning, while the later assessments are more accurate estimates, one would expect to see the observed decline in both groups of children after the 12-month evaluation. The differential magnitude of the decline (i.e., the downturn in scores was greater for the controls than for the experimentals) may be because the 6- and 12-month assessments focused on motor behaviors, while the later assessments incorporate more verbal behaviors. Perhaps the deficits associated with an impoverished environment may be mostly cognitive and verbal, rather than motor. This also could explain why the greatest fall in mean IQ after the 12-month assessment occurred in the subgroup of control children of mentally retarded mothers.

Improvement in the control group's mean IQ after 36 months of age may be due to the beneficial impact of community day care programs since approximately half of the control families entered their children into licensed community day care programs when the children were around three years old. A recent study of the impact of community day care in this sample of children concluded that the controls benefited intellectually from the community day care experience, although not to the same degree as the experimentals benefited from the Abecedarian educational day care.²⁰

The positive impact of educational day care was especially pronounced for the children with mentally retarded mothers. At 6 months of age, all experimental and control children of retarded mothers had IQ scores within the normal range; however, by 54 months, all experimental group children of retarded mothers, but only 14 percent of the control children of retarded mothers, had normal range IQ scores. Although the number of children with retarded mothers in this sample is small ($n = 13$), the strong beneficial impact of this intervention merits attention because these children are at extreme risk for intellectual impairment.^{21,22}

Given the beneficial effect of early educational day care in this sample of children with retarded mothers, the question arises as to whether families such as these typically receive day care services for their children. Data from the US National Longitudinal Survey of Youth²³ suggest that this is not the case: only 6 percent of the lowest functioning mothers of preschoolers (i.e., those mothers who scored in the bottom 5 percent on a standardized achievement test) enrolled their children in day care, compared to 20 percent of the highest functioning mothers (i.e., those mothers who scored in the top 95 percent on the achievement test). Thus the children who may be in most need of educational day care do not tend to receive these services. Given the positive findings of the Carolina Abecedarian Project, the children of low functioning mothers appear to be a group which public health policies should target to receive high quality educational day care interventions.

In addition to the educational day care effect, this study found both maternal mental retardation and home environment to be independent predictors of children's IQ scores. By the final 54-month assessment, the IQ scores of the children of retarded mothers averaged 12 points less than those of the children of non-retarded mothers, and the IQ scores of the children from more stimulating homes averaged 8 points higher than those of the children from less stimulating homes, when the effect of the experimental day care was controlled.

Finally, one may ask whether educational day care programs for impoverished families are cost-effective. Although, to date, no specific cost-benefit analyses have been performed using the Abecedarian data, a study of the teenage mothers in the sample found that by the 54-month evaluation, mothers in the experimental group were significantly more likely to have graduated from high school and be self-supporting than were mothers in the control group.²⁴ Given the large numbers of teenage mothers and children living in poverty in the United States today, the provision of high quality educational day care services to impoverished families may be a feasible strategy aimed at the prevention of mild mental retardation.

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Individuals planning to attend pre-convention activities related to the American Public Health Association's annual meeting this fall in New York City should note that Yom Kippur falls on Saturday, September 29. For those pre-annual meeting participants who wish to attend Yom Kippur services, two New York City educational institutions offer services open to the public.

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