

# Long-term Effects of an Early Childhood Intervention on Educational Achievement and Juvenile Arrest

## A 15-Year Follow-up of Low-Income Children in Public Schools

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**E**ARLY EDUCATIONAL INTERVENTIONS during the preschool years are widely touted as an effective way to prevent learning difficulties and to promote healthy development. Preschool programs are central to many human service reforms. State and local expenditures for preschool exceed \$15 billion annually, and they are expected to continue to increase.<sup>1</sup> Advances in the neuroscience of brain development have further accelerated interest and investments in the early years of life.<sup>2,3</sup>

The main attraction of early childhood programs is their potential for prevention and cost-effectiveness.<sup>4,5</sup> In the past 2 decades, many studies have demonstrated the positive effects of participation in early intervention for school readiness, health status, academic achievement, reduced need for grade retention, and special education services.<sup>6-8</sup> Evidence is emerging for delinquency prevention and higher educational attainment.<sup>9-11</sup> Yet several limitations remain that reduce confidence in the implications of findings for policy making.

First, most evidence for the link between preschool participation and its

**Context** Most studies of the long-term effects of early childhood educational interventions are of demonstration programs rather than large-scale public programs. Previous studies of one of the oldest federally funded preschool programs have reported positive effects on school performance, but effects on educational attainment and crime are unknown.

**Objective** To determine the long-term effectiveness of a federal center-based preschool and school-based intervention program for urban low-income children.

**Design, Setting, and Participants** Fifteen-year follow-up of a nonrandomized, matched-group cohort of 1539 low-income, mostly black children born in 1980 and enrolled in alternative early childhood programs in 25 sites in Chicago, Ill.

**Interventions** The Chicago Child-Parent Center (CPC) Program (n=989 children) provides comprehensive education, family, and health services and includes half-day preschool at ages 3 to 4 years, half- or full-day kindergarten, and school-age services in linked elementary schools at ages 6 to 9 years. The comparison group (n=550) consisted of children who participated in alternative early childhood programs (full-day kindergarten): 374 in the preschool comparison group from 5 randomly selected schools plus 2 others that provided full-day kindergarten and additional instructional resources and 176 who attended full-day kindergartens in 6 CPCs without preschool participation.

**Main Outcome Measures** Rates of high school completion and school dropout by age 20 years, juvenile arrests for violent and nonviolent offenses, and grade retention and special education placement by age 18 years.

**Results** Relative to the preschool comparison group and adjusted for several covariates, children who participated in the preschool intervention for 1 or 2 years had a higher rate of high school completion (49.7% vs 38.5%;  $P=.01$ ); more years of completed education (10.6 vs 10.2;  $P=.03$ ); and lower rates of juvenile arrest (16.9% vs 25.1%;  $P=.003$ ), violent arrests (9.0% vs 15.3%;  $P=.002$ ), and school dropout (46.7% vs 55.0%;  $P=.047$ ). Both preschool and school-age participation were significantly associated with lower rates of grade retention and special education services. The effects of preschool participation on educational attainment were greater for boys than girls, especially in reducing school dropout rates ( $P=.03$ ). Relative to less extensive participation, children with extended program participation from preschool through second or third grade also experienced lower rates of grade retention (21.9% vs 32.3%;  $P=.001$ ) and special education (13.5% vs 20.7%;  $P=.004$ ).

**Conclusions** Participation in an established early childhood intervention for low-income children was associated with better educational and social outcomes up to age 20 years. These findings are among the strongest evidence that established programs administered through public schools can promote children's long-term success.

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long-term effects on child health and development comes from model demonstration programs rather than established programs implemented by school districts and human service agencies.<sup>12</sup> Although research on model programs provides crucial information concerning what effects are possible under the most controlled conditions, evidence from larger-scale, institutionalized programs can better assess the effectiveness of the existing state and federal investments.

A second limitation of the existing research is that few studies of program impact have been conducted in inner cities with high concentrations of neighborhood and family poverty. Beginning with Head Start, preschool programs were designed to benefit children at highest risk of school failure. Given increasing concentrations of social disadvantage in many urban settings,<sup>13</sup> corresponding evidence about the compensatory effects of early childhood programs is warranted.

Finally, the impact of the length of participation has not been systematically investigated. Previous studies do not have sufficient sample sizes and variation in length of participation to investigate this issue. Knowledge about the added value of programs that continue into the primary grades may reveal, for example, the extent to which the fading effects of intervention on some outcomes can be moderated or reversed.<sup>7,14</sup>

In this report, we present evidence from the Chicago Longitudinal Study on the long-term effects of a preventive intervention called the Chicago Child-Parent Center (CPC) program.<sup>12,15</sup> Located in 24 centers in high-poverty neighborhoods, this ESEA (Elementary and Secondary Education Act) Title I program began in 1967 and is the country's second oldest (after Head Start) federal preschool program and the oldest extended early intervention. We investigated the link between program participation and educational attainment by age 20 years, official juvenile arrests by age 18 years, and need for school remedial services. Earlier studies have found that program participation beginning in

preschool is significantly associated with greater cognitive skills at school entry, higher school achievement in elementary school, and reduced rates of grade retention and special education by early adolescence.<sup>12,16,17</sup> The duration of program participation also is positively associated with school performance.<sup>16</sup> We expected this pattern of results would lead to higher rates of school completion and decreased likelihood of juvenile crime and remedial services.

## METHODS

### Sample and Design

Data are from the Chicago Longitudinal Study, a prospective investigation that tracks the well-being of a same-age cohort of 1539 low-income minority children (93% black and 7% Hispanic) born in 1980 who attended early childhood programs in 25 sites in 1985-1986.<sup>15</sup> Since 1985, data have been collected yearly on educational and family experiences from school records and participant surveys. The original sample included the entire cohort of 989 children who completed preschool and kindergarten in all 20 CPCs with combined programs. School-age services are provided in first to third grades in schools affiliated with the centers. The comparison group of 550 children in this nonrandomized cohort design participated in alternative early childhood programs (full-day kindergarten). The preschool comparison group included 374 children comprising the entire kindergarten class in 5 randomly selected schools plus 2 others that provided full-day kindergarten and additional instructional resources (23% enrolled in Head Start). An additional 176 children attended full-day kindergartens in 6 CPCs without preschool participation. They were eligible to receive some program services (ie, parent resources) but were located in separate classrooms. Because these 2 groups had similar demographic profiles, they were combined for analysis.

The intervention group was matched on age of kindergarten entry, eligibility for and participation in government-funded programs, and neighborhood

and family poverty.<sup>12,15</sup> *Neighborhood poverty* is defined as residence in a Title I school attendance area. *Family poverty* is defined as eligibility for the subsidized lunch program (130% of the federal poverty level). All intervention and comparison group children were eligible and participated in the study under informed consent. The legal and ethical requirements to serve children most in need prevented random assignment in this established program. The study was approved by the institutional review board at the University of Wisconsin-Madison.

The design of the study assessed the impact of 3 measures of CPC participation. For preschool participation, children entering the program at ages 3 or 4 years (original cohort, n=989) were compared with all other children in the study who did not participate in CPC preschool but had the alternative full-day kindergarten (preschool comparison group, n=550; TABLE 1). The effects of school-age intervention, which was available to any child attending a program school, were estimated by comparing children participating for at least 1 year from first to third grade regardless of whether they participated in preschool (n=850) with those with no participation in the school-age program (school-age comparison group, n=689). The effects of each program component were estimated while controlling for the influence of the other. The effects of participation in extended intervention were estimated by comparing children who entered the CPCs in preschool and continued their participation through second or third grade (for 4-6 years, n=553) with all other children with less participation in either preschool or first to third grades (nonextended intervention group, 1-4 years, n=602). The pattern of participation and postprogram data collection are shown in Table 1.

The validity of the estimated intervention effects is strengthened by the following study features. First, most children in the preschool and school-age comparison groups did not enroll in the program because they did not live in the attendance area of the CPCs. Thus, home

residency rather than parent interest determined their participation. Second, by comparing groups that received different intervention services, findings in this report estimate the value added by the CPC program above and beyond participation in more typical programs. Third, to assess the impact of extended vs nonextended participation, results of word analysis skill tests at the end of kindergarten were used as a control variable. Finally, previous studies of this project<sup>16,18</sup> support the equivalence of the program groups and show no evidence of selection bias that would alter findings. Accordingly, confidence is high that the group differences reflect true program effects.<sup>19</sup>

### Follow-up Study and Comparability of Intervention Groups

At age 20 years, 83.2% of the original sample (n=1281) had data on educational attainment (84.6% and 80.7%, respectively, for the preschool and comparison groups) with no evidence of selective attrition in this study or previously.<sup>12,17</sup> Rates of sample recovery were even higher for juvenile court records. As shown in TABLE 2, both the age 20 follow-up samples and original sample were similar on many child and family characteristics. The characteristics were measured from school records and family surveys up to age 12 years. The means of the risk index, a sum of 6 dichotomous factors associated with lower child health and with cumulative effects of child risk factors on later outcomes in many previous studies<sup>20,21</sup> (ie, low parent education [parents did not complete high school], neighborhood poverty [ $\geq 60\%$  of children in attendance area reside in low-income families], low family income [eligibility for the subsidized lunch program], single-parent family status, not employed full- or part-time [parent report of less than full-time employment], and large family size [ $\geq 4$  children in the family as reported by parents]) were equal between groups. Extended and school-age intervention groups showed similar patterns. Con-

**Table 1.** Patterns of Participation of Original Intervention and Comparison Groups in the Chicago Longitudinal Study

Study Category	Preschool Intervention Group†	Comparison Group†
<b>Program Participants' Characteristics at Study Start*</b>		
No. of cases with preschool participation	989	0
Years in preschool (0-2)	1.55	0.0
No. of cases with kindergarten participation	989	550
Years in full/half-day kindergarten	1.0	1.0
Full-day kindergarten, %	59.9	100.0
No. of cases with school-age participation	684	166
Years of school-age program (0-3)	1.43	0.68
School-age participation, %	69.2	30.2
No. of cases with extended program participation (4-6 y)	553	0
Extended participation, %	55.9	0.0
Total years of program (0-6)	3.95	0.68
<b>No. of Lost Cases in Postprogram Years</b>		
Moved‡		
From ages 6-9 y	67	51
From ages 10-14 y	146	101
Child death	4	6
<b>Follow-up Study Characteristics of Participants at Age 15-20 Years, No. of Cases With Data</b>		
School records of remedial services	837	444
Juvenile court records	911	493
Educational attainment		
School dropout	837	444
High school completion	807	426
Highest grade completed through high school	805	421

\*Cases for program participation are at the beginning of the study.

†Values for the preschool comparison group include participation in an alternative full-day kindergarten. One hundred seventy-six comparison-group cases were eligible to receive limited services in the Child-Parent Center kindergarten but enrolled in different classrooms. Some comparison-group cases participated in a school-age program because it was open to any child who enrolled in the program schools in first to third grades. Fifteen children in the preschool groups enrolled in the alternative full-day kindergarten.

‡Some of those children moving away by age 14 years were included in the follow-up study.

sistent with developmental research, the risk index provides a summary measure of the cumulative effects of child risk factors on later outcomes.<sup>20,21</sup> It was significantly associated with all but 1 child outcome. Rates of reported child abuse and neglect and births to teenage mothers also were similar between groups. Among the age 20 follow-up samples, the CPC preschool group had a higher proportion of girls and parents who had completed high school and fewer siblings. Alternatively, the preschool group was more likely than the comparison group to reside in higher-poverty neighborhoods and had higher unemployment rates. The latter differences are the result of the centers being located in the most disadvantaged neighborhoods, leading to conservative estimates of effects.

### Intervention

The CPC is described fully in previous reports.<sup>12,16</sup> It provides educational and family-support services to children ages 3 to 9 years (preschool to second or third grade). The centers serve 100 to 150 three- to five-year-olds in separate facilities or in wings of neighborhood schools. The centers are located in the poorest neighborhoods in Chicago. The mean rate of family poverty in 1989 for the community areas serving the CPCs was 41% compared with 17% for other areas of the city.<sup>12</sup> Each center is directed by a head teacher and 2 coordinators. The parent-resource teacher coordinates the family-support component. The school-community representative provides outreach to families. The eligibility criteria for the program are (1) residence in a high-poverty (Title I)

**Table 2.** Equivalence of Intervention and Comparison Groups on Selected Attributes for the Age 20 Follow-up Study and Original Sample

Child/Family Attribute	Age 20 Follow-up Sample (n = 1281)*			Original Sample (n = 1539) P Value
	Preschool Intervention Group (n = 837)	Comparison Group (n = 444)	P Value	
Female child, %	52.9	46.8	.04	.11
Black, %	94.1	92.8	.34	.95
High school poverty (>59%), %†	77.9	72.3	.03	.04
School stability (>5 y in Chicago schools), %	92.2	91.0	.44	.08
Risk index (0-6), mean (SD)	3.6 (1.3)	3.6 (1.4)	.55	.09
Child eligible for subsidized meals), %‡	92.7	92.9	.93	.79
Parent(s) completed high school, %†	66.1	59.8	.048	.02
Single-parent status, %†	70.4	66.1	.17	.27
Parent(s) not employed full- or part-time, %†	52.5	48.9	.30	.61
Missing parent education or meals, %†	24.9	29.6	.28	.04
No. of siblings, mean†	2.6	2.8	.007	.04
Parent(s) <age 20 y at child's birth, %	23.4	19.2	.14	.25
Child abuse or neglect by age 4 y (indicated report), %	1.0	1.4	.52	.95
Census-track poverty, age 4 y, mean (SD)§	46.1 (13.9)	39.9 (11.8)	0	0
Census-track of parent unemployment, age 4 y, mean (SD)§	24.4 (6.0)	22.8 (5.0)	0	0

\*Data for age 20 follow-up sample collected from preschool to age 12 years. P values show the significance of mean (or percentage) group differences for age 20 and original sample. The preschool comparison group participated in an alternative full-day kindergarten but no Child-Parent Center preschool participation. School-age and extended intervention groups had similar profiles as the preschool intervention group.

†Variable included in risk index. Sample sizes vary by factor. Each variable in the risk index was coded as a negative indicator. Number of siblings was converted to 4 or more children for the risk index.

‡Low family income is eligibility for the subsidized lunch program (<130% of federal poverty level).

§Census information is the mean of 1980 and 1990 data. High school poverty is defined as residence in a school area in which 60% or more children live in families with low income.

school area, (2) demonstration of educational need due to poverty and associated factors as assessed by a screening interview and community outreach by center staff, and (3) parent(s) agree to participate. Rates of participation exceeded 80%, as the program was located in areas not being served by other preschool programs.

The intervention emphasizes the acquisition of basic skills in language arts and math through relatively structured but diverse learning experiences (eg, whole class, small groups). After full-day or part-day kindergarten, continuing services are provided in the affiliated schools under the direction of the curriculum parent-resource teacher.<sup>12</sup> Participation in the school-age intervention is open to any child in the school,

either in first and second grade in 14 sites or first through third grade in 6 sites.

The following features are central to the program: (1) a structured set of learning activities as described in the instructional guide<sup>22</sup>; (2) low child to teacher ratios in preschool (17 to 2) and kindergarten (25 to 2); (3) a multifaceted parent program that includes participating in activities in the parent resource room with other parents (eg, educational workshops, reading groups, and craft projects), volunteering in the classroom, attending school events and field trips, and completing high school; (4) outreach activities including resource mobilization, home visitation, and enrollment of children; (5) ongoing staff development; (6) health and nutrition services, including health

screening, speech therapy, and nursing and meal services; and (7) comprehensive school-age services to support the school transition through reduced class sizes (25 from  $\geq 35$  children), the addition of teacher aides, parent-program activities, extra instructional supplies, and coordinated instructional activities. The mean per-child expenditures in 1996 for 1 year of preschool and 1 year of school-age participation are \$4350 and \$15.00.<sup>12</sup>

## Outcome Variables

**Indicators of Educational Attainment.** Three measures of educational attainment of youth by age 20 years (mean 19.7 years, January 2000) were included. These measures were extracted from administrative records in all schools youth attended and were supplemented by interviews with family members. High school completion measured whether youth completed their secondary education with an official diploma or were awarded a General Education Diploma (GED). All others, including those who remained in high school, were coded as “noncompleters.” Highest grade completed was an ordinal indicator of educational attainment: the minimum value was 6 and the maximum value was 12 (graduation or GED). School dropout measured whether youth left formal education in an elementary school or in a diploma-granting high school prior to graduation for any reason other than school transfer. Youth who enrolled in a GED or equivalent program were coded as “dropouts.” Graduates and active high school students were coded as “non-dropouts.”

**Official Juvenile Arrests.** Several indicators of juvenile arrests reported to the Cook County Juvenile Court and 2 other locations were analyzed. These arrests occurred between ages 10 and 18 years (from 1990 to 1998). They consist of formal petitions for youth who are arrested on criminal charges and go before a judge. Some petitions result in warnings or referrals to social service agencies. The indicators were the incidence of juvenile arrest ( $\geq 1$  arrest), the

incidence of multiple arrests ( $\geq 2$  arrests), and the number of arrests. Arrests were further divided into those involving violent offenses (eg, assault, robbery) and nonviolent offenses (eg, property theft, drug possession). Data were collected through record searches at the juvenile court in spring and summer of 1999 without knowledge of youths' program participation. Searches were repeated twice for 5% random samples and verified against computer records. To be included in the analysis, youth had to reside in Chicago at age 10 years or older. The number of arrests ranged from 0 to 15 and included up to 38 individual charges. Property offenses were the most common, followed by violent and drug offenses.

**School Remedial Services.** Two cumulative measures of school-related competency indexed the receipt of remedial services. Data came from school administrative records. *Incidence of grade retention* was defined as whether children repeated a grade from kindergarten through the eighth grade (age 15 years) because of failure to meet minimum levels of performance.<sup>23</sup> Once in high school, students are no longer formally retained in grade. Special education services were measured in 2 ways: number of years children received special education services from ages 6 to 18 years (grades 1-12) and incidence (any and  $\geq 2$ ) of special education services. Most children receiving special education services participated in the regular school program. The most frequent categories of placement (based in part on federal definitions) were specific learning disability, behavioral disorder, and speech and language impairments.<sup>24</sup>

### Statistical Analysis

Following previous analyses in this project,<sup>17,25</sup> intervention effects were estimated by probit and negative binomial regression within an alternative-program design. First, the impact of CPC preschool participation (1 or 2 years vs 0) and school-age participation (1-3 years vs 0) were assessed by including 2 dummy variables in the model. Second, the effects of participation in the extended

intervention were assessed by estimating regressions with a dummy variable indicating children's participation for 4 to 6 years (preschool starting at age 3 or 4 years to second or third grade) vs nonextended participation for 1 to 4 years (all other children with any preschool or school-age participation). Analyses that included children with 0 years of participation or with only preschool participation yielded similar estimates of extended participation. Adjusted coefficients and group differences denote effects above and beyond the influence of the covariates. The covariates were sex of child, race/ethnicity, risk index, earlier/later program participation, and 20 dummy variables representing the sites of the program. All have demonstrated significant associations with child outcomes in previous studies. The program site indicators measure the local influences associated with attendance in a particular center. Results were unaffected by alternative covariate specifications, such as the individual risk indicators entered separately, and the addition of other indicators of family and neighborhood disadvantage (Table 1). To assess the effects of extended program participation, word analysis score results at the end of kindergarten on the Iowa Tests of Basic Skills were included.<sup>26</sup>

Probit regression analysis was used to estimate coefficients for the dichotomous outcomes of educational attainment (high school completion and school dropout) and the incidence of juvenile arrests, grade retention, and special education placement. Negative binomial regression analysis was used for the outcomes based on count data, including the number of years receiving special education services, the number of arrests (total, violent, and nonviolent), and the highest grade completed (with upper truncation). To enhance interpretability, the coefficients from these analyses were transformed to marginal effects using LIMDEP.<sup>27</sup> Consistent with previous studies,<sup>12,17</sup> corrections for nonrandom attrition and clustering (random-effects model) proved unnecessary and did not affect estimates. Similarly, no significant across-equation correlations

were detected in models estimating the presence of selection bias into or out of the program. Following previous analyses, interaction terms were tested for program by sex of child, neighborhood poverty, and the risk index.

## RESULTS

### Educational Attainment

**Preschool Participation.** Relative to the preschool comparison group and adjusting for the covariates, including school-age participation, preschool participants had a significantly higher rate of high school completion at age 20 years (49.7% vs 38.5%,  $P=.01$ ) and a lower rate of school dropout (46.7% vs 55.0%,  $P=.047$ ; TABLE 3). Preschool participants also completed more years of education than the comparison group (10.6 vs 10.2 years,  $P=.03$ ).

Boys benefitted from preschool participation more than girls, but only for school dropout was the program by sex of child interaction significant ( $P=.03$ ). Adjusted rates of school dropout between groups were substantially lower for boys (51.0% vs 67.7%,  $P=.004$ ) but not for girls (42.4% vs 41.7%,  $P=.90$ ). This finding is notable given that black males are at highest risk of school failure. Differences in rates of high school completion between groups also favored boys (42.6% vs 29.0%,  $P=.02$ ) over girls (56.5% vs 48.0%,  $P=.17$ ).

**School-Age Participation.** Relative to the school-age comparison group and controlling for other model variables, including preschool participation, school-age participation was not associated with any measure of educational attainment (Table 3).

**Extended Program Participation.** Although children with extended intervention for 4 to 6 years had the highest levels of educational attainment, these higher levels were, on average, not significantly different from children with nonextended program participation ( $P=.19$ ; TABLE 4). School dropout rates for program participants were significantly lower than the nonextended group in the highest poverty neighborhoods ( $P=.048$ ).

**Official Juvenile Arrests**

**Preschool Participation.** Preschool participation was associated with a significantly lower rate and number of juvenile arrests. The adjusted rate of arrest was 16.9% for the preschool group and 25.1% for the preschool comparison group ( $P = .003$ ; Table 3). Preschool participants also had a lower rate of multiple arrests (9.5% vs 12.8%,  $P = .01$ ) and violent arrests (9.0% vs 15.3%,  $P = .002$ ). No differences in effects were detected by sex of child, risk index, and neighborhood poverty.

**School-Age Participation.** Unlike preschool participation, school-age participation was not associated with lower arrest rates or with fewer arrests for any measure (Table 3).

**Extended Program Participation.** Relative to nonextended participation, extended participation was marginally associated with only a lower rate of violent arrests ( $P = .09$ ; Table 4). Rates of multiple violent arrests for participants were significantly lower than

those of the nonextended group at higher levels of the risk index ( $P = .03$ ).

**School Remedial Services**

**Preschool Participation.** Relative to the preschool comparison group, preschool participation was associated with significantly lower rates of grade retention (23.0% vs 38.4%;  $P < .001$ ; Table 3) and special education placement (14.4% vs 24.6%;  $P < .001$ ). Moreover, the program group spent, on average, 0.7 years in special education compared with 1.4 years for comparison counterparts.

**School-Age Participation.** As shown in Table 3, participation in the school-age program for at least 1 year was associated with significantly lower rates of special education (15.4% vs 21.3%,  $P = .02$ ), multiple years of special education (13.9% vs 18.4%,  $P = .01$ ), and grade retention (23.8% vs 34.3%,  $P = .001$ ).

**Extended Program Participation.** As shown in Table 4, participation in the extended program was associated with lower rates of grade retention (21.9%

vs 32.3%,  $P = .001$ ) and 2 of the 3 measures of special education placement, including any placement (13.5% vs 20.7%,  $P = .004$ ), above and beyond less extensive participation. Children with 5 or 6 years of participation had the lowest rates of remediation.

**COMMENT**

This study makes 3 contributions to the literature on child health and development. First, as one of the most comprehensive longitudinal studies of a large-scale early intervention on education and crime, the finding that preschool participation was associated with a significantly higher rate of school completion demonstrates that established public programs can have a positive impact through early adulthood. To date, almost all evidence for the effects of early intervention on educational attainment comes from model programs rather than large-scale programs.<sup>6,8,10</sup> The largest increases in educational attainment (especially dropout rates) occurred for boys

**Table 3.** Adjusted Means and Differences for Child-Parent Center (CPC) Preschool and School-Age Intervention Groups\*

Outcome Measures	Preschool†				School-Age‡			
	Intervention (n = 837)	Comparison (n = 444)	Difference	P Value	Intervention (n = 729)	Comparison (n = 552)	Difference	P Value
Educational attainment by age 20 y								
High school completion, %	49.7	38.5	11.2	.01	46.0	45.6	0.4	.91
School dropout, %	46.7	55.0	-8.3	.047	49.8	49.6	0.2	.96
Highest grade completed (7-12)	10.56	10.21	0.35	.03	10.44	10.43	0.01	.96
Juvenile arrests by age 18 y§								
Any arrest, %	16.9	25.1	-8.2	.003	19.8	19.8	0.0	.99
≥2 arrests, %	9.5	12.8	-3.3	.01	10.4	11.0	-0.6	.62
No. of arrests	0.45	0.78	-0.33	.02	0.56	0.58	-0.02	.84
Any violent arrest, %	9.0	15.3	-6.3	.002	10.8	11.8	-1.0	.58
≥2 violent arrests, %	4.7	7.6	-2.9	.008	5.9	5.4	0.5	.60
No. of violent arrests, %	0.22	0.35	-0.13	.02	0.28	0.25	0.03	.64
Any nonviolent arrest, %	14.4	19.2	-4.8	.02	16.3	15.9	0.4	.81
≥2 nonviolent arrests, %	9.6	12.6	-3.0	.02	11.0	10.3	0.7	.52
No. of nonviolent arrests	0.49	0.83	-0.34	.03	0.59	0.63	-0.04	.74
School remedial services								
Grade retention by age 15 y, %	23.0	38.4	-15.4	<.001	23.8	34.3	-10.5	.001
Special education by age 18 y, %	14.4	24.6	-10.2	<.001	15.4	21.3	-5.9	.02
≥2 years in special education, %	12.9	21.3	-8.4	<.001	13.9	18.4	-4.5	.01
Years in special education from ages 6-18 y, No.	0.73	1.43	-0.70	.06	0.76	1.24	-0.48	.08

\*Coefficients are from probit and negative binomial regression analysis transformed to marginal effects, and they are adjusted for earlier/later (preschool or school-age) program participation, sex of child, risk index, program sites, and race/ethnicity. Means for dichotomous variables are percentages. The  $P$  value is the probability level of the adjusted mean (percentage) difference. Sample sizes are for the outcomes of educational attainment and school remedial services.

†The preschool comparison group included all children who did not enroll in CPC preschool regardless of their school-age participation.

‡The school-age comparison group included all children who did not enroll in the school-age intervention (at any time) regardless of their preschool participation.

§The sample size for juvenile arrests was 1404 (911 and 493 for preschool and comparison groups, and 811 and 593 for school-age and comparison groups).

in the program. This may be explained by the finding that boys experienced a greater cognitive advantage at age 5 from preschool participation,<sup>12,18</sup> culminating in larger educational benefits.

The second major contribution was the finding that participation in CPC preschool was associated with significantly lower rates of juvenile arrest. This is the only study of a contemporary preschool intervention reporting crime prevention effects. Preschool participants had lower rates of arrest and multiple arrest for all types of offenses. Given the high costs of treatment and incarceration,<sup>28,29</sup> the results of this study reinforce those of model programs<sup>10,30,31</sup> and demonstrate the value of public programs in reducing delinquency.

Third, participation in the extended childhood intervention program was associated with lower rates of special education and grade retention by late adolescence. Consistent with previous studies of the project,<sup>12,17</sup> programs that extend into the primary grades can enhance school performance above and beyond less extensive intervention. That extended intervention was not significantly associated with educational attainment and official arrests suggests some limits to its long-term benefits. This may be due to the less intensive services of the school-age intervention as well to the conservative bias of the comparisons made. The nonextended group had some intervention exposure and was enrolled in school full-time. Nevertheless, participants in extended intervention consistently outperformed their comparison counterparts and had the highest levels of performance across outcomes.

As preventive interventions, the Chicago CPCs and others like it have advantages over other programs. They generally provide greater levels of intensity, longer durations, and comprehensive services. These attributes make it more likely that child outcomes will be improved.<sup>32</sup> The demonstrated impact on education attainment is especially significant given its link to health status and lower disease risk.<sup>33,34</sup> Given that the annual cost to society of school dropout and crime is estimated at

**Table 4.** Adjusted Means and Differences for Extended Intervention and Nonextended Intervention Groups\*

Outcome Measure	Extended Intervention Group (n = 491)†	Nonextended Intervention Group (n = 480)†	Difference	P Value
Educational attainment by age 20 y				
High school completion, %	48.7	44.0	4.7	.19
School dropout, %	46.9	51.5	-4.6	.19
Highest grade completed (7-12)	10.63	10.44	0.19	.16
Juvenile arrests by age 18 y‡				
Any arrest, %	19.2	20.1	-0.9	.73
≥2 arrests, %	10.0	11.0	-1.0	.43
No. of arrests	0.48	0.62	-0.14	.32
Any violent arrest, %	9.3	12.4	-3.1	.09
≥2 violent arrests, %	4.9	6.2	-1.3	.19
No. of violent arrests	0.21	0.30	-0.09	.40
Any nonviolent arrest, %	15.2	16.6	-1.4	.43
≥2 nonviolent arrests, %	10.2	11.0	-0.8	.49
No. of nonviolent arrests	0.48	0.69	-0.21	.29
School remedial services				
Grade retention by age 15 y, %	21.9	32.3	-10.4	.001
Special education by age 18 y, %	13.5	20.7	-7.2	.004
≥2 years of special education by age 18 y, %	12.7	17.8	-5.1	.008
Years in special education from ages 6-18 y	0.56	1.23	-0.67	.08

\*Coefficients are from probit and negative binomial regression analysis transformed to marginal effects, and they are adjusted for sex of child, race/ethnicity, the risk index, program sites, and word analysis achievement scores at the end of kindergarten. Means for dichotomous variables are percentages. The P value is the probability level of the adjusted mean (percentage) difference. Sample sizes reported are for the educational attainment and school remedial services sample. They were larger for juvenile arrests.

†The extended intervention group participated in Child-Parent Center (CPC) preschool for 1 or 2 years, kindergarten, and 2 or 3 years of the school-age intervention (4-6 years of participation). The nonextended intervention group includes all other children who participated in the CPC program from 1 to 4 years. Comparison groups that included children with 0 years of intervention or children with only CPC preschool yielded the same pattern of findings.

‡The sample size for juvenile arrests was 1067 (n = 540 for extended program group and n = 527 for the nonextended group).

\$350 billion,<sup>4,28</sup> study findings suggest that the benefits to society of program participation can exceed costs.<sup>35</sup>

While the results demonstrate the long-term benefits of early intervention, they also show the limits of intervention in meeting children's educational needs. Like earlier studies, rates of school dropout and delinquency for program participants are substantially higher than for children nationally. Although early intervention can provide a stronger foundation for learning than would otherwise be expected, it alone cannot ameliorate the effects of continuing disadvantages children may face.

Three limitations of this study are notable. The first is that while selection bias into the program appeared to be controlled, a randomized design would have further strengthened inferences as would have additional preschool baseline mea-

asures. Several study features and results, however, increase confidence in the validity of findings. Groups were reasonably well matched at the beginning of the study. Some of the differences that did exist (eg, neighborhood poverty) worked against the program group; others were included in the analysis. In addition, unlike many previous studies, comparison groups participated in an alternative early childhood program, generating more conservative estimates. Finally, extensive analyses of selection bias with alternative covariates and comparison groups have been conducted and findings continue to be robust.<sup>12,17,18</sup>

Another limitation concerns measurement of 2 outcomes. Official juvenile arrests is only 1 indicator of crime. Convictions and sentencing were not measured. Alternative measures, such as self-reports and school reports, have led to

different estimates.<sup>36</sup> Nevertheless, juvenile arrests are important predictors of adult crime. Second, educational attainment is likely to change as young adults reenter educational institutions. This process will continue to be monitored.

The third limitation is that while the findings of the study are more generalizable to contemporary federal and state programs than previous studies, they should be applied cautiously outside large urban cities with high proportions of black children. While the CPC program has a history of successful implementation in public schools, very few programs other than Head Start have this implementation experience.

One major question outstanding is the mechanisms that explain the link between program participation and later outcomes. Three seem likely given the program goals.<sup>12</sup> One is that participation leads to cognitive advantages at school entry that increased educational and social success. A second is that program participation enhances family support behaviors on behalf of children that promote well-being. The third is that program graduates attain higher levels of success because of the school support they experience in the years after the program, either by attending higher-quality schools or having fewer school moves.<sup>36,37</sup> Previous studies support the credibility of these hypotheses,<sup>10,38</sup> and they deserve further investigation.

This study indicates that public investments in early educational programs in the first decade of life can contribute positively to children's later success. Replication and extension of findings to other locations and samples will further strengthen confidence in the benefits of large-scale preventive interventions for young children.

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**CORRECTIONS**

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**Incorrect Affiliation Description:** In the Letters entitled "Outcomes of a Trial of HIV-1 Immunogen in Patients With HIV Infection" published in the May 2, 2001, issue of THE JOURNAL (2001;285:2191), the author affiliation description was incorrect. On page 2191, the sentence that read "ASG Inc is a provider of information technology consulting services" should have read "ASG is a provider of clinical research, data management, and statistical services to the pharmaceutical industry."

**Error in Text and Table:** In the Original Contribution entitled "Long-term Effects of an Early Childhood Intervention on Educational Achievement and Juvenile Arrest: A 15-Year Follow-up of Low-Income Children in Public Schools" published in the May 9, 2001, issue of THE JOURNAL (2001;285:2339-2346), there was an error in the text and in the table. On page 2342, in Table 2, the zeros in the last 2 columns of the last 2 rows should have been  $P < .001$ . In the third column of the text, the paragraph above the heading "Outcome Variables," the last sentence that reads "The mean per child expenditures in 1996 for 1 year of preschool and 1 year of school-age participation are \$4350 and \$15.00." should read "The mean per child expenditures in 1996 for 1 year of preschool and 1 year of school-age participation are \$4350 and \$1500."

**Incorrect Word:** In the Letters entitled "Overuse of Administrative Data to Measure Underuse of Care" published in the February 14, 2001, issue of THE JOURNAL (2001;285:735-736), an incorrect word, "biannual," was placed in the text. On page 735, the sentence that read "Nonetheless, a recent cost-effectiveness analysis concluded that biannual eye examinations were appropriate for low-risk individuals with type 2 diabetes.<sup>1</sup>" should have read "Nonetheless, a recent cost-effectiveness analysis concluded that biennial eye examinations were appropriate for low-risk individuals with type 2 diabetes.<sup>4</sup>"

**Reference Incorrectly Cited:** In the Original Contribution entitled "Policy Analysis of Cervical Cancer Screening Strategies in Low-Resource Settings: Clinical Benefits and Cost-effectiveness" published in the June 27, 2001, issue of THE JOURNAL (2001;285:3107-3115), the reference was cited incorrectly. On page 3114, reference 9, "Visual inspection with acetic acid for cervical-cancer screening: test qualities in a primary-care setting: University of Zimbabwe/JHPIEGO Cervical Cancer Project. *Lancet*. 1999;353:869-873." should be "University of Zimbabwe/JHPIEGO Cervical Cancer Project. Visual inspection with acetic acid for cervical-cancer screening: test qualities in a primary-care setting. *Lancet*. 1999;353:869-873."

**Incorrect Wording:** In the Letters entitled "Industry Support of Researchers in Universities and Academic Medical Centers" published in the May 9, 2001, issue of THE JOURNAL (2001;285:2324-2325), there was incorrect wording in a sentence. On page 2324, in the second column, third paragraph, the sentence that read "The economics of low-margin computer chip markets are forcing companies to scale back their basic university-supported research and they are focusing on increasing productivity." should have read "The economics of low-margin computer chip markets are forcing companies to scale back their university-supported basic research and they are focusing on increasing productivity."

**Incorrect Spelling of Author's Last Name:** In the Letters entitled "Helping Patients Integrate Research Evidence" published in the November 22/29, 2000, issue of THE JOURNAL (2000;284:2595), the author's last name was misspelled. On page 2595, the author's last name "Kritiansen" should have been "Kristiansen."