

# Effects of a School-Based, Early Childhood Intervention on Adult Health and Well-being

## A 19-Year Follow-up of Low-Income Families

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**Objective:** To determine the effects of an established preventive intervention on the health and well-being of an urban cohort in young adulthood.

**Design:** Follow-up of a nonrandomized alternative-intervention matched-group cohort at age 24 years.

**Setting:** Chicago, Illinois.

**Participants:** A total of 1539 low-income participants who enrolled in the Child-Parent Center program in 20 sites or in an alternative kindergarten intervention.

**Interventions:** The Child-Parent Center program provides school-based educational enrichment and comprehensive family services from preschool to third grade.

**Main Outcome Measures:** Educational attainment, adult arrest and incarceration, health status and behavior, and economic well-being.

**Results:** Relative to the comparison group and adjusted for many covariates, Child-Parent Center pre-

school participants had higher rates of school completion (63.7% vs 71.4%, respectively;  $P = .01$ ) and attendance in 4-year colleges as well as more years of education. They were more likely to have health insurance coverage (61.5% vs 70.2%, respectively;  $P = .005$ ). Preschool graduates relative to the comparison group also had lower rates of felony arrests (16.5% vs 21.1%, respectively;  $P = .02$ ), convictions, incarceration (20.6% vs 25.6%, respectively;  $P = .03$ ), depressive symptoms (12.8% vs 17.4%, respectively;  $P = .06$ ), and out-of-home placement. Participation in both preschool and school-age intervention relative to the comparison group was associated with higher rates of full-time employment (42.7% vs 36.4%, respectively;  $P = .04$ ), higher levels of educational attainment, lower rates of arrests for violent offenses, and lower rates of disability.

**Conclusions:** Participation in a school-based intervention beginning in preschool was associated with a wide range of positive outcomes. Findings provide evidence that established early education programs can have enduring effects on general well-being into adulthood.

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**E**ARLY CHILDHOOD INTERVENTIONS (ECIs) have demonstrated consistent positive effects on children's health and well-being. Their impacts are unique in 2 important ways. First, ECIs in the first 5 years of life show links to a broad range of positive outcomes up to 3 decades later, including better reproductive health and birth outcomes, higher cognitive skills, school achievement and performance, higher school attainment, higher earnings capacity, and lower rates of delinquency and crime.<sup>1-12</sup> Few if any other interventions have shown such multifarious impacts. The second unique feature is that ECIs have proven to be cost-effective in providing public benefits and increased well-being that substantially exceed costs.<sup>13-16</sup>

Preschool programs for mostly at-risk 3- and 4-year-olds provide center-based educational enrichment and family services, and they have experienced the larg-

est growth in public funding. Although such programs can promote health and well-being, several limitations in the knowledge base are evident. One is that there is only a small amount of evidence that large-scale public programs have long-term effects into adulthood.<sup>1,17,18</sup> Most previous studies<sup>18,19</sup> either have had limited

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follow-up or have assessed small-scale programs with low generalizability. A second limitation is that to our knowledge, no studies have investigated a broad set of health and well-being outcomes. Most of the evidence concerns school attainment and social behavior. Because education and delinquency are significant predictors of health behavior and economic well-being in adulthood,<sup>1,3,9</sup> ECIs may have broader effects. Third, owing to the tra-

ditional focus on model programs that include few families,<sup>5-8</sup> differential effects by child and family attributes have not been tested.<sup>19</sup> Effects would be expected to vary by participant characteristics.

One of the few studies of a large-scale program that have assessed effects comprehensively is the Chicago Longitudinal Study, which investigates the Child-Parent Center (CPC) program for more than 1500 children born in 1979 or 1980. Beginning in preschool, the program provides comprehensive services and has been administered through the public school system since 1967. In an earlier study,<sup>20</sup> participation in the CPC preschool intervention relative to participation in the usual enrichment program was associated with significantly higher rates of school completion by age 20 years, significantly lower rates of juvenile arrest for both violent and nonviolent offenses, and lower rates of school remedial services. School-age intervention was associated with lower rates of school remedial services. Extended intervention for 4 to 6 years was linked to significantly lower rates of remedial education and juvenile arrests for violent offenses. These impacts translated to positive economic returns.<sup>21</sup>

In this article, we describe a follow-up study at age 24 years to assess CPC program links with measures of educational attainment, economic status, crime, health status and behavior, and mental health. The study is unique in several respects. To our knowledge, it is the first prospective investigation of a public ECI into the third decade, a key period of life course development. Second, it is one of the first studies to examine direct measures of health status and behavior including health insurance coverage, substance use, and out-of-home placement. We also investigate whether the effects of intervention vary by child and family characteristics. Previous studies<sup>22,23</sup> have indicated that program length and high risk status are associated with greater effects by the end of childhood. Given our previous findings and the well-established links among educational attainment, socioeconomic status, crime, and health status,<sup>24-26</sup> we hypothesize that program participation, especially in preschool and continued into school age, is associated with greater adult well-being.

## METHODS

### SAMPLE AND DESIGN

The Chicago Longitudinal Study is a prospective investigation of the life course of a cohort of 1539 low-income minority children (93% black, 7% Hispanic) born in 1979 or 1980 who attended early childhood programs in 25 sites between 1985 and 1986.<sup>22,27</sup> Since 1985, data have been collected continuously on health and well-being from school records, participant and family surveys, and administrative records. The original sample included the complete cohort of 989 children who completed preschool and kindergarten in all of the 20 CPCs with combined programs. School-age services are provided in first to third grades in affiliated elementary schools. The preschool comparison group of 550 children in this quasi-experimental cohort design participated in alternative full-day kindergarten programs that were available to low-income families. The comparison group included all of the 374 kindergartners from 5 randomly selected schools with full-day kindergarten and extra instructional re-

sources. The rest of the comparison group (n=176) attended full-day kindergartens in 6 CPCs but had no preschool experience. They were located in separate classrooms but received some program services. As in previous studies,<sup>20-22</sup> these 2 demographically similar groups were combined. **Table 1** shows the pattern of participation and postprogram data collection.

The intervention and comparison groups were matched on age, eligibility for and enrollment in government-funded ECIs, and neighborhood and family poverty.<sup>20,22</sup> Neighborhood poverty is defined as residence in a Title I school area. Family poverty is defined as eligibility for the subsidized lunch program ( $\leq 185\%$  of the federal poverty level). The intervention and comparison groups participated by written and oral consent. The legal and ethical requirements to serve children most in need prevented random assignment. Approvals have been granted by institutional review boards at the University of Wisconsin, Madison, and the University of Minnesota, Minneapolis.

Four study features make group comparisons interpretable as program effects. First, the comparison group was largely chosen from randomly selected schools participating in full-day kindergarten, which was the "treatment as usual." In addition, 15% of the comparison group was participating in Head Start. This contrast results in a conservative bias compared with the more typical contrast in long-term studies between center-based intervention and home care. Second, more than 80% of children in the neighborhoods of the centers participated in the program, which indicates that participants are largely representative of the center neighborhoods. Most of the comparison group did not enroll in the CPCs because they did not live in a neighborhood with an intervention. Third, the pattern of effects over time is largely explained by the mechanisms central to the intervention theory, including the enhancement of developed abilities important for school success, family support behavior, and the quality of later school environments.<sup>28</sup> Finally, results from a wide range of selection and attrition analyses using propensity score, econometric methods, and latent-variable structural modeling have consistently indicated that program estimates are robust to alternative analyses.<sup>12,19-22</sup>

### FOLLOW-UP AT AGE 24 YEARS AND COMPARABILITY OF INTERVENTION GROUPS

At an average age of 24 years, 90.3% (n=1389) of the original sample had valid data on educational attainment or employment. Retention rates for the preschool intervention and comparison groups were 91.2% and 88.6%, respectively. Rates were higher for crime and public aid data (92%-94%) and lower for mental health and health outcomes based largely on the adult survey at ages 22 to 24 years (77%-80%). The high rates of sample retention are owing to the use of many sources of administrative and survey data and to follow-up tracking. About two-thirds of the sample resided in Illinois between ages 20 and 24 years, with many others remaining in the Midwest. As in previous studies,<sup>12,20-22</sup> there was no evidence of selective attrition by program status that affects findings. The attrition sample (n=150) included individuals who moved and were not located, died, or had insufficient information (Table 1). They had background characteristics nearly identical to the follow-up sample regardless of program status. Attrition in the adult survey was not selective by program status.

As shown in **Table 2**, the follow-up groups at age 24 years were similar in most characteristics. These were measured from state and local administrative records as well as family surveys between birth and age 3 years, and they are updated from previous reports.<sup>20-22,28</sup> The intervention and comparison groups were similar in race/ethnicity (parent reported), parental employment (mothers), low-income status (measured by eligibil-

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

Study Category	Total Sample	Preschool Intervention Group <sup>a</sup>	Comparison Group <sup>a</sup>
Program participants' characteristics at start of study <sup>b</sup>			
Original sample, No.	1539	989	550
Cases with preschool participation, No.	1073	989	84
Cases with CPC preschool participation, No.	989	989	0
CPC preschool program, mean, y (range, 0-2 y)	0.99	1.55	0.00
Cases with Head Start preschool participation, No.	85	1	84
Cases with kindergarten participation, No.	1539	989	550
Cases with CPC participation, No.	989	989	0
Full-day kindergarten, %	NA	59.9	100.0
Cases with CPC school-age participation, No.	850	684	166
CPC school-age program, mean, y (range, 0-3 y)	1.16	1.43	0.68
School-age participation, %	NA	69.2	30.2
Cases with CPC extended intervention for 4-6 y, No.	553	553	0
Extended participation, %	NA	55.9	0.0
CPC program, mean, total y (range, 0-6 y)	2.78	3.95	0.68
Cases with no CPC participation, No.	384	0	384
Lost cases in postprogram years, No.			
Moved <sup>c</sup>			
Ages 6-10 y	69	41	28
Ages > 10 y	52	30	22
Other	11	4	7
Child death	18	12	6
Cases with data for follow-up study characteristics at ages 22-24 y, No.			
Educational attainment	1368	888	480
Public aid	1315	857	458
Arrest and incarceration	1418	918	500
Adult survey	1142	750	392
Employment and income	1389	902	487
≥ 1 Outcome	1507	973	534
≥ 3 Outcomes	1406	911	495

Abbreviations: CPC, Child-Parent Center; NA, not applicable.

<sup>a</sup>Cases for program participation cover the 6-year period (1983-1989) that defines enrollment in the CPC intervention.

<sup>b</sup>The CPC preschool comparison group participated in a full-day kindergarten program, and 84 participants had Head Start preschool. A total of 176 participants in the preschool comparison group were eligible to receive limited services in the CPC kindergarten but enrolled in different classrooms. They are not part of the original CPC intervention group. Some participants in the comparison group participated in the school-age program because it was open to any child enrolled in elementary school from first to third grade. Fifteen children in the CPC intervention group enrolled in the alternative full-day kindergarten.

<sup>c</sup>These categories account for attrition from the original study sample of 1539 participants. Cases were lost during postprogram years because the individuals moved from Chicago, Illinois, and could not be located, died, did not have sufficient identifying information to track, refused to participate, or were incarcerated (other). At age 24 years, the total number of deceased participants in the study was 41. The attrition sample (cases lost in postprogram years) of 150 participants had missing data on educational attainment and employment between ages 22 and 24 years.

ity for subsidized lunches and Aid to Families With Dependent Children), single-parent family and teenage parenthood status, large family size ( $\geq 4$  children), and low-birth-weight status. They differed in parent educational attainment and neighborhood poverty status but in opposite directions, as the intervention group had higher rates of both parental high school completion and neighborhood poverty concentration. The latter difference is a function of the centers being located in the most disadvantaged neighborhoods. A summary of key attributes is the family risk index, which is the sum of the 8 aforementioned attributes coded dichotomously. The preschool intervention and comparison groups experienced, on average, 4½ risks. Child welfare histories also were similar.

Group comparisons of baseline characteristics for the original sample of 1539 participants largely mirror those of the follow-up sample.<sup>29</sup> Comparisons using school-age and extended intervention groups showed a pattern similar to that in Table 2.

## INTERVENTION

Because the CPC intervention is described fully in previous reports,<sup>19-23</sup> we provide a summary of the main features. Located in or close to elementary schools, the CPC program provides

educational and family-support services between the ages of 3 and 9 years (preschool to second or third grade). Within a structure of comprehensive services similar to Head Start, the intervention emphasizes the acquisition of basic skills in language arts and math through relatively structured but diverse learning experiences that include teacher-directed whole-class instruction, small-group and individualized activities, and field trips.<sup>30</sup> All of the teachers have bachelor's degrees and are certified in early childhood education.

Each center is directed by a head teacher and 2 coordinators. The parent-resource teacher coordinates the family-support component. The paraprofessional school-community representative provides outreach to families. Major elements of the intervention include low child-to-staff ratios in preschool (17:2), kindergarten (25:2), and the primary grades (25:2); an intensive parent program that includes parenting education, volunteering in the classroom, attending school events and field trips, furthering educational attainment, and home visitation; and health and nutrition services, including screening and diagnostic services, speech therapy, meal services, and referrals by program nurses.<sup>22,31</sup> Parents are expected to participate in the program up to half of a day per week through a variety of supported activities.<sup>22,28</sup>

**Table 2. Equivalence of Child-Parent Center Preschool Intervention and Comparison Groups on Preprogram Attributes for the Follow-up Study at Age 24 Years**

Child or Family Characteristic <sup>a</sup>	Follow-up Sample at Age 24 y (n = 1389) <sup>b</sup>		P Value <sup>c</sup>
	Preschool Intervention Group (n = 902)	Comparison Group (n = 487)	
Sample recovery	91.2	88.6	.11
Adult administrative records	98.7	98.8	> .99
Black	93.7	92.6	.50
Female child	53.0	47.0	.05
Low birth weight < 2500 g	11.4	14.3	.16
Residence in high-poverty area <sup>d,e</sup>	77.3	71.7	.02
Child welfare case history by age 4 y	3.2	5.3	.08
Parent aged < 18 y at child birth <sup>d</sup>	9.7	10.3	.76
Mother did not complete high school <sup>d</sup>	51.0	59.4	.003
Single-parent family status <sup>d</sup>	76.4	75.3	.69
Mother not employed <sup>d</sup>	64.9	59.9	.09
Child eligible for subsidized meals <sup>d,f</sup>	83.3	82.3	.65
Participation in TANF program <sup>d</sup>	62.8	60.9	.48
≥ 4 Children in family <sup>d</sup>	16.7	19.2	.26
Missing ≥ 1 risk factor	11.4	13.4	.29
Risk index on scale of 0-8, mean (SD)	4.50 (1.69)	4.49 (1.75)	.91

Abbreviation: TANF, Temporary Assistance for Needy Families.

<sup>a</sup>Data on child and family characteristics were collected from birth to age 3 years based on multiple administrative records and parent surveys. Data on TANF and subsidized meals were collected up to age 8 years. Sample sizes ranged from 1270 to 1389 participants for the follow-up sample and from 1342 to 1539 participants for the original sample (not shown).

<sup>b</sup>The follow-up sample at age 24 years had known educational attainment by August 31, 2003, or employment status from January 1, 2002, to September 31, 2004. For some outcomes, additional cases were included. Values are expressed as percentages unless indicated otherwise.

<sup>c</sup>P values show the significance of percentage or mean group differences for the follow-up sample at age 24 years and the original samples. The preschool comparison group participated in an alternative full-day kindergarten but had no Child-Parent Center preschool participation. School-age (n = 778) and extended intervention (n = 522) groups had similar profiles as the Child-Parent Center preschool group.

<sup>d</sup>Variables were included in the risk index.

<sup>e</sup>High poverty is defined as residence in a school area in which 60% or more children live in low-income families.

<sup>f</sup>Eligibility is defined as greater than 130% of the federal poverty level.

The preschool program is 3 hours per day, 5 days per week during the school year and usually includes a 6-week summer program. After full-day or part-day kindergarten, school-age services are provided under the direction of the curriculum parent-resource teacher. The school-age intervention is open to any child in the school in either first and second grades in 14 sites or first through third grades in 6 sites.

## OUTCOME MEASURES

### Educational Attainment

Assessed by age 23 years (mean, 23.5 years as of August 31, 2003), attainment was derived from administrative records from colleges and universities in Illinois and other states, administrative records from K-12 schools, and brief surveys of participants or family members. High school completion measured whether participants finished their high school education with an official diploma or received a GED or equivalent credential. All others were coded as noncompleters. College attendance and 4-year college attendance measured whether participants earned course credit for enrollment in a 2- or 4-year college program or in a college awarding a bachelor's degree. Highest grade completed was an ordinal indicator ranging from 6 to 16 (bachelor's degree). Those completing high school or the GED were coded as 12. Postsecondary education was derived from the number of credits earned in college courses. These and other outcomes are described elsewhere.<sup>27,31</sup>

### Criminal Behavior

Arrest, conviction, and incarceration histories from ages 18 to 24 years were obtained from administrative records from county, state, and federal agencies supplemented with the adult survey. Arrests were measured dichotomously both overall and by whether charges were felonies or involved violent offenses (eg, aggravated assault, armed robbery). Convictions were whether individuals were found guilty by courts and included both felonies and charges for violence. Incarceration measured whether individuals were sentenced to correctional institutions at the state or federal level or to county jails beyond 30 days. Most records were from Illinois and other Midwestern states through December 9, 2004.

### Economic Status

Economic well-being was assessed by age 24 years from records of the Illinois Department of Employment Security and from the adult survey between ages 22 and 24 years (July 2002 through July 2004). Full-time employment was measured from the adult survey and defined as 35 or more hours per week. To measure general socioeconomic status, a dichotomous variable indicated whether participants had ever attended college or had a stable work history defined as 4 quarters of earned income exceeding \$3000.

Public aid participation included enrollment in any of 3 major programs (Temporary Assistance for Needy Families, Food Stamp Program, and Medicaid) from ages 18 to 24 years (Janu-

ary 1998 to December 2004). The number of months of enrollment and cumulative prevalence were analyzed for sample members residing in Illinois in 1999 or later. We also assessed participation in the Food Stamp Program. Data came from the Illinois Public Assistance Data Base maintained on behalf of the Illinois Department of Human Services.

### Health Status and Behavior

Health insurance coverage from either public or private (employer-based) sources was assessed between ages 22 and 24 years. Public insurance coverage data came from state-level Medicaid records and the adult survey. Private insurance coverage data came from adult survey responses (eg, "Do you get health benefits from your employer?") and were supplemented with records from the Illinois Department of Employment Security.

Substance use was a dichotomous variable indicating whether individuals reported on the adult survey any of the following: current use of marijuana or "harder" drugs, drinking alcohol more than once a day, having a substance use problem, or having received substance abuse treatment since age 16 years. Frequent use or misuse was restricted to marijuana or harder drug use at least a few times per week. Tobacco use was defined as currently smoking 1 or more cigarettes daily.

Disability status measured receipt of disability assistance (ie, from Social Security Disability Insurance or Supplemental Security Income) since age 18 years from either the Illinois Department of Human Services records or the adult survey.

Teenage parenthood was a dichotomous variable indicating whether girls gave birth before age 18 years. Data were from the adult survey and public aid records. Finally, out-of-home placement indicated whether youth had foster care or adoption histories primarily owing to maltreatment from ages 4 to 17 years. Data were from the Illinois Department of Children and Family Services and the Cook County Juvenile Court. Children who left Chicago before age 10 years with no service record were excluded.

### Mental Health

Depressive symptoms were reported in the adult survey.<sup>32</sup> Participants rated how often in the past month they felt depressed, helpless, lonely, that life is not worth living, and sad (0=not at all, 5=almost every day).<sup>33</sup> To maximize reliability, we used a dichotomous variable indicating the frequent presence of 1 or more symptoms defined at levels ranging from a few times a month to almost every day.

### STATISTICAL ANALYSIS

Following many previous studies,<sup>12,20-22</sup> intervention effects were estimated by multiple, probit, and negative binomial regression. The main analyses are summarized as follows based on the study sample for educational attainment at the follow-up at age 24 years. First, the effects of CPC preschool beginning at age 3 or 4 years (for 1 or 2 years [n=888] vs 0 years [n=480]) and school-age participation from first to third grade (for 1-3 years [n=778] vs 0 years [n=590]) were assessed simultaneously with 2 dummy variables. Children could participate in the school-age program without preschool participation (Table 1). Second, the effects of CPC extended intervention were assessed in 2 ways. The first was with a dummy variable indicating participation for 4 to 6 years (preschool starting at age 3 or 4 years and continuing to second or third grade [n=522]) vs all other children, who had 0 to 4 years of participation (n=846) (extended-1 contrast). This contrast assessed whether children who received the full program did bet-

ter than others regardless of intervention experience. Analyses that included children with 1 to 4 years yielded similar results. The 4- to 6-year group (n=522) also was contrasted with children who attended only CPC preschool and kindergarten (n=254) (extended-2 contrast). This contrast assessed the added value of extended intervention above and beyond preschool and kindergarten. Kindergarten achievement also was included as a control variable.

Findings are reported as adjusted means or percentages and group differences controlling for the influence of the covariates. The covariates in Table 2 were measured between birth and age 3 years from birth and public aid records as well as family surveys. Following established procedures,<sup>34</sup> a dummy code for missing data on the covariates also was included to determine whether estimates based on multiple imputation were associated with program outcomes. Analyses based on the family risk index instead of the individual indicators and the addition of program site dummy variables and other family factors yielded a similar pattern of results.

Data were analyzed in STATA statistical software version 9.<sup>35</sup> Dichotomous variables were analyzed with probit regression, count data (eg, months of public aid) with negative binomial regression, and continuous variables (eg, highest grade completed) with linear regression. To enhance interpretability, coefficients from probit and negative binomial regression were transformed to marginal effects. As found in previous studies,<sup>12,20-22</sup> corrections for nonrandom attrition and clustering did not affect estimates, nor did alternative analyses using propensity score and latent-variable selection modeling. Adjusted group differences at the .05 probability level were emphasized (95% confidence intervals also are provided). To test subgroup effects, program interaction terms included sex of child, race/ethnicity, low-birth-weight status, parent educational attainment, employment, single-parent status, family risk, preschool length, and neighborhood poverty. The statistical significance of subgroup effects was set at .05, emphasizing those with overall effects.

## RESULTS

### EDUCATIONAL ATTAINMENT

#### Preschool Participation

Major findings regarding preschool participation are shown in **Table 3**. Relative to the comparison group and controlling for preprogram characteristics, the preschool group had significantly higher rates of high school completion (63.7% vs 71.4%, respectively;  $P=.01$ ) and 4-year college attendance (10.0% vs 14.7%, respectively;  $P=.02$ ; a 47% increase over the comparison group). The preschool group also had more years of education. Rates of overall college attendance were similar, reflecting no differences in 2-year attendance.

#### School-age Participation

No group differences were found in school-age participation.

#### Extended Program Participation

As shown in **Table 4**, for extended program participation, relative to fewer years of participation and control-

**Table 3. Adjusted Means and Differences for Child-Parent Center Preschool and School-age Intervention Groups for Young Adult, Family, and Parent Outcomes<sup>a</sup>**

Outcome Measure	Preschool Intervention					School-age Intervention				
	Intervention Group	Comparison Group	Group Difference	P Value	95% CI	Intervention Group	Comparison Group	Group Difference	P Value	95% CI
	(n = 888)	(n = 480)				(n = 778)	(n = 590)			
Educational attainment by age 23 y										
High school completion, %	71.4	63.7	7.7	.01	1.8 to 13.6	69.1	68.5	0.6	.85	-5.0 to 6.1
Highest grade completed, mean	11.73	11.44	0.29	.006	.09 to .50	11.62	11.64	-0.02	.82	-2.2 to -18
College attendance, %	29.4	27.4	2.0	.49	-3.7 to 7.7	29.6	27.6	2.0	.47	-3.4 to 7.5
4-y College attendance, %	14.7	10.0	4.7	.02	0.9 to 8.5	12.5	12.4	0.1	.96	-3.7 to 3.9
Adult crime by age 24 y, %										
Any incarceration or jail	20.6	25.6	-5.0	.03	-9.7 to -0.3	23.7	21.5	2.2	.32	-2.1 to 6.6
Any arrest	35.8	40.0	-4.2	.19	-10.3 to 2.0	37.5	36.9	0.6	.85	-5.3 to 6.5
Felony arrest	16.5	21.1	-4.6	.02	-8.6 to 0.6	18.7	18.2	0.5	.77	-3.1 to 4.2
Any violent arrest	16.3	18.8	-2.5	.24	-6.6 to 1.7	16.1	17.1	-1.0	.62	-4.9 to 2.9
Any conviction	20.3	24.7	-4.4	.06	-9.1 to 0.4	24.2	22.6	1.6	.47	-2.8 to 6.0
Felony conviction	15.8	19.9	-4.1	.03	-7.8 to 0.3	18.2	16.8	1.4	.43	-2.0 to 4.7
Violent crime conviction	5.1	7.1	-2.0	.06	-4.3 to 0.2	6.0	6.0	0.0	.98	-1.9 to 2.0
Economic status by age 24 y										
Any quarterly income > \$3000, %	37.7	33.1	4.6	.15	-1.6 to 10.7	35.3	37.0	-1.7	.59	-7.6 to 4.3
Employed full time, % <sup>b</sup>	39.4	37.4	2.0	.55	-4.6 to 8.6	39.8	37.3	2.5	.43	-3.8 to 8.8
Ever attended college or reported ≥ 4 quarters of income, %	54.1	48.7	5.4	.09	-0.8 to 11.6	51.0	53.9	-2.9	.34	-8.9 to 3.0
Receiving Food Stamps, %	52.3	56.0	-3.7	.28	-10.5 to 3.1	54.7	52.1	2.6	.43	-3.9 to 9.1
Receiving Food Stamps, mo	12.9	12.1	0.8	.39	-1.1 to 2.7	12.2	13.4	-1.2	.20	-3.0 to 0.6
Public aid, overall, %	61.6	63.2	-1.6	.64	-8.1 to 5.0	61.9	62.5	-0.6	.84	-6.9 to -5.7
Public aid, overall, mo	32.1	28.3	3.8	.08	-0.5 to 8.1	28.3	33.9	-5.6	.008	-9.7 to -1.5
Health and mental health by age 24 y, %										
Had child when aged < 18 y, females	29.6	31.5	-1.9	.65	-10.1 to 6.3	27.4	34.1	-6.7	.09	-14.4 to 1.0
Out-of-home placement	4.5	8.4	-3.9	.01	-6.9 to -0.9	5.7	5.7	0.0	.99	-2.6 to 2.5
Any substance use at age ≥ 16 y	25.8	28.3	-2.5	.42	-8.6 to 3.6	26.9	26.4	0.5	.86	-5.3 to 6.3
Frequent substance use at age ≥ 16 y	14.0	17.0	-3.0	.14	-7.2 to 1.1	15.1	15.0	0.1	.98	-3.7 to 3.8
Daily tobacco use	17.9	22.1	-4.2	.13	-9.7 to 1.2	19.1	19.5	-0.4	.89	-5.5 to 4.7
Any health insurance	70.2	61.5	8.7	.005	2.4 to 14.8	62.6	69.5	-3.9	.19	-9.7 to 1.9
Private	37.5	33.7	3.8	.23	-2.3 to 9.9	36.4	35.8	0.6	.86	-5.3 to 6.5
Public	27.9	22.8	5.1	.08	-0.7 to 10.7	24.0	28.8	-4.8	.10	-10.3 to 0.9
Any disability	6.4	5.7	0.7	.58	-1.9 to 3.4	4.8	8.4	-3.6	.01	-6.3 to -0.8
Reported any depression symptom	12.8	17.4	-4.6	.06	-9.5 to 0.3	14.5	14.0	0.5	.82	-3.9 to 5.0

Abbreviation: CI, confidence interval.

<sup>a</sup>Coefficients are from linear, probit, or negative binomial regression analysis transformed to marginal effects, and they are adjusted for earlier and later program participation (preschool or school-age), 8 indicators of preprogram risk status, sex of child, race/ethnicity, child welfare history, and a dummy-coded variable for missing data on risk status. Coefficients for Child-Parent Center preschool and school-age intervention were estimated simultaneously. The *P* value is the probability level of the adjusted mean or percentage difference. Sample sizes are for the outcomes of educational attainment and employment status (*n* = 1389), but they varied by indicator. The preschool and school-age comparison groups were defined regardless of their participation in the other component of the intervention.

<sup>b</sup>Based on the adult survey only (ages 22-24 years).

ling for preprogram characteristics, 4- to 6-year participants had higher rates of high school completion (65.5% vs 73.9%, respectively; *P* = .002) and 4-year college attendance (13.1%, vs 16.7%, respectively; *P* = .05; a 27% increase) as well as more years of completed education. Relative to preschool participation and controlling for kindergarten achievement, extended intervention was not associated with attainment (extended-2 contrast).

## CRIME

### Preschool Participation

For preschool participation, by age 24 years, the preschool group relative to the comparison group had significantly lower rates of felony arrest (16.5% vs 21.1%, respectively; *P* = .02; a 22% reduction) and incarceration

(20.6% vs 25.6%, respectively; *P* = .03; a 20% reduction). They also were less likely than the comparison group to be found guilty of a crime both overall and for a felony (15.8% vs 19.9%, respectively; *P* = .03; a 21% reduction). No group differences were found for overall and violent arrests.

### School-age Participation

No group differences were found across measures in school-age participation.

### Extended Program Participation

Relative to fewer years of participation, extended intervention was linked to lower rates of arrest for violence (17.9% vs 13.9%, respectively; *P* = .04; a 22% reduction)

**Table 4. Adjusted Means and Differences for Child-Parent Center Extended Intervention Groups for Young Adult, Family, and Parent Outcomes<sup>a</sup>**

Outcome Measure	Extended-1 Contrast					Extended-2 Contrast				
	Intervention Group (n = 522)	Comparison Group (n = 846)	Group Difference	P Value	95% CI	Intervention Group (n = 522)	Comparison Group, P + K Only (n = 254)		P Value	95% CI
							Group Difference	P Value		
Educational attainment by age 23 y										
High school completion, %	73.9	65.5	8.4	.002	3.3 to 13.6	70.7	68.2	2.5	.50	-4.8 to 9.8
Highest grade completed, mean	11.82	11.51	0.31	.001	0.13 to 0.50	11.67	11.60	0.07	.58	-0.18 to 0.32
College attendance, %	30.9	27.4	3.5	.17	-1.6 to 8.6	30.5	27.3	3.2	.38	-4.0 to 10.3
4-y College attendance, %	16.7	13.1	3.6	.05	-0.1 to 7.2	11.9	11.8	0.1	.97	-4.5 to 4.7
Adult crime by age 24 y, %										
Any incarceration or jail	21.7	24.7	-3.0	.16	-7.2 to 1.1	24.6	24.7	-0.1	.96	-6.0 to 5.7
Any arrest	35.4	38.4	-3.1	.28	-8.8 to 2.5	37.5	37.1	0.4	.92	-7.3 to 8.1
Felony arrest	18.4	20.6	-2.2	.23	-5.6 to 1.3	21.9	20.6	1.3	.61	-3.7 to 6.4
Any violent arrest	13.9	17.9	-4.0	.04	-7.6 to -0.3	12.9	15.9	-3.0	.25	-7.9 to 2.0
Any conviction	21.3	24.6	-3.3	.12	-7.5 to 0.8	24.6	24.3	0.3	.93	-5.7 to 6.2
Felony conviction	17.9	19.4	-1.5	.37	-4.8 to 1.7	21.0	19.4	1.6	.51	-3.2 to 6.4
Violent crime conviction	5.5	8.0	-2.5	.01	-4.2 to 0.7	6.1	8.0	-1.9	.14	-4.3 to 0.5
Economic status by age 24 y										
Any quarterly income > \$3000, %	38.3	34.6	3.7	.19	-1.8 to 9.2	35.8	36.2	-0.4	.92	-7.9 to 7.1
Employed full-time, %	42.7	36.4	6.3	.04	0.3 to 12.2	43.0	36.0	7.0	.09	-1.1 to 15.0
Ever attended college or reported ≥ 4 quarters of income, %	55.5	50.3	5.2	.07	-0.4 to 10.8	52.5	52.2	0.3	.94	-7.4 to 8.0
Receiving Food Stamps, %	52.4	54.5	-2.1	.49	-8.2 to 3.9	54.2	53.8	0.4	.93	-8.0 to 8.8
Receiving Food Stamps, mo	12.3	12.9	-0.6	.52	-2.2 to 1.1	12.1	13.1	-1.0	.38	-3.4 to 1.3
Public aid, overall, %	58.8	64.2	-5.4	.07	-11.3 to 0.4	59.5	63.9	-4.4	.29	-12.6 to 3.8
Public aid, overall, mo	29.1	31.7	-2.6	.19	-6.4 to 1.3	27.2	33.0	-5.8	.03	-11.1 to -0.6
Health and mental health by age 24 y, %										
Had child when aged < 18 y, females	26.7	32.7	-6.0	.10	-13.0 to 1.1	27.2	32.1	-4.9	.32	-14.4 to 4.6
Out-of-home placement	4.0	7.1	-3.1	.01	-5.4 to -0.7	5.2	5.9	-0.7	.72	-4.2 to 2.9
Any substance use at age ≥ 16 y	26.5	26.7	-0.2	.94	-5.7 to 5.3	26.4	27.1	-0.7	.85	-6.7 to 8.1
Frequent substance use at age ≥ 16 y	13.9	15.0	-1.1	.57	-4.7 to 2.6	14.3	15.0	-0.7	.78	-5.6 to 4.1
Daily tobacco use	18.4	20.0	-1.6	.52	-6.4 to 3.2	19.8	19.1	0.7	.83	-5.9 to 7.4
Any health insurance	69.7	65.8	3.9	.16	-1.6 to 9.4	66.7	67.7	-1.0	.80	-8.5 to 6.5
Private	41.2	33.2	8.0	.005	2.4 to 13.6	38.8	34.6	4.2	.27	-3.3 to 11.8
Public	23.5	27.7	-4.2	.12	-9.4 to 0.9	22.8	17.9	-4.9	.17	-11.7 to 2.1
Any disability	4.5	7.4	-2.9	.02	-5.3 to -0.5	3.5	7.9	-4.4	.002	-7.2 to -1.7
Reported any depression symptom	12.4	15.6	-3.2	.14	-7.4 to 1.0	12.7	15.4	-2.7	.35	-8.3 to 2.9

Abbreviations: CI, confidence interval; K, kindergarten; P, preschool.

<sup>a</sup>Coefficients are from linear, probit, or negative binomial regression analysis transformed to marginal effects, and they are adjusted for the 8 indicators of preprogram risk status, sex of child, race/ethnicity, child welfare history, and a dummy-coded variable for missing data on risk status. The estimates for extended-1 contrast (4-6 years vs lesser intervention) and extended-2 contrast (4-6 years vs preschool and kindergarten intervention only) were computed separately and did not include earlier and later program participation. Estimates for Child-Parent Center extended-2 contrast added word analysis test scores at the end of kindergarten; they also included a dummy code for other levels of Child-Parent Center participation (0-3 years). The *P* value is the probability level of the adjusted mean or percentage difference. Sample sizes are for the outcomes of educational attainment (extended-1 contrast, *n* = 1368; extended-2 contrast, *n* = 776), but they varied by indicator. The comparison group for the extended-2 contrast is lower because only those with 2 to 3 years of intervention are included.

and violent convictions as well as multiple incarcerations (9.7% vs 7.5%, respectively; *P* = .02; not shown). No differences were found for the extended-2 contrast.

## ECONOMIC STATUS

### Preschool Participation

With regard to preschool participation, the preschool group was somewhat more likely to have a stable employment history or to have attended college by age 24 years. No other indicators showed significant differences, including receipt of Temporary Assistance for Needy Families (among females) and Medicaid.

### School-age Participation

For school-age participation, the program group had fewer months receiving any public aid (Temporary Assistance for Needy Families, Food Stamps, or Medicaid) from ages 18 to 24 years.

### Extended Program Participation

In addition to lower rates of public aid receipt, extended intervention participants had higher rates of full-time employment than the comparison group (42.7% vs 36.4%, respectively; *P* = .04; a 17% increase). The employment difference was similar for the extended-2 contrast.

## HEALTH STATUS AND BEHAVIOR

### Preschool Participation

For preschool participation, the preschool group had higher rates of health insurance coverage from any source than the comparison group (70.2% vs 61.5%, respectively;  $P = .005$ ; a 14% increase). Rates of both private and public insurance coverage favored the program group. No differences were found for substance use, smoking, and teenage parenthood. Preschool participation was associated with lower rates of out-of-home placement in the child welfare system ( $P = .01$ ).

### School-age Participation

The lone significant finding in school-age participation was that participants had a lower rate of disability assistance.

### Extended Program Participation

The extended program group was less likely than the comparison group to receive disability assistance as young adults (extended-1 contrast; 4.4% vs 7.0%, respectively;  $P = .04$ ). Although overall rates of health insurance were equivalent, participants had a higher rate of private insurance coverage than the comparison group (41.2% vs 33.2%, respectively;  $P = .005$ ). The program group had a lower rate of out-of-home placement. No differences were detected for smoking and substance use. The extended-2 contrast yielded differences only for disability ( $P = .002$ ).

## MENTAL HEALTH

### Preschool Participation

For preschool participation, relative to the comparison group, the intervention group was less likely to have 1 or more depressive symptoms (17.4% vs 12.8%, respectively;  $P = .06$ ; a 26% reduction).

### School-age Participation

No group differences were found in school-age participation.

### Extended Program Participation

No differences were found for either program contrast in extended program participation.

## DIFFERENTIAL EFFECTS BY SUBGROUPS

We found limited evidence of differential intervention effects. The most notable finding was a significant program  $\times$  sex interaction. Males had a significantly greater preschool effect on high school completion (63.6% for program males vs 48.2% for comparison males,

$P < .001$ ) than females (78.2% for program females vs 79.2% for comparison females,  $P = .79$ ). Program males also had significantly more positive well-being than comparison males on incarceration (37% vs 47%, respectively), health insurance coverage (57% vs 44%), and depressive symptoms (10% vs 23%), although the sex interaction terms were not significant. No other subgroup effects were detected.

## COMMENT

This study makes several contributions to child development. First, as the most comprehensive investigation of an established large-scale program, the CPC intervention had impacts on adult health and well-being not apparent in previous studies.<sup>5-11,17,18</sup> Preschool participants had comparatively higher rates of educational attainment and health insurance, lower rates of more severe criminal behaviors including felony arrests, convictions, and incarceration, and lower rates of depressive symptoms. That the impacts of intervention extend beyond educational performance is not surprising given the well-documented links between education outcomes and adult health, mental health, and social behavior.<sup>25,26,36-38</sup> Almost all of the previous long-term studies focused on school performance and educational attainment and did not continue into adulthood. Most noteworthy, this is the first ECI study to our knowledge linking participation to higher rates of insurance coverage and lower rates of depressive symptoms, a byproduct of better school performance and attainment. Links to adult crime prevention have been documented,<sup>8,9</sup> but not for large-scale prospective studies or over a wide range of indicators. Because expenditures for the medical care and justice systems comprise roughly 20% of the gross domestic product, the potential cost savings to governments and taxpayers of early childhood prevention programs are considerable. At present, the economic returns of ECIs exceed costs by an average ratio of 6 to 1.<sup>13-15</sup>

Second, we find continuing effects of intervention on educational attainment. In addition to impacts on high school completion and years of completed education, preschool was associated with significantly higher rates of attendance in a 4-year college. This is particularly important given the increasing economic and health benefits experienced by college and postsecondary graduates relative to nongraduates and school dropouts.<sup>39,40</sup> Nevertheless, by age 24 years, only a fraction of program participants attended a 4-year college; so far, higher levels of education have not resulted in significant differences in income, although program participants are more likely to be employed or attending college. Additional follow-ups will provide a more complete assessment of socioeconomic status. That preschool intervention was linked to a lower rate of out-of-home placements suggests that school-based ECIs can prevent maltreatment.<sup>41</sup>

Third, we found evidence that program participation continuing into the primary grades was associated with greater adult well-being. Relative to less extensive intervention, participation for 4 to 6 years was associated with higher educational attainment, a higher rate of full-time

employment, less need for public aid, and lower levels of out-of-home placement and violent crime. As expected, effect sizes were lower when kindergarten achievement was included as a covariate. Overall, these findings indicate the positive effects of length of intervention and provide long-term empirical support for efforts to integrate services between preschool and third grade.

A final contribution of the study is that differential effects of intervention were investigated for program, child, and family characteristics. Although for most outcomes the impact of intervention was similar for different subgroups, preschool participation was linked to higher school completion for males. This pattern is consistent with the 15-year follow-up study.<sup>20</sup> The lone advantage of 2 years of preschool was on public aid receipt, as previous studies found its strongest effects on early school achievement.<sup>13,21,23</sup>

Why does the CPC intervention promote enduring effects on health and well-being? Four program elements seem paramount. First, a system of intervention is in place beginning at age 3 years that continues to the early grades. This school-based system promotes stability in children's learning environments, which can provide smooth transitions to formal schooling.<sup>4,22</sup> A second key feature is that as a public-school program, all teachers have bachelor's degrees and certification in early childhood education. Well-trained and well-compensated staff are common for programs demonstrating long-term effects.<sup>5,7,10,20</sup> Third, instructional activities address all of the learning needs of children, but special emphasis is given to literacy and school readiness through diverse activities.<sup>21,29</sup> Finally, comprehensive family services provide many opportunities for positive learning experiences in school and at home.

Given the growing evidence of long-term positive effects of ECI, the processes through which intervention leads to greater well-being are better understood.<sup>16,28</sup> In the CPC program, there is evidence that long-term effects on educational attainment and crime are explained by 4 factors: increased cognitive-scholastic skills, positive family support behaviors, positive postprogram school experiences such as enrollment in higher-quality schools, and increased school commitment.<sup>19,28</sup> The contributions of a wider range of cognitive, noncognitive, and family factors warrant further study.<sup>19,42-44</sup>

We note 3 limitations that may affect the interpretability of findings. First, because study findings are based on a quasi-experimental design, causal inferences are less certain than findings from many randomized controlled trials. Although it is possible that unmeasured factors contributed to part of the estimated effects, the consistency of findings over a wide range of analyses strengthens interpretations.

Second, some outcome measures were not assessed completely. As 1 indicator of mental health, depressive symptoms were obtained from a brief self-report checklist and not from clinical assessments, suggesting that intervention effects may be underestimated. Employment and income were measured prior to the completion of postsecondary education for many study participants. More stable and predictable economic profiles occur between ages 25 and 30 years. For example, between ages

19 and 24 years, the Chicago Longitudinal Study sample increased their rate of high school completion by nearly 50%.<sup>20</sup>

Finally, although the generalizability of findings to existing state- and federal-funded early education programs is greater than most previous studies, the intervention effects are most likely to be reproduced in urban contexts serving relatively high concentrations of low-income children.

This study provides evidence that established early educational interventions can positively influence the adult life course in several domains of functioning. The scope and magnitude of intervention effects reveal not only the benefits to participants in fundamental indicators of health and well-being but also the potential returns to society for investments in early educational programs.

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### Announcement

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