Adverse Childhood Experiences and Adult Well-Being in a Low-income, Urban Cohort

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abstract

OBJECTIVE: This study tests the association between adverse childhood experiences (ACEs) and multidimensional well-being in early adulthood for a low-income, urban cohort, and whether a preschool preventive intervention moderates this association.

METHODS: Follow-up data were analyzed for 1202 low-income, minority participants in the Chicago Longitudinal Study, a prospective investigation of the impact of early experiences on life-course well-being. Born between 1979 and 1980 in high-poverty neighborhoods, individuals retrospectively reported ACEs from birth to adolescence, except in cases of child abuse and neglect.

RESULTS: Nearly two-thirds of the study sample experienced ≥ 1 ACEs by age 18. After controlling for demographic factors and early intervention status, individuals reporting ACEs were significantly more likely to exhibit poor outcomes than those with no ACEs. Those with ≥ 4 ACEs had significantly reduced likelihood of high school graduation (odds ratio [OR] = 0.37; $P < .001$), increased risk for depression (OR = 3.9; $P < .001$), health compromising behaviors (OR = 4.5; $P < .001$), juvenile arrest (OR = 3.1; $P < .001$), and felony charges (OR = 2.8; $P < .001$). They were also less likely to hold skilled jobs (OR = 0.50; $P = .001$) and to go further in school even for adversity measured by age 5.

CONCLUSIONS: ACEs consistently predicted a diverse set of adult outcomes in a high-risk, economically disadvantaged sample. Effective and widely available preventive interventions are needed to counteract the long-term consequences of ACEs.

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Ms Giovanelli conceptualized much of the study, carried out the initial analysis drafted significant parts of the initial manuscript, and revised the manuscript. She approved the manuscript as submitted; Dr Reynolds conceptualized much of the study, designed the measures analyzed, directed the data analysis, reviewed and revised the manuscript, and approved the final manuscript as submitted; Ms. Mondí helped conceptualize the study, drafted significant parts of the manuscript, developed the measures analyzed, revised the manuscript, and approved the manuscript as submitted; and Dr. Ou designed the data collection instruments and project data, developed measures analyzed, reviewed the manuscript, helped revise the manuscript, critiqued the revised the analysis plan, and approved the manuscript as submitted.

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WHAT'S KNOWN ON THIS SUBJECT: Despite a large literature showing the detrimental effects of adverse childhood experiences (ACEs) on life-course outcomes, links to broader well-being, including educational attainment, occupational status, and crime, have not been assessed. The observed gradient associations are for predominately middle-class, white samples.

WHAT THIS STUDY ADDS: Based on prospectively measured outcomes for an economically disadvantaged cohort, findings indicated a consistent pattern of associations in which high ACE exposure was linked to multidimensional well-being by age 26 after the influence of family risk status was taken into account.

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Extensive research has linked adverse childhood experiences (ACEs) to negative physical and mental health outcomes across the lifespan.¹⁻⁵ It has been shown that these relations are mediated by both physiologic and social processes.⁶ ⁷ Less clear, however, are the impacts of ACEs on other domains of functioning, such as educational and career success, which would enhance understanding of the complex influences of childhood adversity and could inform the development of new strategies to reduce social and economic costs. Increasing priority on identifying preventive interventions that reduce the prevalence and consequences of ACEs is also shifting attention to broader health and well-being.^{8,9}

Previous research has demonstrated a graded relationship between ACEs and a host of negative physical and mental health outcomes. In the seminal ACE Study,¹⁰⁻¹³ researchers examined experiences of maltreatment and family dysfunction in a nonclinical sample of 17 421 adults. They reported that incidences of substance abuse, obesity, depression, chronic lung disease, and heart disease increased in a graded fashion as the number of self-reported ACEs increased.¹⁰⁻¹²

Three limitations in existing research are evident, however. First, previous samples in the United States have been predominantly composed of middle-income participants. All participants in the original ACE study were enrolled in private health insurance plans, and nearly three-quarters were white and had attended college. Growing up in high-poverty, low-resource neighborhoods may heighten the deleterious effects of adversity on later well-being.¹⁴ However, the added effects of ACEs above and beyond the structural and family demographic risks already present have rarely been assessed longitudinally.

A second limitation of previous studies is their narrow focus on the physical and mental health consequences of ACEs, to the exclusion of broader outcome measures of well-being, including educational attainment, socioeconomic status, and social behavior. Educational attainment is the leading social determinant of health, and the impacts of ACEs in this domain have been understudied. Furthermore, research has documented the interplay among physical health, educational attainment, involvement in the criminal justice system, and economic well-being.^{15,16}

Finally, previous studies have not fully assessed whether preventive interventions can reduce the incidence of ACEs or mitigate their negative repercussions once they have occurred. Early childhood intervention programs, for example, have been found to be most cost-effective for children exhibiting the highest degree of psychosocial risk on program entry,¹⁷⁻¹⁹ but the extent to which this finding generalizes to ACEs is unknown.

The current study assessed the impact of ACEs on educational attainment, socioeconomic status, crime, mental health, and health behavior in early adulthood. Data were drawn from the Chicago Longitudinal Study (CLS), a prospective longitudinal investigation of the effects of early life experiences on the development of 1539 low-income, minority children who grew up in the inner city.^{20,21} A wide variety of data have been regularly collected, including birth records, ACEs, school and social services records, and measures of adaptive functioning in adulthood.

Two major questions were addressed: (1) do cumulative ACEs predict multiple indicators of well-being, over and above environmental and demographic risk; and (2) does participation in the Child-Parent

Center program moderate the impact of ACEs on adult well-being?

METHODS

Sample and Design

The 1539 participants in the CLS grew up in the most economically disadvantaged neighborhoods and attended early childhood programs in the Chicago Public Schools.^{20,21} The original sample was evenly split by gender and was representative of the local context's racial and ethnic composition (93% African American, 7% Hispanic). Intervention group members ($N = 989$) attended the CPC preschool program at age 3 and/or 4 years. At that time, the CPC program provided a comprehensive array of educational and family support services at 24 sites. Members of the control group ($N = 550$) were from 5 randomly selected schools and attended the usual full-day kindergarten programs available to low-income Chicago Public Schools students. All participants attended kindergarten from 1985 to 1986. Previous research has demonstrated that these groups are comparable on child, family, and school characteristics and are representative of children living in urban poverty.^{22,23}

Follow-up at Age 22 to 24 Years

Followed prospectively throughout school and into adulthood, 1142 (74.2%) of the original sample completed a 45-minute survey at age 22 to 24 years about their family and school experiences, as well as their current well-being. They completed a life-event checklist assessing ACEs in 5-year intervals: ages 0 to 5, 6 to 10, 11 to 15, and 16 years to the present day (see Table 1). In addition to this survey data, administrative data on childhood maltreatment were obtained for 60 additional children, thus providing a final study sample of 1202 (54.1% female). The entire

TABLE 1 Participation in the CLS

Study Category	Female	Male	Total Sample
Participants' characteristics at start of study ^a			
Original Sample	770	761	1531
African American	721	702	1423
Hispanic	49	59	108
Child-Parent Center preschool participation	512	476	988
Child-Parent Center school-age participation	430	420	850
Enrolled ≥ 6 y in Chicago Public Schools	650	617	1267
Early adult participation status			
Completed survey at age 22–24 y on ACE	621	521	1142
Obtained administrative records to assess ACE	29	31	60
Total participants with ACE data	650	552	1202
Total participants missing ACE data due to attrition	120	209	329
Number of study participants with data ^b			
Highest grade completed	534	642	1176
Attended any 4-year college	537	641	1178
High school graduation	537	642	1179
High school completion	537	642	1179
Adult felony	552	650	1202
Juvenile arrest	552	650	1202
Depression	517	617	1134
Occupational prestige	543	639	1182
Health compromising behavior	514	614	1128
≥ 1 outcome	552	650	1202

^a Of the original sample of 1539, 8 individuals were excluded due to lack of identifying information. Participants were followed prospectively from ages 5 to 25 years.

^b The age 22 to 24 years survey and/or interview was completed from August 2002 to September 2004.

sample had 1 or more valid outcome measures.

CPC Intervention

Since previous publications have described the CPC program in-depth,^{23–25} we will provide a brief overview here. The CPC program provides educational and family support services to children ages 3 to 9 years (preschool to third grade) within a comprehensive model similar to Head Start. Major program elements include: low student-to-staff ratios throughout preschool (17:2) and early elementary school (25:2); a literacy-focused curriculum that employs a variety of teacher- and child-directed techniques; a comprehensive parent involvement and education program; home visits; and health services. Preschool participants attend the program for 3 hours each weekday.

Adverse Childhood Experiences

Nine ACEs before age 18 years were assessed in the age 22 to 24 years survey and supplemented by

administrative records. These are acute and chronic stressors.^{10,11} Slight variations in items from the original ACE studies are partially due to evidence that certain stressors (eg, witness to a shooting or stabbing) are more common in this population.^{26–28} Participants were presented with an events checklist and instructed to “indicate if any of these events have occurred in your life.” If they had experienced an event, they were prompted to circle the relevant age range(s) (0–5, 6–10, 10–15, and 16 years or older). We used a count of participants' affirmative responses to the following items: (1) “prolonged absence of parent”; (2) “divorce of parents”; (3) “death of parent”; (4) “death of brother or sister”; (5) “death of a close friend or relative”; (6) “frequent family conflict”; (7) “problems of substance abuse of parent”; (8) “witness to a shooting or stabbing”; and (9) “being a victim of a violent crime.” “Prolonged absence of parent” and “divorce of parents” were combined into 1 dichotomous variable because of the possible

conflation of these choices. Likewise, “death of parent,” “death of brother or sister,” and “death of a close friend or relative” were combined into a dichotomous variable (findings were unaffected by alternative coding). Thus, the maximum possible score for the survey items was 6. Because of the sensitive nature of childhood maltreatment and the likelihood of under-reporting, participants were not asked about maltreatment experiences. Rather, indicators of physical abuse, sexual abuse, and neglect were obtained via court and county records. Thus, the maximum possible score based on maltreatment records was 3, and the maximum possible ACE score was 9.

Outcome Measures

Mental Health and Health Behavior

Two measures were included based on the age 22 to 24 years survey. Depressive symptoms were a 5-item modified version of the Brief Symptom Inventory.²⁹ Participants rated how often they had felt depressed, helpless, lonely, that life was not worth living, and/or very sad in the past month, ranging from 0 (not at all) to 5 (almost every day). We used a dichotomous indicator for the frequent presence of ≥ 1 of these symptoms (a few times a month or more). Health compromising behavior was defined as current engagement in ≥ 2 of the following: (1) illegal substance use, (2) daily tobacco use, and (3) frequent alcohol use (eg, drinking a few times a week or more). Current substance use was defined as reports of substance abuse problems, receipt of substance abuse treatment, smoking marijuana almost daily, or using drugs harder than marijuana a few times a week or more.

Educational and Occupational Status

Five measures were assessed by age 26 years from administrative records from school districts, higher education institutions, and

employers, as well as self-reports. The highest grade completed was the number of years of education ranging from 7 to 16, with 12 years denoting high school graduation or a General Educational Development (GED) credential. College years were based on the number of earned credits. College attendance was based on whether the individual attended a 4-year college for any length of time by age 26 years (self-report or school records). High school completion was a dichotomous indicator of a diploma or GED credential by age 26 years. High school graduation counted only those who had earned a diploma by age 21.

Occupational prestige was the skill level of the current and/or 2 most recent jobs reported on the age 22 to 24 years survey, per the Barratt scale³⁰: 1 indicated a low job-skill or education classification; 5 indicated a moderate level of job-skill or postsecondary training; and 9 indicated a high level of skill requiring an advanced degree. We used a dichotomous variable indicating a prestige level of ≥ 4 (semi-skilled). Missing data were estimated from education and income (see Supplemental Tables 6 and 8).

Criminal Behavior

Two dichotomous measures of criminal justice system involvement were included: juvenile arrest (ages 10–18 years) and adult felony charge (ages 18–24 years). Juvenile arrest records were primarily obtained from petitions to the Cook County Juvenile Court and 2 other Midwestern locations from 1990 to 1998. Searches were conducted without knowledge of individuals' intervention statuses. Searches were repeated twice for 5% random samples and cross-checked with computer records. One or more felony charges were taken from federal prison records, as well as

documented histories in state, county, and circuit courts.

Statistical Analyses

Probit, multiple, and binary logistic regression analyses were conducted in Stata (StataCorp, College Station, TX). The model included 4 dichotomous ACE frequency variables (1, 2, 3, and ≥ 4). The reference group was 0-ACEs. Gender, race, CPC preschool participation, CPC school-age participation, and an index of family ecology of risk were covariates. The risk index was comprised of 8 dichotomous indicators measured from birth to age 3 years: (1) single parent household; (2) mother under age 18 years at child's birth; (3) ≥ 4 children in the household; (4) mother a high school dropout; (5) family income $< 185\%$ of the federal poverty level; (6) mother unemployed; (7) welfare receipt; and (8) residence in a high-poverty neighborhood. The inclusion of indicators individually did not alter results. Associations for ACEs from birth to age 5 years were estimated separately using the same model, but only 2 dummy codes were included (1 ACE and ≥ 2 ACEs; 0 ACEs as the reference group). Missing data on ACEs for 77 individuals were imputed in SPSS (IBM SPSS Statistics, IBM Corporation, Armonk, NY) using the expectation-maximization algorithm³¹ based on official records of child abuse and neglect, which are highly correlated with ACEs and are known predictors of adversity.

To assess moderators, each early ACE indicator (birth to age 5 years) was interacted with CPC preschool participation and added to the model as a group. Coefficients were reported as log odds ratios (OR) and marginal effects, which are the change in the outcome unit (percentage points for all outcomes except educational attainment) associated with each ACE conditional on the covariates. Ninety-five percent confidence intervals (CIs) were used

for all significance tests. Standardized mean differences also were reported.

RESULTS

Prevalence of Adverse Childhood Experiences

Overall ACE prevalence rates are shown in Table 2. In 62.4% ($N = 750$) of the sample ≥ 1 ACEs by age 18 were reported. In 25% of the sample, 1 ACE was reported; 15% reported 2; 10% reported 3; and 13% reported ≥ 4 . ACE prevalence from birth to age 5 years was 26.7%, with 8% reporting ≥ 2 and 19% reporting 1.

The most prevalent of the 9 ACE indicators was prolonged absence of a parent or parental divorce (32.1%), followed by death of a family member or close friend (29.2%) and frequent family conflict (15.8%). Physical abuse, sexual abuse, and neglect had the lowest prevalence (1.7% to 7.3%).

Among the subgroups, males reported significantly higher rates of ACEs than females. With the exception of child neglect, CPC and comparison-group participants had equivalent rates of ACEs. Study participants with ≥ 4 demographic risk factors also had a similar pattern of ACEs as those with fewer risks (see Supplemental Tables 7 and 9).

ACEs and Adult Well-Being

Table 3 shows the associations between ACEs and the 9 outcome measures. Log ORs and marginal effects are shown. These are summarized below. All coefficients are adjusted for the covariate influences. See Supplemental Table 5 for an alternate model.

Mental Health and Health Behavior

There was a graded relationship between ACE score and depressive symptoms. Relative to the 0-ACE group, the 1-ACE group had an increased odds of depression of nearly 50% ($OR = 1.45$; $P < .05$),

TABLE 2 Prevalence of ACEs by Domain in Overall Sample and for Subgroups

Child/Family Characteristics	N	Percentage of Total Sample	CLS Sample		
			Male, Female Percentage	CPC versus Comparison Percentage	High Risk, Low Risk Percentage
Prolonged absence of a parent or divorce of parents	366	32.1	38.8*, 26.4	31.6, 32.9	31.8, 32.6
Death of a parent, sibling, or close friend	333	29.2	31.9, 26.9	29.7, 28.1	30, 27
Frequent family conflict	180	15.8	17.3, 14.5	14.8, 17.6	16, 15.1
Parent substance abuse	124	10.9	11.1, 10.6	12.1, 8.4	11.2, 10
Witness to a violent crime	154	13.5	22.3*, 6.1	13.3, 13.8	13.4, 13.8
Victim of a violent crime	68	6.0	9.0*, 3.4	5.8, 6.1	6, 6
Physical Abuse 4–17	32	2.8	3.7, 2.1	2.1, 4.1	1.8, 1.3
Sexual Abuse 4–17	19	1.7	0.8, 2.4*	1.5, 2.0	8.6, 3.8
Neglect 4–17	83	7.3	6.7, 7.8	5.5, 10.7**	3.3*, 1.6
Child Welfare (overall) 0–3	58	3.8	3.5, 4.0	3.1, 4.9	4.3, 2.4
Birth to age 17 y composite	1202				
0	452	37.6	32.6, 41.9*	39.1, 34.8	36.3, 41.4
1	294	24.5	24.5, 24.5	24.7, 24.0	24.4, 24.6
2	181	15.1	15.0, 15.1	15.3, 14.6	15.8, 13.2
3	115	9.6	10.1, 9.1	8.8, 11.1	9.9, 8.7
≥4	160	13.3	17.8*, 9.5	12.1, 15.5	13.7, 12.3
Birth to age 5 y composite	1159				
0	849	73.3	68.7, 77.1	73.6, 72.6	72.3, 75.6
1	218	18.8	21.1, 16.8	18.3, 19.7	19.1, 16.1
≥2	92	7.9	10.19*, 6.04	8.05, 7.73	7.8, 8.3

ACEs 0–17 y, *n* = 1202. ACEs 0–5 y, *n* = 1159.* *P* < .01.** *P* < .001.

which doubled for the 2- and 3-ACE groups, and nearly quadrupled for the ≥4-ACE group (OR = 3.87; *P* < .001). The ≥4-ACE group was 29.3 points more likely to report depressive symptoms than the reference group (Table 3, column 4). The standardized mean difference was 0.86 SDs.

Two of the 4 ACE groups had significantly higher rates of health compromising behavior. The 2-ACE group had increased odds of 2.18 (*P* < .01) and the ≥4-ACE group had increased odds of 4.52 (*P* < .01). For the latter group, the corresponding marginal effect showed an increase of 25.7 points.

Education and Occupational Status

As shown in Table 3, 3 of the 4 ACE groups were significantly less likely to complete high school (diploma or GED.) The group with ≥4 ACEs had an odds of completion that was half that of reference group (OR = 0.503, *P* < .01). The 1- and 2-ACE groups were close to this odds ratio (OR). This corresponds to a reduction in high

school completion from 7.4 to 12.5 points.

The associations were more graded for high school graduation, with the ≥4-ACE group showing the lowest odds (OR = 0.368; *P* < .001) and the 1-ACE group showing the highest odds (OR = 0.695; *P* < .001).

Similar to depression, years of education had a linear and relatively graded relationship for all 4 ACE groups. The group with ≥4 ACEs completed, on average, 0.5 fewer years of education (marginal effect = −0.508; *P* < .001). ACEs were less consistently associated with enrollment in a 4-year college, although this may be because of the low rate of college attendance in the sample (see also Supplemental Table 5).

For occupational prestige, only the ≥4-ACE group (OR = 0.50; *P* < .001) and the 2-ACE group (OR = 0.542; *P* < .001) had significantly lower odds of employment in moderate-skill jobs. For the ≥4-ACE group, this translates to 10% in moderate-skill jobs

compared with 22% for the reference group.

Criminal Behavior

Individuals with multiple ACEs were significantly more likely to be arrested as juveniles. The pattern was generally linear and graded. For example, the ≥4-ACE group had threefold higher odds of arrest (OR = 3.12, *P* < .001; marginal effect = 0.253) whereas the 1-ACE group had 40% higher odds (OR = 1.39; *P* = .09; marginal effect = 0.066).

Only the ≥4-ACE group (2.82, *P* < .001) and the 2-ACE group (1.78, *P* < .060) had significantly higher odds of a felony charge by age 24.

ACEs From Birth to Age 5 Years and Adult Well-Being

As shown in Table 4, we found that participants with ≥2 ACEs in early childhood had significantly worse outcomes for 5 of 9 measures, including depression (OR = 3.0; *P* < .001), high school graduation (OR = 0.43; *P* < .001), juvenile arrest (OR = 2.1; *P* < .01), felony charge (OR = 2.4;

TABLE 3 ORs and Marginal Effects of ACEs (0 to 18 years) on Adult Well-Being

Outcome	N	Log OR	Marginal Effect	95% CI	P Value	Standardized Mean Difference
Depression	1134					
0 ACE (reference group)	77	1.00	—	—	—	—
1 ACE	68	1.45*	*0.066	−0.004 to 0.136	.063	0.21
2 ACE	52	1.93**	0.128	0.042 to 0.213	.003	0.43
3 ACE	33	2.31**	0.171	0.062 to 0.280	.002	0.54
≥4 ACE	52	3.87**	0.293	0.188 to 0.398	.000	0.86
Health compromising behaviors	1128					
0 ACE (reference group)	47	1.00	—	—	—	—
1 ACE	43	1.35	0.046	−0.013 to 0.104	.125	0.20
2 ACE	38	2.18**	0.108	0.030 to 0.186	.006	0.45
3 ACE	17	1.49	0.051	−0.039 to 0.140	.267	0.25
≥4 ACE	45	4.52**	0.257	0.153 to 0.362	.000	0.89
High school completion	1179					
0 ACE (reference group)	376	1.00	—	—	—	—
1 ACE	220	0.606**	−0.084	−0.151 to −0.016	.015	−0.29
2 ACE	137	0.637*	−0.074	−0.154 to 0.006	.071	−0.26
3 ACE	87	0.714	−0.058	−0.154 to 0.037	.229	−0.21
≥4 ACE	100	0.503**	−0.125	−0.215 to −0.035	.006	−0.42
High school graduation	1179					
0 ACE (reference group)	301	1.00	—	—	—	—
1 ACE	168	0.695*	−0.087	−0.163 to −0.010	.026	−0.22
2 ACE	82	0.416**	−0.212	−0.299 to −0.125	.000	−0.55
3 ACE	56	0.510**	−0.164	−0.269 to −0.059	.002	−0.42
≥4 ACE	57	0.368**	−0.237	−0.330 to −0.145	.000	−0.60
College attendance	1178					
0 ACE (reference group)	85	1.00	—	—	—	—
1 ACE	48	0.902	−0.013	−0.063 to 0.036	.600	−0.04
2 ACE	24	0.719	−0.040	−0.094 to 0.015	.152	−0.16
3 ACE	12	0.543	−0.062	−0.120 to 0.003	.039	−0.25
≥4 ACE	19	0.794	−0.022	−0.085 to 0.040	.477	−0.07
Highest grade completed	1176					
0 ACE (reference group)	446	—	—	—	—	—
1 ACE	292	—	−0.231	−0.465 to −0.004	.054	−0.14
2 ACE	180	—	−0.389	−0.664 to −0.114	.006	−0.23
3 ACE	113	—	−0.378	−0.707 to −0.050	.024	−0.22
≥4 ACE	145	—	−0.508	−0.809 to −0.208	.001	−0.30
Occupational prestige (3+)	1182					
0 ACE (reference group)	172	1.00	—	—	—	—
1 ACE	91	0.78	−0.051	−0.116 to 0.013	.120	−0.13
2 ACE	43	0.542**	−0.117	−0.186 to −0.048	.001	−0.32
3 ACE	32	0.740	−0.061	−0.150 to 0.028	.181	−0.16
≥4 ACE	29	0.500**	−0.129	−0.204 to −0.054	.001	−0.66
Juvenile arrest	1200					
0 ACE (reference group)	101	1.00	—	—	—	—
1 ACE	89	1.386	0.066	−0.009 to 0.142	.086	0.20
2 ACE	69	2.121**	0.161	0.069 to 0.253	.001	0.45
3 ACE	43	1.915**	0.141	0.032 to 0.250	.011	0.40
≥4 ACE	85	3.119**	0.253	0.156 to 0.349	.000	0.68
Felony charge	1200					
0 ACE (reference group)	63	1.00	—	—	—	—
1 ACE	55	1.252	0.030	−0.029 to 0.088	.373	0.13
2 ACE	42	1.782*	0.081	0.004 to 0.157	.060	0.31
3 ACE	22	1.193	0.018	−0.063 to 0.099	.792	0.08
≥4 ACE	61	2.823**	0.168	0.081 to 0.255	.001	0.58

Total *N*s indicate number of participants for whom we have outcome data for a given variable. *N*s for specific ACEs are only for those coded a 1 on that variable. —, not estimated.

* $P < .05$.

** $P < .01$.

TABLE 4 ORs and Marginal Effects of ACEs (0 to 5 years) on Adult Well-Being Outcome

	N	Log OR	Marginal Effect	95% CI	P Value	Standardized Mean Difference
Depression	1134					
0 ACE (reference group)		1.00	—	—	—	—
1 ACE		1.33	0.054	−0.013 to 0.122	.116	0.23
≥2 ACE		3.00*	0.241	0.123 to 0.359	.000	0.67
Health compromising behaviors						
0 ACE (reference group)	1128	1.00	—	—	—	—
1 ACE		1.67**	0.073	0.014 to 0.132	.015	0.30
≥2 ACE		3.50***	0.207	0.094 to 0.321	.000	0.70
High school completion	1144					
0 ACE (reference group)		1.00	—	—	—	—
1 ACE		0.957	−0.007	−0.067 to 0.053	.820	−0.02
≥2 ACE		0.697	−0.062	−0.159 to 0.035	.211	−0.20
High school graduation	1144					
0 ACE (reference group)		1.00	—	—	—	—
1 ACE		1.023	0.007	−0.070 to 0.083	.866	0.02
≥2 ACE		0.428*	−0.204	−0.317 to −0.092	.000	−0.53
Highest grade completed	1142					
0 ACE (reference group)		—	—	—	—	—
1 ACE		N/A	−0.081	−0.317 to 0.156	.504	−0.05
≥2 ACE		N/A	−0.491	−0.841 to −0.141	.006	−0.29
College Attendance	1143					
0 ACE (reference group)		1.00	—	—	—	—
1 ACE		0.852	−0.020	−0.071 to 0.032	.461	−0.09
≥2 ACE		0.668	−0.044	−0.113 to 0.026	.223	−0.19
Occupational prestige	1152					
0 ACE (reference group)		1.00	—	—	—	—
1 ACE		0.761	−0.058	−0.126 to 0.010	.095	−0.16
≥2 ACE		0.860	−0.030	−0.132 to 0.073	.573	−0.08
Juvenile arrest	1158					
0 ACE (reference group)		1.00	—	—	—	—
1 ACE		1.377	0.066	−0.009 to 0.140	.083	0.13
≥2 ACE		2.071*	0.160	0.047 to 0.273	.006	0.43
Felony charge	1158					
0 ACE (reference group)		1.00	—	—	—	—
1 ACE		1.330	0.038	−0.020 to 0.095	.200	0.14
≥2 ACE		2.443*	0.145	0.045 to 0.245	.004	0.47

—, not estimated.

* $P < .01$.** $P < .05$.*** $P < .001$.

$P < .01$), and health compromising behavior (OR = 3.5; $P < .001$). Standardized mean differences were as high as 0.70. Additionally, there was strong evidence of a linear and graded relationship.

Moderation of ACEs by CPC Participation

We found no evidence that CPC preschool participation moderated the relationship between ACEs and adult outcomes. CPC participation did show greater benefits on educational attainment for those at higher levels of risk (≥ 4 risk factors vs fewer).

Family, school, and individual child factors mediated links to outcomes (see Supplemental Table 10).

DISCUSSION

Our study is one of the first to show that ACEs are negatively associated with broad domains of well-being, including educational attainment, occupation prestige, criminal behavior, and mental health. Key indicators of economic well-being, including educational and occupational success, declined as the number of ACEs increased.

These new findings are based on independent, prospectively assessed measures of well-being. Because educational attainment predicts a wide range of health, disease risk, and quality of life measures,^{8,32} our findings are particularly salient for prevention efforts. High school graduation was identified as the leading indicator of the social determinants of health in Healthy People 2020.³³ In our study, a relatively graded association emerged, with high-ACE participants graduating at just two-thirds the rate of the 0-ACE group.

Our findings replicate previous studies showing strong associations among ACEs, health compromising behavior, and depressive symptoms.^{2,10,34} However, we have further extended this pattern to an urban cohort that grew up in high-poverty neighborhoods. A dose-response relation was found for depressive symptoms in early adulthood, but this was not as clear-cut for a composite of smoking, alcohol, and substance use. As one of the first studies to examine juvenile delinquency and adult felony charges, we also found that high-ACE participants had significantly elevated rates of crime. Even after accounting for many family risk factors and intervention exposure, the ≥ 4 -ACE group had the highest rates of official arrest by far.

The absence of a strong dose-response link between ACEs and felony charge, health compromising behavior, and high school completion suggest that a threshold relation may be present for high-risk populations. It is possible that the added influence of ACEs requires a larger cumulative magnitude to noticeably affect well-being among those who have already been exposed to higher levels of risk in childhood (eg, poverty).³⁵ The mixed pattern of outcomes for ACEs measured from birth to age 5 years also supports their cumulative influence throughout childhood in impacting outcomes.

Our findings of deleterious impacts across domains of functioning are consistent with the neurobiological effects of early adversity on the developing brain.^{36,37} Cumulative exposure to severe physiologic stress affects many structures and functions that would limit or impair coping and self-regulatory skills required for successful performance in educational, occupational, and social pursuits. Early exposure to risk factors within the home and family exacerbate these consequences.^{38,39} Childhood maltreatment, in particular, has been linked to an

increased risk for school failure, criminal activity, depression, and substance use.^{40–42}

Although we found that CPC intervention did not moderate the association between ACEs and adult well-being, previous studies have shown that this intervention has compensatory benefits for children who grew up in the highest-poverty neighborhoods, who experienced high levels of economic risk, and whose parents were high school dropouts.^{21,22,43} These factors are associated with elevated risk for adverse and stressful experiences. Preventive interventions and evidence-based practices in early childhood can counteract the harmful consequences of many risk factors by enhancing school and home environments and promoting healthy child development (Supplemental Table 10).^{17–19,22}

This study has 2 notable limitations. First, most of the ACE indicators were reported retrospectively by participants in their early to mid-twenties. It is possible that ACEs were under-reported, especially given the measure's checklist format. However, unlike previous studies, our measure of child maltreatment was from official court and family service records, which strengthens the validity of the measure. The inclusion of child welfare services and a range of home experiences (eg, frequent family conflict) also have the advantage of being good proxies for unsubstantiated maltreatment.

While the prevalence of ACEs in our study was higher than in earlier studies of more advantaged samples and recent national studies,^{10,44} prevalence is likely underestimated in this sample, and therefore findings are likely to be conservative. Individuals who under-report ACEs are more likely to have lower levels of well-being, which would increase the strength of the documented associations.

Second, the study sample is primarily comprised of African American participants who grew up in urban Chicago. Findings are therefore not necessarily generalizable to other populations. Nevertheless, the results of this study replicate the findings of many previous studies conducted on dissimilar (eg, primarily white, middle-class) populations, supporting the hypothesis that the detrimental effects of ACE exposure are consistent across populations. Continued research on the mechanisms of influence will strengthen generalizability.^{45–47}

CONCLUSIONS

The results of this study suggest that adverse childhood experiences exert detrimental effects for previously unexamined measures of adult well-being, above and beyond the effects of demographic risk and poverty. We are aware of no previous studies that have documented links with educational attainment and socioeconomic status, especially for prospectively measured outcomes. The physical and psychological repercussions of ACEs have been well-documented over the last 2 decades, and there has consequently been a growing movement to screen for ACEs in healthcare and intervention settings. Our results reveal that the breadth of ACE impacts is wider than previously documented. This increases the priority on assessing the full range of ACEs beginning as early as possible, and on preventing as well as buffering their harmful effects.

Although ameliorating poverty and its negative impacts continue to be high priorities, greater investments in interventions aimed at reducing the incidence of ACEs and counteracting their effects are also warranted. In addition to healthcare settings, ACE screenings during early childhood in other settings, such as schools, could identify children susceptible to

adverse effects early on and provide preventive intervention immediately, rather than provide treatment later in life.

Preventive interventions beginning in the first few years of life have demonstrated positive effects on long-term health and well-being by reducing family stress and adversity and promoting children's school readiness, achievement, and socioemotional learning.^{19, 48–50} Nationally, about one-third of young children are enrolled in publicly funded preschool programs.⁵¹ Fewer are in intensive and high-dosed programs that have

been linked to positive long-term effects for vulnerable children and families. Greater access to effective interventions and services during and immediately after these early years is an important priority for promoting healthy development.

To design and implement effective preventive interventions, we must deepen our understanding of both the ways in which the incidence of ACEs can be reduced and the ways in which individuals can be protected from these adverse effects. By investigating the long-term effects of early childhood programs on ACEs, the field can provide further evidence

that scalable interventions during these early years can have a lasting impact on healthy development and the reduction of ACEs.

ABBREVIATIONS

ACE: adverse childhood experiences
CI: confidence interval
CLS: Chicago Longitudinal Study
CPC: Child–Parent Center
GED: General Educational Development
OR: odds ratio

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