Adverse Childhood Experiences and ADHD Diagnosis at Age 9 Years in a National Urban Sample

Manuel E. Jimenez, MD, MS, **Wade Roy Jr., MD, PhD, MPH**, **Ofira Schwartz-Soicher, PhD**, **Yong Lin, PhD**, and **Nancy E. Reichman, PhD**

Department of Pediatrics (Drs Jimenez and Reichman), Boggs Center on Developmental Disabilities (Dr Jimenez), Department of Family Medicine and Community Health (Dr Jimenez), Children's Health Institute of New Jersey (Drs Jimenez and Reichman), Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ; Children's Specialized Hospital (Dr Jimenez), New Brunswick, NJ; Department of Pediatrics (Dr Wade), The Children's Hospital of Philadelphia, Pa; Princeton University (Drs Schwartz-Soicher and Reichman), NJ; Rutgers Biomedical Health Sciences, The School of Public Health (Dr Lin), Piscataway, NJ; and Institute of Health Policy, Management and Evaluation, Dalla Lana School of Public Health (Dr Reichman), University of Toronto, Ontario, Canada

Abstract

Objective—To examine associations between adverse childhood experiences (ACEs) and attention-deficit/hyperactivity disorder (ADHD) at age 9 years using longitudinal data and assess the extent to which ACEs during middle childhood are independently associated with ADHD at age 9 years.

Methods—We conducted a secondary analysis of data from the Fragile Families urban birth cohort 5- and 9-year interviews. The sample was limited to children for whom mothers were the primary caregiver and mother-reported information on 8 ACEs and ADHD were available at age 5 and 9 years. We examined associations between ACEs and parent-reported ADHD at age 9 years using logistic regression and controlling for potential confounders.

Results—We included 1572 children; 48% were African American, 11% had parent-reported ADHD at age 9 years, 41% and 42% experienced ≥1 ACE by age 5 years and between the ages of 5 and 9 years, respectively. ACEs before age 5 years were associated with ADHD at age 9 years. One, 2, and ≥3 ACEs between age 5 and 9 years were associated with ADHD at age 9 years even after controlling for ACEs before age 5 years and ADHD at age 5 years (adjusted odds ratio [AOR], 1.9; 95% confidence interval [CI], 1.2–3; AOR, 2.1; 95% CI, 1.2–3.8; and AOR, 2.2; 95% CI, 1.1–4.3).

Conclusions—In this study of urban children, ACEs occurring before age 5 years as well as between the ages of 5 and 9 years were associated with ADHD at age 9 years. Even after

controlling for early childhood ACEs and ADHD at age 5 years, the association between ADHD and ACEs in middle childhood remained significant, highlighting the importance of screening and intervention throughout childhood.

Keywords

adverse childhood experiences; attention-deficit/hyperactivity disorder; child development and behavior

Attention-deficit/hyperactivity disorder (ADHD) is a common neurodevelopmental diagnosis among US children.[1,2] Individuals with ADHD experience poor health outcomes, increased psychiatric morbidity, increased injury, poor peer relationships, and poor educational outcomes compared with individuals without ADHD.[3-6] The estimated economic effect of childhood ADHD in the United States ranges from 38 to 72 billion US dollars annually.[7]

Adverse childhood experiences (ACEs) are associated with high-risk health behaviors and poor health outcomes.[8-16] More recent work has linked ACEs to poor academic and behavioral outcomes in kindergarten and poor school engagement and behavior problems in middle childhood.[17-19] Whereas associations between ACEs and parent-reported ADHD has been reported in past work,[18-20] to our knowledge no studies have examined associations between ACEs occurring at different developmental periods in childhood and ADHD. The answer to this question can elucidate underlying pathways connecting ACEs to ADHD and inform interventions.

To better understand the potential effect of ACE exposures on ADHD, we used a unique, longitudinal, urban birth cohort with data on ACE exposures and ADHD diagnosis in early childhood, defined in this study as before age 5 years, as well as middle childhood, defined as between the ages of 5 and 9 years. We hypothesized that ACEs occurring between the ages of 5 and 9 years would be independently associated with ADHD diagnosis at age 9 years even after controlling for ACE exposures and ADHD diagnosis at age 5 years.

Methods

Study Design and Data Source

We conducted a secondary analysis of data from the Fragile Families and Child Wellbeing Study (FFCWS) birth cohort. The FFCWS cohort consists of nearly 5000 children born between 1998 and 2000 in 20 large US cities.[21] Most children in the study were born to unmarried parents by design. This longitudinal data set includes post-partum (baseline) and follow-up interviews with mothers with children at ages 1, 3, 5, and 9 years. A more detailed description of the study design and methods, including protection of human subjects, can be found in past work.[21,22] The current study used publicly available deidentified data files.[22] The FFCWS data has been previously used to study associations between ACEs occurring in early childhood and kindergarten outcomes.[17] The current study used data from the 5-year and 9-year follow-up interviews, which includes information on approximately 84% and 74%, respectively, of the baseline sample.

Study Population

The study sample was limited to children for whom the mother was the primary caregiver and mother-report information on ACE exposures and ADHD diagnosis was available at the age 5- as well as 9-year follow-up interviews.

Outcome

ADHD at Age 9 Years—The primary outcome was parent-reported ADHD diagnosis at age 9 years. Mothers were asked whether a "doctor or health care professional ever told you" that the child has "attention deficit disorder or ADHD." Outcome data were missing for only 1 child from the study sample as defined previously (0.06%).

Exposures

Measures of individual ACEs were created from mother-report information at the 5- and 9-year follow-up interviews. Following previous work using the FFCWS data to study ACEs and child academic and behavioral outcomes,[17] we included the original 9 ACEs from the 1988 study from Felitti et al, which did not include divorce/separation as an ACE.[12] Although more recent studies included divorce/separation as an additional ACE, recent qualitative research does not endorse that particular ACE for disadvantaged inner-city youth, many of whom have parents who were never married.[23] Emotional and physical neglect were characterized using a single measure of neglect because we were unable to distinguish between the 2 types using the available data. Overall, ACEs included 4 categories of child maltreatment (psychological aggression, physical abuse, neglect, and sexual abuse) and 4 categories of household dysfunction (maternal depressive symptoms, substance use, incarceration, and caregiver treated violently). Time periods for which we were able to characterize ACE exposures varied across the different types of exposures, from "currently" for incarceration to "the past 4 years" for information regarding physical abuse, sexual abuse, and neglect as described in the following sections.

Individual ACEs were dichotomized as exposed or not and then summed to create a score ranging from 0 to 8. We then created a categorical variable consisting of "0," "1," "2," and " 3" ACEs, on the basis of the distribution in the study sample.

Child Maltreatment—The FFCWS contains information regarding child maltreatment in 2 forms at the 5-year and 9-year follow-up interviews. First, at the child's age of 5 and 9 years mothers were asked whether Child Protective Services (CPS) had been contacted for the child regarding physical abuse, sexual abuse, and/or neglect, and if so, when. We included contact with CPS that was reported to have occurred up to 4 years before the interviews (CPS contact between the child's ages of 1 and 5 years for the 5-year follow-up interview and between the ages of 5 and 9 years for the 9-year follow-up interview). Second, mothers completed the Conflict Tactics Scale: Parent Child Version (CTS-PC)[24] at the 5-year as well as 9-year follow-up interviews in reference to their behavior that covered 3 relevant domains: psychological aggression, physical assault, and neglect. The FFCWS surveys included 5 items about physical assault (eg, spanked, hit, slapped, shook), 5 items about neglect (eg, failure to provide supervision, not able to make sure child got to a doctor or hospital when needed), and 5 items about psychological aggression (eg, threatened, called

him/her a name, swore or cursed at child). The most commonly occurring examples of psychological aggression contributing to a top 10th percentile score were "shouted, yelled, or screamed at the child" and "threatened to spank or hit him/her but did not actually do it," at ages 5 as well as 9 years. The mother was asked how many times each type of behavior occurred in the past year. On the basis of past work,[25,26] responses were assigned a score ("0" for never or not in the past year, "1" for event occurred once, "2" for twice, "4" for 3–5 times, "8" for 6–10 times, "15" for 11–20 times, and "25" for more than 20 times) and we considered domain scores in the top 10th percentile as high-risk for maltreatment.

At the 5-year as well as 9-year time points, psychological aggression was considered present based on the CTS-PC score, neglect was considered present on the basis of the CTS-PC score for neglect and/or if the mother reported CPS involvement for neglect, physical abuse was considered present on the basis of the CTS-PC score for physical assault and/or if the mother reported CPS involvement for physical abuse, and sexual abuse was considered present if the mother reported CPS involvement for sexual abuse.

Household Dysfunction

Maternal depressive symptoms—Maternal depressive symptoms were assessed with the Composite International Diagnostic Interview-Short Form at the 5-year and 9-year follow-up interviews. The Composite International Diagnostic Interview-Short Form has been used in past studies and categorizes respondents as having experienced a depressive episode in the past 12 months on the basis of Diagnostic and Statistical Manual of Mental Disorders, Fourth Revision criteria.[27]

Substance use—Mothers were asked, "In the past 12 months, was there ever a time when your drinking or being hung over interfered with your work at school, or a job, or at home?" and "Did you use any of these drugs during the past 12 months?" at the 5-year and 9-year interviews. For the latter question, 9 categories of drugs (sedatives, tranquilizers, amphetamines or other stimulants, analgesics or other pain killers, inhalants, marijuana or hashish, cocaine, LSD, and heroin) were specifically asked about in terms of use without a doctor's prescription, in larger amounts than prescribed, or for a longer period than prescribed. They were also asked whether the biological father and current partner if applicable "had problems such as keeping a job or getting along with family and friends because of alcohol or drug use?" at the 5-year and 9-year interviews. An affirmative response to any of these questions for the mother, father, or current live-in partner was considered an exposure.

Incarceration—Incarceration was assessed according to maternal reports of whether the child's father was in jail at the time of the 5-year and 9-year interviews. An affirmative response was considered an exposure.

Caregiver treated violently—This information was on the basis of questions from a previous study that was included in the FFCWS survey at the 5-year and 9-year interviews. These questions were taken from the Conflict Tactic Scale as well as qualitative interviews with victims of domestic violence.[28] Questions explored physical and sexual violence (ie,

slap or kicks, hits with fist, tries to make you have sex, throws something at you, and pushes you) by the biological father or current partner in the past year. These questions have been used in other studies.[29,30] A reply of "sometimes" or "often" to any of the items as opposed to "never" was considered an exposure. We also considered whether the mother had been in a physical fight with the biological father or current partner (if applicable) in front of the child (between ages of 3 and 5 years for before age 5 years, or between the ages of 5 and 9 years) and whether she had been seriously hurt in a fight with the father or current partner (if applicable), with an affirmative response coded as an exposure.

Covariates

We controlled for the child's gender, the mother's race and ethnicity, the mother's education level and the relationship status of the parents at the time of child's birth (in detailed categories), as well as household income at the time of the 9-year follow-up interview (dichotomized on the basis of the poverty threshold for a family of 4 at the time of data collection for the 9-year follow-up). We used an imputed variable for household income provided by the FFCWS because of degree of missing data.[22] We also controlled for a measure of maternal impulsivity. During the 5-year follow-up interview mothers were asked to respond to 2 questions using a 4-point Likert scale with response options ranging from strongly disagree to strongly agree, "I often say and do things without considering the consequences" and "I often get into trouble because I don't think before I act." On the basis of past work the responses were assigned numeric values (ie, strongly agree = 1, agree = 2, disagree = 3, and strongly disagree = 4) and were summed to create a score ranging from 2 (high impulsivity) to 8 (low impulsivity).

Statistical Analysis

First, we summarized sample characteristics using descriptive statistics. Next, we assessed independent variables for colinearity and found none to be highly correlated (defined as r 0.7). We then estimated unadjusted and adjusted logistic regression models of associations between ACEs before age 5 years and parent-reported ADHD at age 9 years, as well as between ACEs between ages 5 and 9 years and parent-reported ADHD at age 9 years. For the latter, we controlled for ACEs occurring before age 5 years and ADHD diagnosis at age 5 years (using the same question as at age 9 years). We used STATA version 13 (StataCorp, College Station, Texas) to conduct all data analyses. Because we relied on parent-reported diagnosis of ADHD, which may reflect difficulties in accessing health care, assessment, or treatment, we ran supplementary models that controlled for whether subjects had at least 1 well-child visit in the past year. We also ran supplementary models that controlled for parent-reported child health status and birth weight.

The Rutgers Biomedical Health Sciences institutional review board determined that this study was exempt.

Results

Study Sample

The study sample included 1572 children. Baseline demographic and socioeconomic characteristics of the study sample are summarized in Table 1 along with corresponding measures for respondents who participated in the FFCWS but were not included in the study sample. There were no statistically significant differences between these groups. Nearly half of the children included in the study sample were African American, one-quarter were Latino, and 69% were born to unmarried parents. Only 4% of the mothers reported infrequent contact with the child's biological father at the time of child's birth as determined by maternal reports at the postpartum interview that they "hardly talk" with the biological father, "never talk" with the biological father, have no relationship with biological father, or the biological father is unknown.

Forty-one percent of the children in the study sample experienced at least 1 ACE before age 5 years. Forty-two percent experienced at least 1 ACE between the ages of 5 and 9 years (Table 2). The prevalence of individual types of ACEs ranged from 0.6% to 11% before age 5 years and from 0.9% to 16% between the ages of 5 and 9 years. These were generally similar at the 2 time points with the exception of substance use, which was experienced by 11% and 16% of children before age 5 years and between the ages of 5 and 9 years, respectively. Fifteen percent of children (236) had at least 1 reported ACE before age 5 years but none reported between the ages of 5 and 9 years, another 15% (243) had no reported ACEs before age 5 years but at least 1 reported ACE between the ages of 5 and 9 years, and 26% (414) had at least 1 reported ACE that occurred before age 5 years as well as between the ages of 5 and 9 years (results not shown).

The prevalence of parent-reported ADHD diagnosis at age 9 years was 10.6% (95% confidence interval [CI], 9.3–12.3; result not shown).

Regression Analysis

In the unadjusted logistic regression models, 2 ACEs and 3 ACEs occurring before age 5 years were associated with parent-reported ADHD at age 9 years (odds ratio [OR], 2.1; 95% CI, 1.3–3.3; and OR, 2.6; 95% CI, 1.5–4.7, respectively). After adjusting for potential confounders, these ORs were substantially reduced and no longer statistically significant (Table 3). However, when interpreting the adjusted estimates it is important to note that the models controlled for parent-reported ADHD at age 5 years, which is very strongly associated with ACEs at age 5 years (Supplementary Table).

ACEs occurring between the ages of 5 and 9 years were also associated with parent-reported ADHD diagnosis at age 9 years in the unadjusted model. These associations remained statistically significant after controlling for potential confounders including ACEs occurring before age 5 years and ADHD diagnosis at age 5 years. Whereas the magnitude of the associations between parent-reported ADHD and 1 as well as 2 ACEs decreased somewhat in the adjusted model, the magnitude of the association between parent-reported ADHD and 3 ACEs decreased nontrivially (Table 3). Specifically, 1, 2, and 3 ACEs between the age of 5 and 9 years were associated with ADHD at age 9 years even after controlling for ACEs

before age 5 years and ADHD diagnosis at age 5 years (adjusted OR [AOR], 1.9; 95% CI, 1.2–3; AOR, 2.1; 95% CI, 1.2–3.8; and AOR, 2.2; 95% CI, 1.1–4.3). At least 2 ACEs occurring in both time periods was also significantly associated with parent-reported ADHD diagnosis (AOR, 2.0; 95% CI, 1.1–3.5; results not shown). The results were also insensitive to the inclusion of having received at least 1 well-child visit in the past year (reported at 9 years) as well as child health status at age 5 years and birth weight (results not shown).

Discussion

In a national US urban sample, we found that experiencing ACEs before age 5 years and experiencing ACEs between age 5 and 9 years were both associated with parent-reported ADHD diagnosis at age 9 years. Even after controlling for ACEs occurring before age 5 years and other potential confounders, including ADHD diagnosis at age 5 years, we found that ACEs occurring during middle childhood were significantly associated with parent-reported ADHD at age 9 years. These findings add to the growing literature linking ACEs to poor developmental and behavioral outcomes.[17-19,31]

The findings from this study are consistent with past work linking ACEs to parent-reported ADHD.[18-20] Our study adds to this literature by providing evidence of an independent association between ACEs experienced in middle childhood and ADHD diagnosis, above and beyond exposures in early childhood and ADHD diagnosis at age 5 years.

There are at least 2 potential explanations for the observed associations between ACEs and ADHD diagnosis—that trauma symptoms are mistaken for ADHD and that there is a causal effect of ACEs on ADHD symptoms. In terms of the latter, although studies support that ADHD is a highly familial condition, environmental factors (including social environments) are also posited to play a role in the development of the condition.[32,33] It is also worth noting that ADHD is a neurobiological disorder that is diagnosed using clinical criteria on the basis of behavioral characteristics, and it is plausible that ACEs play a role in amplifying the symptomology (eg, inattention) that could result in an ADHD diagnosis. Of course, it is possible that the observed associations between ACEs and ADHD reflect unobserved confounding factors or reverse causality wherein children's ADHD affects their family environments.

Because of the vulnerability of the developing brain to toxic stress, interventions addressing ACEs in early childhood are paramount.[34] Moreover, our findings suggest that links between ACEs and poor outcomes occur throughout childhood and addressing ACEs remains important at school age. Because of its frequent contact with children through regular visits,[35] the pediatric medical home is well positioned to help identify adversity throughout childhood and prevent potentially adverse effects. However, recent work suggests that although pediatricians recognize that there are links between adversity and poor outcomes, few pediatricians regularly inquire about ACEs in practice.[36,37] Additional work is necessary to understand how more pediatricians can be encouraged to screen for ACEs as part of a larger process of identification and linkage to community resources to address the developmental and behavioral needs of vulnerable children. Our findings suggest an

opportunity to work collaboratively with schools to identify and support children who are experiencing toxic stress.

Our work is subject to certain limitations. First, because the study sample consisted of children from large US cities, our findings might not generalize to all settings. When possible we used validated measures to assess ACEs and used conservative criteria to ensure consistency across interviews occurring at different time points; as a result we likely underestimated the number of ACEs to which children were exposed. Although a strength of our study was our ability to assess ACEs occurring at 2 different time points in childhood, we were still not able to characterize the severity of ACEs with the available data. Another general limitation of the ACE index is that assigning equal weight to each of the individual ACE exposures implies that these exposures have a uniform effect on children's development and well-being and that there are no dose-response or interactive effects, which is highly unlikely. Furthermore, the included ACEs might not fully reflect how affected individuals would characterize adversity as noted in qualitative work with urban youth.[23] Finally, we relied on parent report of ADHD diagnosis and cases were not clinically confirmed. Although most children in our sample had a regular source of care and had at least 1 well child visit in the past year, there could have been other difficulties in health care access or treatment that confounded rates of ADHD diagnosis in our sample. Because poor impulse control and inattention can be manifestations of traumatic experiences in children,[38] additional work is needed to further explore the observed associations between ACEs and ADHD as well as other mental health concerns and ensure that children are linked to appropriate interventions that can address the underlying source of their symptoms.

Despite these limitations, our study findings reinforce the importance of detection and intervention for ACEs throughout childhood. Our findings also highlight the importance of understanding school-age attention problems in the broader context of children's experiences.

Acknowledgments

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What'S New

In a longitudinal urban sample, adverse childhood experiences (ACEs) were associated with subsequent attention-deficit/hyperactivity disorder (ADHD). Even after controlling for early ACEs and ADHD diagnosis, ACEs in middle childhood were associated with ADHD, highlighting the importance of screening and intervention throughout childhood.

Table 1

Baseline Demographic Characteristics

Variable	Study sample (n = 1572), % (n)	Not included in sample (n = 3326), % (n)[*]	P
Gender			.78
Female	49 (769)	47 (1560)	
Male	51 (803)	53 (1765)	
Race			.64
White	35 (538)	29 (942)	
African American	48 (737)	51 (1652)	
Other	17 (269)	20 (666)	
Ethnicity			.52
Not Latino	75 (1174)	71 (2353)	
Latino	25 (393)	29 (940)	
Maternal education			.28
< High School diploma	27 (431)	38 (1268)	
High School diploma	30 (473)	30 (1007)	
Some college	28 (440)	23 (749)	
College	15 (228)	9 (296)	
Parents' relationship status			.38
Married	31 (489)	21 (698)	
Cohabiting	35 (554)	37 (1229)	
Visiting	26 (403)	26 (871)	
Friends	5 (71)	7 (225)	
Infrequent contact[†]	4 (55)	9 (301)	

[*] Primary caregivers who participated in the Fragile Families and Child Wellbeing Study but not included in study sample.

[†] Includes mothers who responded that they "hardly talk" with the biological father, "never talk" with the biological father, have no relationship with the biological father, or the biological father is unknown. P values for differences between groups on the basis of chi-square tests.

Table 2

ACE Exposures (n = 1572)[*]

Type of ACE	Before Age 5 Years, % (n)	Between Age 5 and 9 Years, % (n)
Neglect	11 (173)	11 (176)
Physical abuse	9 (146)	9 (142)
Sexual abuse	0.6 (9)	0.9 (14)
Maternal depressive symptoms	10 (160)	11 (171)
Substance abuse	11 (173)	16 (250)
Incarceration	5 (77)	6 (87)
Violence toward mother	9 (138)	8 (125)
Total number of ACEs experienced		
0	59 (922)	58 (915)
1	25 (399)	24 (371)
2	11 (167)	12 (182)
3	4 (56)	5 (72)
4	1 (22)	1 (21)
5	0.3 (5)	0.6 (9)
6	0.1 (1)	0.1 (2)

ACE indicates adverse childhood experience.

[*] Psychological abuse omitted from the table because only the top 10th percentile score on mother-reported Conflict Tactic Scale was considered exposure.

Table 3

Logistic Regression Estimates of Associations Between ACEs Before Age 5 Years and Parent-Reported ADHD at Age 9 Years and ACEs Between Age 5 and 9 Years and Parent-Reported ADHD at Age 9 Years

	Model 1[*]		Model 2[*]		Model 3[*]
	OR (95% CI)	AOR[*] (95% CI)	OR (95% CI)	AOR[*] (95% CI)	AOR[*] (95% CI)
Number of ACEs before age 5 years					
0	Referent	Referent	-	-	Referent
1	1.2 (0.8–1.8)	1 (0.6–1.6)	-	-	0.8 (0.5–1.3)
2	2.1 (1.3–3.3)	1.5 (0.9–2.6)	-	-	1.1 (0.6–2.0)
3	2.6 (1.5–4.7)	1.6 (0.8–3.2)	-	-	1 (0.5–2.1)
Number of ACEs between ages 5 and 9 years					
0	-	-	Referent	Referent	Referent
1	-	-	1.9 (1.3–2.9)	1.8 (1.2–2.9)	1.9 (1.2–3.0)
2	-	-	2.4 (1.5–3.8)	2.1 (1.3–3.6)	2.1 (1.2–3.8)
3	-	-	3.1 (1.8–5.4)	2.2 (1.1–4.1)	2.2 (1.1–4.3)

ACE indicates adverse childhood experience; ADHD, attention-deficit/hyperactivity disorder; AOR, adjusted odds ratio; CI, confidence interval; and OR, odds ratio.

[*]
Model 1 includes ACEs occurring before age 5 years, Model 2 includes ACEs occurring between age 5 and 9 years, and Model 3 includes ACEs occurring before age 5 years and between ages 5 and 9 years. Adjusted for child gender, race, ethnicity, maternal education, and parent relationship status at baseline; maternal impulsivity and parent-reported ADHD diagnosis at age 5 years; and income at age 9 years.