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Research article

Adverse experiences in infancy and toddlerhood: Relations to adaptive behavior and academic status in middle childhood

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ABSTRACT

Findings from the Adverse Childhood Experiences (ACE) study articulated the negative effects of childhood trauma on long-term well-being. The purpose of the current study is to examine the associations between ACEs experienced in infancy and toddlerhood and adaptive behavior and academic status in middle childhood. We used data collected from a sample of low-income families during the impacts study of Early Head Start (EHS). Data were collected by trained interviewers demonstrating at least 85% reliability with protocols. Data come from 1469 sociodemographically diverse mothers and children collected at or near ages 1, 2, 3, and 11. At ages 1, 2, and 3, an EHS-ACEs index was created based on interview and observation items. The EHS-ACEs indices were averaged to represent exposure across infancy and toddlerhood. At age 11, parents were asked about school outcomes and completed the Child Behavior Checklist. Across development, children were exposed to zero (19%), one (31%), two (27%), and three or more ACEs (23%). Logistic regression analyses, controlling for EHS program assignment, and parent, school, and child characteristics, showed ACEs were significantly associated with parental report of the child: having an individualized educational program since starting school and in the current school year, having been retained a grade in school, and problems with externalizing and internalizing behavior, as well as attention. Findings suggest that ACEs influence children's behavioral and academic outcomes early in development.

1. Introduction

Adverse Childhood Experiences (ACEs), including child maltreatment and household dysfunction, are associated with problems for health and adaptive behavior during adulthood (Anda et al., 2006; Centers for Disease Control & Prevention, 2014; Felitti et al., 1998). Approximately 52% of adults in the United States report having experienced ACEs in their childhoods (Anda et al., 2006; Felitti et al., 1998). While it is helpful to understand the negative effects of ACEs on development, retrospective reports leave unanswered questions as to how adverse experiences earlier in life lead to particular negative outcomes. The purpose of the current study is to examine how very early exposures to ACEs may have negative associations with behavioral and academic outcomes prior to adolescence. We focus our study on behavioral and academic outcomes as these are associated with successful development into adulthood (Ek, Sovio, Remes, & Järvelin, 2005; Fergusson, John Horwood, & Ridder, 2005; Narusyte, Ropponen, Alexanderson, &

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Svedberg, 2017). Additionally, behavioral and academic outcomes are domains of development in which there are strong associations within and across time (Achenbach, Ivanova, Rescorla, Turner, & Althoff, 2016; Masten & Cicchetti, 2010). Below we summarize the extant literature on the association between ACEs and: 1) adaptive behavior (e.g., problems with externalizing and internalizing behaviors and attention) and 2) academic status (e.g., grade retention and individualized services).

1.1. ACEs and adaptive behavior in childhood

There is cross-sectional empirical evidence that ACEs experienced in childhood are associated with less adaptive behavior. Multiple studies have reported the impact of ACEs on children's development using data from the National Survey of Children's Health (NSCH), a nationally representative sample of children aged 6–17 years. One study using NSCH data reported that 3% of the population had externalizing behavior problems, but the rates increased to 24% and 61% if they had 1 or 2 or more ACEs, respectively (Bethell et al., 2014). Using those same data, associations were demonstrated between ACEs and the sum number of behavioral health conditions, including problems with attention, depression, anxiety, or conduct (Porche, Costello, & Rosen-Reynoso, 2016). Finally, ACEs were also associated with increased odds of having an emotional, mental, or behavioral condition that required treatment or counseling (Bethell, Gombojav, Solloway, & Wissow, 2016).

Additional cross-sectional studies have shown ACEs experienced very early in childhood, before school entry, are associated with less optimal behavioral development. Using a child welfare sample of children under 6 years of age, Kerker et al. (2015) documented an association between cumulative ACEs and behavioral health, documenting a 32% increase of having clinically significant behavioral health difficulties for every additional ACE. A study using a low-income community sample of children under the age of six (average age 33 months) examined the impact of ACEs on social-emotional development. The study reported that, compared to children in families with no ACEs, the odds of screening at risk for social-emotional delay were double for children with 1 adversity, more than two and a half times higher for children with 2 or 3 adversities, and 6 times higher for children with four or more ACEs (McKelvey, Whiteside-Mansell, Conners-Burrow, Swindle, & Fitzgerald, 2016).

Longitudinal research on exposure to adversities, especially as it applies to exposures during particular developmental periods, is only beginning to emerge. One study demonstrated ACEs reported by parents at age 5 were related to attention, social, and aggression problems at the end of kindergarten (Jimenez, Wade, Lin, Morrow, & Reichman, 2016). Two recent studies have examined the association between ACEs and behavioral outcomes using data collected from children in the Fragile Families and Child Wellbeing Study. The studies report the deleterious effects of lifetime ACEs reported by parents at age 5 on elevated internalizing and externalizing behavior problems (Hunt, Slack, & Berger, 2017) and parent-reported attention-deficit/hyperactivity diagnosis at age 9 (Jimenez et al., 2017). Further, a recent study examined temporal patterns of exposure to ACEs across infancy and toddlerhood and reported that both emotion regulation and aggressive behaviors at age 5 were associated with risk exposure at any point in earlier development (McKelvey, Selig, & Whiteside-Mansell, 2017).

1.2. ACEs and academic status in childhood

Several studies indicate child maltreatment and family dysfunction is a predictor of a school-related difficulties (Leiter & Johnsen, 1997; Margolin & Gordis, 2000; Trickett, Noll, & Putnam, 2011), including repeating grades (Eckenrode, Laird, & Doris, 1993) and special education (Jonson-Reid, Drake, Kim, Porterfield, & Han, 2004; Solis, Shadur, Burns, & Hussong, 2012). Cross-sectional studies of ACEs also demonstrate negative effects on academic status. Compared to school-aged children without a lifetime history of ACEs, children with a lifetime history of ACEs exposure had increased odds of less optimal academic outcomes, including 1) decreased school engagement, 2) missing more than 2 weeks of school during a school year, 3) having an Individual Education Plan (IEP), and 4) grade retention (Bethell, Newacheck, Hawes, & Halfon, 2014; Porche et al., 2016).

As these studies include items that represent parental report of ACEs that occurred within their child's lifetime, these studies leave questions as to the importance of the timing of ACEs exposure for predicting school and behavioral outcomes. To our knowledge, there have not been published studies of the longitudinal impact of ACEs experienced before entry into school on school outcomes. We are aware of two studies that examined the longitudinal impacts of ACEs exposure on academic abilities. One study found ACEs were negatively associated with academic and pre-literacy skills measured later in kindergarten (Jimenez et al., 2016). Another study examined patterns of ACEs experienced at ages 1, 2, and 3 and reported that adversities that occurred at closer temporal proximity to the measurement of academic skills at age 5 (i.e., those patterns with higher ACEs at age 3) were a stronger predictor of performance than patterns with earlier exposures (McKelvey et al., 2017). While these studies may help us understand how ACEs influence children's cognitive development, we are not aware of studies of academic outcomes in later childhood.

2. Current study

The goal of this study is to examine the association between experiences of ACEs in infancy and toddlerhood and academic and behavioral outcomes in a low-income community sample. We assessed exposure to ACEs at ages 1, 2, and 3 to capture adversity very early in development. Given the rapid brain growth experienced during infancy and toddlerhood, children exposed to ACEs during this period of development may be at a critical level of risk than children exposed at later time points (Shonkoff et al., 2012).

The concepts of toxic stress and allostatic load are key to any discussion of mechanisms by which ACEs impact child development. Toxic stress is the physiological response that develops when an infant or young child experiences severe or prolonged early adversity, especially in the absence of a nurturing caregiver (Johnson, Riley, Granger, & Riis, 2013; Shonkoff et al., 2012). Toxic stress

leads to the prolonged activation of the body's stress response system, disrupting the development of the infant or young child's brain, neuroendocrine, and immune systems (Johnson et al., 2013; Shonkoff et al., 2012; Shonkoff, Boyce, & McEwen, 2009). Children whose stress response system has been disrupted may be more likely to exhibit problems with attention, behavior, and impulsivity, with impacts on the development of self-regulatory competence particularly during early childhood (Hamoudi, Murray, Sorensen, & Fontaine, 2015). The erosion of these competencies may lead to maladaptive behavior in learning situations (Morrison, Ponitz, & McClelland, 2010; Simonds, Kieras, Rueda, & Rothbart, 2007). This hypothesis (the adjustment erosion hypothesis) has been directly tested in studies of developmental cascades (Masten & Cicchetti, 2010), which draw on ecological and developmental systems theories (Bronfenbrenner, 2005; Lerner & Castellino, 2002) to test the interactional nature of development across domains, system and time.

To our knowledge, there have not been studies that examine exposure to ACEs in infancy and toddlerhood on academic outcomes in middle childhood. This gap that seems particularly important to address in light of our understanding of toxic stress and the aforementioned developmental cascade of adjustment erosion (Masten et al., 2005). Taken together, we expect that exposure to ACEs in infancy and toddlerhood would increase the risk for developing negative behavioral (problems with externalizing, internalizing behaviors, and attention) and academic (Individual Education Plan status, grade retention) outcomes in middle childhood compared to children without exposure to ACEs.

3. Methods

3.1. Study design

This study used data collected for the Early Head Start Research and Evaluation Project (EHSRE; Love et al., 2005; Raikes, Brooks-Gunn, & Love, 2013; Raikes, Vogel, & Love, 2013). EHS is a two-generation program designed to serve low-income pregnant women and families with children birth to age three. Families who met the eligibility requirements for the EHS (e.g., income at federal poverty) were enrolled into the EHSRE and randomly assigned to program (51%) or comparison (49%) groups; randomization yielded equivalent groups (Love et al., 2005). The study was approved by the Institutional Review Boards of each of the participating universities and families provided informed consent for services and use of data for evaluation.

Data were collected at ages 1 (14 months), 2 (24 months), 3 (36 months), and 11 years. The sample for the EHSRE was 3001 families. The sampling plan for the age 11 data collection reduced the sample to 2565 (Vogel, Xue, & Moiduddin, 2010). Data collection occurred primarily within families' homes through structured interviews, videotaped observations of parent-child interactions, and examiner-based assessments of children's outcomes. Training of interviewers required demonstrating at least 85% consistency or reliability for administration following the EHSRE protocol (Faldowski, Chazan-Cohen, Love, & Vogel, 2013; Love et al., 2002; Vogel et al., 2010). All child assessors were also required to demonstrate 80% reliability on Examiner Ratings, referenced against standardized ratings of child behavior on a set of six common videotaped child assessments. Videotaped observations were scored by an independent EHSRE research team also reaching 85% reliability (Faldowski et al., 2013; Love et al., 2002; Vogel et al., 2010).

4. Sample description

Our research study used data collected at ages 1, 2, 3, and 11, for which retention was 78%, 72%, 70%, and 54%, respectively (Love et al., 2002; Vogel et al., 2010). This study used data collected from EHSRE participants who were assessed with items we defined as ACEs indicators on at least twice between ages 1 and 3 ($N = 2250$) and again at age 11 ($N = 1632$) which resulted in a final analysis sample of 1469. Participants were racially/ethnically diverse with 33.6% African-American, 22% Hispanic, 40.2% White, and 4.2% other. At enrollment, primary caregivers were 23 years of age ($SD = 6$) on average at their child's birth and 43.5% lacked a high school degree (see Table 1 for family and child demographics at enrollment).

5. Measures

5.1. Adverse childhood experiences

As shown in Table 2, at each age (ages 1, 2, and 3), an EHS-ACE Index was created for this study to match as closely as possible the original constructs (i.e., physical and emotional abuse/neglect, sexual abuse, household substance abuse, incarcerated household member, domestic violence, parental separation and divorce, and parental mental illness). We computed an EHS-ACE Index at each age based on multiple single item responses to hypothetical discipline situations, a stressful life events checklist, and several standardized instruments. The three EHS-ACE indices were then averaged and rounded to represent exposure across infancy and toddlerhood (Table 3).

Computations of abuse and neglect EHS-ACEs included parent responses to hypothetical discipline situations and multiple standardized instruments (see Table 2). Specifically, at ages 1, 2, and 3, parenting behaviors were observed using the Infant-Toddler version of the Home Observation for Measurement of the Environment (HOME; Bradley & Caldwell, 1988; Bradley, 1994). The HOME observes the parent's emotional and physical responsiveness to their child. In the EHSRE study, internal consistency reliability was high at all ages (> 0.76). As seen in Table 2, individual items from the HOME were used in the construction of emotional abuse and physical abuse and neglect. Parent-child interaction behaviors observed during a semi-structured play task, the Three-Bag Task

Table 1
Characteristics of the Sample (N = 1469).

	Percent
Demographics	
Parent Age: Years at Child's Birth (*M*, *SD*)	23 (6)
Race/Ethnicity	40.2
Caucasian	33.6
African-American	22.0
Hispanic	4.2
Other	
Education	43.5
Less than High School Graduate	29.1
High School Graduate or Equivalent	27.3
Some College or Degree	
Child is Male	51.5
Child Outcomes in Fifth Grade	
Child ever had IEP	22.2
Child has current IEP	16.6
Grade retention since First Grade	13.4
Externalizing Problems; Clinically Elevated	25.2
Internalizing Problems; Clinically Elevated	20.7
Attention Problems; Clinically Elevated	13.6
ADD/ADHD since First Grade	14.9
Model Covariates	
Child Emotionality (Age 1: *M*, *SD*)	2.97 (.95)
Child Mental Development Index (Ages 1-3: *M*, *SD*)	92.62 (11.21)
Child Matrix Reasoning (Age 11: *M*, *SD*)	8.44 (3.28)
Percent on School Free/Reduced Lunch (Age 11: *M*, *SD*)	0.61 (0.27)
Household Income (Age 11: *M*, *SD*)	36,064 (31,057)

(Fuligni & Brady-Smith, 2013; Fuligni & Brooks-Gunn, 2013), were also used in computations of abuse and neglect. At ages 1, 2, and 3 the dyad was given three bags of toys and asked to play with the toys in sequence. At all ages, the task was videotaped, and behaviors were coded by child development researchers on a scale adapted from the NICHD Study of Early Child Care (Owen, Barfoot, Vaughn, Domingue, & Ware, 1996). Parent behavior with their children was rated on a 7-point scale. *Detachment* measures a lack of awareness, attention, and engagement with the child. Coding examples included 'flat affect', 'not talking to the child' and 'rarely making eye contact'. *Negative Regard* measures the expression of discontent with, anger toward, disapproval of, and/or rejection of the child. Examples of coding included 'disapproving and/or negative voice', and 'signs of frustration (e.g., sighs, rolling eyes)'. Intercoder agreement was high (94%). To be included as an ACEs indicator, we included the most extreme condition (parents within the top 10% for negative interactions). Also included in abuse and neglect constructs is family conflict, assessed using one subscale from the Family Environment Scale (FES; Moos & Moos, 1994). The conflict subscale measured the extent to which the open expression of anger, aggression and conflictual interactions are characteristic of the family. Parents respond to 5 items on a 4-point scale, where 4 indicates higher levels of agreement with statements such as, "We fight a lot" and "We hardly ever lose our tempers". In the EHSRE study, Cronbach's alpha was computed as 0.65 (1 year), 0.67 (2 years), and 0.68 (3 years). The risk was defined as families scoring in the highest 10% of conflict.

Family functioning ACEs were primarily measured using a stressful life events checklist, however, parental mental illness was assessed using a measure of parental depression (the Center for Epidemiological Studies Depression Scale-Short Form, CESD-SF (Ross, Mirowsky, & Huber, 1983), at ages 1 and 3 and the Composite International Diagnostic Interview Short Form, CIDI-SF (Kessler, Andrews, Mroczek, Ustun, & Wittchen, 1998), at age 2). The CESD-SF scale included 12 items that represent the number of days in the past week the participant experienced symptoms including poor appetite, restless sleep, loneliness, sadness, and lack of energy (Ross et al., 1983). At all assessments, the internal consistency of CESD-SF was high ($\alpha > 0.88$; Love et al., 2002). For the CESD-SF, we used a cutoff score of 16 as an indicator of depression. The CIDI-SF uses a stem-branch logic in which a small number of diagnostic stem questions are used to eliminate respondents who are least likely to be cases before they are asked further symptom questions. An example stem item for depression is "In the past 12 months, have you had a period of two weeks or longer when you felt sad or depressed or empty?". The CIDI-SF yields a score that can be converted to the probability of clinical caseness ranging from 0 to 1 for major depression in the previous 12 months. To indicate depression, we used a probability cutoff of 0.8.

5.2. Academic Status

Parents were interviewed about their children's school experiences. Questions asked at age 11 included whether the child: 1) "ever had an Individualized Education Plan or IEP", 2) had a current IEP at age 11 ("has an IEP now"), and 3) "ever repeated any grades".

Table 2
Adverse Childhood Experiences in the Early Head Start Research and Evaluation Project: Exposure in Percentages.

Original Construct/Question	Scale/Items	Age 1 N = 1,372	Age 2 N = 1,337	Age 3 N = 1,310	Average N = 1,459
1 Emotional Abuse: "Did a parent or other adult in the household often or very often swear at you, insult you, put you down, or humiliate you? or Act in a way that made you afraid that you might be physically hurt?"	HOME Inventory[a]: Shouted at Child during Assessment; High Parent Negative Regard in Three-Bag Task[b]; Hypothetical Discipline ("Shout at", "Punish verbally", "Shake")	13.8	17.6	17.8	16.4
2 Physical Abuse: "Did a parent or other adult in the household often or very often push, grab, slap, or throw something at you? or Ever hit you so hard that you had marks or were injured?"	HOME Inventory[a]: Slapped/Spanked Child during Assessment; Hypothetical Discipline ("Slap or physically punish"); Child Spanked Daily	12.0	18.1	15.5	15.2
3 Sexual Abuse: "Did an adult or person at least 5 years older than you ever touch or fondle you or have you touch their body in a sexual way? or Attempt or actually have oral, anal, or vaginal intercourse with you?"	Child in Foster Care; Child Attacked	2.1	1.6	1.6	1.8
4 Emotional Neglect: "Did you often or very often feel that no one in your family loved you or thought you were important or special? or Your family didn't look out for each other, feel close to each other, or support each other?"	High Family Environment Scale[c] Family Conflict; High Parent Detachment in Three-Bag Task[b]	20.0	15.1	10.0	15.1
5 Physical Neglect: "Did you often or very often feel that you didn't have enough to eat, had to wear dirty clothes, and had no one to protect you? or Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?	HOME Inventory[a]: Unsafe Play Environment and/or Did Not Keep Child in Visual Range	37.4	34.1	11.7	27.9
6 Parental Separation: "Were your parents ever separated or divorced?"	Current Relationship with Child's Father ("Not in any Relationship", "Separated/Divorced", "Deceased")	22.0	27.3	32.8	27.3
7 Domestic Violence: "Was your mother or stepmother often or very often pushed, grabbed, slapped, or had something thrown at her? or Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard? or Ever repeatedly hit over at least a few minutes or threatened with a gun or knife?"	Stress Checklist: Mother Abused	12.1	10.9	10.1	11.0
8 Substance Abuse: "Did you live with anyone who was a problem drinker or alcoholic, or who used street drugs?"	Stress Checklist: Lived with Addict	12.4	9.9	8.4	10.3
9 Household Mental Illness: "Was a household member depressed or mentally ill, or did a household member attempt suicide?"	Center for Epidemiological Studies-Depression-Short Form[d] (Score > 16) at ages 1 and 3; Composite International Diagnostic Interview Short Form (Score > .80) at age 2	15.1	12.4	14.8	14.1
10 Household Incarceration: "Did a household member go to prison?"	Stress Checklist: Friend/Relative in Jail	32.4	33.7	34.7	33.6
Totals: None		23.2	21.7	26.7	19.1
One		26.5	27.7	27.4	30.9
Two		23.1	22.4	20.1	27.3
> Three		27.2	28.2	25.8	22.6
Total (*M, SD*)		1.68 (1.33)	1.70 (1.32)	1.57 (1.33)	1.53 (1.04)

Notes: a. Bradley and Caldwell (1988), Bradley (1994). b. Fuligni and Brady-Smith (2013), Fuligni and Brooks-Gunn (2013). c. Moos and Moos (1994). d. Ross et al. (1983). e. Kessler et al. (1998).

Table 3
Adjusted Odds Ratios for Academic Status and Adaptive Behavior by Adverse Childhood Experiences Scores.

	Number of ACEs			
Construct	1	2	3 or More	Wald
Academic Status				
Child ever had IEP	1.84 (1.04–3.25)*	1.62 (0.88–2.97)	2.65 (1.42–4.95)**	10.62*
Child has current IEP	1.49 (0.76–2.9)	1.51 (0.75–3.03)	2.48 (1.22–5.08)**	7.82*
Grade retention since First Grade	1.60 (0.79–3.28)	2.06 (0.98–4.34)†	2.58 (1.2–5.55)**	6.5†
Adaptive Behavior				
Externalizing Problems	1.42 (0.83–2.44)	2.67 (1.54–4.64)***	5.36 (3.02–9.53)***	48.14***
Internalizing Problems	1.34 (0.78–2.3)	1.99 (1.14–3.48)*	3.92 (2.19–7.01)***	29.84***
Attention Problems	0.91 (0.45–1.83)	1.57 (0.78–3.14)	2.73 (1.34–5.55)**	17.08***
ADD/ADHD since First Grade	1.56 (0.79–3.08)	2.08 (1.04–4.18)*	3.15 (1.53–6.48)**	11.66**

Notes: Odds Ratios (95% CIs) represent comparisons to a zero ACEs score. Adjustments included EHS random assignment and location, parental race, education, and age at enrollment, family income at age 11, percent free and reduced lunch of the school at age 11, child gender, temperament at age 1, and cognitive abilities at ages 1, 2, 3, and 11. †$p < .10$; *$p < .05$;**$p < .01$; ***$p < .001$.

5.3. Adaptive behavior

Behavior Problems were assessed using the 113 items on the Child Behavior Checklist for Ages 6–18 (CBCL/6-18; Achenbach & Rescorla, 2001). The CBCL/6-18 was used at age 11 years to cover a wide range of social, emotional, and behavioral problems. Items are rated by parents about the child's behavior in the last 6 months on a range of 0 (not true), 1 (somewhat or sometimes true), and 2 (very true or often true). There is extensive normative data available for children ranging from 6 to 18 and the instrument has been widely used across cultures. We used the two summary scales, Internalizing Problems and Externalizing Problems, and a specific subscale of Attention Problems. Example items representing each of the scales include "there is very little he/she enjoys", "cruelty, bullying, or meanness to others", and "can't concentrate, can't pay attention for long". Validity and reliability are excellent with internal consistency reliability estimates at or better than 0.84 (Vogel et al., 2010). We used the recommended T-scores of 60 or greater for internalizing and externalizing behavior and 65 or greater for attention problems, which indicates borderline or clinically meaningful issues. Finally, parents responded to the question "since child started first grade, has he/she been diagnosed by a health professional or any other professional with ADD or ADHD", which was used to indicate a diagnosis of Attention Deficit Disorder/Attention Deficit Hyperactivity Disorder.

5.4. Covariates

In an effort to isolate the effect of EHS-ACEs from other correlates, we included variables about the program (assignment and location), parents (race, education, age at enrollment, and income reported at age 11), and school (percent free and reduced lunch) in analyses. We also controlled for characteristics of the child including gender, temperament at age 1, and cognitive abilities assessed at ages 1, 2, 3, and 11. Child intelligence, family socioeconomic status, and parenting quality have all been examined as factors associated with the outcomes in the current study (Masten et al., 2005). Temperament was measured with the Emotionality, Activity, Sociability, & Impulsivity (EASI) survey (Buss & Plomin, 1984). Child difficult temperament was assessed using parent reports on five items that assess emotionality (e.g., "often fusses or cries", "gets upset easily"), which were rated on a 5-point Likert scale from 'not at all like' to 'very much like' their child. Internal consistency reliability was 0.72. Cognitive abilities were measured at ages 1, 2, and 3 using the Bayley Scales of Infant Development-II Mental Development Index (MDI; Bayley, 1993). MDI scores reflect performance on the cognitive and language portion of the assessment with high internal consistency reliability ($\alpha = 0.88$; Love et al., 2002). Cognitive abilities were measured at age 11 the Matrix Reasoning subtest of the Wechsler Intelligence Scale for Children(WISC-IV; Weschsler, 2003), which has high internal reliability ($\alpha = 0.89$).

6. Approach to analysis

As the outcomes examined in the current study are binary, we used logistic regression analyses (IBM SPSS Statistics Version 24.0; IBM Corporation, 2015) to examine the association between EHS-ACE groups (children in families with scores of 0, 1, 2, and 3 or more) and academic and behavioral outcomes. All analyses included the covariates described above. The observations are independent and there were no problems with multicollinearity between EHS-ACEs and other model covariates (variance inflation factors, maximum = 3.12; tolerance values, minimum = 0.32; O'Brien, 2007; Pedhazur, 1997). We demonstrated that the sample size in the current study is sufficient using odds ratios reported in previous ACEs work (Bethell et al., 2014; Hunt et al., 2017) to inform power estimates (Chinn, 2000). Setting alpha at .05 and power at 0.95, the current sample would be able to detect an odds ratio of 1.69 for the smallest (0.03) and 1.23 for the largest (0.7) effect sizes previously published (Demidenko, 2007).

7. Results

Averaged across ages 1, 2, and 3, children were exposed to zero (19%), one (31%), two (27%), and three or more ACEs (23%). Logistic regression analyses, controlling for the aforementioned covariates, showed ACEs were significantly associated with school outcomes. There were significant associations between ACEs and parental report of the child having an individualized educational program (IEP) since starting school ($Wald(3) = 10.62$, $p = .01$) and in the current school year ($Wald(3) = 7.82$, $p = .05$). For example, the odds of having an IEP for children who were in families with 3 or more ACEs across infancy and toddlerhood were more than twice those of children with no ACE exposure, when examining all grades ($OR = 2.65$, $p = .002$, CI [1.42, 4.95]) and the current grade ($OR = 2.48$, $p = .01$, CI [1.22, 5.08]). Further, ACEs were marginally associated with having been retained a grade in school ($Wald(3) = 6.5$, $p = .09$). Compared to children with no ACE exposure, the odds of having been retained in school were at least double when children were exposed to ACEs (2 ACEs $OR = 2.06$, $p = .06$, CI [0.98, 4.34]; 3 or more ACEs $OR = 2.58$, $p = .02$, CI [1.2, 5.55]).

Findings from the logistic regressions also demonstrate that ACEs are associated with children's behavior. ACEs were associated with parent report of current child behavior problems on the CBCL for global externalizing ($Wald(3) = 48.14$, $p < .001$) and internalizing ($Wald(3) = 29.84$, $p < .001$) problems, as well as issues with attention ($Wald(3) = 17.08$, $p < .001$). For externalizing behaviors, the odds of having clinically elevated problems were nearly three ($OR = 2.67$, $p < .001$, CI [1.54, 4.64]) times higher for children with 2 and over five times higher for children with 3 or more average ACEs ($OR = 5.36$, $p < .001$, CI [3.02, 9.53]) than those with no ACEs. For internalizing behaviors, the odds of having clinically elevated problems were twice ($OR = 2$, $p = .02$, CI [1.14, 3.48]) and nearly four times ($OR = 3.92$, $p < .001$, CI [2.19, 7.01]) for children with 2 and 3 or more average ACEs than those with no ACEs. For attention, the odds of having clinically elevated problems were nearly three times higher ($OR = 2.73$, $p = .006$, CI [1.34, 5.55]) for children with 3 or more average ACEs than children in families with no ACEs. Not surprisingly, when you examine whether the child has had an ADD/ADHD diagnosis during their schooling, ACEs are significantly associated ($Wald(3) = 11.63$, $p = .01$). Compared to children with no ACEs, the odds of having an ADD/ADHD diagnosis were twice ($OR = 2.08$, $p = .04$, CI [1.04, 4.18]) and triple ($OR = 3.15$, $p = .002$, CI [1.53, 6.48]) for children having an average of two and three or more ACEs across infancy and toddlerhood, respectively.

8. Discussion

Our study is the first to examine early exposure to ACEs, specifically in infancy and toddlerhood, on behavioral and academic outcomes in middle childhood. Our findings demonstrated that ACEs exposure in infancy and toddlerhood was associated with an increased likelihood that a child would exhibit maladaptive behavior and have less optimal academic outcomes. Our findings on behavioral outcomes are similar to what has been demonstrated in existing longitudinal studies (Hunt et al., 2017; Jimenez et al., 2016; McKelvey et al., 2017), namely exposure to ACEs is associated with maladaptive behavior. However, our study extends our current understanding of the longitudinal impact of ACEs in several ways. Our study is only the second to focus specifically on ACEs experienced in infancy and toddlerhood and it expands upon the findings in the existing study (McKelvey et al., 2017) by examining outcomes later in development. Further, we expand our understanding of the impact of ACEs on adaptive behavior, as we are the first study to examine clinically elevated attention problems using a standardized tool. Addressing this gap is of particular importance as attention has been suggested a more salient predictor of academic outcomes than general internalizing and externalizing problems (Breslau et al., 2009).

Our findings also suggest that ACEs experienced before the age of three years are associated with having an IEP in any grade since first grade, as well as in the current school year. Early ACEs were also associated with having been retained a grade in school. As would be expected based on cross-sectional studies examining these outcomes, children who experience more ACEs had the least optimal outcomes. These findings were robust even after controlling for correlates of these outcomes in middle childhood (i.e., poverty of the family and the school environment, and the child's cognitive functioning). Our findings are similar to cross-sectional studies that have examined the association between ACEs and children having an IEP and being retained in school (Bethell, Newacheck, Hawes, & Halfon, 2014; Porche et al., 2016), but also extend what is known by being the first to examine adversity before the start of school on later school outcomes.

While we have discussed the findings of the effect of ACEs on behavioral and academic outcomes separately, we recognize the associations between these outcomes that have been theorized and tested in the literature (Achenbach et al., 2016; Masten & Cicchetti, 2010). Developmental cascades models have examined the direction of influence between behavioral health and outcomes academic competencies from middle childhood into adolescence and adulthood. Multiple hypotheses that describe the interactions of behavioral and academic functioning across time have been proposed. The hypotheses include, 1) externalizing behavior problems increases future vulnerability to academic problems (adjustment erosion hypothesis), 2) academic difficulties result in the genesis or worsening of behavioral problems (academic incompetence hypothesis), and 3) cascades are the result of other variables, such as trauma or economic disadvantage (shared risk hypothesis). Support for each of these hypotheses has been documented in the literature; however, there is not a clear consensus on the direction of influence, perhaps because of the heterogeneity in the ages examined across studies (Masten et al., 2005; Moilanen, Shaw, & Maxwell, 2010; Obradović, Burt, & Masten, 2010; Vaillancourt, Brittain, McDougall, & Duku, 2013; Van der Ende, Verhulst, & Tiemeier, 2016; Wigelsworth, Qualter, & Humphrey, 2017).

Drawing from additional studies that have examined ACEs in infancy and toddlerhood on later development, it is clear that early exposure to adversity is associated with difficulty regulating emotion and increases in aggressive behaviors (McKelvey et al., 2017, 2016; Murray, Rosanbalm, Christopoulos, & Hamoudi, 2015). A recent study examined temporal patterns of exposure to ACEs across

infancy and toddlerhood on later development at age 5 (McKelvey et al., 2017). The study examined cognitive and language development, as well as emotion regulation and aggressive behaviors. An interesting pattern of findings emerged where behavioral health was negatively associated with all patterns of ACEs exposure. In other words, exposure to ACEs at any time in development had a negative impact on child behavior. For cognitive and language development, however the findings suggested that the most proximal insult was the most robust and that patterns of children with earlier compared to later exposures to ACEs were less significant.

The universal insult of ACEs on socioemotional functioning is somewhat unsurprising. Theoretically and empirically, caregivers who expose their children to ACEs, through less optimal parenting or family context, likely also provide fewer opportunities for children to develop practice and develop self-regulatory skills (Morris, Silk, Steinberg, Myers, & Robinson, 2007). Self-regulatory skills, including emotion regulation and attention (Simonds et al., 2007) translate into adaptive or maladaptive behavior and attention in the learning situations, which may eventuate into academic competence (Morrison et al., 2010; Simonds et al., 2007). Indeed, one study that examined early behavioral problems on later academic skills reported that, when externalizing, internalizing, and attention problems at school entry are examined simultaneously, that problems with attention are the strongest predictor of achievement in math and reading at age 17. This study does not test a specific hypothesis; however, the findings suggest the need to examine developmental cascades earlier in the life course.

One limitation of the current study is the use of an index of ACEs exposure. The use of an index makes it impossible to disentangle the role of individual ACEs on development, therefore these analyses do not permit knowing how different ACEs are driving the effects on behavioral and academic outcomes. Further, it is clear that behavior problems and academic status are associated and, as stated, the current study does not examine the direction of the associations between the outcomes. The families used in this study were eligible for Early Head Start, which means they have greater socio-economic risk than families from the general population. Thus, the study should be replicated in a more economically diverse sample.

The American Academy of Pediatrics recommends that pediatricians screen for toxic stress and provide resources to help families address those risks (Garner et al., 2012). Findings from this study highlight that screening and intervention should start very early in the life. Screening for ACEs requires sensitivity as ACEs include highly stigmatized and even illegal behaviors, including child maltreatment, domestic violence, mental illness, and substance abuse. Asking parents about their child's ACEs could be potentially incriminating and, as a result, likely unreliable. The EHS-ACEs index used in the current study did not directly document child abuse and neglect of the children but extrapolated these adversities through observation and self-reported parenting behavior. This could be seen as a limitation of the current work in that our findings are not directly comparable to data from child welfare samples. However, the similarity of our findings with the literature from child welfare samples provides additional evidence that ACEs can be assessed using proxy variables that are associated with, but do not ask about abuse, neglect or other illegal activities directly (Marie-Mitchell & O'Connor, 2013; McKelvey et al., 2016). This is especially important because the parent is not only the source of identification of the risks but also the partner in intervention activities that would support the improvement of the child's environment and optimal development.

Our data suggest that interventions that support the development of children in high-risk families should start in infancy. In addition to pediatric medical visits, ACEs screenings using these less intrusive methods could also be integrated into early care and education and parent education settings, providing interventionists an avenue to discuss the child's daily experiences and how these influence the child's development. It also provides for information needed for appropriate referrals to additional services. It is imperative to start intervention efforts for high-risk children and families starting early in life when it is more cost effective to support a child to stay on a typical developmental trajectory.

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study and their parents.

Conflictof interest

The authors declare that they have no conflict of interest.

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