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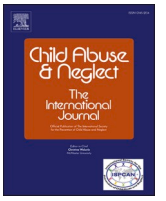

The long arm of adversity: Children's kindergarten math skills are associated with maternal childhood adversity☆

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ABSTRACT

Background: Childhood adversity is associated with poorer health and lower academic achievement later in life. Poor math skills in particular place individuals at higher risk for physical and mental illness, unemployment, and incarceration, suggesting math achievement may be one explanatory mechanism linking adversity to later functioning. While it is well documented that children's adversity is associated with lower academic achievement, it is also plausible that adversity *mothers* experience across their lifetime may affect the child's academic achievement.
Objective: Determine whether adversity children directly experience and adversity mothers experience in their own childhood and/or adulthood is related to children's kindergarten math skills.
Participants and methods: 91 Mothers completed the Assessment of Parent and Child Adversity questionnaire, and their kindergartners completed the KeyMath-3 Diagnostic Assessment.
Results: Maternal childhood adversity, but not adulthood adversity, was negatively related to children's numeration ($\beta = -0.27$, 95% CI [−0.48, −0.05], $p = .015$) and addition/subtraction abilities in kindergarten ($\beta = -0.25$, 95% CI [−0.46, −0.04], $p = .023$). Maternal childhood maltreatment and other adversity were together related to their child's numeration only ($R^2 = 0.08$, 95% CI [0.02, 0.23], $p = .026$). Prevalence of children's direct adversity was low and not related to their kindergarten math skills.
Conclusions: Our findings suggest that adversity impacts children's math skills as early as kindergarten via the intergenerational transmission of maternal adversity. Mothers that experienced early-life adversity and their children may benefit from early intervention to level the playing field at school entry.

1. Introduction

Childhood adversity includes maltreatment (e.g., abuse and neglect), exposure to violence, parental divorce, living with a person experiencing mental illness, experiencing discrimination, being bullied, and living in foster care (Cronholm et al., 2015). In addition to poorer physical and mental health in adolescence and adulthood (Felitti et al., 1998; Gilbert et al., 2015; Green et al., 2010;

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Humphreys et al., 2020; LeMoult et al., 2020), childhood adversity is also associated with lower academic achievement later in life (Blodgett & Lanigan, 2018; Coohey et al., 2011; Eckenrode et al., 1993). In fact, academic achievement may be one explanatory mechanism linking adversity to later functioning. Poor math skills in particular place individuals at higher risk for leaving school early, physical and mental illness, unemployment, and incarceration (Litster, 2013; Parsons & Bynner, 2006), and poor math skills at school entry (above and beyond reading and attention skills) are associated with poor academic achievement in later grades (Duncan et al., 2007). Moreover, while most studies examining the link between childhood adversity and academic achievement focus on a child's direct experience with adversity, emerging evidence suggests that maternal adversity may indirectly influence children's physical and mental health (King et al., in press; Waters et al., 2014). It remains unclear, however, whether adversity experienced by mothers during their own childhood or adulthood influences their child's math achievement. Understanding this relation will inform how early life experiences and environments contribute to children's academic achievement and associated life outcomes, and may help to identify a pathway of intergenerational transmission in which clinicians and educators may eventually intervene.

1.1. Children's direct experience with adversity and academic achievement

It is well documented that children's direct exposure to adversity is associated with lower academic achievement. Extensive research shows that maltreatment in childhood and adolescence is associated with poorer math and reading abilities (Coohey et al., 2011; Crozier & Barth, 2005; Eckenrode et al., 1993; Rouse & Fantuzzo, 2009). Earlier childhood maltreatment (e.g., prior to kindergarten) is associated with disproportionately poorer academic outcomes (Fantuzzo et al., 2011) and these disparities may persist despite academic improvements over the course of a year (Kurtz, Gaudin, Howing, et al., 1993). Additional studies show that children that witness violence, are bullied, or who live with a parent experiencing mental illness show poorer academic outcomes (Amato & Anthony, 2014; Claessens et al., 2015; Hurt et al., 2001; Kitzmann et al., 2003; Schwartz & Hopmeyer, 2003). Many types of childhood adversity co-occur (Dong et al., 2004; Fantuzzo et al., 1997; Matsumoto et al., 2021; Spaccarelli et al., 1994), such as maltreatment and interparental violence (Appel & Holden, 1998; Hamby et al., 2010; McGee et al., 1997). Recent studies show that, relative to those who did not experience adversity, children that experience at least 2 childhood adversities are more than twice as likely to repeat a grade or not meet grade expectations (Bethell et al., 2014; Blodgett & Lanigan, 2018). The degree to which childhood adversity affects various components of math achievement, however, is unknown because the extant literature has focused on broad measures of math and reading achievement.

1.2. Children's indirect experience with adversity and math achievement

In addition to adversity children experience directly, it is also plausible that adversity experienced by the child's caregivers may indirectly affect the child's math achievement. Maternal adversity during pregnancy is associated with offspring's math achievement in middle childhood (J. Li et al., 2013; Niederhofer & Reiter, 2004), yet such studies leave open multiple mechanistic possibilities. Extensive research demonstrates the importance of parenting behaviors and the home environment on the development of children's math skills (Elliott, Bachman, 2018a, 2018b; Levine et al., 2019). Mothers may experience various types of adversity during their child's lifetime that indirectly impact their child (e.g., abortion or miscarriage, financial/employment problems) that in turn may reduce the availability of supportive and stimulating interactions (e.g., King et al., 2021), including those that foster the development of children's math skills. Even the stress mothers experience from the duties of parenting itself may indirectly impact children's academic achievement negatively, potentially via quality of the parent–child relationship (Harmeyer et al., 2016; Tan et al., 2017). To date, limited research explores whether mothers' experiences of adversity is linked to children's math achievement. One longitudinal study found that worse maternal adversity is related to children's poorer math performance by 6th grade (but not 1st, 2nd, or 3rd) (Teo et al., 1996). It remains unclear, however, whether the timing of maternal adversity influences how and when it impacts children's math achievement.

1.3. Intergenerational transmission of adversity and math achievement

Another possibility is that adversity mothers experience during their own childhood, as opposed to during their child's lifetime, may indirectly influence their children's math achievement, setting into motion a pathway for intergenerational transmission of academic achievement decades earlier and well prior to conception. Previous work shows that maternal childhood adversity may indirectly influence children's physical and mental health, as well as behavioral and cognitive outcomes (Bowers & Yehuda, 2016). Mothers' experience of childhood maltreatment is associated with poorer parenting practices (Savage et al., 2019), an increased risk of engaging in child maltreatment (Madigan et al., 2019), and mental illness across childhood, adolescence, and adulthood (Plant et al., 2017; Yehuda et al., 2008). Thus, the pathway connecting maternal adversity and children's math skills may begin decades before conception. However, it remains unclear whether all types of maternal adversity, and maternal adversity during childhood and/or adulthood, are similarly related to children's math skills.

1.4. The current study

We measured lifetime adversity of mothers and their kindergartners using the newly validated Assessment of Parent and Child Adversity (King et al., in press), and we measured kindergartner's math skills using the KeyMath-3 Diagnostic Assessment (Connolly, 2007). We focus on kindergarteners because: (1) school entry is a crucial developmental point in which children's math skills mostly reflect home environmental factors, and (2) math skills at school entry are associated with children's long-term academic achievement (e.g., Duncan et al., 2007). First, we aimed to determine whether the adversity children directly experience is related to their kindergarten math skills. We predicted that childhood maltreatment would be more strongly associated with math skills, relative to 'other' more broadly defined adversity (e.g., parental divorce, witnessing violence, experiencing discrimination) because the neurobiological consequences of adversity are believed to differ based on the type and severity of the exposures (McLaughlin et al., 2019). Second, we tested whether the adversity mothers experience in their own childhood and/or adulthood are related to their child's kindergarten math skills. We predicted that maternal adulthood adversity, relative to maternal childhood adversity, would be more strongly associated with children's math achievement because of the known link between recent stressors and parenting behaviors (Crnic et al., 2005; Repetti & Wood, 1997). Alternatively, given a social-contextual model (Belsky, 2014), it is plausible that both maternal childhood and adulthood adversity would be linked to children's math outcomes as suggested by the large literature linking mothers' own history of childhood adversity with their parenting practices (Lotto et al., 2021).

2. Methods

2.1. Participants

Ninety-one 5- to 6-year-old children ($M = 5.98$, 44 female) and their mothers completed the study. We asked mothers to report their child's race/ethnicity in a single question. In the final sample, children were 83.7% White, 1.1% Asian, 6.5% Latinx, 6.5% Multiracial, 1.1% "other", and 1.1% declined to answer. The socioeconomic make-up of our final sample, as measured by maternal education, was as follows: 1.1% high school; 5.5% some college; 4.4% associate degree; 35.2% bachelor's degree, 31.8% master's degree; 22% terminal/professional degree (e.g., MD, JD, PhD, etc.). Mothers provided consent and children provided their assent in accordance with our University IRB policies.

2.2. Procedures

Families were recruited through social media advertisements, flyers, university listservs and researchmatch.org. While we invited any parent/legal guardian to participate with their child, only mothers participated in the study. During a behavioral visit, children completed a larger testing battery designed to examined math abilities and neurocognitive development. Mothers completed a battery of questionnaires designed to measure their child's home environment and their beliefs and attitudes about their child's academic abilities. Our final sample includes only mother–child dyads that completed both the math achievement test and adversity questionnaires. For clarity we therefore refer to the caregiver/parent as "mother" throughout.

2.3. Measures

2.3.1. Math achievement

We assessed children's math achievement using the Numeration, Written Computation: Addition & Subtraction, and Foundations of Problem Solving subtests of the KeyMath-3 (KM-3) Diagnostic Assessment (Connolly, 2007). The Numeration subtest is an untimed verbal-response and picture-based measure of children's basic math concepts, including number comparison, counting, and simple calculation. The Addition & Subtraction subtest is an untimed written measure of children's simple operation abilities, including single- and double-digit addition and subtraction. The Foundations of Problem Solving subtest is an untimed verbal-response and picture-based measure of children's ability to use math concepts to solve simple problems. We used age-normed standardized scores for all analyses. Since children typically learn simple addition and subtraction during kindergarten, children that were in the first half of their kindergarten year were too young for raw scores to be age normed. Thus, 7 children were excluded from analyses including the Addition & Subtraction subtest.

2.3.2. Assessment of Parent and Child Adversity (APCA)

We assessed mothers' and children's exposure to adversity using the APCA (King et al., in press). The APCA is a parent-report measure of 40 adverse experiences mothers may have experienced independent of their child, and 10 adverse experiences children may have experienced either independent of their mothers (e.g., bullying at school) or because their mothers (e.g., maltreatment by parent). The APCA is structured so that parents first answer questions about their own exposure, with follow-up questions that address the severity of the event and potential indirect exposure to the child. After this section, parents are asked about their child's direct

Table 1
Correlations between adversity types and children's kindergarten math skills.

	Variable ($N = 91$)	Mdn	(SD)	Skewness (Z-score)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1.	Parent's Childhood Adversity	3	(3.50)	5.17											
2.	Parent's Adulthood Adversity	5	(3.78)	2.50	0.32**										
3.	Parent's Childhood Maltreatment Adversity	0	(1.15)	9.87	0.63***	0.14									
4.	Parent's Childhood Other Adversity	3	(2.71)	3.45	0.97***	0.31**	0.47***								
5.	Parent's Adulthood Maltreatment Adversity	0	(0.89)	8.48	0.17	0.50***	0.14	0.12							
6.	Parent's Adulthood Other Adversity	5	(3.31)	1.72	0.31**	0.99***	0.12	0.31**	0.37***						
7.	Child's Direct Adversity	0	(0.94)	6.11	0.08	0.25*	−0.01	0.08	0.10	0.24*					
8.	Child's Direct Maltreatment Adversity	0	(0.35)	13.10	−0.03	0.20	0.03	−0.03	0.13	0.19	0.50***				
9.	Child's Direct Other Adversity	0	(0.79)	6.73	0.07	0.22*	−0.05	0.08	0.09	0.22*	0.97***	0.29**			
10.	Child's Numeration Score	12	(3.04)	−3.20	−0.28**	−0.1	−0.23*	−0.24*	−0.09	−0.09	−0.05	0.07	−0.08		
11.	Child's Addition/Subtraction Score[a]	12	(2.68)	−3.20	−0.30**	−0.13	−0.21	−0.27*	0.04	−0.15	0.01	−0.01	0.02	0.61***	
12.	Child's Problem Solving Score	12	(2.41)	1.16	−0.05	−0.11	−0.03	−0.04	−0.05	−0.12	0.00	0.18	−0.04	0.61***	0.57***

Note: Mdn, median; SD, standard deviation
* $p < .05$.
** $p < .01$.
*** $p < .001$.
[a] N = 84.

adversity experiences, with follow-up questions about the severity of the event.

For both mothers and children, we classified adverse experiences as "maltreatment" or "other". Maltreatment experiences included physical, emotional and sexual abuse, and physical and emotional neglect. Other adverse experiences were more broadly defined and included a serious accident, a natural disaster, emigrating to a foreign country, having trouble communicating, incarceration, discrimination, parental divorce, adoption or foster care, financial and/or employment problems, a serious physical/mental illness, abortion/miscarriage, child separation, death of a loved one, robbery/mugging, and neighborhood violence. We further classified maternal adversity by time it occurred in the mothers' lifetime, either during their own childhood (<18 years old) or adulthood (>18 years old, inclusive). Thus, the APCA provided a measure of the number of mothers' maltreatment and other adverse experiences that occurred in either their childhood and adulthood, and a measure of the number of children's maltreatment and other adverse experiences. See Supplementary Tables 1 and 2 for description of maternal and childhood adversity exposure.

2.4. Analysis plan

Our primary goal was to determine whether children's kindergarten math skills are related to children's and mothers' experience of adversity. In separate analyses we tested the relation between children's math skills and children's direct maltreatment and/or other adversity, mothers' childhood and/or adulthood adversity, and mothers' childhood maltreatment and/or other adversity.

For each of these effects of interest, we first correlated the number of adverse experiences (e.g., childhood maltreatment, childhood other) with children's math skills scores (e.g., numeration, addition/subtraction). To test for the unique contribution of each type of adverse experience, we then submitted the number of relevant adverse experiences as predictor variables and math skills scores as outcome variables to separate linear regressions. Together, these analyses should reveal whether the influence of adversity on children's kindergarten math skills is specific to one or both adversity variables entered. Exploratory analyses revealed that adversity measures were positively skewed (see Table 1). Therefore, we used Spearman's rank-order correlations and rank-ordered measures prior to submitting to linear regression analyses. Note that we used age-normed standardized math scores to account for effects of age on math abilities.

We also conducted supplementary sensitivity analyses in which we included children's sex/gender as a covariate and, separately, examined adversity severity (rather than count) as the dependent variable. Given that effects were largely unchanged when considering these alternative models, we report results with adversity counts as the dependent variable and exclude sex/gender as a covariate.

3. Results

3.1. Children's direct maltreatment and other adversity

We first tested whether children's direct maltreatment and other adversity was related to their kindergarten math skills. We found that neither maltreatment nor other types of adversity were related to any of the math skill measures (Table 1, *all p's* > 0.09).

While neither children's maltreatment nor other adverse experiences were separately associated with children's math skills, we also tested whether the experience of adversity in general is related to children's math skills. Thus, we submitted children's maltreatment adversity and other types of adversity to linear regressions for each math skill measure separately. However, in none of these models was adversity statistically significantly associated with children's math skills (*all p's* > 0.13).

3.2. Maternal childhood and adulthood adversity

We next tested whether the mothers' childhood or adulthood adversity was related to their child's math abilities (see Table 1). We found that maternal childhood adversity was negatively related to their child's numeration (95% CI [−0.47, −0.09], $p = .007$), and addition/subtraction abilities (95% CI [−0.50, −0.08], $p = .006$), but not their problem-solving abilities (95% CI [−0.25, 0.16], $p = .672$). Conversely, maternal adulthood adversity was *not* related to any of their child's math abilities (all *p's* > 0.240).

To further test the specificity of the relation between maternal childhood adversity and their child's math abilities, we submitted maternal adulthood and childhood adversity to linear regressions for each of their child's math skill measures separately. Overall, these models were statistically significant for their child's numeration ($R^2 = 0.08$, 95% CI [0.01, 0.21], $p = .03$), and addition/subtraction abilities ($R^2 = 0.07$, 95% CI [0.01, 0.22], $p = .046$), but not problem-solving abilities ($R^2 = 0.02$, 95% CI [0.00, 0.12], $p = .502$). Fig. 1 shows that maternal childhood adversity was uniquely related to their child's numeration (β = −0.27, 95% CI [−0.48, −0.05], $p = .015$), and addition/subtraction abilities (β = −0.25, 95% CI [−0.46, −0.04], $p = .023$), but not their problem-solving abilities (β = 0.01, 95% CI [−0.21, 0.23], $p = .930$). Parents' adulthood adversity, however, was not uniquely related to their child's numeration (β = −0.02, 95% CI [−0.24, 0.19], $p = .827$), addition/subtraction (β = −0.02, 95% CI [−0.23, 0.19], $p = .858$), or problem-solving abilities (β = −0.13, 95% CI [−0.35, 0.09], $p = .257$).

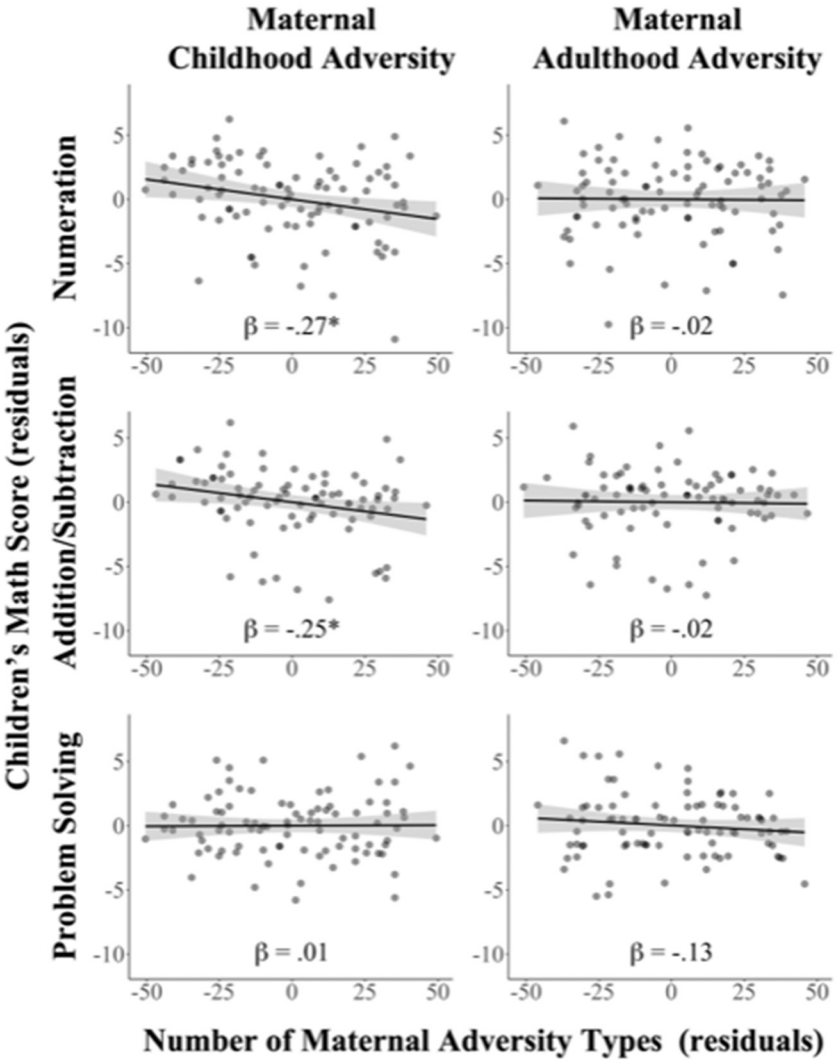

Fig. 1. Partial regression plots depicting the association between maternal childhood adversity and children's kindergarten math skills. Data plotted are residuals controlling for the number of maternal adulthood adversity types. Points are semi-transparent such that overlapping points appear darker. *$p < .05$.

3.3. Maternal childhood maltreatment and other adversity

So far, we have demonstrated that maternal childhood adversity is related to their child's numeration and addition/subtraction abilities. However, it remains unclear whether the influence of maternal childhood adversity on children's math abilities reflects maternal childhood maltreatment or other maternal adversity more broadly defined. Therefore, we also tested whether maternal childhood maltreatment and other childhood adversity was related to their child's math abilities (see Table 1). Maternal childhood maltreatment was negatively related to their child's numeration abilities (95% CI [−0.42, −0.02], $p = .031$, but not addition/subtraction (95% CI [−0.39, 0.00]. $p = .059$) or problem-solving abilities (95% CI [−0.24, 0.19], $p = .773$). Other maternal childhood adversity was related to their child's numeration (95% CI [−0.43, −0.02], $p = .024$) and addition/subtraction abilities (95% CI [−0.48, −0.05], $p = .012$), but not problem-solving abilities (95% CI [−0.25, 0.16], $p = .708$).

To further test the specificity of maternal childhood adversity type (i.e., maltreatment or other), we submitted maternal childhood maltreatment and other childhood adversity to linear regressions for each of their child's math abilities measures separately. Overall, these models were significant for their child's numeration ($R^2 = 0.08$, 95% CI [0.02, 0.23], $p = .026$), but not addition/subtraction abilities ($R^2 = 0.07$, 95% CI [0.01, 0.23], $p = .052$), or problem-solving abilities ($R^2 = 0.00$, 95% CI [0.00, 0.09], $p = .940$). Fig. 2 shows that maternal childhood maltreatment was not uniquely related to their child's numeration (β = −0.19, 95% CI [−0.42, 0.04], $p = .10$), addition/subtraction (β = −0.08, 95% CI [−0.31, 0.14], $p = .459$), or problem-solving abilities (β = 0.02, 95% CI [−0.22, 0.26], $p = .842$). Other maternal childhood adversity was also not uniquely related to their child's numeration (β = −0.14, 95% CI [−0.37, 0.09], $p = .246$), addition/subtraction (β = −0.20, 95% CI [−0.43, 0.03], $p = .093$), or problem-solving abilities (β = −0.04, 95% CI [−0.28, 0.20], $p = .728$).

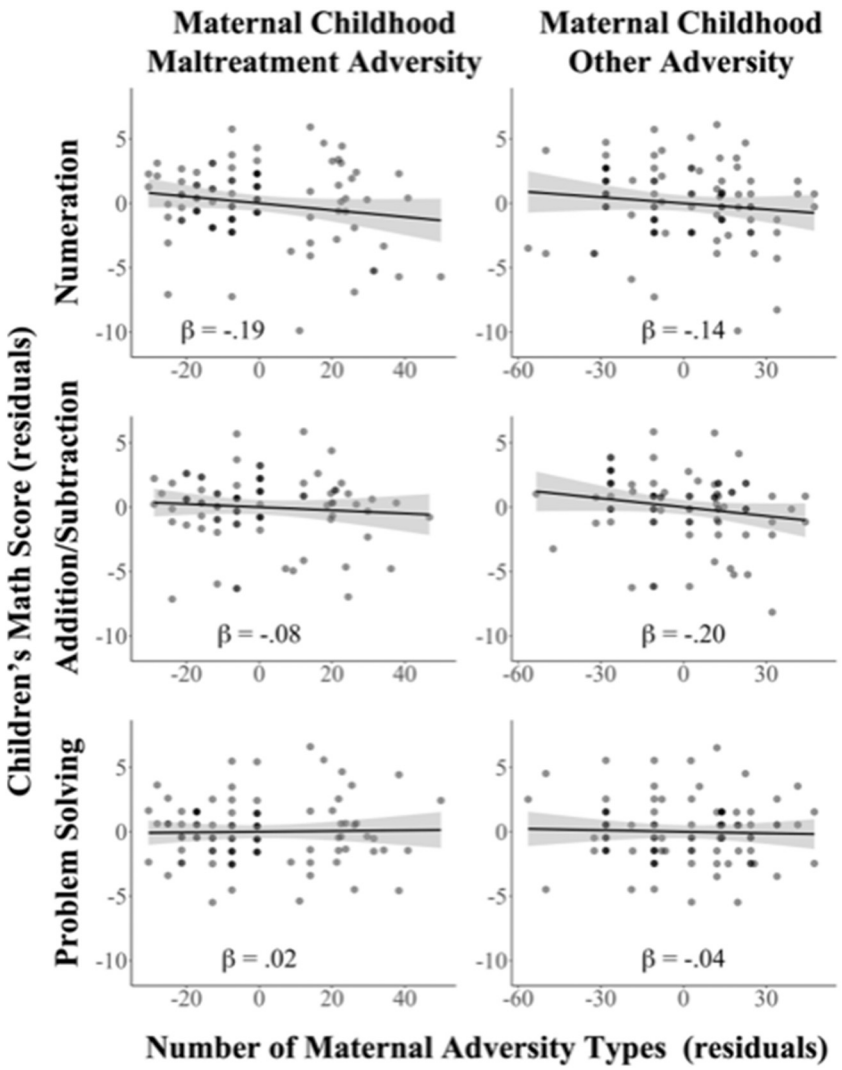

Fig. 2. Partial regression plots depicting the association between maternal childhood maltreatment and other adversity and children's kindergarten math skills. Data plotted are unstandardized residuals. Points are semi-transparent such that overlapping points appear darker. *$p < .05$.

3.4. Summary

We found that maternal childhood adversity, but not maternal adulthood adversity, is negatively related to children's numeration and addition/subtraction abilities in kindergarten. We also found that both maternal childhood maltreatment and other maternal childhood adversity is similarly related to children's numeration abilities. These findings demonstrate that general effects of maternal childhood adversity may influence children's math abilities a generation later.

4. Discussion

In the present study, we tested whether children's and mothers' adversity are associated with children's kindergarten math skills in a sample of 91 mother-child dyads, using the recently validated APCA which measures both maternal and child lifetime adversity with an eye toward characterizing the timing of maternal adversity (King et al., in press). We found that maternal childhood adversity is associated with children's numeration and calculation skills in kindergarten, such that more maternal childhood adversity of any kind is associated with poorer kindergarten math skills a generation later. Conversely, we found no evidence that any type of children's adversity or maternal adulthood adversity is associated with children's math achievement. These findings provide preliminary evidence that adversity may impact children's math achievement as early as kindergarten through intergenerational transmission of maternal adversity.

4.1. Intergenerational adversity and math achievement

To our knowledge, this is the first study to demonstrate that maternal childhood adversity is related to chidlren's math abilities in kindergarten. This finding adds off-spring's math achievement to the list of negative consequences of early-life adversity, including maltreatment, and physical and mental illness (Bowers & Yehuda, 2016; Madigan et al., 2019; Plant et al., 2017; Yehuda et al., 2008). Both maltreatment (e.g., abuse, neglect) and other adversity types (e.g., natural disaster, adoption, parental divorce) during a mother's childhood were similarly related to their child's kindergarten math skills, suggesting adversity during this period, rather than maltreatment specifically, may impact math achievement in the following generation. Early studies of academic achievement primarily focused on child maltreatment and violence exposure (Eckenrode et al., 1993; Kurtz, Gaudin, Wodarski, et al., 1993; Rouse & Fantuzzo, 2009; Teo et al., 1996). Because adverse experiences tend to co-occur, it is challenging to determine whether maltreatment per se or the experience of adversity in general is the culprit (Dong et al., 2004; Fantuzzo et al., 1997; Matsumoto et al., in press). We build on current literature working toward capturing a broader range of adverse experiences to begin to address this challenge (King et al., in press). We speculate that, while intergenerational transmission of adversity may contribute to children's educational attainment, different mechanisms may underlie different adversity types.

4.2. Potential mechanisms linking adversity to math achievement

Despite this, it remains unclear *how* maternal childhood adversity influences math achievement a generation later. Intergenerational transmission of adversity mechanisms linked to children's poorer cognitive and behavioral outcomes, as well as physical and mental health include: epigenetic changes, disruptions to the intrauterine milieu, perinatal mental health, and subsequent parent–child interactions (Bowers & Yehuda, 2016; Roubinov et al., 2021). For example, maternal childhood maltreatment may result in epigenetic processes, such as DNA methylation, that may influence hippocampal development, a key brain region supporting learning and memory (Yehuda & Bierer, 2009; Yehuda & Lehrner, 2018). Conversely, childhood adversity may affect mothers' emotion regulation and emotion socialization practices that later influence parenting behaviors (Cabecinha-Alati et al., 2020; Hajal & Paley, 2020; Rudenstine et al., 2019). Building on this model, mothers' early adversity may influence their children's academic achievement indirectly via disruptions to children's behavioral outcome and/or mental health. Another direction for future work is that of maternal adversity timing. For example, children whose mothers experienced childhood adversity may experience greater behavioral dysregulation which in turn affects attention during the school day and increases in disciplinary action. If these findings are replicated, a key goal of future work is to consider biological and behavioral pathways between maternal childhood adversity and children's academic achievement.

4.3. The timing of adversity

While our current findings suggest maternal *adulthood* adversity is not associated with children's kindergarten math skills, this does not rule out the possibility that this relation may emerge later in childhood (e.g., Teo et al., 1996). Childhood adversity is associated with increased likelihood of experiencing adversity later in life (King et al., in press; S. Li et al., 2019; Parks et al., 2011), and we observe this pattern in our data as well (Table 1, $r = 0.32$, 95% CI [0.11, 0.51], $p = .002$). It is possible that distinct mechanisms underlie the impact of a mother's own childhood and adulthood adversity on their child's academic achievement. Maternal childhood and adulthood adversity may also affect different developmental periods, with the former affecting children as early as kindergarten. If this is true, children of mothers that experience both childhood and adulthood adversity may experience a double hit relative to children of mothers that experience only adulthood adversity. Future work should consider the possibility that maternal adulthood adversity impacts children's math achievement later, potentially as individual differences begin to emerge around 3rd grade (8–10 years old) and maternal adulthood adversity accumulates (Geary & Hoard, 2005; Jordan & Hanich, 2003). Although future work in understanding the mechanisms linking maternal adversity and child math achievement is important for determining targets for intervention, existing parenting interventions in childhood (e.g., Family Check-Up, Parenting Through Change, New Beginnings Program) are linked to improved outcomes for children across a range of domains, including academic achievement (see Sandler et al., 2015), suggesting the potential for such interventions to address the effect of intergenerational transmission of adversity on child academic achievement.

Contrary to previous work (Bethell et al., 2014; Blodgett & Lanigan, 2018; Coohey et al., 2011; Eckenrode et al., 1993; Kurtz, Gaudin, Wodarski, et al., 1993; Rouse & Fantuzzo, 2009), we found no evidence that children's adversity in the first 5 years of life is associated with their kindergarten math skills. Several characteristics of the present sample may help to explain this null finding. First, and thankfully, the prevalence of children's direct adversity was relatively low in the present sample, with only 16.5% of children directly experiencing two or more types of adversity by kindergarten. Second, children's math abilities were above the population mean. Together, these sample characteristics may limit our ability to detect a relation between childhood adversity and math achievement.

4.4. Future directions and limitations

While the present study advances our knowledge about key relations between intergenerational transmission of adversity and educational attainment, there are also key limitations that must be considered in future work. The first key limitation is our measure of adversity exposure – the APCA (King et al., in press). While the APCA addresses a broad range of adversity types, it is not an exhaustive

list. Moreover, our measure of adversity exposure relies on parent report because of the age-range of our child participants. Previous work has demonstrated parents may underreport their child's experiences of early adversity (e.g., Kobulsky et al., 2017), potentially due to social desirability and concern for reporting to child protective services. When considering these two limitations together, it is possible we may be missing adversity exposure in our sample that may be better captured through other measures (e.g., child report and/or teacher report). However, this is a challenge for future work on childhood adversity given the difficulty in reporting on early life events (i.e., infantile/childhood amnesia; Alberini & Travaglia, 2017; Newcombe et al., 2007) and challenges for younger children to clearly communicate the nature and severity of the adversity they experienced (Bartlett, 2020). Finally, the APCA has not been directly compared to other measures (e.g., Traumatic Events Screening Inventory – Child; Ford et al., 2002) to determine how well it captures children's direct adversity exposure, but there is evidence for construct validity for maternal adversity exposure (King et al., in press).

A second key limitation is that our findings reflect a cumulative risk of adversity and do not consider how severity of these adverse experiences may be associated with children's math achievement. Supplementary analyses replaced the cumulative risk (i.e., count based) approach with one that weighted each event by the severity of the exposure, finding a similar pattern of results regardless of the approach to quantifying exposure. A third key limitation of the present study is that our sample fell along the upper half of the socioeconomic spectrum, with 89% of mothers having obtained at least a bachelor's degree relative to the approximately 36% of adult women in the US with similar educational attainment (U.S. Census Bureau, 2020). This selection may have reduced variation in both the exposure to child adversity and in math achievement. Previous literature shows that lower parental socioeconomic status is related to higher child stress exposure and poorer child academic achievement (e.g., Roksa & Potter, 2011). Future work, however, must consider the entire socioeconomic spectrum with an eye toward distinguishing socioeconomic-related adversity (e.g., financial problems) from other, more pervasive forms of adversity (e.g., death of a close relative, discrimination) (see Amso & Lynn, 2017). Finally, a fourth key limitation of the present study is that the sample lacks representation of Black and Latinx(e) families. Historically marginalized populations face increased rates of adversity that both span the socioeconomic spectrum (e.g., discrimination) and are concentrated across the lower end of the socioeconomic spectrum (e.g., poverty). Some types of adversity that marginalized groups face may be distinct from those faced by dominate groups. Moreover, Black and Latinx(e) children tend to have lower scores on math achievement tests, with those in poverty potentially facing a double hit (NECS, 2020). Thus, the present study does not allow the opportunity to examine whether unique adversity experienced by racially marginalized populations may be linked to their children's kindergarten math skills.

4.5. Conclusions

Here, we demonstrate that maternal childhood (but not adulthood) adversity is associated with poorer kindergartener math skills, suggesting that childhood adversity may impact the academic achievement of the subsequent generation. Our findings suggest that a trauma-informed education model (i.e., an approach that considers the ways in which trauma and other adversity may influence classroom behavior and performance) may be usefully expanded to include maternal lifetime adversity that occurs well prior to a child's school entry. Additionally, mothers that experienced early-life adversity and their children may benefit from early intervention to level the playing field at school entry. However, future work should first consider the pathways by which maternal childhood adversity impacts their child's math achievement, including epigenetic processes, parenting behaviors, child behavioral regulation, and/or executive functions.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chiabu.2022.105561.

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