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Maternal childhood trauma and prenatal stressors are associated with child behavioral health

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Abstract

Maternal adversity and prenatal stress confer risk for child behavioral health problems. Few studies have examined this intergenerational process across multiple dimensions of stress; fewer have explored potential protective factors. Using a large, diverse sample of mother–child dyads, we examined associations between maternal childhood trauma, prenatal stressors, and offspring socioemotional-behavioral development, while also examining potential resilience-promoting factors. The Conditions Affecting Neurocognitive Development and Learning and Early Childhood (CANDLE) study prospectively followed 1503 mother–child dyads (65% Black, 32% White) from pregnancy. Exposures included maternal childhood trauma, socioeconomic risk, intimate partner violence, and geocode-linked neighborhood violent crime during pregnancy. Child socioemotional-behavioral functioning was measured via the Brief Infant Toddler Social Emotional Assessment (mean age = 1.1 years). Maternal social support and parenting knowledge during pregnancy were tested as potential moderators. Multiple linear regressions ($N = 1127$) revealed that maternal childhood trauma, socioeconomic risk, and intimate partner violence were independently, positively associated with child socioemotional-behavioral problems at age one in fully adjusted models. Maternal parenting knowledge moderated associations between both maternal childhood trauma and prenatal socioeconomic risk on child problems: greater knowledge was protective against the effects of socioeconomic risk and was promotive in the context of low maternal history of childhood trauma. Findings indicate that multiple dimensions of maternal stress and adversity are independently associated with child socioemotional-behavioral problems. Further, modifiable environmental factors, including knowledge regarding child development, can mitigate these risks. Both findings support the importance of parental screening and early intervention to promote child socioemotional-behavioral health.

Introduction

According to the Developmental Origins of Health and Disease (DOHaD) hypothesis, mothers who experience stress during pregnancy, including socioeconomic (SES) risk and intimate partner violence (IPV), have children who are at increased risk for socioemotional and behavioral difficulties, such as internalizing and externalizing problems.[1–5] Following bioecological models of health and development,[6] such experiences of stress and trauma occur across contexts, ranging from more proximal (e.g., an individual's direct experience of stress, such as trauma or IPV) to more intermediate stressors (e.g., the effects of SES as a stressor on the family as a whole) to more distal (e.g., living in a high crime neighborhood), yet these multiple contexts are often not examined simultaneously. Experiences across these multiple levels of influence have the potential to impact not only the pregnant mother's wellbeing but may also have intergenerational effects for their offspring.[7] Even beyond her experiences during pregnancy, a growing body of research also highlights intergenerational effects of mothers' histories of experiencing trauma (e.g., physical or sexual abuse), during their own childhoods, on their offspring decades later.[4,8,9]

A range of maternal stressors and risk factors, occurring across levels of influence, have been implicated in children's socioemotional and behavioral development, but are often studied in isolation or as part of a more global, cumulative risk score that ignores the independent contribution of different types of stress exposures.[10,11] In one exception, a recent study examined

how multiple maternal stressors, including self-reports of prenatal psychosocial risk (e.g., pregnancy stress, mental health), maternal childhood adversity, and health risk (e.g., pregnancy complications), were associated with poorer infant development at age one.[12] Despite the advances and novel contributions of recent research, the large majority of these studies still ignore the broader neighborhood context. A growing body of epidemiological and health research indicates that broader neighborhood factors – such as objective measures of poverty or residential stability – are associated with physical and mental health problems.[13–15] Fewer studies have looked at the associations between stress related to neighborhood crime – such as violent crime rates as reported by law enforcement agencies – and increased health problems, however growing research suggests a positive association between living in neighborhoods with higher crime and experiencing more mental health problems, including stress, anxiety, and depression.[16–19] Fewer still have examined this association intergenerationally to assess whether these risks are transmitted to offspring in a manner that impacts their wellbeing,[7] and to our knowledge none have looked beyond birth outcomes. In addition, prior examinations of maternal stressors are limited by their use of predominantly White, middle class samples that might not generalize to more diverse, low-income individuals who often experience greater frequency and elevated severity of community stressors. There is a need, therefore, to simultaneously examine multiple dimensions of maternal stressors – capturing experiences from childhood (e.g., trauma) and pregnancy, and incorporating stressors from multiple contexts (e.g., socioeconomic, interpersonal, neighborhood) – in order to determine the degree to which these stressors have general or specific associations with offspring socioemotional and behavioral difficulties. A number of studies also have found that prenatal programming effects of maternal stress on offspring behavior may differ by sex, however these findings have been mixed and require additional study.[20,21]

Within the burgeoning prenatal programming research, examination of potentially malleable moderators of the association between maternal prenatal stress and child behavioral health has been limited,[21–23] although extant research is promising.[24–27] More specifically, identifying modifiable environmental protective factors, such as parenting knowledge and social support, that could buffer child health from the risks associated with prenatal stress may inform the development of pediatric screening and intervention efforts designed to protect against the deleterious effects of maternal stress exposures on child health.[28,29] Parents with more social support (e.g., receiving additional help in the home, being emotionally supported) or greater knowledge of child development may have advantages in managing the struggles of parenting very young children[30] and be better able to support children's socioemotional and behavioral development. For example, some studies have found that knowledge of child development was positively associated with parental confidence and responsiveness to offspring.[30,31] These may be especially salient protective factors within families experiencing high levels of stressors. However, the few existing intergenerational studies that have explored the protective effects of such factors largely utilize single stressors, limiting understanding of the value of these potential buffers across multiple forms of stress. Further, to our knowledge, none have explored the potential moderating effects of parental knowledge of child development on the association between maternal prenatal stress and child behavioral health.

In a large, diverse pregnancy cohort of mother–child dyads, we examined exposures of maternal trauma during childhood, as well as SES risk, IPV, and neighborhood violent crime during pregnancy in relation to offspring socioemotional and behavioral difficulties at age one. Consistent with the DOHaD framework, it is valuable to elucidate intergenerational effects of maternal stress on offspring development and behavior in infancy and very early childhood, prior to the substantial impact of postnatal environmental factors.[5,32] Based on prior research,[23,30] we also tested whether parental knowledge of child development and perceptions of social support buffered children from these risks. We hypothesized that each type of maternal stressor would be independently associated with higher levels of child socioemotional-behavioral problems. We further hypothesized that prenatal social support and knowledge of child development would moderate these associations, such that greater support and knowledge would buffer against the negative effects of multiple maternal stressors on child functioning. Finally, given the mixed findings from previous studies, we tested whether child sex would moderate the relation between each maternal stressor and child socioemotional-behavioral problems.

Method

Participants and Procedure

The present study utilized data from the Conditions Affecting Neurocognitive Development and Learning in Early Childhood (CANDLE) study, a prospective pregnancy cohort that is part of the ECHO PATHWAYS consortium.[33–35] Between 2006 and 2011, 1503 women from Shelby county, Tennessee, were enrolled in the study. Inclusion criteria included women between 16–40 years old, 16–27 weeks gestation, low-risk pregnancies, and no preexisting conditions that required medication. Details on study enrollment are available elsewhere.[33]

Data were collected during the second and third trimesters of pregnancy, at a home-visit 4 weeks post-birth, and at a clinic visit 1-year post-birth. Of the original 1503 women recruited during pregnancy, 1127 provided child outcome data for the present study at the 1-year clinic visit, which make up the total sample in current analyses. For the retained sample, mothers tended to be older, have higher annual household income, and lived in neighborhoods with lower violent crime rates. The study was conducted at the University of Tennessee Health Science Center and approved by its Institutional Review Board. All participants provided written informed consent for themselves and their children.

Exposure variables

Maternal childhood traumatic events

Maternal report of childhood traumatic events (CTE) was obtained during pregnancy via the Traumatic Life Events Questionnaire,[36] which assesses whether they experienced any of the following three types of traumatic events before the age of 13: a) physical abuse, b) sexual abuse, or c) witnessed family violence. Each item was answered yes/no, resulting in a summed count ranging from 0–3.[35,37]

Socioeconomic risk

Socioeconomic (SES) risk during pregnancy comprised a composite of education (5-point scale ranging from less than high school to graduate school/professional degree) and yearly income adjusted for household size (11-point scale ranging from <$5,000 to >$75,000; Table 1). Both variables were standardized, then averaged to create an SES composite, which was reverse-scored so that higher values indicated increased risk.

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Table 1. Demographic information and model variables ($N = 1127$)

Variable	Characteristics	Mean (SD) or N (%)
Maternal variables		
Age	Years	26.6 (5.5)
Partner status	Married/living with partner	673 (59.7)
	Single/divorced/not married	454 (40.3)
Education	Some elementary/high school	110 (9.8)
	Graduated high school/GED	505 (44.8)
	Graduated technical school	105 (9.3)
	Bachelor's degree	253 (22.4)
	Graduate/professional degree	153 (13.6)
Household income	$0–$9,999	206 (18.2)
	$10,000–$19,999	145 (12.9)
	$20,000–$34,999	185 (16.5)
	$35,000–$54,999	177 (15.8)
	$55,000–$64,999	148 (13.1)
	$75,000 or over	196 (17.4)
Race	Black	672 (60)
	White	388 (34)
	Other	67 (6)
Postnatal depression	Range 0–24	4.6 (4.0)
Maternal SES risk	Income/Education composite	−0.09 (0.9)
Maternal CTE, mean (SD)		0.52 (0.8)
Maternal CTE, count	0	672 (59.6)
	1	280 (24.8)
	2	89 (7.9)
	3	34 (3.0)
	Missing	52 (4.6)
Pregnancy IPV, mean (SD)	IPV experienced in past year	0.97 (0.9)
Pregnancy IPV, count	0	315 (28.0)
	1	563 (52.5)
	2	122 (10.8)
	3	54 (4.8)
	4	19 (1.7)
	Missing	54 (4.8)
Neighborhood violent crime	Violent crime rate per 1000	13.9 (10.4)
Parental knowledge	Total correct score (0–1)	0.66 (0.2)
Prenatal social support	Range 0–9	3.6 (1.9)
Child variables		
Child age	Years	1.1 (0.1)
Sex	Female	562 (49.9)
	Male	565 (50.1)
BITSEA score	Range 0–46	9.7 (5.8)

CTE: childhood traumatic event types; IPV: intimate partner violence; SES: socioeconomic status.

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Intimate partner violence

Women reported on their experiences of intimate partner violence (IPV) at their third trimester pregnancy visit via the short-form version of the revised Conflict Tactics Scale.[38] For this study, participants' indications (yes/no) of whether they had experienced any of four forms of aggression (physical, sexual, psychological, and injury) perpetrated by their partner in the past year[38] were summed to create a total count ranging from 0–4 (Table 1).

Neighborhood violent crime

To assess a neighborhood-level measure of stress exposure, we used an objective, geospatial index of neighborhood violent crime that was derived from a national register of crime data obtained from Neighborhood Scout.[39–41] This national database of geocode-linked crime statistics is based on Uniform Crime Reports provided annually to the FBI by a broad range of local law enforcement agencies and includes all known violent crime incidents that occurred within each agency's jurisdiction.[40,42] Participant address information was collected during enrollment and subsequently at each study visit (including second trimester, third trimester, 1 month postpartum, and at the 1-year clinic visit). These addresses were then geospatially linked to Neighborhood Scout crime statistics at the census block group level, where incidents of violent crime were partitioned and reported per 1000 residents (range 0.1–50.5). Given the study enrollment period spanned 5 years, and given that births spanned from 2007 to 2012, crime rate statistics were obtained for two different years – 2009 and 2012. For each participant, statistics for the year closest to their child's birth were utilized. Of note, the crime statistics were quite stable between 2009 and 2012 (Pearson correlation was 0.93). For participants who moved during the study period (about 25% of the sample), a residence-weighted average crime rate was used across all reported residences to most accurately assess the average violent crime rate exposure per participant during the perinatal period.

Moderator variables

Knowledge of child development

The Knowledge of Infant Development Inventory (KIDI)[43] was administered during pregnancy to assess familiarity with a range of typical developmental norms and milestones. It includes 58 items probing knowledge of physical, cognitive, linguistic, social, and perceptual development from birth to 24 months, such as "babies cannot see or hear at birth" and "one-year-olds know right from wrong." Women indicated whether they "agree", "disagree", or are "unsure." A total correct score was created (range 0–1), representing the percentage of total correct answers out of 58.[43] The KIDI has previously shown good internal consistency/reliability and validity.[30,44]

Maternal social support

Women reported on their social support during pregnancy via the short-form version of the widely used Social Support Questionnaire.[45] Participants indicated the number of people (up to nine allowed) that they could rely on in six different situations during which they might need social support. Counts for these six items were then averaged to create a composite score ranging from 0–9.[33]

Outcome variable

Socioemotional and behavioral health assessment

Child socioemotional and behavioral problems were assessed via the Brief Infant Toddler Social and Emotional Assessment (BITSEA) at the age-one clinic visit. The BITSEA is a 42-item parent report screening tool for infants and toddlers. We utilized the Total Problems scale, which combines internalizing, externalizing, and dysregulation problems. This measure has been validated with sociodemographically diverse samples,[46,47] has demonstrated good internal consistency, and concurrent and predictive validity with measures of functioning later in childhood.[46–48]

Covariates

Several sociodemographic variables were obtained from participants and used as covariates, as they have been shown to be associated with child behavioral health problems and have been commonly used in prior prenatal programming research.[49–53] These included maternal age (years) at study recruitment, marital/partnered status, and race, as well as child sex and age at the outcome (year-one) visit. In addition, we included maternal report of depression symptoms, measured at 4-week post-birth, using the Edinburgh Postnatal Depression Scale (EPDS),[54] in order to account for the potential influence of postpartum depression on young child behavioral problems, given that postpartum depression can affect as many as one in six mothers.[55,56]

Statistical analysis

We performed three multiple linear regressions with listwise deletion using SPSS version 26[57] to assess the independent association of each exposure variable (CTE, SES risk, IPV, neighborhood violent crime) with child socioemotional-behavioral problems. Results are presented in six models. Overall, missing data ranged from none (mainly demographic information) to 7.9% for one of our covariates (postnatal depression), with most variables having less than 5% data missing. Given the limited amount of missing data, we chose to utilize a complete case analysis approach.[58] Model 1 examined the association between all four exposures and child problems. Given the strong correlation between race and other study variables (Table 2), Model 2 added all covariates except for race. Model 3 built on Model 2 by including race. To test moderation, we utilized the SPSS PROCESS macro[59] to multiply each stress exposure by each moderator variable (all variables were standardized prior to interacting), resulting in four interaction terms for both parental knowledge and social support. We then examined the conditional effect of each exposure at varying levels of the moderator. For the tests of moderation, both moderator variables were modeled continuously, with illustrative probing of simple slopes conducted at ±1 SD, per standard practice.[60] Model 4 examined parental knowledge by adding the KIDI variable and its four interaction terms to Model 3. Model 5 replicated the Model 4 procedure, but instead examined maternal social support as a moderator. Finally, in Model 6, we tested for potential sex-specific effects of each exposure variable on child socioemotional-behavioral problems by adding four sex-by-exposure interaction terms (one for each exposure) to the fully adjusted model (Model 3).

Results

Sample characteristics

Demographic information of the analytic sample is presented in Table 1. At recruitment, women's average age was 26.6 years, the median education completed was high school, and approximately 60% of participants were married or living with their

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Table 2. Bivariate correlations between study variables

	1	2	3	4	5	6	7	8	9	10	11
1. Maternal age	1										
2. Maternal race	−0.30**	1									
3. Postnatal depression	0.02	−0.03	1								
4. Maternal CTE	−0.07*	0.14**	0.11**	1							
5. Maternal SES risk	−0.56**	0.54**	0.03	0.19**	1						
6. Pregnancy IPV	−0.08*	0.12**	0.22**	0.24**	0.12**	1					
7. Neighborhood violent crime	−0.34**	0.53**	−0.01	0.12**	0.56**	0.10**	1				
8. Parental knowledge	0.47**	−0.52**	−0.06	−0.03	−0.53**	−0.06	−0.41**	1			
9. Prenatal social support	0.17**	−0.35*	−0.15**	−0.13**	−0.38**	−0.15**	−0.25**	0.31**	1		
10. Child age	−0.04	0.01	0.03	0.03	0.03	0.07*	−0.01	−0.03	0.04	1	
11. Child socioemotional-behavioral problems	−0.26**	0.32**	0.21**	0.17**	0.36**	0.19**	0.28**	−0.31**	−0.21**	0.08*	1
Sample size per variable[a]	1127	1127	1038	1075	1127	1073	1090	1075	1074	1127	1127

CTE: childhood traumatic event types; IPV: intimate partner violence; SES: socioeconomic status.
*$p < 0.05$.
**$p < 0.01$.
[a]Analytic dataset $N = 1127$.

partners. Median family income was between $25k–$35k. The analytic sample was 60% Black, 34% White, and 6% other/mixed race. Approximately 36% of women reported experiencing at least one type of childhood trauma (11% experienced two types; 3% experienced three types). Twenty eight percent of participants reported experiencing no form of IPV during pregnancy, 67.2% reported experiencing at least one form, and 17.3% reported experiencing two or more forms. The mean neighborhood violent crime rate in this sample was 13.9 per 1000 residents, which was significantly higher than the 2011 national average of 3.9 per 1000 residents, but consistent with regional rates. On average, the percentage of total correct answers on the KIDI was 66%, which is similar to previous studies with representative samples. KIDI scores were well distributed, with roughly 150 participants (13%) scoring below one standard deviation of the mean, and roughly 200 participants (18%) scoring above one standard deviation of the mean. The mean score on the BITSEA was 9.7; 25% of the sample fell in the child behavior problem range, which is consistent with previous normative samples. Correlations are presented in Table 2. Of note, maternal SES risk was significantly correlated with neighborhood violent crime ($r = -0.56$, $p < 0.001$).

Maternal stress exposures and child socioemotional-behavioral problems

Multiple linear regression models are summarized in Table 3. In the predictor-only model (Model 1), all four maternal stress exposures (CTE, SES risk, IPV, neighborhood violent crime) were significantly associated with child socioemotional-behavioral problems at age one. In Model 2, all four exposures remained significant after including all covariates except maternal race. In the fully adjusted model (Model 3), which included race, maternal CTE ($\beta = 0.38$, $p = 0.043$, 95% CI: 0.01, 0.74), SES risk ($\beta = -1.03$, $p < 0.001$, 95% CI: −1.58, −0.48), and IPV ($\beta = 0.48$, $p = 0.012$, 95% CI: 0.11, 0.86) remained significantly associated with childhood problems (Table 4); however, neighborhood violent crime did not ($\beta = 0.35$, $p = 0.11$, 95% CI: −0.08, 0.79). Collectively, the four prenatal stress exposures accounted for approximately 15% of the variance in child problems (Model 1; see Table 3); the fully adjusted model (Model 3) accounted for approximately 22% of variance.

Tests of moderation

Moderation tests for parental knowledge (Model 4) revealed that the KIDI significantly moderated the association between both a) maternal SES risk ($\beta_{interaction} = 0.60$, $p = 0.020$, 95% CI: 0.09–1.10) and b) maternal CTE ($\beta_{interaction} = 0.43$, $p = 0.042$, 95% CI: 0.02–0.85) on child socioemotional-behavioral problems. For illustration, Figure 1 shows the interaction with SES risk, with tests of the simple slopes, plotted at 3 levels of the continuous KIDI measure.[59,60] For participants with KIDI scores in the "average" (i.e., mean levels) or "low" range (i.e., −1 SD), maternal SES risk was significantly positively associated with child problems. For participants with KIDI scores in the "high" range (i.e., +1 SD), however, SES risk effects were buffered such that there was no significant association with child problems. Regarding maternal CTE (Fig 2), for participants scoring lower on the KIDI (i.e., −1 SD), children exhibited greater socioemotional-behavioral problems regardless of mother's history of CTE. In contrast, for participants with KIDI scores closer to or above the mean (i.e., +1 SD), CTE was positively associated with child problems, such that greater knowledge was associated with fewer child problems, and this difference was strongest at lower levels of maternal CTE.

Tests of moderation by prenatal social support (Model 5) were not supported (all four interaction terms were not significant). However, the social support-by-pregnancy IPV interaction term

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Table 3. Standardized regression models of maternal multidomain stress exposure associations with child socioemotional-behavioral health problems and tests of moderators

	Main effects models			Parental knowledge interaction terms	Social support interaction terms
	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Model 5[e]
Stress variable	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Maternal CTE	0.47 (0.09, 0.84)*	0.40 (0.04, 0.77)*	0.38 (0.01, 0.74)*	0.43 (0.02, 0.85)*	−0.14 (−0.53, 0.25)
Maternal SES risk	1.74 (1.28, 2.21)***	1.25 (0.71, 1.79)***	1.03 (0.48, 1.58)***	0.60 (0.09, 1.10)*	0.38 (0.83, −0.08)
Pregnancy IPV	0.79 (0.41, 1.17)***	0.53 (0.15, 0.90)**	0.48 (0.11, 0.86)*	0.02 (−0.33, 0.38)	−0.35 (−0.73, 0.03)
Neighborhood violent crime	0.58 (0.16, 1.01)**	0.61 (0.20, 1.03)**	0.35 (−0.08, 0.79)	−0.04 (−0.45, 0.37)	0.31 (−0.14, 0.76)
Model R^2	0.15	0.20	0.22	0.23	0.23

CI: confidence interval; CTE: childhood traumatic events; IPV: intimate partner violence; SES: socioeconomic status.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
[a]Predictor-only model.
[b]Partially adjusted model including the following covariates: maternal age, marital status, postnatal depression, child age, child sex.
[c]Fully adjusted model: Includes Model 2 covariates as well as maternal race.
[d]Model 4 includes all covariates and the four interaction terms between each stress variable and knowledge of infant development.
[e]Model 5 includes all covariates and the four interaction terms between each stress variable and prenatal social support.

Table 4. Standardized regression model with full covariates (Model 3) predicting child socioemotional-behavioral health problems

Variable	β	SE	*p*
Prenatal predictors			
Maternal CTE	0.38	0.19	0.043*
Maternal SES risk	1.03	0.28	<0.001**
Pregnancy IPV	0.48	0.19	0.012*
Neighborhood violent crime	0.35	0.22	0.112
Covariates			
Maternal age	−0.08	0.04	0.019*
Marital status (not married)	−0.40	0.43	0.358
Postnatal depression	0.27	0.04	<0.001**
Maternal race (black)	1.72	0.48	<0.001**
Child age	0.38	0.19	0.042*
Child sex	−0.82	0.35	0.019*

Notes: All variables were standardized in the model. Overall $R^2 = 0.22$; CTE: childhood traumatic events; IPV: intimate partner violence; SES: socioeconomic status.
*$p < 0.05$.
**$p < 0.001$.

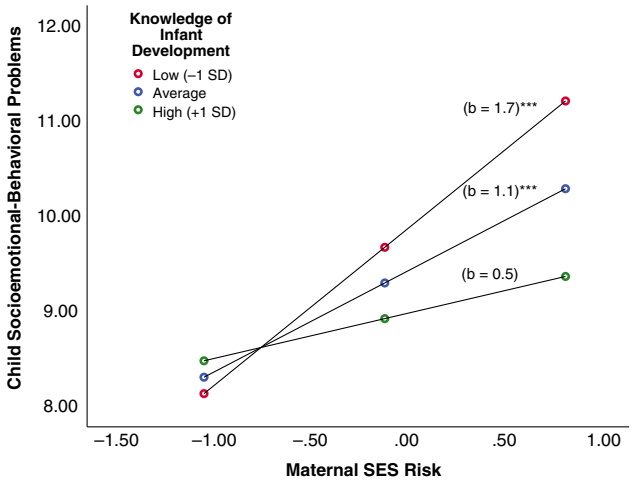

Fig. 1. Maternal knowledge of infant development moderates the association between maternal SES risk and child socioemotional-behavioral problems. Maternal SES risk wassignificantly associated with child problems for mothers with "average" or "low" levels of knowledge, but not for mothers with "high" levels of knowledge.
***$p = .001$.

and social support-by-SES risk interaction term both demonstrated trend-level patterns ($\beta_{interaction} = -0.35$, $p = 0.07$, 95% CI: −0.73, 0.03; $\beta_{interaction} = 0.38$, $p = 0.09$, 95% CI: −0.06, 0.83, respectively), with simple slopes reflecting a potential buffering effect of social support. Finally, tests of moderation by child sex (Model 6) were also not supported: all four interaction terms were not significant (results not shown).

Post hoc sensitivity analysis

Although we sought to isolate prenatal stress effects by adjusting for postnatal depression, given the possibility that maternal psychopathology might be "on the pathway" from maternal stress to child psychopathology, we performed a sensitivity analysis on our full model (Model 3) by re-running the model without postnatal depression. The three exposures that were previously significantly associated with child problems remained significant: SES risk ($\beta = 1.11$, $p < 0.001$), maternal CTE ($\beta = 0.45$, $p = 0.017$), and IPV ($\beta = 0.72$, $p < 0.001$). Similarly, neighborhood violent crime remained not significant ($\beta = 0.32$, $p = 0.148$). We note that in the present study, maternal postnatal depression was only weakly correlated with maternal CTE, pregnancy IPV, and child socioemotional-behavioral problems (r's ranging from 0.11 to 0.22; see Table 2). Removing postnatal depression did significantly reduce the overall model R^2 from 0.22 to 0.19.

Discussion

Utilizing a large, diverse pregnancy cohort, we examined associations between maternal childhood trauma, multi-level stress

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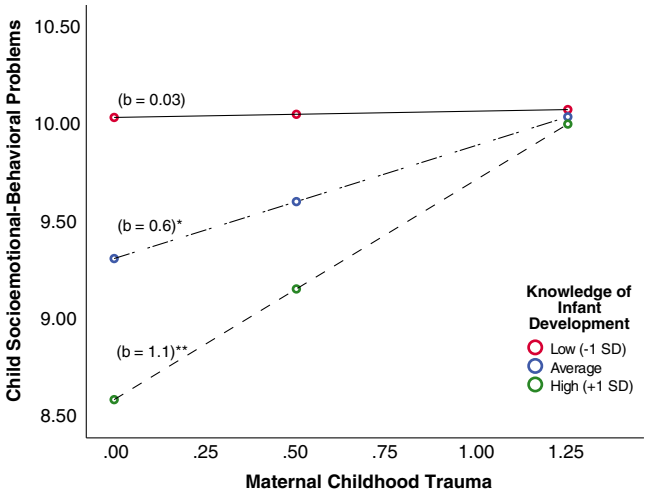

Fig. 2. Maternal knowledge of infant development moderates the association between maternal CTE and offspring socioemotional-behavioral problems. Maternal CTE was significantly associated with offspring problems for mothers with "average" and "high" levels ofknowledge, but not for mothers with "low" levels of knowledge.
*$p = .05$; **$p = .01$.

exposures during pregnancy, and offspring socioemotional-behavioral problems at age 1 year. We found that maternal childhood trauma exposure, prenatal SES risk, and intimate partner violence during pregnancy were all uniquely associated with young children's socioemotional-behavioral problems, after covariate adjustment, within a diverse urban southern sample – advancing evidence from extant prenatal programming research.[1,21] To our knowledge, this is one of the first studies to include community-level stressors (neighborhood violent crime) when assessing the intergenerational association of maternal stress and adversity on child development. When directly comparing the four predictors in our full model, maternal SES risk had the strongest association with child problems, followed by pregnancy IPV and maternal CTE. This is consistent with prior findings that highlight the critical importance of income and education (both measures of longer-standing, potentially chronic risk) as strong social determinants of health,[61–64] with the ability to impact the wellbeing of multiple generations. Regarding maternal experiences of IPV during pregnancy vs. her experiences of trauma during childhood, it is possible that the more proximal nature of the former measure of stress (i.e., during pregnancy) – compared to the more distal nature of the latter (i.e., during the mother's childhood) – could explain the differences in the strengths of these associations, although additional research is necessary.[65,66] Regarding covariates, maternal postnatal depression had one of the strongest associations with child problems. This is also consistent with a large body of literature highlighting the impact of maternal psychopathology on child development and psychopathology.[5,67,68]

Another novel finding was that maternal knowledge of child development moderated associations between both family SES risk and maternal CTE on offspring socioemotional-behavioral problems. First, greater parental knowledge mitigated the adverse association between SES risk and offspring socioemotional-behavioral problems. Second, more knowledge also buffered the effects of maternal CTE against risk for offspring problems, with this difference being strongest at lower levels of maternal CTE. Third, while two interaction coefficients of social support approached significance, social support did not significantly moderate associations between maternal stressors and child functioning. This might be due to how social support was measured. Previous research suggests that specific domains of support, such as tangible versus informational support, may be more salient for protecting against the deleterious effects of prenatal stress, rather than the broadly defined support measure used in this sample.[69] Additionally, maternal social support may also be more protective for maternal wellbeing, while factors more closely related to parenting young children may be more buffering for children. In our final test of moderation, we did not find any sex-specific effects of maternal stressors on child socioemotional-behavioral problems for any of the four prenatal stress exposures. As extant findings have been quite mixed with regard to how maternal prenatal stress might differentially impact boys and girls, this is not necessarily surprising.[20,21] Given that our large sample size provided adequate power, the lack of sex-specific associations suggest the patterns found in this study at age one are consistent for pregnancies carrying boys and girls.

Another novel finding was the relations observed between objectively measured, geospatially linked neighborhood violent crime, race, and child socioemotional and behavioral problems. Although exposure to neighborhood violent crime during pregnancy was significantly associated with child problems in partially adjusted models, it was attenuated after including race – highlighting the complex, potentially confounding nature of using race as a covariate.[70] Notably, the average crime rate in Shelby County was significantly higher than the national average. The association between crime rates, SES, and race are consistent with long-standing social inequities, including residential segregation, redlining, and discriminatory policing practices.[71–73] Indeed, on average, Black mothers in this sample lived in neighborhoods with violent crime rates nearly three times that of White mothers. The considerable correlation between race and violent crime likely accounts for the loss of predictive value of crime when adding race to the model. We therefore interpret these findings to indicate that broader, community-level factors do indeed pose an increased intergenerational risk to offspring socioemotional and behavioral problems and provide an opportunity for additional programs and intervention efforts. The negative impacts of neighborhood disadvantage, more broadly characterized, on health are well documented.[74–77] Differential associations between maternal demographic factors, race, and child socioemotional and behavioral problems in the present sample have also been previously documented.[78] A smaller body of research also suggests that neighborhood violent crime has health implications for young children.[7,79,80] Findings from the present study suggest that greater exposure to low SES and higher rates of neighborhood violent crime during pregnancy, which are disproportionally borne by Black families – largely due to structural racism and long-standing inequities[81–83] – places children at increased risk for behavioral health problems. We also suggest that additional research is needed to further disentangle the overlap between race and neighborhood inequities – including exposure to neighborhood violent crime – especially when examining potential intergenerational impacts, via maternal experience, on child behavioral health.

Our findings advance the current literature in several ways. First, the large sample size enabled assessment of the unique associations between multiple domains of maternal stress exposure – across both maternal childhood and pregnancy – on offspring socioemotional and behavioral development simultaneously. While previous intergenerational research had analytic models that accounted for roughly 12% of variance in child outcomes at age one,[12,84] our final

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models accounted for almost twice as much variance – closer to 23%. This increase might in part be due to the use of multiple measures of maternal stress within one model. Second, this is one of the first large-scale studies examining these intergenerational associations to include a large, lower SES, Black sample – increasing generalizability beyond predominately White, and/or economically privileged samples by including individuals who often experience higher levels of multiple stressors (e.g., discrimination, socioeconomic strain). Third, the identification of maternal knowledge of child development as a protective influence provides evidence for resilience-promoting factors in the prediction of child behavioral health. Findings highlight a viable point of intervention: increasing parental understanding of children's development and appropriate expectations and responses could mitigate the well-documented association between lower SES, histories of maternal trauma, and greater child socioemotional and behavioral problems. Parents with more understanding of normative development are generally more equipped to navigate the challenges of parenting a child in stressful contexts, which may lead to better child outcomes.[85] Indeed, such anticipatory guidance has been deemed a critical component of pediatrician visits, and has been demonstrated to help promote resilience in the face of childhood adversity.[86–88]

Although the present study has several strengths, some limitations are noteworthy. First, we measured IPV in the third trimester, assessing violence experienced in the past year. It is possible that some IPV was experienced just prior to pregnancy. Second, our measure of maternal childhood trauma was retrospective, and focused on three main forms of traumatic events (physical abuse, sexual abuse, family violence). Although CTE is a well-documented predictor of later mother and child health,[89–91] broader measures of maternal childhood adversity, such as the 10-item adverse childhood experiences (ACEs),[92–94] may provide different information, and might account for additional variance in offspring socioemotional and behavioral development. In addition, two of our predictor variables (maternal SES risk and neighborhood crime) were weakly to moderately correlated with our moderator variables – suggesting potential lack of independence. As we were not able to establish temporal precedence between these variables, and neither moderator was strongly correlated with our outcome variable, we did not pursue mediational analysis, however future researchers may want to consider these constructs to advance understanding of mechanisms. Regarding, our measure of neighborhood violent crime, given study recruitment and child births spanned 5 years, we were unable to obtain crime statistics for each year to most accurately approximate this prenatal stress exposure. However, as previously noted, violent crime statistics between 2009 and 2012 were quite stable. In addition, given the mobility of our sample during the perinatal period, as well as the large number of neighborhood block groups with very few individuals, we were unable to model violent crime as a higher-order stress exposure. Thus, our models may have biased estimates of regression coefficients by not accounting for the fact that individuals living in the same neighborhood were exposed to the same levels of violent crime, per our measure, and may have had shared experiences of violence. Future intergenerational studies would benefit from utilizing an approach that accounts for this hierarchical relation (e.g., multilevel modeling, where individuals are nested within neighborhoods) when examining associations between neighborhood-level stress exposures and child behavioral health. Finally, another stressor that is especially salient for sociodemographically disadvantaged groups is discrimination.[95–98] Although such a measure was not available in the present study, previous findings highlight the potential value of its inclusion in future research.[99,100]

Conclusion

The present findings highlight the importance of examining intergenerational associations between maternal prenatal stressors and child health from a multi-dimensional perspective, especially within populations that experience higher levels of stressors. Our findings build upon existing research that emphasizes multiple opportunities for intervention in order to break the association between maternal risk and child behavioral health problems.[101] This includes screening for parents' exposure to childhood adversity and partner conflict, as well as broader, community-level factors, such as violent crime, during pediatric visits and providing referrals for potential interventions to address these challenges.[102,103] Furthermore, the buffering effects of knowledge of child development emphasize opportunities that primary care providers have with new parents during the pre- and early postnatal period. In addition to anticipatory guidance, providing accessible resources that increase parents' knowledge of child development can help protect the future emotional and behavioral wellbeing of children in high-risk environments.[101,104] Findings also suggest that policies and community programs addressing the causes of major stress exposures,[103] and interventions that increase parental knowledge of child development, would further benefit child emotional and behavioral health.

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Conflicts of Interest. None.

Ethical Standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation (U.S. Department of Health and Human Services Policy for Protection of Human Subjects) and with the Helsinki Declaration of 1975, as revised in 2008, and has been approved by the Institutional Review Board at the University of Tennessee Health Science Center.

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