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Maternal postpartum stress and toddler developmental delays: Results from a multisite study of racially diverse families

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Abstract

Maternal psychosocial stress during pregnancy can adversely influence child development, but few studies have investigated psychosocial stress during the postpartum period and its association with risk of toddler developmental delays. Moreover, given the expanding diversity of the U.S. population, and well-documented health and stress disparities for racial and ethnic minorities, research examining the effect of postpartum stress on risk of developmental delays in diverse populations is of critical importance. In this study, data from the Community Child Health Network provided the opportunity to test maternal postpartum stress as a predictor of toddler risk of developmental delay in a sample of African American, Latina and non-Hispanic White women and their toddlers (*N* = 1537) recruited in urban, suburban, and rural communities. Postpartum maternal stress over 1 year was operationalized as perceived stress, life events, and negative impact of life events. Regression results revealed higher risk of developmental delays in toddlers whose mothers experienced more negative life events, greater negative impact of events, and higher perceived stress over the year. Prenatal stress, pregnancy/birth complications, and postpartum depression did not explain these associations. Maternal postpartum stress may contribute to increased risk for developmental delays and is an important target for psychosocial intervention.

KEYWORDS

child health, early childhood, maternal health, psychosocial stress

1 | INTRODUCTION

Early childhood is a critical period of physical and cognitive growth, and developmental delays at this stage can have lasting consequences for health, cognitive skills, and academic achievement (Bornstein, Hahn, & Wolke, 2013; Flensborg-Madsen & Mortensen, 2015; Hitzert, Roze, Van Braeckel, & Bos, 2014; Maggi, Irwin, Siddiqi, & Hertzman, 2010). Our understanding of developmental delays, and particularly how they are influenced by family contexts, is limited, despite the high prevalence of developmental disabilities in the U.S. (one in six children are diagnosed with behavioral, learning, or physical disabilities between the ages of 3 and 17 years) (Boyle et al., 2011). Although some developmental delays are related to genetic or biological risk factors, research shows that social environments shape children's risk for delays (McDonald, Kehler, Bayrampour, Fraser-Lee, & Tough, 2016). Caregivers and related family contexts may be particularly important for preventing developmental delays, as families provide critical support and resources during infancy and early childhood (Bradley & Corwyn, 2002). Disadvantaged family environments, as indicated by low socioeconomic status and single-parent households, have been associated with higher risk for developmental delays in childhood (Murphey, Cooper, & Forry, 2013; Potijk, Kerstjens, Bos, Reijneveld, & De Winter, 2013), as have more proximate factors such as infrequent parent-child interactions (McDonald et al., 2016).

This study contributes to the body of empirical research on maternal distress and child developmental delays by focusing on maternal stress during the first year postpartum and associations with developmental delays in toddlerhood. Research on maternal distress has often focused on maternal postpartum depression or anxiety, both of which have been associated with less optimal parenting and poor infant and toddler outcomes (Field, 2010; Kingston, McDonald, Austin, & Tough, 2015; Talge, Neal, & Glover, 2007). Post-traumatic stress disorder is also a large area of research (Simpson, Schmied, Dickson, & Dahlen, 2018) showing adverse effects on birth outcomes (Seng, Low, Sperlich, Ronis, & Liberzon, 2011), and some (albeit conflicting) evidence of associations with developmental outcomes (Cook, Ayers, & Horsch, 2018).

A less studied aspect of maternal distress, maternal postpartum stress, is experienced by a larger percentage of mothers and may be a precursor to, or additional component of, maternal mental health issues with important implications for offspring development (Hammen, 2005). Dealing with stress requires time, energy, and strong coping skills, which may reduce maternal resources available to interact with and support their children in positive ways, with known negative implications for child health and development (Belsky, 1984; Conger, Rueter, & Conger, 2000; Cprek, Williams, Asaolu, Alexander, & Vanderpool, 2015; McDonald et al., 2016). A recent review of maternal distress studies suggested more research is needed on maternal stress, both during and after pregnancy, as a distinct measure of maternal distress that influences children's care and development (Graignic-Philippe, Dayan, Chokron, Jacquet, & Tordjman, 2014).

Existing stress research has shown that maternal stress *during pregnancy* is adversely associated with numerous birth and developmental outcomes, including birth weight and length of gestation or pre-term birth (Dunkel Schetter, 2011; Graignic-Philippe et al., 2014; Wadhwa, Sandman, Porto, Dunkel Schetter, & Garite, 1993), attention shifting (Plamondon et al., 2015), cognitive and language development (Keim et al., 2011), infant temperament and stress response (Bush et al., 2017), and motor development (Moss et al., 2017). Using data from the Queensland Flood Study, Moss and colleagues found that for women exposed to a major flood during pregnancy, greater negative cognitive appraisal of the flood consequences, and not the objective severity of their exposure to the flood, was associated with poorer child gross motor development at 16 months as measured by the Bayley-III, independent of maternal postpartum mental health symptoms (Moss et al., 2017). Using objective measurement of the severity of the stressor to compare with maternal ratings of the perceived stress during pregnancy, along with assessment of child developmental outcomes by trained examiners, Moss et al. (2017) demonstrated the importance of the mothers' subjective experience of the stressor during pregnancy for later child development.

Despite the convincing evidence of an association between perceptions of maternal stress during pregnancy and child neurobehavioral outcomes, empirical evidence regarding the effects of maternal psychosocial stress during the postpartum period is limited and results are inconclusive. One U.S. study indicated that infants whose mothers had elevated parenting stress at 6 months postpartum had lower mastery motivation (effort to achieve without a physical reward) at 18 months (Sparks, Hunter, Backman, Morgan, & Ross, 2012). A more recent study, assessing maternal stress at 6 months postpartum in a low-income sample, found that perceived maternal stress was negatively associated with positive aspects of infant temperament (surgency and regulation) as reported by the mothers at 6 months (Bush et al., 2017). Though racially/ethnically diverse, the majority of the women lived below the poverty line (median household income was $19,000), limiting the generalizability of the findings. Two smaller international studies also provide support for the idea that parent stress may be important for child development. A New Zealand study of small-for-gestational-age infants found that mothers with high levels of parenting stress reported more missed developmental milestones (Slykerman et al., 2007); and a Canadian study of women using anti-depressants during pregnancy (N = 71) found that both maternal and paternal perceived stress at 2 months postpartum were associated with lower motor and socioemotional development in 1-year-old infants (Karam et al., 2016).

Although this research suggests a potential for maternal postpartum stress to affect child development, additional research using larger and more representative samples and multiple measures of stress is needed. Further, with the exception of the Bush et al. (2017) study, there remains a dearth of research investigating the association between maternal postpartum stress and infant/toddler developmental outcomes within racially/ethnically diverse populations. With the expanding diversity of the U.S. population and well-documented health and stress disparities for racial/ethnic minorities and those of lower socioeconomic status, this is a critically important area of research.

We contribute to research in this area by providing an assessment of the associations between postpartum maternal stress and toddler development using a relatively large (N = 1537), racially diverse sample of mothers and their toddlers across geographical areas in the U.S. This is important because most prior studies maternal postpartum stress have relied on small samples or a sample that is limited to those with a particular maternal (e.g., depression) or infant (e.g., small for gestational age) health condition. Moreover, the sample was derived from geographical areas with high proportions of maternal-child health disparities (Ramey et al., 2015), including urban (Washington, DC; Baltimore, MD; Los Angeles County, CA), suburban (Lake County, IL), and rural (eastern North Carolina) communities.

The second contribution is the use of multiple measures of maternal stress. As past studies have indicated, multiple measures of stress (perceived and events-based counts) should be included in studies to capture multiple dimensions of stress and potential differential impacts of various aspects of maternal stress on child outcomes (Bush et al., 2017; Dunkel Schetter, 2011; Graignic-Philippe et al., 2014). However, most studies to date have considered multiple measures of stress during pregnancy but not in the postpartum period. In this study, we measure postpartum stress using indicators of perceived stress (collected prospectively), negative life events (reported for the past year), and the number of life events experienced (reported for the past year). These measures go beyond parenting stress, capture maternal stress over a longer postpartum period than past studies, and provide an assessment of postpartum stress based on both life events experienced and prospectively reported feelings of stress.

In conducting these analyses, we further test whether prenatal stress accounts for associations between postpartum maternal stress and toddler development. Maternal psychosocial stress during pregnancy may affect both maternal postpartum stress and child development (DiPietro, 2012; DiPietro, Novak, Costigan, Atella, & Reusing, 2006; Dunkel Schetter, 2011; Grant, Sandman, Wing, Dmitrieva, & Davis, 2015; Sandman, Davis, Buss, & Glynn, 2012). Adjusting for stress during pregnancy allows us to control for potential lasting biological effects from prenatal stress to better assess the role of postpartum maternal stress in increasing the risk of child developmental delays.

Similarly, we consider whether links between postnatal maternal stress and toddler development are due to poor birth outcomes or 1-month postnatal infant health. Poor birth outcomes and infant health problems may induce stress in mothers due to the emotional and financial strain related to caring for an unhealthy infant, while also hindering infant development (McDonald, Kingston, Bayrampour, Dolan, & Tough, 2014; Simon, Pastor, Avila, & Blumberg, 2013). Birth conditions, such as low birthweight and premature birth, have also been suggested as key factors underlying both missed developmental milestones in infancy and later developmental delays in children (Ghassabian et al., 2016).

Our conceptual model, incorporating these contributions, is delineated in Figure 1. The primary study hypothesis is that maternal stress during the year after a birth will be associated with greater risk of toddler development delays. Although we do not test specific pathways, based on past research we expect that maternal stress may reduce emotional support, social interactions, and cognitive stimulation mothers provide for their children, resulting in an increased risk of delays (Mcfadden & Tamis-Lemonda, 2013; Muller-Nix et al., 2004; Schechter et al., 2017). Stress and mothers' reaction to stress in their lives may reduce their reflective capacity and sensitivity, which are critical aspects of maternal-child interactions that shape development (Stacks et al., 2014; Thompson, 2008). This process may be compounded by substance use, and other ways of coping with stress, which have been associated with negative maternal behaviors and child outcomes (Brancato & Cannizzaro, 2018; Forray & Foster, 2015).

Other types of interactions between the child and father, or with other family members, may also be strained if maternal stress leads to negative or conflictual family conditions (Conger et al., 2000). Thus, high maternal postpartum stress may lead to developmental delays through both direct mother-toddler interactions and via other aspects of the family environment that are less conducive to toddler development. Socioeconomic status and demographic characteristics are also known to be correlated with postpartum stress (O'Campo et al., 2016), health and healthcare utilization (Seplowitz et al., 2015), quality of parent-child interactions (McDonald et al., 2016), and risk for developmental delays (Murphey et al., 2013; Potijk et al., 2013). Thus, our conceptual framework includes maternal and family socioeconomic and demographic characteristics as part of the larger context in which the core of the model operates.

Given the lack of conclusive research on maternal postpartum stress and toddler developmental delay in general, the aim of this study is to empirically assess whether maternal stress is

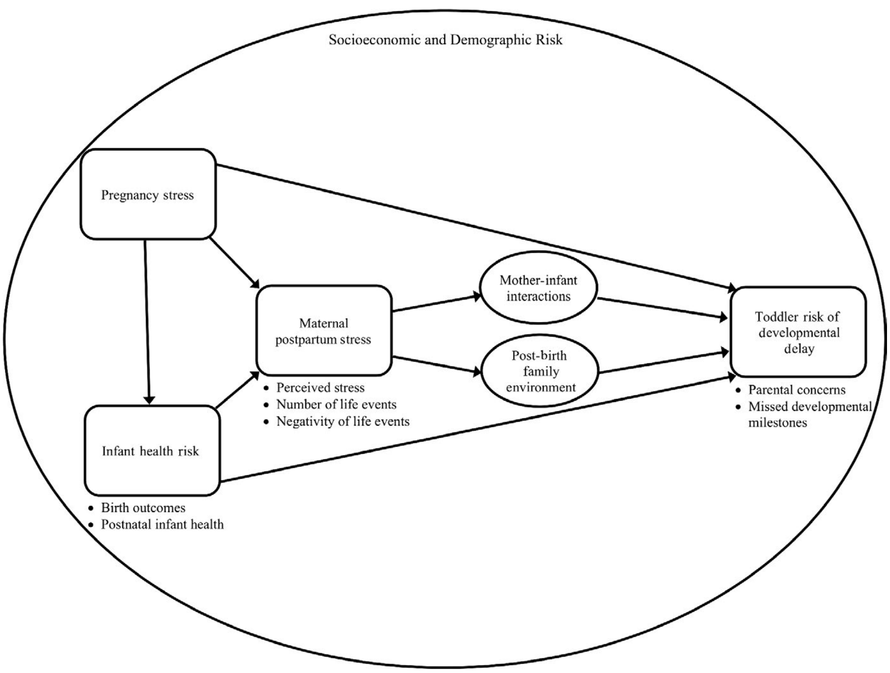

FIGURE 1 Conceptual framework

associated with toddler outcomes net of demographic and socioeconomic characteristics. The ability to control for pregnancy stress, birth outcomes, and postnatal infant health factors, helps us further isolate the role of maternal postpartum stress for toddler development. If maternal stress can be identified as a contributor to toddler developmental delays, net of other maternal and family conditions, it may be a potential point of leverage for improving child development and a fruitful area for further research.

2 | METHOD

2.1 | Sample

Study participants were enrolled in the five-site National Institute of Child Health and Human Development (NICHD) Community Child Health Network (CCHN) study, a longitudinal, multi-site study of predominately low-income mothers and their infants. The study included three urban sites (Washington, DC; Baltimore; Los Angeles), one suburban site (Lake County, IL), and one rural site (eastern North Carolina). Women were recruited in the hospital following the birth of a child, and were eligible to participate if they were: 18–40 years old; White, Latina, or Black; English or Spanish speakers; in the target zip codes; and not planning to be surgically sterilized. Research was conducted within prevailing ethical principles and was reviewed by relevant Institutional Review Boards. Further description of the study can be found elsewhere (Community and Child Health Network, 2019;O'Campo et al., 2016; Ramey et al., 2015).

Trained community members administered standardized interviews during in-home visits when the children were, on average, 1 month (T1), 6 months (T2), and 14 months (T3). Toddler development was assessed only at T3, restricting the sample to mothers who completed the T3 interview (N = 1,787) with toddler development data (N = 1,722 for PEDS and N = 1,696 for PEDS-DM). This sample was further reduced by removing infants younger than 12 months (n = 185) from the sample for two reasons. Firstly, so that the life events measures that referred to the past year captured the postpartum period only, and not pregnancy. Secondly, because infants younger than 1 year could not be expected to pass the 1-year milestones measured by one of the dependent variables (PEDS-DM). This resulted in final analytical sample size of 1,537 for the PEDS outcome and 1,511 for the PEDS-DM outcomes (due to more missing cases for the PEDS-DM variable).

2.2 | Measures

2.2.1 | Toddler development

The dependent variables are two validated measures of parent-reported toddler development: Parental Evaluation of Development Status (PEDS) and Parental Evaluation of Development Status—Developmental Milestones (PEDS-DM), administered during the T3 interview.

The PEDS is an instrument involving parental report that has demonstrated strong convergent validity when compared with 14 other d

evelopmental assessments and screeners (Halle, Zaslow, Moodie, & Darling-Churchill, 2011). The areas of development referenced on the PEDS are similar to several other development measures, including: the Bayley Scales of Infant Development, Child Development Inventory, Kaufman Assessment Battery for Children, Stanford-Binet Intelligence Scale (4th Edition), Test of Language Development, Developmental Profile-II, Brigance Screens, and Battelle Developmental Inventory Screening Test (Halle et al., 2011).

Following standard PEDS protocol (Glascoe, 1997), mothers reported whether they were “concerned, a little concerned, or not concerned” about their child in terms of multiple aspects of development. Of the concerns elicited, those found to be predictive of developmental delays are used to create the PEDS score (Glascoe, 2000, 2003). These are concerns about: the infant/child being behind others or unable to do what others do; how s/he talks and makes speech sounds; how well s/he gets along with others; and how s/he sees, hears, eats or sleeps or about his/her health. We created a variable indicating the number of predictive parental concerns based on the PEDS scoring sheet (Glascoe, 1997, 2003). Following recommended scoring protocol, the PEDS scores were categorized into low (no predictive concerns), moderate (one predictive concern), and high (2+ predictive concerns) risk for developmental delay (Glascoe, 1997).

The second dependent variable, the Parental Evaluation of Development Status—Developmental Milestones (PEDS-DM), is also validated measure of risk for developmental delay based on parental reports. However, this measure asks parents to report on specific developmental milestones across six domains: fine motor, gross motor, social-emotional, self-help, expressive language, and receptive language (Brothers, Glascoe, & Robertshaw, 2008; Glascoe, 1997). The PEDS-DM was originally developed using items from two well-validated diagnostic instruments: The Brigance Inventory of Early Development–II (IED-II), which is for children from birth to 6 to 11 years of age, and the Brigance Comprehensive Inventory of Basic Skills–Revised (CIBS-R), which is for children in kindergarten through sixth grade. The IED-II demonstrated strong convergent validity with scales of similar content (0.51–0.87) (Brothers et al., 2008). Halle et al. (2011) examined the relationships between the PEDS-DM and the IED-II/CIBS-R and found the scores were strongly correlated.

Like PEDS, PEDS-DM was implemented during the T3 home visit. Mothers were asked to report on 12-month milestones, including whether the toddler could: make a squeeze toy squeak or try to; drink from a cup; look around for bottle when you say “where's your bottle?”; put lots of sounds together like talking; take a few steps with you holding only one of his/her hands; look for new things to play with and try to figure out how they work? Mothers answered “yes,” “no,” or “sometimes.” A milestone was considered missed if the mother answered no or sometimes. Following PEDS-DM protocol, we totaled the number of missed milestones per toddler and created a categorical variable of low (no missed milestones), moderate (1 missed milestone) and high (2+ missed milestones) risk for developmental delay (Brothers et al., 2008). Importantly, research has found that missed developmental milestones are associated with later disabilities (Ghassabian et al., 2016).

The PEDS and PEDS-DM measures are marginally correlated in general (r = 0.02 in this sample), in part due to the fact that each measures somewhat distinct aspects of child development. The PEDS focuses on a broader range of developmental issues, including social concerns such as getting along well with others and being behind other children in development, as well as the broad category of other concerns related to hearing, seeing, eating, sleeping, and overall health. The PEDS-DM is more specific to the child's behavioral development, and does not include social behaviors or refer to how the child compares to others. They further differ in that development is evaluated based on the level of parental concern in the PEDS, while the PEDS-DM asked mothers to recall more specific actions/accomplishments of their young children. Both measures may be influenced by socio-demographic factors that affect the level of concern and milestones mothers reported. For this reason, multiple maternal characteristics were included as control variables in the regression models.

2.2.2 | Maternal postpartum stress

Maternal postpartum stress was measured in several ways. At T3 (1 year postpartum) mothers were asked whether any items on a list of 24 major life events had occurred during the past year using a standardized assessment of stressful life events (Dominguez, Dunkel Schetter, Mancuso, Rini, & Hobel, 2005; Dunkel Schetter et al., 2013; Hobson et al., 1998; Lei & Skinner, 1980; Masuda & Holmes, 1978). The events included those they had experienced (e.g., moving, loss of a major asset, problems with relationships, high pressure at work, death of someone close, victim of crime), and events that may have occurred for someone close to them (e.g., job loss, divorce, serious illness, serious accident, problems with the police/jail). The number of life events reported to have occurred in the past year were calculated. Since this measure is skewed toward fewer events, in the analysis the square root of total life events was used.

The second stress measure is based on maternal reports of the extent of negative impact of each event they experienced in the past year. Mothers were asked to rate each life event on a seven-point scale, from positive to negative. These scores were averaged across all the events reported by the mother to create a total score of the negativity of life events experienced in the past year. Although life event count and negative impact measures can be combined into a single indicator, research on maternal stress most commonly treats them as two distinct aspects—episodic stress and impact of stressors (Bush et al., 2017; Dominguez et al., 2005; Dunkel Schetter, 2011). Thus, we used life event count and life event negativity in the past year as separate measures of stress. This also allows us to compare our findings to recent research using life events counts (but not the impact) assessed at 6 months postpartum (Bush et al., 2017).

The third stress measure is maternal perceived stress, based on the *perceived stress scale* (PSS) measured at three time points (T1, T2, and T3) postpartum. The PSS is a gold standard in stress research and has been well-validated as a measure of stress (Cohen, Kamarck, & Mermelstein, 1983). The PSS asks about feelings and thoughts in the past month, such as feeling: upset, nervous, stressed, could not cope, out of control, overwhelmed, etc. For each of the 10 questions, mothers were asked to report how often they felt that way, from never (=0) to very often (=4). A total PSS score was calculated at each wave and then averaged across waves T1-T3 to provide a measure of chronic stress during this time period (α = 0.85). In the regression models, mean PSS was log transformed due to its skewed nature and to reduce the influence of outliers.

The three measures of postpartum stress capture different aspects of psychosocial stress. The number of life events score reflects mostly acute stress exposures that are associated with life instability in the past year, while negativity of life events assesses the negative impact associated with life events occurring during that time. The perceived stress score is a report of the mother's feelings of stress from any source (not only life events but also life circumstances, especially chronic ones). Importantly, perceived stress was measured prospectively and then averaged to create the PSS score for the past year. The correlations among these three stress variables were modest. Specifically, life events number and negativity were correlated at r = 0.28; and average perceived stress was correlated with number of events at r = 0.37 and negativity of life events at r = 0.20.

2.2.3 | Other explanatory variables

In assessing the maternal postpartum stress associations with toddler development, we also consider whether maternal pregnancy stress, birth conditions, or early infant health account for the postpartum stress and development associations. Pregnancy stress was measured using a standardized measure of pregnancy stress (Misra, O'Campo, & Strobino, 2001), which asked mothers during the T1 interview (1 month postpartum) about stressors including: food, shelter, health care, and transportation; money; family problems; pregnancy itself; abuse; work problems; friend problems; feeling generally overloaded; and neighborhood crime that occurred during the pregnancy. The mothers were asked to rate how these potential stressors made them feel during pregnancy, from no stress (1) to severe stress (4). The responses on the 10 items were totaled creating a continuous measure of pregnancy stress (α = 0.76). We also considered whether the extent to which the pregnancy was planned as a second measure of stress during pregnancy. Mothers reported whether they had planned to get pregnant in the month before the pregnancy. This was coded as "unplanned" if the mother reported that she did not plan the pregnancy.

Infant birth outcomes were obtained from medical records and included: low birth weight (<2,500 g), preterm birth (<37 weeks gestation), and low Apgar score (below 9) at 5 minutes after birth. Each of these was coded as a dummy variable. The Apgar score is a measure of physical health immediately after the birth, measuring the baby's color, heart rate, reflexes, muscle tone and respiratory effort, with a maximum score of 10 if the baby is doing well on all. At T1 (infant age 1 month), two infant health measures were obtained through mothers' reports: whether the infant had a diagnosed hearing problem (yes/no); and infants' overall health status (rated by mothers as excellent, very good, good, fair or poor). We categorized infant poor health status as 1 = good, fair, or poor versus 0 = excellent or very good. Results did not change when infant health was considered as continuous measure.

2.2.4 | Control variables

Child demographic variables included in regression models were sex (coded as 0 = female; 1 = male), age at T3 (the time when PEDS and PEDS-DM were administered), and whether this was the mother's first child (first born). Maternal demographic, health and socioeconomic variables included: maternal age at the time of the birth; whether the mother was pregnant again by T2 or T3; T1 postpartum depression (linear score in the Edinburgh Postnatal Depression Scale); years of education; race/ethnicity with Hispanics separated by immigrant status (non-Hispanic white, African American, Foreign-born Hispanic and U.S.-born Hispanic); T1 marital status with the baby's father; number of children in the household at T1; and a dummy variable for family poverty (family income-to-poverty ratio below the federal poverty line). A dummy variable was also included for living in an urban versus suburban or rural area.

Descriptive statistics for the maternal stress, socioeconomic and demographic variables, along with the pregnancy and infant health measures, and when each measure was collected, are shown in Table 1 below. Reflecting the design of the study, this sample consists of predominantly low-income, non-white, and low-educated mothers. Average age of the toddlers was 14 months at the time of the development reports and approximately 42% were male. Ten percent of the infants had low birth weight, 13% were born preterm, and 9% had low 5-minute Apgar scores.

2.3 | Statistical analyses

Twenty-one percent of the sample had missing data on one or more of the explanatory variables, with most of the missing data (17%) coming from the birth outcome data that were obtained via medical chart review, and the negative impact of life events variable (10% missing). All other independent variables had negligible missing cases. Missing data were handled using multiple imputation, then deletion (MID), wherein observations with imputed outcomes are excluded from analyses, thus aiding in the minimization of potential bias introduced by misspecification of the outcome imputation model (von Hippel, 2007).

We used multinomial logistic regression to test associations between maternal postpartum stress and PEDS and PEDS-DM risk categories. Socioeconomic and demographic variables were included in all models as controls, reflecting their theoretical role as a larger contextual system in which the key variables of interest operate. Pregnancy stress and birth/infant health variables were added in secondary models to assess how the associations between maternal postpartum stress and toddler development changed after adjusting for these factors.

To assess model fit, we used the final models (including birth variables) to calculate the proportional by-chance accuracy of the PEDS and PEDS-DM model. In order to judge a model as a statistically significant improvement over by-chance accuracy, the accuracy rate must exceed the threshold of 25% improvement over the rate of accuracy achievable by chance (Bayaga, 2010). The threshold for the PEDS model was 62% and the overall model classification accuracy was 65%. For PEDS-DM, the threshold was 52% and the model classification accuracy was 59%. Thus, overall, both models predicted the outcomes better than could be reasonably expected by chance. The relative predictive accuracy of each category for the PEDS model was as follows: 97% for the low risk for delay category, 7% for moderate risk for delay category, and 6% for the high risk for delay category. For the PEDS-DM model successful prediction was 92% for the low risk for delay category, 13% for moderate risk for delay category, and 22% for the high risk for delay category.

In presenting the regression results, we calculated relative risk ratios (exponentiated coefficients) to indicate the risk of toddlers being in the moderate or high developmental delay risk categories compared to the reference group (low risk for developmental delay). A risk ratio >1 indicates higher risk and <1 lower risk of the outcome relative to the reference group. Standard errors were adjusted for heteroskedasticity and geographic clustering by study site. Statistical significance level was set at $p < 0.05$.

3 | RESULTS

3.1 | Sample characteristics

Maternal postpartum stress descriptive statistics are presented in Table 1. Mothers experienced a mean score of 5 (out of 7) on the negative impact of life events measure. Average number of life events experienced was almost 4 (maximum of 16) during the year after the birth. With a standard deviation of three events, there was relatively large variation, and the data were skewed toward lower number of life events. Mothers' average perceived stress (PSS) ranged from 0 to 33, with a mean of 14 (see Table 1).

Table 2 shows descriptive statistics for toddler development. For PEDS, 26% of the toddlers had one predictive development concern (moderate risk of developmental delay) and 9% had two or more predictive concerns (high risk of developmental delay) by 14 months (average age). For PEDS-DM, over a quarter (26%) were at moderate risk (missed one milestone) and almost one in five (18%) were at high risk for delay (missed two or more milestones).

3.2 | Regression results

Table 3 shows the regression results for the PEDS (parental concerns) models. In Model 1, number of life events and perceived stress were

TABLE 1 Sample characteristics of mothers and children ages 12–22 months

Variable	When collected[a]	Mean or percent	*SD*	Min	Max
Maternal postpartum stress					
Life events impact	T3	5.1	1.3	1	7
Life events count	T3	3.90	3.0	0	16
Mean perceived stress score (α = 0.85)	T1, T2, T3 averaged	13.6	5.4	0.67	33
Maternal pregnancy stress					
Pregnancy stress score (α = 0.76)	T1	15.6	4.6	10	35
Pregnancy not planned	T1	67%		0	1
Infant health					
Low birth weight	T1	10%		0	1
Preterm birth (<37 weeks gestation)	T1	13%		0	1
Low 5 min. Apgar score	T1	9%		0	1
Infant hearing problem (1 month)	T1	3%		0	1
Infant good/fair/poor health (1 month)	T1	12%		0	1
Sociodemographic characteristics					
Male	T1	42%		0	1
T3 age in months	T1	14.1	1.4	12	22
First born	T1	45%		0	1
Maternal age	T1	26	5.8	18	42
Mother pregnant	T2 & T3	9%		0	1
Mother post-partum depression score	T1	4.6	4.6	0	26
Mother years of education	T1	13	2.9	4	23
Maternal race/ethnicity					
Non-Hispanic white	T1	23%		0	1
African American	T1	51%		0	1
Foreign-born Hispanic	T1	19%		0	1
US-born Hispanic	T1	7%		0	1
Mother relationship status with father					
Married	T1	38%		0	1
Non-marital cohabiting	T1	27%		0	1
Not married or cohabiting	T1	35%		0	1
Family below poverty line	T1	37%		0	1
Number of other children in household	T1	1.8	0.9	0	8
Urban community	T1	57%		0	1

Note: NICHD Community Child Health Network Study. *N* = 1537.
T1 = 1 month postpartum; T2 = 6 months postpartum; T3 = 14 months postpartum.

associated with an increased risk of a toddler being at moderate risk for developmental delays net of the infant and maternal controls. All three stress measures (negative impact of life events, number of life events, and perceived stress) were significantly associated with high risk of developmental delay, compared with low risk, as measured by the PEDS in Model 1.

Model 2 indicates a small decline in the relative risk ratios (RRRs) for the maternal postpartum stress measures when accounting for pregnancy stress and birth factors. However, the RRRs for all stress measures remained statistically significant. Model 2 also indicates that neither the pregnancy stress score nor an unplanned pregnancy was related to later toddler development as measured by PEDS. Among the birth and postnatal health indicators, infants who scored less than nine on the Apgar test had over two times higher chance of being at high risk for developmental delays in toddlerhood. A diagnosed hearing problem at 1 month was associated with moderate risk, and maternal-rated poorer infant health was associated with high risk for development delays in toddlerhood.

Of the sociodemographic control variables significant in Model 2, being male and having more children in the household were associated with higher risk of delays. Having an African American mother and living in an urban area were associated with lower risk of delay (less development concerns).

The PEDS-DM multinomial regression results are shown in Table 4. In Model 3, higher negativity of life events and average PSS score over the past year were significantly associated with both moderate and high risk for developmental delay. Each point higher on the negativity of life events scale was associated with 11% in moderate and a 16% increase in high risk for developmental delays as assessed by PEDS-DM reports. Since the PSS score was log scaled, the relative risk ratios represent the effect of a 1% increase in the PSS score, which was associated with a an increase of 42% for moderate and 72% for high developmental delay risk, controlling for the life events measures and sociodemographic and other factors. The count of life events was not significantly associated with high risk for developmental delay, and had a negative association with the risk for moderate delay based on the PEDS-DM reports.

Model 4 shows the results with pregnancy stress and birth/postnatal health conditions included in the PEDS-DM model. Of these, low birth weight, low Apgar score and poorer 1-month health were associated with high risk for toddler developmental delays (multiple missed milestones). The postpartum maternal stress associations with high developmental delay risk were slightly attenuated when controlling for pregnancy and birth factors, but the associations with moderate developmental delay risk remained unchanged.

The control variables significant in Model 4 were toddler age (older toddlers have lower risk of missing milestones), maternal age (a small positive association), mother cohabiting at birth (higher risk compared to toddlers with married mothers), and living in an urban area (lower risk compared to mothers in suburban/rural areas).

TABLE 2 Toddler risk of developmental delays descriptive statistics, ages 12–22 months

Variable	Percent of sample (*n*)
Parental evaluation of development status (PEDS)	
No concerns (low risk of delay)	65% (995)
1 concern (moderate risk of delay)	26% (398)
2 + concerns (high risk of delay)	9% (144)
Parental evaluation of development status – developmental milestones (PEDS-DM)	
No missed milestones (low risk of delay)	56% (844)
1 missed milestone (moderate risk of delay)	26% (400)
2 + missed milestones (high risk of delay)	18% (267)

Note: NICHD Community Child Health Network Study. *N* = 1537.

4 | DISCUSSION

We studied maternal postpartum stress as a critical factor for toddler development considering an understudied developmental outcome, risk for developmental delay, in a racially diverse and predominantly low-income sample. Using the PEDS and PEDS-DM, mothers reported on physical, cognitive, and social aspects of their toddlers' development. The PEDS measure indicated that 26% of the sample toddlers were at moderate and 9% at high risk for developmental delay. This is comparable to PEDS-based risk assessed in representative national samples, which indicate that among infants 4–24 months 14% scored in the moderate risk category and 7% in the high risk category (Murphey et al., 2013). The higher percent in the moderate risk category in this sample is due to, most likely, the recruitment of women from communities high in health disparities and socioeconomic risk factors. The percent of toddlers in the high-risk PEDS category, however, was similar to the national statistic.

The PEDS-DM assessment revealed that 26% of the toddlers were at moderate and 18% at high risk for developmental delays due to missed milestones. We could find no national-level data using the PEDS-DM to compare with these results. Research applying a similar measure (the Ages and Stages Questionnaire) found 17% of 1-year-old infants had missed two or more milestones in a large Canadian sample (McDonald et al., 2016). This is comparable to the percent of toddlers in the high-risk PEDS-DM category in the present study, which reflects two or more missed milestones (18%). Another study of 1 year olds in New Zealand found approximately 33% had missed one or more developmental milestones (Slykerman et al., 2007), which is consistent with, though lower than, the percent of toddlers missing one or more PEDS-DM milestone in this lower-income U.S. sample (44%).

The regression results indicated that multiple aspects of maternal postpartum stress were associated with higher risk for developmental delays after controlling for potential confounders. The negativity of life events, count of life events, and perceived stress were independently associated with increased risk for developmental delays as measured by the PEDS. Higher negativity of life events and higher perceived stress scores during the year after birth were also associated with toddlers' increased risk of missed milestones according to the PEDS-DM. We also tested interaction effects but did not find any significant interactions among the stress measures, unlike Bush et al. (2017) who found an interaction effect between their pregnancy stress measures (life events and perceived stress). The present results suggest that multiple measures of maternal stress in the year following birth (postpartum) may have unique and additive effects. These results suggest that understanding toddlers' risk for developmental delay requires understanding multiple aspects of mothers' broader social context, including major life events, their impact, and general stress perceptions reflecting more chronic demands.

There was also an unexpected negative association between the number of maternal life events in the year since birth and the toddler missing one milestone in the PEDS-DM models. The effect of number of life events on reports of multiple missed milestones was positive but not significant in these models. Reconciling this with the PEDS findings, the PEDS-DM results may indicate that mothers who experienced higher life events were less likely to notice and report a specific missed milestone, though they were more likely to have developmental concerns.

TABLE 3 Multinomial logistic regression results of maternal postpartum stress associations with PEDS categories among toddlers 12–22 months

	Model 1				Model 2			
	Moderate risk		High risk		Moderate risk		High risk	
Variables	RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI
Maternal postpartum stress								
Negativity of major life events	1.10	0.95–1.28	1.17*	1.00–1.37	1.10	0.95–1.28	1.17*	1.01–1.35
Count of major life events	1.26**	1.08–1.47	1.34**	1.10–1.62	1.23*	1.01–1.50	1.31**	1.07–1.60
Average perceived stress score	1.82**	1.38–2.40	1.97**	1.24–3.12	1.73**	1.42–2.11	1.82*	1.13–2.94
Pregnancy stress								
Pregnancy stress score					1.02	0.97–1.07	1.02	1.00–1.05
Pregnancy not planned					0.91	0.70–1.19	0.82	0.51–1.32
Birth/postnatal health								
Low birth weight (< 5.5 g)					1.07	0.51–2.26	1.01	0.43–2.38
Preterm birth (<37 weeks)					0.91	0.61–1.37	1.09	0.56–2.11
Low Apgar score at birth					1.17	0.73–1.89	2.27*	1.21–4.28
Hearing problem −1 month					1.87*	1.01–3.47	1.86	0.64–5.44
1 month good/fair/poor health					1.25	0.69–2.27	1.96*	1.09–3.52
Controls[a]								
Male	1.07	0.95–1.21	1.38*	1.08–1.77	1.05	0.94–1.19	1.35*	1.02–1.79
Toddler age (T3)	1.09*	1.01–1.18	1.07	0.94–1.22	1.10	1.00–1.21	1.08	0.93–1.25
First-born	0.91	0.66–1.25	1.38	0.98–1.94	0.92	0.67–1.27	1.39	1.00–1.93
Maternal age	1.00	0.99–1.02	1.02	0.98–1.06	1.00	0.99–1.02	1.01	0.97–1.06
Mother pregnant T2 or T3	1.30*	1.01–1.68	1.09	0.61–1.94	1.30*	1.01–1.67	1.03	0.58–1.83
Maternal postpartum depression	0.98	0.96–1.01	1.01	0.95–1.08	0.98	0.95–1.01	1.01	0.95–1.07
Mother years of education	1.03	0.98–1.08	1.05	0.95–1.15	1.03	0.98–1.09	1.05	0.96–1.17
Family in poverty	0.87	0.75–1.01	1.26	0.89–1.78	0.85	0.72–1.01	1.20	0.86–1.67
Mother U.S.-born Hispanic[b]	1.31	0.77–2.21	0.97	0.40–2.33	1.31	0.76–2.26	0.95	0.39–2.33
Mother Hispanic immigrant[b]	1.52	0.73–3.15	1.23	0.84–1.80	1.46	0.73–2.93	1.09	0.73–1.64
Mother African American[b]	0.85**	0.75–0.96	0.48**	0.36–0.64	0.85*	0.74–0.98	0.46**	0.33–0.63

(Continues)

TABLE 3 (Continued)

Variables	Model 1				Model 2			
	Moderate risk		High risk		Moderate risk		High risk	
	RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI
Mother cohabiting at birth[c]	0.98	0.77–1.25	1.16	0.83–1.62	1.02	0.77–1.34	1.26	0.85–1.87
Mother single at birth[c]	0.93	0.70–1.25	0.97	0.53–1.76	0.97	0.67–1.42	1.11	0.70–1.75
# other children in home	0.89	0.75–1.06	1.22*	1.04–1.44	0.90	0.74–1.09	1.27**	1.08–1.51
Urban area	0.75	0.52–1.08	0.61*	0.40–0.94	0.77	0.53–1.11	0.63*	0.43–0.93

Note: NICHD Community Child Health Network Study. $N = 1537$.
[a]Assessed at T1 unless otherwise noted.
[b]Ref: Mother non-Hispanic white.
[c]Ref: Mother married at birth.
$^{*}p < 0.05$,
$^{**}p < 0.01$.

Our second goal was to assess the role of pregnancy stress and birth or early infant health conditions in accounting for the maternal postpartum stress-toddler development link. Prenatal stress and unplanned pregnancies were not associated with toddlers' risk of developmental delays in this study. The lack of significant results for pregnancy stress was somewhat divergent from existing research showing that pregnancy stress is associated with birth and infant outcomes (Bush et al., 2017; Shapiro, Fraser, Frasch, & Seguin, 2013; Wadhwa et al., 1993). This may be due, in part, to the use of maternal-reported developmental outcomes assessed 1–2 years after the pregnancy. However, these results are consistent with the Bush et al. (2017) study that found pregnancy life events count was not associated with 6-month infant temperament as reported by the mothers, but was associated with biologically measured reactivity in infants.

Of the birth and early infant health indicators, lower Apgar scores and low birth weight were important predictors of high risk for developmental delay. This is consistent with past research reporting that low birth weight was associated with later possible and probable developmental delays based on parent-reported concerns (Simon et al., 2013). The effect of a low Apgar score on both measures of toddler development is a relatively new finding that should be explored in future research. In addition, in the present study, infants whose mothers reported poorer overall health and a hearing problem at one month of age were at elevated risk for developmental delays in toddlerhood.

Importantly, even when accounting for birth and 1-month postpartum infant health conditions, as well as postpartum depression, maternal postpartum stress as measured by negativity of life events and perceived stress were consistently significant predictors of risk for developmental delay in both the PEDS and PEDS-DM models. Our findings related to postpartum stress corroborate prior research showing that mothers with higher postpartum parenting stress had infants with less optimal development outcomes (Slykerman et al., 2007; Sparks et al., 2012). Postpartum maternal stress also has been associated with infant temperament in a study of infants in the U.S. (Bush et al., 2017) and toddlers in China (Lin et al., 2017). This study contributes to this growing body of research indicating the potential importance of maternal stress following a birth as a risk factor for infant and toddler development.

There are several limitations to this study. Although extensive control variables were included in the regression models, causality cannot be inferred due to, in part, the inability to account for unobserved maternal/family characteristics. Of particular concern is the potential unobserved bias involved in mothers reporting of both stress and toddler developmental outcomes. For example, symptoms of trauma or substance use among mothers, which were not included in the present study, may affect their reports of stress and their child's development.

Given that the outcomes studied here were limited to maternal-reports, future research would benefit from assessing toddler developmental outcomes by trained observers in connection with maternal stress reports. However, recent research does suggest that parental reports are preferred over questions of disability diagnosis used in national studies of developmental disabilities (Zablotsky, Black,

TABLE 4 Multinomial logistic regression results of maternal postpartum stress associations with PEDS-DM categories among toddlers 12–22 months

	Model 3				Model 4			
	Moderate risk		High risk		Moderate risk		High risk	
Variables	RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI
Maternal stress								
Negativity of major life events	1.11*	1.02–1.20	1.16*	1.02–1.33	1.11**	1.03–1.20	1.16*	1.01–1.33
Count of major life events	0.87*	0.79–0.97	1.06	0.82–1.36	0.90*	0.82–0.99	1.05	0.86–1.29
Average perceived stress score	1.42**	1.16–1.74	1.72*	1.13–2.61	1.42**	1.16–1.74	1.63*	1.03–2.59
Pregnancy stress								
Pregnancy stress score					0.98	0.95–1.02	1.01	0.98–1.05
Pregnancy not planned					1.20**	1.06–1.36	0.79	0.55–1.12
Birth/postnatal health								
Low birth weight (<5.5 g)					1.44	0.70–2.96	2.34**	1.43–3.83
Preterm birth (<37 weeks)					1.17	0.86–1.58	1.28	0.80–2.04
Low Apgar score at birth					1.17	0.73–1.89	1.62*	1.05–2.50
Hearing problem −1 month					1.68	0.65–4.35	2.52	0.45–14.0
1 month good/fair/poor health					1.67**	1.39–2.01	1.97*	1.08–3.58
Controls[a]								
Male	1.14	0.91–1.43	1.99	0.92–4.28	1.15	0.90–1.46	2.01	0.89–4.54
Toddler age (T3)	0.87**	0.79–0.96	0.76**	0.70–0.83	0.87**	0.78–0.96	0.77**	0.70–0.83
First-born	1.17	0.97–1.42	0.64	0.36–1.16	1.16	0.94–1.45	0.65	0.38–1.11
Maternal age	1.03	1.00–1.07	1.05**	1.02–1.08	1.03	1.00–1.07	1.04*	1.00–1.07
Mother pregnant T2 or T3	0.72	0.40–1.30	0.77	0.36–1.68	0.71	0.39–1.30	0.69	0.32–1.51
Maternal postpartum depression	0.98	0.95–1.01	1.02**	1.01–1.04	0.99	0.95–1.02	1.01	0.99–1.04
Mother years of education	1.03	0.98–1.08	1.05	0.99–1.10	1.04	0.99–1.09	1.05	1.00–1.11
Family in poverty	0.78**	0.65–0.93	1.07	0.74–1.54	0.75**	0.64–0.89	1.02	0.66–1.58
Mother U.S.-born Hispanic[b]	1.00	0.35–2.87	1.99	0.93–4.25	0.93	0.32–2.72	1.79	0.83–3.86
Mother Hispanic immigrant[b]	1.15	0.60–2.22	1.05	0.45–2.44	1.03	0.54–1.98	0.87	0.39–1.94
Mother African American[b]	0.79	0.46–1.36	0.61	0.29–1.30	0.72	0.42–1.24	0.54	0.24–1.22
Mother cohabiting at birth[c]	0.99	0.74–1.34	1.34**	1.16–1.55	0.99	0.74–1.33	1.41**	1.18–1.69

(Continues)

TABLE 4 (Continued)

Variables	Model 3				Model 4			
	Moderate risk		High risk		Moderate risk		High risk	
	RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI
Mother single at birth[c]	1.18	0.75–1.85	1.15	0.84–1.57	1.17	0.75–1.80	1.30	0.96–1.76
# other children in home	1.07	0.97–1.18	1.05	0.92–1.20	1.07	0.96–1.18	1.10	0.99–1.23
Urban area	0.45**	0.24–0.82	0.44*	0.23–0.84	0.46**	0.26–0.83	0.46*	0.25–0.85

Note: NICHD Community Child Health Network Study. $N = 1511$.
[a]Assessed at T1 unless otherwise noted.
[b]Ref: Mother non-Hispanic white.
[c]Ref: Mother married at birth.
$^{*}p < 0.05$,
$^{**}p < 0.01$.

& Blumberg, 2017). Lower SES family conditions, along with other parental and family disadvantages, may impede parents' ability to connect with pediatricians and to obtain diagnosed disorders. Thus, parental evaluations may be especially important for capturing potential developmental delays among children in disadvantaged populations. Further, while it is important to understand maternal stress and development among low-income children, the findings from this study cannot be generalized to more advantaged populations.

A further limitation is our inability to establish causal direction of the significant associations between maternal stress and child development, due to potential dynamic, bidirectional effects. For instance, one study indicated that declines in infant cognitive skills over time were associated with increased parenting stress among mothers with preterm infants (Brummelte, Grunau, Synnes, Whitfield, & Petrie-Thomas, 2011). Thus, some of the associations found in the present study may be due to bidirectional process whereby stress affects developmental delays, and delays affect stress over time (Baker et al., 2003).

Another study limitation was the use of pregnancy stress measures that were necessarily retrospective and did not parallel the post-partum measures. Though we aimed to control for pregnancy stress using the measure available, we cannot rule out that some part of postpartum stress was a continuation of prenatal stress that carried over after birth. Studies that consider both pregnancy and postpartum stress are rare. One study found both to be important for infant outcomes, although prenatal and postnatal perceived stress were not included simultaneously in the models, and life events were not measured during the postpartum period, making it difficult to draw conclusions about pre- versus postpartum stress effects (Bush et al., 2017).

Finally, findings of this study are limited by the use of developmental outcomes assessed at only one point in time, which prevented testing how maternal stress and child developmental delay risks changed over time. Longitudinal data on outcomes would allow further inference as to how maternal stress exerts influence over time, and whether the early developmental disadvantages reported here accumulate with age or may be ameliorated by environmental conditions and/or health care in early childhood.

Notwithstanding these limitations, this study builds on existing research that suggests that maternal stress in the postpartum period needs attention in research, policy, and practice. It is an understudied source of risk within the family environment that likely operates in concert with other family conditions and contextual factors to impede toddler development. In this study, we advanced existing research by considering multiple measures of maternal stress, accounting for pregnancy stress and infant health conditions, and by using two validated, global measures of child developmental risk. The inclusion of a lower-income, ethnically diverse, and relatively large sample provided evidence applicable to a broader population than in previous studies, and advances our understanding of potential maternal stress risks for toddler development delays in racially diverse and low-resourced families. Given that pregnancy and birth conditions did not fully account for the associations between maternal postpartum stress and risk of toddler developmental delays, these findings suggest the potential importance of providing support to mothers and their families in the postpartum period in addition to prenatal support.

These findings should be further tested in future research to delineate the potential sources of maternal postpartum stress and the mechanisms through which they shape child development and influence long-term outcomes. Although we theorized that diminished parent-child interactions and family conflict and strain may be main pathways through which maternal postpartum stress could affect toddler developmental risks, future studies should empirically test these and other potential mechanisms; such as, maternal substance abuse and reduced reflective capacity. Thus, subsequent research is needed to fully understand the role of maternal stress. If research continues to find important effects of maternal stress on toddler development, programs for reducing maternal stress before and after delivery through economic, social, and other support should be developed, tested, and implemented as a way to improve child outcomes and reduce child health and developmental disparities.

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CONFLICT OF INTEREST

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere. All authors have reviewed and approved the manuscript and have no conflicts of interest to report.

AUTHOR CONTRIBUTIONS

Baltimore, MD: Baltimore City Healthy Start, Johns Hopkins University; Community PI: M. Vance; Academic PI: C. S. Minkovitz; Co-Invs: P. O'Campo, P. Schafer; Project Coordinators: N. Sankofa, K. Walton. **Lake County, IL:** Lake County Health Department and Community Health Center, the North Shore University Health System; Community PI: K. Wagenaar; Academic PI: M. Shalowitz; Co-Invs: E. Adam, G. Duncan*, A. Schoua-Glusberg, C. McKinney, T. McDade, C. Simon; Project Coordinator: E. Clark-Kauffman. **Los Angeles, CA:** Healthy African American Families, Cedars-Sinai Medical Center, University of California, Los Angeles; Community PI: L. Jones; Academic PI: C. Hobel; Co-PIs: C. Dunkel Schetter, M. C. Lu; Co-I: B. Chung; Project Coordinators: F. Jones, D. Serafin, D. Young. **North Carolina:** East Carolina University, NC Division of Public Health, NC Eastern Baby Love Plus Consortium, University of North Carolina, Chapel Hill; Community PIs: S. Evans, J. Ruffin, R. Woolard; Academic PI: J. Thorp; Co-Is: J. DeClerque, C. Dolbier, C. Lorenz; Project Coordinators L. S. Sahadeo, K. Salisbury. **Washington, DC:** Virginia Tech Carilion Research Institute, Virginia Tech, Washington Hospital Center, Developing Families Center; Community PI: L. Patchen; Academic PI: S. L. Ramey; Academic Co-PI: R.Gaines Lanzi; Co-Invs: L. V. Klerman, M. Miodovnik, C. T. Ramey, L. Randolph; Project Coordinator: N. Timraz; Community Coordinator: R. German. **Data Coordination and Analysis Center DCAC (Pennsylvania State University)** PI: V. M. Chinchilli; Co-Invs: R. BeLue, G. Brown Faulkner*, M. Hillemeier, I. Paul, M. L. Shaffer; Project Coordinator: G. Snyder; Biostatisticians: E. Lehman, C. Stetter; Data Managers: J. Schmidt, K. Cerullo, S. Whisler; Programmers: J. Fisher, J, Boyer, M. Payton. **NIH** Program Scientists: V. J. Evans and T. N.K. Raju, Eunice Kennedy Shriver National Institute of Child Health and Human Development; L. Weglicki, National Institute of Nursing Research, Program Officers: M. Spittel* and M. Willinger, NICHD; Y. Bryan,* NINR.

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*Indicates those who participated in only the planning phase of the CCHN.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in the Data and Specimen Hub (DASH) of the National Institute of Child Health and Human Development (NICHD) at https://dash.nichd.nih.gov/study/1649.

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