Moderate low birth weight and socioemotional competence among children: The role of parenting factors in early childhood

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ABSTRACT

Background: Although the importance of birth weight for socioemotional trajectories among children has become a topic of growing interest for researchers, the majority of prior studies were limited to the more extreme subgroups of low birth weight children.

Purpose: The purpose of this study was to examine the longitudinal associations among moderate low birth weight status, parenting factors, and socioemotional competence among at-risk children. This paper also examined the role of parenting factors as a moderator in the associations between birth weight and indicators of socioemotional competence at age 9.

Methods: Participants include a subsample ($N = 1809$) of families participating in the Fragile Families and Child Wellbeing Study, a national longitudinal birth cohort study. Birth weight and prenatal data were taken from medical records. Parenting factors were assessed during in-home assessments at ages 3 and 5. Teachers reported on externalizing behaviors and social skills at age 9. Structural equation modeling was used to examine the associations among study variables.

Results: Overall, results indicate that moderate low birth weight was significantly associated with lower levels of teacher-reported socioemotional competence at age 9 even after accounting for a large battery of control variables. Results also showed that maternal warmth, but not parenting stress, moderated the longitudinal association between birth weight and indicators of socioemotional competence.

Conclusion: Findings highlight the importance of birth weight and positive parenting processes in socioemotional outcomes among children. The implications of these findings are discussed for targeting positive parenting interventions and developmental outcomes for at-risk children.

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Low birth weight (LBW) is considered an important public health problem that is associated with a range of short- and long-term consequences (World Health Organization, 2014). Although, the percentage of children born LBW (birth weight less than 2500 g or 5 Lbs. 8 Ounces) was slightly declined from 2007 to 2012 (7.99%), the LBW rate has increased in recent years and remained roughly constant between 2017 and 2018 at 8.28% in the United States (Martin et al., 2019). While the neonatal outcomes of LBW children have improved in recent years via rapid advances in fetal medicine and perinatology, LBW children are generally at greater risk for continuing vulnerabilities in multiple domains of their health and development, in particular socioemotional competence.

Background

The empirical literature examining the impact of LBW indicates that LBW is associated with increased socioemotional and behavioral difficulties among children (Anderson et al., 2003; Bhutta et al., 2002; McCormick et al., 1996; Vaske et al., 2013). For instance, LBW children have an increased risk of developing externalizing difficulties including aggression, delinquency, hyperactivity, and conduct problems across childhood (Bhutta et al., 2002; Horwood et al., 1998; Vaske et al., 2013). Additional research also suggests that children with early life vulnerabilities will be at increased risk for behavioral maladjustment and psychopathology in later life (Räikkönen & Pesonen, 2009). Although the magnitude of the impairment varies across studies and subgroups of LBW children, LBW children are less likely to be socially competent and more likely to experience behavior problems during school years (Kelly et al., 2001; McCarton, 1998; McCormick et al., 1996) as compared to their normal birth weight (NBW: birth weight > 2500 g) counterparts during school years. Recent studies linking LBW and socioemotional development, however, have focused mainly

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on select subpopulations of LBW children, such as very low birth weight (VLBW; birth weight between 1000 and 1499 g) (Aarnoudse-Moens et al., 2009; Arpi & Ferrari, 2013; Hack et al., 2004; Horwood et al., 1998) and extremely low birth weight (ELBW; birth weight < 1000 g) (Anderson et al., 2003; Hack et al., 2009) categories. Thus, little is known about the developmental trajectories of LBW children in less extreme categories, particularly the moderate low birth weight (MLBW: birth weight 1500–2499 g) group.

MLBW infants account for greater than 85% of LBW children in the United States (Martin et al., 2019). Also, although the effects of LBW on socioemotional development begin in early childhood years (Arpi & Ferrari, 2013), effects can persist through middle childhood, adolescence, and into adulthood (Anderson et al., 2003; Bhutta et al., 2002; Hack et al., 2004; McCormick et al., 1996). The development of socioemotional competence is a crucial challenge for these at-risk children when they enter the social context of the school along with the complex interactions with teachers and peers. Notably, limited research has examined these associations among samples of MLBW children with a comparison group of NBW children in middle childhood and using multiple indicators of socioemotional competence. Acknowledging those limitations, the present study examined the longitudinal associations between MLBW and multiple dimensions of socioemotional competence, including externalizing behaviors, and social skills at age 9.

Regardless of their ongoing medical and developmental vulnerabilities, LBW children require contingent responsiveness and sensitive care from their parents in enhancing self-regulatory capacities and optimal neurodevelopmental outcomes (Jaekel et al., 2015; Jaffee, 2007). In particular, LBW and/or preterm children are generally more difficult to manage, more prone to difficult temperament, and fussier than their NBW counterparts resulting in difficulties with behavioral regulation (Landry et al., 2000) and slower to adapt to the environmental changes (Weiss et al., 2004). Consistent with the developmental vulnerability perspective, LBW children are particularly susceptible to adverse environmental contexts due to their temperamental and behavioral characteristics compared to their NBW peers (Weiss et al., 2004; Zukerman, 1999), thus requiring higher levels of warmth and sensitivity during the early years of development to achieve positive outcomes (Jaekel et al., 2015; Pudasainee-Kapri & Razza, 2019; Shah et al., 2013). For that reason, early positive parenting may be beneficial for these at-risk children to strengthen the impacts of biological vulnerability on behavioral competence (Landsem et al., 2015; Räikkönen & Pesonen, 2009). Findings of prior intervention studies targeting key parenting constructs, including enrichment of the home environment and increased warmth, stimulation, and positive interaction indicate that intervention groups had significantly lower perceived difficulties and lower total problem behavior as compared to the control group of LBW preterm children during early childhood (McCarton, 1998; Nordhov et al., 2012).

Because of these temperamental vulnerabilities and increased medical risks at early ages, mothers of LBW preterm infants show significantly higher levels of parenting stress during infancy than mothers of their NBW peers which can impact long-term development (Howe et al., 2014; Whiteside-Mansell et al., 2009). Since maternal psychological wellbeing (e.g., low levels of parenting stress) has important implications for children's long-term behavioral adjustment (Anthony et al., 2005; Monti et al., 2013), it is important to examine how birth weight and parenting processes interact to influence socioemotional development. Although prior research highlights the importance of positive parenting processes on long-term behavioral adjustment across different developmental ages, to date, none of the studies have examined these constructs in a single model and/using a moderational framework. Thus, consistent with the vulnerability perspective (Belsky et al., 2007; Zukerman, 1999) and prior research on parenting and LBW (Jaffee, 2007; Pudasainee-Kapri & Razza, 2019; Treyvaud et al., 2010; Tully et al., 2004), the present study examines the role of maternal warmth and parenting stress as moderators in the link between birth weight status and socioemotional competence.

Objectives of the present study

The primary objective of this study was to examine the longitudinal associations between moderate low birth weight status and socioemotional competence among children at age 9. In addition, this study explored the processes through which LBW influences socioemotional competence including externalizing problems behaviors, and social skills among at-risk children. Based on prior research in LBW children (Anderson et al., 2003; Bhutta et al., 2002; Vaske et al., 2013), the present study hypothesized that MLBW status would be associated with decreased socioemotional competence at age 9 (Hypothesis (H): H1). Since positive parenting and increased warmth have important implications to socioemotional outcomes (Altschul, Lee, & Gershoff, 2016; Landry et al., 1997; Nordhov et al., 2012; Tully et al., 2004), the present study also hypothesized that higher levels of maternal warmth at ages 3 and 5 would be associated with increased socioemotional competence at age 9 (H2a). Subsequently, higher levels of parenting stress at ages 3 and 5 would be negatively associated with socioemotional competence at age 9 (H2b). Consistent with developmental vulnerability framework (Belsky et al., 2007; Zukerman, 1999) and prior research on the impacts of early parenting processes (Howe et al., 2014; Landry et al., 1997; Poehlmann et al., 2012; Shah et al., 2013), the present study also proposed that maternal warmth (H3a) and parenting stress (H3b) would moderate the longitudinal association between birth weight and socioemotional competence at age 9. In addition to the parenting influences, multiple sociodemographic variables including maternal age, education, family income, and race/ethnicity, are significant predictors of long-term behavioral outcomes across different LBW groups (McCarton, 1998; Nordhov et al., 2012).

The present study used data from the Fragile Families and Child Wellbeing (FFCW) study to examine the longitudinal associations among study variables. While birth weight is classified as an important biological parameter that may have an important implication in long-term child outcomes, sociodemographic and prenatal/postnatal factors are often stronger predictors of children's developmental outcomes across the continuum of LBW (Bhutta et al., 2002; Poehlmann et al., 2012). Given the higher incidence of LBW across minority families (Martin et al., 2019; Reichman et al., 2007), and the effectiveness of parenting intervention among families from low socioeconomic status (Spiker et al., 1993), it was important to examine those links across a diverse sample of at-risk families. FFCW data was particularly suitable for the present analyses with the inclusion of diverse families in terms of race/ethnicity, family structure, income, and educational level. Thus, the present study accounted for the effects of a large number of potentially key prenatal, family and child characteristics, and sociodemographic variables in the model to examine the link among these constructs using FFCW data.

Methods

Study design and setting

Data for the present study were drawn from the FFCW Study, a national longitudinal birth cohort study of 4898 children born between 1998 and 2000 across 20 large cities in the United States. The survey was conducted by the Center for Research on Child Wellbeing at Princeton University and the Social Indicators Survey Center at Columbia University. The FFCW study follows a birth cohort of children born to unmarried parents (75% of the sample) with a comparison group of married families using a stratified, multistage sample of 200,000 or more people (Reichman et al., 2001). This sampling strategy resulted in the oversampling of minority and low-income families. Medical records data for mothers and children ($n = 3684$ of those births) were obtained from the birth hospitalization record. Baseline interviews with mothers were conducted after 48 hours of childbirth in the hospital using maternity ward lists. Fathers were interviewed shortly after

childbirth in person during hospital visits or by telephone at baseline. Following initial interviews with mothers and fathers at the child's birth, the telephone interviews with both mothers and fathers were conducted when children were ages 1, 3, 5, and 9 (Reichman et al., 2001). The teacher survey was administered when children were at ages 5 and 9. Families also participated in in-home assessments capturing the home environments and child outcomes at ages 3, 5, and 9. This study used Restricted Use Contract Data (i.e., medical records data) from the FFCW to examine the relationships among study variables. Permission to use restricted data was obtained through the FFCW via Contact Data Agreement and the author followed the procedures to protect the data files based on the contact data agreement and data protection plan. The ethical approval for the human subject's study was obtained by Syracuse University Institutional Review Board.

Participants

The participants consist of a subsample of families participating in the FFCW study ($n = 1809$). The eligibility criteria of the analytic sample included families with complete medical record data with a singleton birth ($n = 3619$) and children with no neurological impairments at birth and birth weight ≥ 1500 g. Thus, families with no medical record data ($n = 1214$), mothers with multiple pregnancy ($n = 65$), children with various neurological impairments ($n = 82$), and children with birth weight less than 1500 g ($n = 80$, VLBW and ELBW children) were excluded from the analytic sample. In addition, mothers who did not participate at ages 3 ($n = 608$) and 5 ($n = 438$) in-home longitudinal surveys of children and families were excluded from analyses. These criteria resulted in the final analytic sample to 1809 (36.9% of the original sample) families.

Data sources

Data on sociodemographic characteristics of the participants including family income, family types, race/ethnicity, poverty status, gender, maternal age were collected at baseline from the core interview with mothers within 48 hours of childbirth. Data on birth weight, gestational age, and prenatal history were also collected from medical records data. Data on maternal parenting stress and maternal warmth were collected from age-3 and 5- In-home Longitudinal Study of Pre-School-Aged children. Data on child externalizing problem behaviors and social skills at age 9 were collected via the maternal interview and teacher reports.

Variables

Birth weight

The variable, birth weight, was obtained from the birth hospitalization report from the medical records data. This is the most accurate record of birth weight compared to parental self-report and has been used in various studies examining child outcomes (McCarton, 1998; McCormick et al., 1996; Nordhov et al., 2012). Birth weight was operationalized into two groups for data analyses including LBW (1501–2499 g) and NBW (≥ 2500 g).

Maternal warmth

The measures of maternal warmth were based on the observer ratings from the Three-year and Five-year In-home Longitudinal Study of Pre-School-Aged children as part of the *Home Observation for Measurement of the Environment (HOME;* Caldwell & Bradley, 1984). Interviewers rated maternal warmth based on their observations of mother-child interactions during an in-home assessment at ages 3 and 5. Data on maternal warmth were collected using eight dichotomous items indicating whether the interviewer observed the mother's positive responsiveness and affection towards the child during the home visit (0 = no, 1 = yes). Example items include *"mothers spontaneously praise the child's behavior or qualities at least twice during the visit,* and

mother's voice conveys positive feelings when talking to or about the child" (for details, please refer to Appendix 1). Items were summed to create a composite score ($\alpha = 0.80$, and 0.79, at ages 3 and 5, respectively) so that higher scores indicated higher levels of maternal warmth.

Maternal parenting stress

Maternal parenting stress was measured using 11 items drawn from the Parenting Stress Index (PSI; Abidin, 1995). During the in-home assessments at ages 3 and 5, mothers completed 11 items questionnaire of parenting distress sub-scale describing stress on a 5-point scale ranging from 1 (strongly agree) to 5 (strongly disagree). Sample items include *"you feel trapped by your responsibilities as a parent"* and *"you often have the feeling that you cannot handle things very well"* (for details, please refer to Appendix 2). Items were recoded on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) before creating a composite scale. Then, responses were summed to create a composite scale ($\alpha = 0.87$ at both ages 3 and 5) with higher scores on these scales indicating higher levels of parenting stress.

Socioemotional competence

Socioemotional outcomes were measured via teacher reports of externalizing behaviors and social skills at age 9 using the Social Skills Rating System (SSRS; Gresham & Elliott, 2007). The externalizing subscale consisted of 6 items ($\alpha = 0.93$) tapping aggressive behaviors; sample items include *"argues with others",* and *"fight with others."* Items were scored on a 4-point Likert scale: never (1), sometimes (2), often (3), and very often (4). Items were averaged to create scales in which the higher scores indicated higher levels of externalizing behaviors among children.

The teacher also reported on social skills adapted from the Early Childhood Longitudinal Study-Kindergarten class of 1998–99 which included select items from the SSRS. The relations with peer subscale consisted of 10 items that measure children's ability to cooperate with peers in the classroom; sample items include *"ignores peer distractions when doing classwork"* and *"follows the directions."* For each item, teachers rated the frequency of the child's behavior on a 4-point scale ranging from (1) never to (4) very often. Items were averaged to create scales ($\alpha = 0.95$) in which higher scores indicated increased social skills among children. Previous studies using this scale also reported high reliability (Altschul et al., 2016).

Control variables

The models controlled for key child characteristics, prenatal/postnatal, and sociodemographic variables to avoid erroneous associations among key study variables. Child characteristics included preterm birth and difficult temperament. Difficult temperament during infancy reflected the average of three items ($\alpha = 0.59$ e.g., *often fusses and cries*) drawn from the Emotionality scale of the Emotionality, Adaptability, Sociability (EAS) Temperament Survey for Children (Buss & Plomin, 1984). Similar to previous studies (Poehlmann et al., 2012; Pudasainee-Kapri & Razza, 2019; Shah et al., 2013), a socioeconomic (SES) risk index was created by averaging the presence of various risk factors from the demographic questionnaire: poverty status (i.e., family income <200% of the federal poverty threshold), single-parent families, adolescent mother, minority race/ethnic groups, less than high school education for the mother, and more than four dependent children in the households. Scores ranged from 0 to 6 with higher scores representing more risk factors ($\alpha = 0.53$). Similarly, the prenatal risk index was created by summing the presence of various prenatal risk factors including substance use, maternal mental health problems, and inadequate weight gain during pregnancy. Scores ranged from 0 to 3 with higher scores representing more risk factors ($\alpha = 0.43$). Both SES and prenatal risk index were entered as control variables in SEM models. Other control variables included maternal body mass index (MBMI) and maternal depression. MBMI was a continuous variable tapping the body mass index

of the mother before pregnancy. The constructed measure of maternal depression at age one was used in analyses denoting whether the mother meets the depression criteria ($1 = yes, 0 = no$), assessed via the Composite International Diagnostic Interview- Short Form (CIDI-SF) Section A (Kessler et al., 1998).

Statistical methods

The structural equation modeling (SEM) was conducted to examine the associations among birth weight, parenting factors, and socio-emotional competence. This study used Analysis of Moment Structures (AMOS) 22.0 software (Arbuckle, 2012) to perform SEM with maximum likelihood (ML) estimation to test the hypothesized models. First, the confirmatory factor analyses were conducted in the measurement model to confirm significant item loadings. These analytic approaches provided the correlations among variables to examine multicollinearity and factor loadings of each variable for reliability. Second, the SEM with latent variables was conducted to examine the hypothesized links among study variables. Third, the SEM with interaction was conducted to examine the potential moderating effects of parenting processes in the link between MLBW and socioemotional competence. The χ^2 statistic, Comparative Fit Index (CFI), and Root Mean Square of Approximation (RMSEA) were used to examine the fit between the hypothesized models and the data. CFI values greater than 0.95 and RMSEA values less than or equal to 0.06 represent a good model fit based on suggestions of evaluating structural equations models by Hu and Bentler (1999).

Results

Descriptive data

Table 1 presents the percentages or means and standard deviations of key demographic and control variables. Similarly, Table 2 shows the mean and standard deviation for independent and outcome variables. Table 3 presents the bivariate correlations among key study variables and control variables. Among the total analytic sample, 8.0% ($n = 143$) of children were born MLBW (birth weight 1501 to 2499 g) of which about two-thirds of them ($n = 89$) were preterm LBW. Fifty-one percent of participants were male. About 41% of children were from single-parent families. More than two-thirds of participants were of the ethnic minority, including 51.5% African American, 25.8% Hispanic, and 2.9% other race/ethnic categories. Similarly, 63.5% of participants fell below the poverty threshold at baseline (family income <200% of the federal poverty threshold) and 34.9% of mothers did not complete high school. In addition, 12.1% of mothers had a history of mental health problems, 20.9% had a history of smoking only, and 26.1% used substances (including tobacco, alcohol, and drugs) during pregnancy. Only about 51% of mothers started prenatal visits during the first trimester of pregnancy.

The significant bivariate associations were found between MLBW status and teacher reports of externalizing behaviors ($r = 0.07, p < .05$) and social skills ($r = -0.07, p < .05$) at age 9. Significant bivariate correlations were also supported between parenting factors and measures of socioemotional competence at age 9 (see Table 3 for details). Covariates of each model were determined based on the significant correlations with key control variables. Preliminary analyses also comprised independent sample t-tests examining values on externalizing behavior and social skills across MLBW and NBW children (see Table 2). Results indicated significant differences in teacher reports of socioemotional competence, in which children with MLBW scored higher on externalizing behavior problems ($t = 2.14, p < .05$; eta squared $= 0.004$) and lower on social skills ($t = 2.11, p < .05$; eta squared $= 0.004$) compared to NBW children. For SEM models, latent factors were created to represent socioemotional competence (externalizing behaviors and social skills), and maternal warmth, and parenting stress (at ages 3 and 5).

Table 1
Descriptive statistics for demographic and control variables ($N = 1809$).

Variable	N	%	M	SD
Moderate low birth weight	143	7.9		
Pre-term birth	177	9.8		
Child gender (male)	921	51.1		
Above poor (income >200%)	661	36.5		
Birth weight (in grams)			3270.0	532.9
Gestational age			38.8	1.8
Difficult temperament			8.6	3.2
Current household income			31,202.5	30,615
Maternal age (in years)			25.1	6.0
Gravida			2.9	1.8
Pre-pregnancy body mass index			26.7	6.8
Dependent children in the household (>4)	59	3.3		
Parity				
First-born	644	35.7		
Second/higher	1160	64.3		
Family types				
Single Parent	734	40.6		
Married/Cohabiting	1075	59.4		
Maternal education				
Less than high school	630	34.9		
High school or GED	546	30.2		
Some college	456	25.2		
College grad or more	175	9.7		
Race/ethnicity				
White	357	19.8		
African American	930	51.5		
Hispanics	466	25.8		
Others	53	2.9		
Prenatal care began				
First trimester	788	50.8		
Second/ higher	764	49.2		
Weight gain during pregnancy				
Inadequate	470	28.8		
Adequate/ more	1031	71.2		
Prenatal substance use	473	26.1		
Prenatal smoking	376	20.8		
Prenatal mental health problems	225	12.4		

Note: Dependent Children in Household (refers to greater than 4 children less than 18 years old in the household), Moderate Low Birth Weight (infant's birth weight between 1500 and 2499 g), Preterm birth (the infant born below 37 completed weeks of gestation), Above poor (refers to family income more than 200% of the federal poverty threshold).

Main results

Moderate low birth weight, parenting factors, & socioemotional competence

Model 1 examined the association between birth weight, parenting factors, and teachers' reports of socioemotional competence at age 9 (see Fig. 1). The model fits the data fairly well with $\chi2 = 90.68$, df $= 38, p < .001$, CFI $= 0.974$, RMSEA $= 0.028$ even after accounting the

Table 2
Means for parenting factors and child outcomes across the full sample, and by birth weight status.

Variables	Full Sample ($N = 1809$)		MLBW ($N = 143$)		NBW ($N = 1666$)		t-statistic
	Mean	SD	Mean	SD	Mean	SD	
Maternal warmth at age 3	6.90	1.71	6.55	2.0	6.93	1.68	−2.09*
Maternal warmth at age 5	6.12	2.06	5.88	2.12	6.14	2.05	−1.29
Parenting stress at age 3	42.86	8.01	42.41	7.33	42.89	8.07	0.73
Parenting stress at age 5	43.44	7.60	42.39	7.66	43.52	7.59	1.65+
Externalizing problems at age 9- TR	9.47	4.13	10.39	4.42	9.39	4.10	2.14*
Social skills at age 9- TR	28.91	7.34	27.30	7.69	29.06	7.30	−2.11*

Note: MLBW = Moderate Low Birth Weight (infant's birth weight between 1500 and 2499 g), NBW = Normal Birth Weight (infant's birth weight ≥ 2500 g); TR = Teacher Reports.
+ $p < .10$.
* $p < .05$.

Table 3
Bivariate correlation matrix of all study variables ($n = 1809$).

Variables	1	2	3	4	5	6	7
1. Moderate low birth weight	1						
2. Maternal warmth at age 3	−0.06*	1					
3. Maternal warmth at age 5	−0.04	0.20***	1				
4. Parenting stress at age 3	0.02	−0.12***	−0.15***	1			
5. Parenting stress at age 5	0.04+	−0.11***	−0.17***	0.49***	1		
6. Externalizing problems at age 9- TR	0.07*	−0.20***	−0.15***	0.06+	0.08*	1	
7. Social skills at age 9-TR	−0.07*	0.15***	0.13***	−0.08*	−0.14***	−0.57***	1
8. Poverty	0.02	−0.12***	−0.15***	0.19***	0.25***	0.13***	−0.15***
9. Education	−0.05*	0.21***	0.18***	−0.19***	−0.26***	−0.10**	0.13***
10. Race/Ethnicity	−0.04+	−0.03	−0.03	0.04+	0.09***	−0.03	0.03
11. Family types	0.03	−0.09**	−0.10***	0.12***	0.15***	0.14***	−0.15***
12. Maternal age	−0.01	0.12***	0.14***	−0.07**	−0.05*	−0.13***	0.10**
13. Dependent children	−0.02	−0.10***	−0.07**	0.07**	0.09***	0.01	0.04
14. Temperament at age 1	0.06*	0.01	−0.07**	0.15***	0.17***	0.13***	−0.07+
15. Preterm birth	0.52***	−0.05	−0.04	0.02	0.03	−0.02	−0.02
16. Pre-pregnancy body mass index	−0.07**	−0.05	−0.05+	0.01	0.01	0.08*	−0.05
17. Prenatal smoking	0.11***	−0.06*	−0.02	0.13***	0.12***	0.08**	−0.07*
18. Prenatal substance use	0.11***	−0.07*	−0.03	0.14***	0.13***	0.09**	0.08**
19. Prenatal mental health problems	0.10***	−0.08**	−0.02	0.13***	0.08**	0.05+	−0.03
20. Weight gain during pregnancy	0.16***	−0.07*	0.04	0.03	0.01	0.03	−0.03
21. Maternal depression at age 1	0.02	−0.01	−0.05+	0.16***	0.19***	0.07*	−0.07*

Note. Bivariate correlations among key study variables (#1- #7) are presented above the line and bivariate correlations between control and key study variables are shown below the line.
TR = Teacher Reports, Dependent children refers to greater than four children under the age of 18 in the household.

+ $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

effects of large battery of controls in the model. Consistent with the first and second hypotheses, significant associations existed from both birth weight and parenting variables to teachers' reports of socioemotional competence with and without controls in the model. Specifically, MLBW status was significantly associated with teachers' reports of lower socioemotional competence ($\beta = -0.09$, $p < .05$), including higher levels of externalizing problem behaviors and lower levels of social skills at age 9. Results also indicate that the higher level of maternal warmth at ages 3 and 5 was associated with teacher reports of increased socioemotional competence ($\beta = 0.45$, $p < .01$) at age 9 which provided
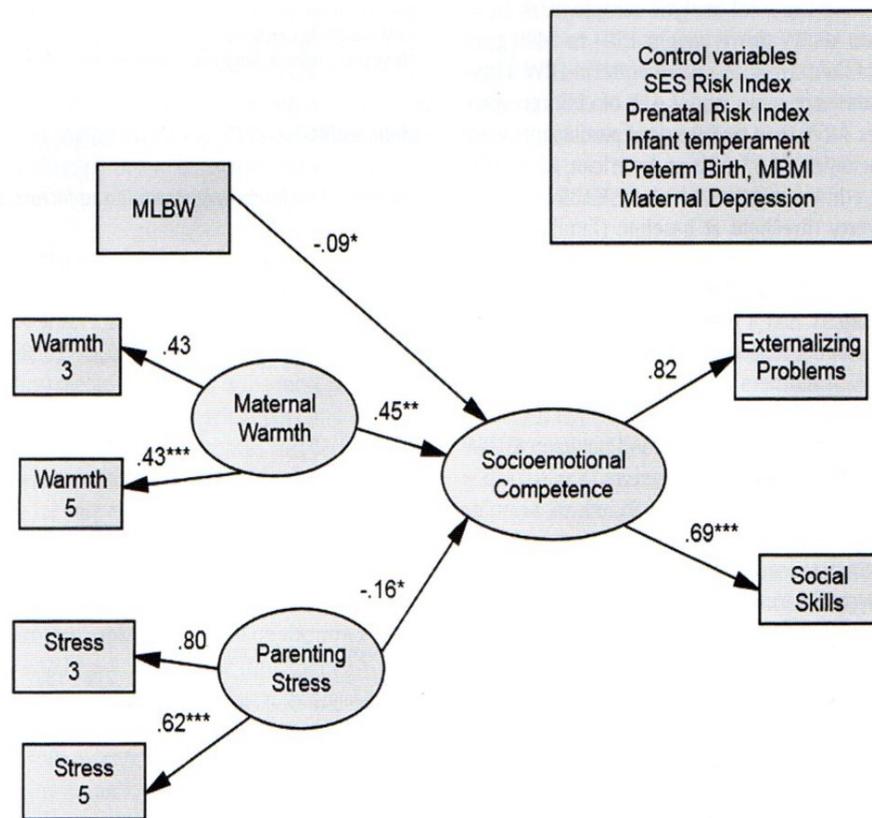

Fig. 1. Model 1. Structural equation model predicting teacher's reports of socioemotional competence at age 9 from birth weight and parenting factors ($N = 1809$).
Model Fit Indices: $\chi2 = 90.68$, df $= 38$, $p < .001$, CFI $= 0.974$, RMSEA $= 0.028$. Significant paths are indicated by asterisks: * $p < .05$, ** $p < .01$, & *** $p < .001$.
Note. SES = Socioeconomic Status, MBMI = Maternal Pre-Pregnancy Body Mass Index, MLBW = Moderate Low Birth Weight, Warmth 3/Warmth 5 = Maternal Warmth at age 3/age 5, Stress 3/Stress 5 = Maternal Parenting Stress at age 3/age 5. The Model explained 21.5% of the variance in teacher-reported socioemotional competence at age 9.

support for H2a. As hypothesized (H2b), higher levels of parenting stress at ages 3 and 5 predicted teacher reports of lower socioemotional outcomes ($\beta = -0.16, p < .05$). Overall, model 1 explained 21.5% of the variance in teacher-reported socioemotional competence at age 9.

Moderating role of parenting factors on socioemotional competence

Two structural equation models were conducted to test the interaction effects of each parenting construct (maternal warmth and parenting stress) and birth weight separately predicting socioemotional competence because one single SEM model with interaction did not fit the data well (results not shown). The first moderation model (Model 2) was tested to determine whether maternal warmth moderates the associations between birth weight and teacher reports of socioemotional competence (see Fig. 2). A test of moderation by maternal warmth was conducted by creating interactions between binary measures of birth weight (1 = MLBW) and standardized scores (z-scores) of warmth at ages 3 and 5. The model fits the data fairly well ($\chi2 = 77.52, df = 31, p < .001, CFI = 0.970, RMSEA = 0.029$), even after accounting the effects of control variables in the model. As predicted (H3a), the interaction term representing maternal warmth and birth weight was significantly and negatively associated with teacher-reported socioemotional competence at age 9 ($\beta = -0.24, p < .05$) suggesting that the association between birth weight and socioemotional competence was stronger at high levels of maternal warmth than low levels of warmth. The model explained 26.3% of the variance in teacher reports of socioemotional competence at age 9.

This interaction was probed by calculating average socioemotional competence from the standard scores of externalizing problems and social skills at selected high warmth (1/2 standard deviation above the mean) and low warmth (1/2 standard deviation below the mean) categories for MLBW and NBW children (see Fig. 3). Interestingly, as depicted in Fig. 3, the differences in mean scores across socioemotional outcomes for high and low warmth groups were significant only for NBW children ($t = -5.37, p < .001$) but not for the MLBW group ($t = -1.29$, ns). Thus, the scores of socioemotional outcomes between children with low and high warmth were significant for those who were born greater than 2500 g (NBW), who represented the majority

of children in this sample. However, MLBW children, who scored 1/2 SD below or above the mean on maternal warmth, did not exhibit a statistically significant mean difference in teacher reports of socioemotional competence at age 9. Given the similar size of differences in mean socioemotional scores between low and high warmth were obtained for children who were NBW ($N = 347$; mean difference = -6.15, SD difference = 1.14) and MLBW ($N = 34$; mean difference = -5.22, SD difference = 3.98) groups, however, it is possible that the small sample size for the MLBW group could contribute to the lack of significance. From the visual inspection of the data, MLBW children had better outcomes when higher levels of warmth were available at both ages 3 and 5 (Fig. 3). Whereas, MLBW children showed lower socioemotional competence when exposed to low levels of maternal warmth across ages 3 and 5 compared with their NBW peers who were exposed to low levels of maternal warmth. These findings support the notion of vulnerability, such that MLBW at-risk children showed worse outcomes on socioemotional competence than NBW children under negative parenting conditions, thus requiring higher levels of warmth for favorable developmental outcomes.

The second moderation model analyzed the interaction effects of birth weight and combined measures of parenting stress at ages 3 and 5 for teacher-reports of socioemotional competence at age 9. The interaction term did not reach significance in the model. Thus, contrary to the expectations (H3b), parenting stress did not buffer the strength of the association between birth weight and measures of socioemotional competence (results not shown). Therefore, the associations between MLBW and socioemotional competence at age 9 did not differ based on the levels of maternal parenting stress at ages 3 and 5.

Discussion

Key results

The present study highlighted the significance of birth weight and the quality of early parenting factors for children's long-term socioemotional competence within an at-risk sample. Specifically, the findings of this study contribute to the current literature indicating the
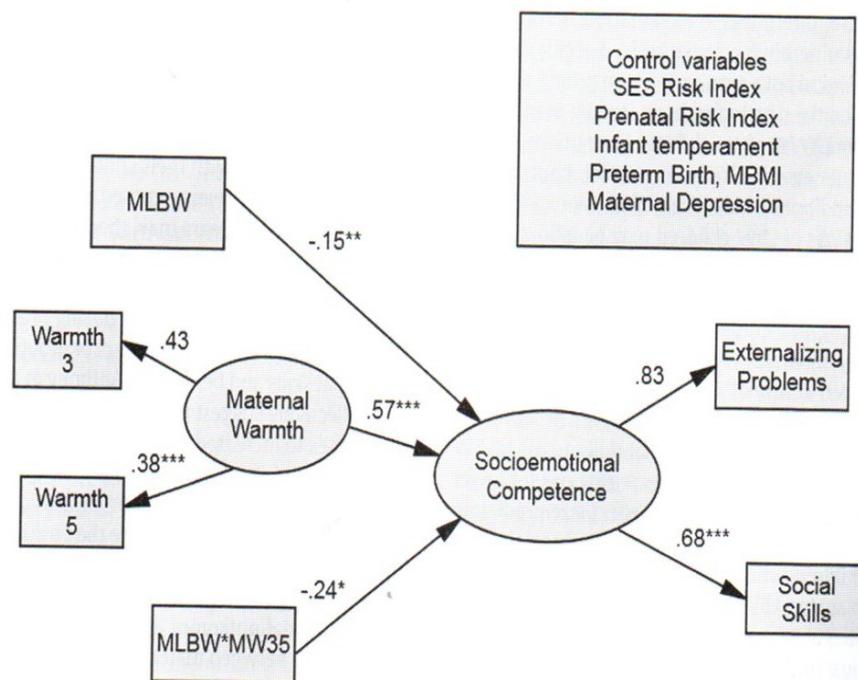

Fig. 2. Model 2 explaining the moderating role of maternal warmth in the associations among MLBW and teachers' reports of socioemotional competence at age 9 ($N = 1809$). Model fit indices: $\chi2 = 77.52, df = 31, p < .001, CFI = 0.970, RMSEA = 0.029$. Significant paths are indicated by asterisks: $^* p < .05, ^{**} p < .01, \& ^{***} p < .001$.
Note. SES= Socioeconomic Status, MBMI = Maternal Pre-Pregnancy Body Mass Index, MLBW = Moderate Low Birth Weight, Warmth 3/Warmth 5: Maternal Warmth at age 3/age 5, MW 35 = Averaged Maternal Warmth at ages 3 and 5. The model explained 26.3% of the variance in teacher reports of socioemotional competence at age 9.
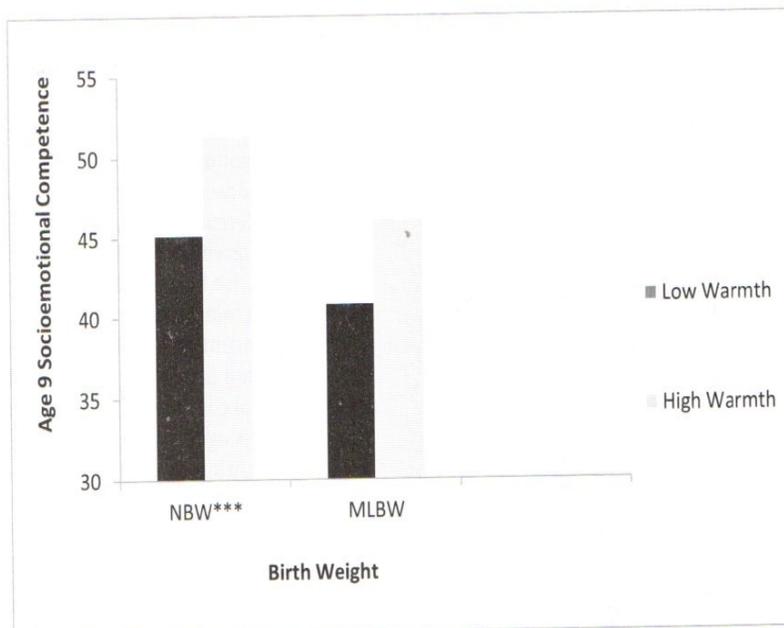
Fig. 3. The association between birth weight and teacher-reports of socioemotional competence at age 9 as a function of levels of maternal warmth. A significant ([***] $p < .001$) mean difference between low warmth and high warmth group (1/2 SD below the mean and above the mean, respectively) is represented by an asterisk on the x-axis.

impacts of MLBW for multiple dimensions of socioemotional competence in middle childhood (Aarnoudse-Moens et al., 2009; Bhutta et al., 2002; Landsem et al., 2015). Similar to a few prior studies among ELBW and/preterm children (Anderson et al., 2003; Hack et al., 2009; McCormick et al., 1996), MLBW status significantly predicted teachers' reports of socioemotional competence, including lower levels of social skills and a higher level of externalizing problem behaviors at age 9 above and beyond the effects of several key control variables. This finding is also consistent with existing research across VLBW preterm children in which VLBW status was significantly associated with teacher reports of increased externalizing problems in school-age children (Aarnoudse-Moens et al., 2009; Horwood et al., 1998; Landsem et al., 2015; Whiteside-Mansell et al., 2009).

Although the mechanisms underlying this association are not well understood in the literature, one possible explanation is consistent with the developmental vulnerability hypothesis. Specifically, the diverse medical and physiological risks at an early age may have a persistent and long-term impact on the developing brain leading to increased behavioral difficulties among LBW preterm children (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; Bhutta et al., 2002; McCarton, 1998). In addition to biological vulnerability; externalizing behaviors and social skills of LBW children may be influenced by other factors, such as home and social environment, child characteristics, and the quality of parenting factors (Landry et al., 2000). Although these factors are included as controls in the present model, the effects of additional factors may be equally important when examining socioemotional outcomes for MLBW children at school. Given the strong associations among these links and the significant mean differences in scores on teacher-reported externalizing problems and social skills across MLBW and NBW groups, MLBW children were still at increased risk for lower socioemotional competence at school. While the effect size predicting socioemotional competence from birth weight was relatively small, findings support that MLBW children, who were previously considered to be relatively a low-risk group among LBW infants, are still at increased risk for socioemotional difficulties at school. These small effects were not surprising given the previous findings across LBW and/VLBW groups (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; Vaske et al., 2013). For instance, Vaske et al. (2013) study of LBW children from the FFCW study revealed that LBW explained a small percentage of variation in serious aggression (0.4%) and destructive behaviors (0.3%) at age 5.

Consistent with prior research demonstrating the importance of early parenting factors on socioemotional outcomes (Altschul, Lee, & Gershoff, 2016; Landsem et al., 2015; Treyvaud et al., 2010), the present study found the significant longitudinal associations between parenting factors and multiple indicators of socioemotional competence among at-risk children above and beyond the effects of key control variables. More specifically, the higher levels of maternal warmth at ages 3 and 5 predicted increased teacher-reported social skills and decreased externalizing behaviors among all children at age 9. Higher levels of maternal warmth and positive interaction may stimulate the immature brain of LBW children (Nordhov et al., 2012), thereby facilitating positive long-term developmental outcomes (McCarton, 1998). Similar to other studies examining the role of parenting processes on child outcomes (Anthony et al., 2005; Monti et al., 2013; Singer et al., 1999), the present study also indicates that higher levels of parenting stress during early childhood made a significant negative contribution on child's socioemotional outcomes at age 9. In general, higher levels of parenting stress negatively influence maternal parenting behavior (Abidin, 1995) thus mothers show a lack of pleasure and encouragement in interacting with their children (Anthony et al., 2005; Robson, 1997). Children who were exposed to negative parenting contexts during early childhood years may, therefore lack the ability to effectively develop skills and competence for their long-term development. Whereas children who are exposed to low levels of parenting stress and positive parenting contexts during preschool build confidence in the positive interactions with peers or group situations, enhancing positive social skills and behaviors (Anthony et al., 2005). Overall, the findings collectively suggest that positive parenting during early childhood contributes to increased social competence and decreased problem behaviors in middle childhood. The findings of the present study also support that positive parenting processes could have a potentially modifiable influence that can promote the positive development of children. Specifically, maternal warmth in early childhood moderated the strength of the association between birth weight and measures of socioemotional outcomes at age 9. The significant interaction effect was stronger between maternal warmth and birth weight in predicting socioemotional competence even after controlling for key control variables in the model. Although a significant interaction effect existed between maternal warmth and birth weight in predicting socioemotional competence, the interaction effect was stronger for NBW children as compared to MLBW children. The follow-up analysis also

suggests that the mean scores of socioemotional outcomes between the high (1/2 standard deviation above the mean) and low (1/2 standard deviation below the mean) warmth group were significantly different only for NBW children but not for MLBW children. As discussed in the results, although the difference in mean scores at levels of high and low warmth was similar across the two groups, the small sample size for the MLBW group could have contributed to the lack of significance for this group. In particular, as the sample size proportions vary within two groups, the power to detect the difference will decrease (Frazier et al., 2004). Thus, unequal sample sizes across MLBW and NBW groups may be a major issue that needs further exploration in future research.

Although the present study did not explicitly test the effects of the differential susceptibility model or the vulnerability model, as indicated in the results and the visual inspection of the data, MLBW children were more susceptible to lower socioemotional competence at age 9 when they were exposed to low levels of maternal warmth central to a vulnerability framework. Thus, MLBW children are particularly more susceptible to poor developmental outcomes due to increased developmental vulnerabilities (Zukerman, 1999). Because of their compromised developmental outcomes, MLBW children required a positive warmth and responsive parenting environment during early childhood to achieve favorable socioemotional outcomes in middle childhood. The moderating effects of maternal warmth on behavior problems were consistent with a prior study across LBW twins, such that higher levels of warmth protect LBW children from developing teacher and parent reports of ADHD problems at age 5 (Tully et al., 2004). Although MLBW children did not outperform their NBW peers, they benefitted from higher levels of maternal warmth across ages 3 and 5 and demonstrated better outcomes in socioemotional domains under the positive parenting environment.

Contrary to expectations, the present study did not support the moderating effects of maternal parenting stress in the link between birth weight and socioemotional outcomes in middle childhood. Thus, MLBW children who were exposed to higher levels of maternal stress during the preschool years did not differ from their NBW peers across the socioemotional outcomes in middle childhood. As compared to the exposure to negative maternal cognitions and stress, LBW children may have more beneficial impacts through more positive maternal interactions (e.g., more positive affect and warmth, less intrusiveness, and high sensitivity) on socioemotional competence (Poehlmann et al., 2012; Spiker et al., 1993). Besides, methodological caution should be considered when interpreting the lack of interaction effects with maternal parenting stress. In particular, several factors may influence the statistical power in determining the moderating effects on outcomes including the reliability of measures, the size of the effect, and unequal sample sizes across groups (Frazier et al., 2004). Although it is recommended to use multi-group SEM with categorical variables in SEM (Frazier et al., 2004), this study employed SEM interaction techniques due to the small sample of MLBW children. Thus, multi-group analyses in SEM with larger samples may provide a more accurate representation of the strengths of the associations and or differences across groups.

Implications

Overall, the results of the present study have several important implications for practitioners and at the policy, level to foster positive parenting interventions and developmental outcomes for MLBW children. More specifically, neonatal and pediatric providers may obtain information to determine whether a child is at greater risk for adverse socioemotional outcomes associated with MLBW and parenting practices at home such that they may develop and utilize an individualized neurodevelopmental assessment for these infants. Providers may also refer those at-risk children and families to the intervention program that includes long-term developmental follow-up and consistent risk assessment and monitoring for those biologically at-risk infants and families. Additionally, the importance of positive parenting during early childhood is critical for MLBW children to achieve socioemotional competence at school. Policymakers and public health professionals will support to design and implement programs and policies that will enhance positive parenting of those mothers who are at-risk for low warmth and sensitivity to promote optimal outcomes for at-risk children. Investing in programs for these children and their families may have significant implications for long-term child outcomes.

Limitations

Although the present study enhances the current literature by examining the associations among birth weight, parenting factors, and children's socioemotional competence in a single model, this study has notable limitations. First, due to data constraints, VLBW and ELBW groups were excluded from the analyses, as there were not enough infants in those categories. However, the inclusion of those extreme weight categories in the model could help to understand if similar or different processes occur across different weight categories of LBW infants. Second, due to data constraints, the report on parenting stress was utilized from ages 3 and 5 in-home assessments. But acknowledging the findings of prior research among VLBW and preterm children (Howe et al., 2014; Monti et al., 2013; Robson, 1997; Singer et al., 1999), maternal parenting stress during infancy may serve as a mechanism for long-term outcomes across MLBW children. Thus, it is possible that parenting stress at earlier ages (e.g., birth to 1 year) may have been more important for long-term developmental outcomes across MLBW children. Third, the maternal warmth can be shown in differing ways across diverse race/ethnic families and the effects of implicit bias on the interviewer on the family could have been impacted since the maternal warmth was measured from interviewer observation of mother-child interactions during an in-home assessment at age 3 and 5. Fourth, the present study is limited to the generalizability of results due to the small sample size of MLBW children. Finally, the generalizability of findings is limited across all race/ethnic groups of at-risk families because of its select sample of urban low-income families, which is not a nationally representative sample of all births in the US.

Conclusion

Despite those limitations, the findings of the present study highlight that biological adversities remain one of the leading causes of a persistent long-term impact on socioemotional outcomes in middle childhood. To my knowledge, this is the first study that examined the longitudinal link between MLBW and multiple indicators of socioemotional competence with a particular role of parenting factors across low-income families. Although the extensive body of work has examined the relation between ELBW/VLBW children and socioemotional outcomes across childhood, the present study's unique aspects include the use of longitudinal design and standardized measures of key study variables, multiple methods of data collection (e.g., questionnaire, in-home assessment), and the ability to investigate the links across MLBW children with a comparison of NBW sample for diverse child outcomes. Future longitudinal studies are needed to better understand the developmental trajectories of socioemotional competence across different developmental ages, with a particular focus on the varying influences of key parenting processes and the home environment over time.

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Author statement

None.

Appendix 1. Measures of maternal warmth

Instructions for Interviewer: Answer on the basis of your personal observations of the home and the mother/child interactions at the time of your visit.

	Items	No	Yes
1	Parent talks twice to (child) during visit (beyond correction and introduction).	0	1
2	Parent verbally answers (child's) questions or requests.	0	1
3	Parent encourages (child) to contribute to conversation during visit.	0	1
4	Parent helps (child) demonstrate some achievement or mentions a particular skill, strength, or achievement during visit.	0	1
5	Parent spontaneously praises (child)'s behavior or qualities twice during visit.	0	1
6	Parent uses some term of endearment or some diminutive for (child)'s name when talking about or to him/her at least twice during visit	0	1
7	Parent's voice conveys positive feelings when speaking of or to (child).	0	1
8	Parent caresses, kisses, or cuddles (child) once during visit.	0	1

Note: These questionnaires were adapted from Fragile Families and Child Wellbeing Study, Public Data Documentation, In-Home Questionnaires: Ages 3 and 5 In-Home Longitudinal Study: *https://fragilefamilies.princeton.edu/data-and-documentation/public-data-documentation*

Appendix 2. Measures of parenting stress

Instructions: Having a child can sometimes be stressful. This section is about how stressful having (CHILD) has been for you and the ways in which you have had to adjust your life. For each statement, please tell me if you strongly agree, agree, disagree, strongly disagree or you are not sure?

	Items	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1	You often have the feeling that you cannot handle things very well	1	2	3	4	5
2	You find yourself giving up more of your life to meet your child(ren)'s needs than you ever expected	1	2	3	4	5
3	You feel trapped by your responsibilities as a parent	1	2	3	4	5
4	Since having (CHILD) you have been unable to do new and different things	1	2	3	4	5
5	Since having (CHILD) you feel that you are almost never able to do things that you like to do	1	2	3	4	5
6	There are quite a few things that bother you about your life	1	2	3	4	5
7	Having (CHILD) has caused more problems than you expected in your relationship with men	1	2	3	4	5
8	You feel alone and without friends	1	2	3	4	5
9	When you go to a party, you usually expect to have a bad time	1	2	3	4	5
10	You are less interested in people than you used to be	1	2	3	4	5
11	You enjoy things less than you used to	1	2	3	4	5

Note: These questionnaires were adapted from Fragile Families and Child Wellbeing Study, Public Data Documentation, In-Home Questionnaires: Ages 3 and 5 In-Home Longitudinal Study: *https://fragilefamilies.princeton.edu/data-and-documentation/public-data-documentation*

References

Aarnoudse-Moens, C. S. H., Weisglas-Kuperus, N., van Goudoever, J. B., & Oosterlaan, J. (2009). Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics, 124*(2), 717–728. https://doi.org/10.1542/peds.2008-2816.

Abidin, R. (1995). *Parent stress inventory* (3rd ed.). Odessa, FL: Psychological Assessment Resources.

Altschul, I., Lee, S. J., & Gershoff, E. T. (2016). Hugs, not hits: Warmth and spanking as predictors of child social competence. *Journal of Marriage and Family, 78*(3), 695–714. https://doi.org/10.1111/jomf.12306.

Anderson, P., & Doyle, L. W.Victorian Infant Collaborative Study Group. (2003). Neurobehavioral outcomes of school-age children born extremely low birth weight or very preterm in the 1990s. *Journal of the American Medical Association, 289*(24), 3264–3272. https://doi.org/10.1001/jama.289.24.3264.

Anthony, L. G., Anthony, B. J., Glanville, D. N., Naiman, D. Q., Waanders, C., & Shaffer, S. (2005). The relationships between parenting stress, parenting behavior and preschoolers' social competence and behavior problems in the classroom. *Infant and Child Development, 14*(4), 133–154. https://doi.org/10.1002/icd.385.

Arbuckle, J. L. (2012). *IBM SPSS Amos (version 21.0.1) [computer software]*. Spring House, PA: Amos Development Corporation, SPSS Inc.

Arpi, E., & Ferrari, F. (2013). Preterm birth and behavior problems in infants and preschool-age children: A review of the recent literature. *Developmental Medicine and Child Neurology, 55*(9), 788–796. https://doi.org/10.1111/dmcn.12142.

Belsky, J., Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (2007). For better and for worse differential susceptibility to environmental influences. *Current Directions in Psychological Science: A Journal of the American Psychological Society, 16*(6), 300–304. https://doi.org/10.1111/j.1467-8721.2007.00525.x.

Bhutta, A. T., Cleves, M. A., Casey, P. H., Cradock, M. M., & Anand, K. J. S. (2002). Cognitive and behavioral outcomes of school-aged children who were born preterm: A meta-analysis. *Journal of the American Medical Association, 288*, 728–737. https://doi.org/10.1001/jama.288.6.728.

Buss, A. H., & Plomin, R. (1984). *Temperament: Early developing personality traits*. Hillsdale, NJ: Lawrence Erlbaum.

Caldwell, B., & Bradley, R. (1984). *Home observation for measurement of the environment (HOME)* (Revised ed.). Little Rock: University of Arkansas.

Frazier, P. A., Tix, A. P., & Barron, K. E. (2004). Testing moderator and mediator effects in counseling psychology research. *Journal of Counseling Psychology, 51*(1), 115–134. https://doi.org/10.1037/0022-0167.51.1.115.

Gresham, F. M., & Elliott, S. N. (2007). *Social skills rating system*. Toronto, Canada: Pearson.

Hack, M., Taylor, H. G., Schluchter, M., Andreias, L., Drotar, D., & Klein, N. (2009). Behavioral outcomes of extremely low birth weight children at age 8 years. *Journal of Developmental and Behavioral Pediatrics, 30*(2), 122–130. https://doi.org/10.1097/DBP.0b013e31819e6a16.

Hack, M., Youngstrom, E. A., Cartar, L., Schluchter, M., Taylor, H. G., Flannery, D., ... Borawski, E. (2004). Behavioral outcomes and evidence of psychopathology among very low birth weight infants at age 20 years. *Pediatrics, 114*(4), 932–940. https://doi.org/10.1542/peds.2003-1017-L.

Horwood, L. J., Mogridge, N., & Darlow, B. A. (1998). Cognitive, educational, and behavioral outcomes at 7 to 8 years in a national very low birthweight cohort. *Archives of Disease in Childhood. Fetal and Neonatal Edition, 79*(1), F12–F20. https://doi.org/10.1136/fn.79.1.F12.

Howe, T. H., Sheu, C. F., Wang, T. N., & Hsu, Y. W. (2014). Parenting stress in families with very low birth weight preterm infants in early infancy. *Research in Developmental Disabilities, 35*(7), 1748–1756. https://doi.org/10.1016/j.ridd.2014.02.015.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118.

Jaekel, J., Pluess, M., Belsky, J., & Wolke, D. (2015). Effects of maternal sensitivity on low birth weight children's academic achievement: A test of differential susceptibility versus diathesis-stress. *Journal of Child Psychology and Psychiatry, 56*(6), 693–701. https://doi.org/10.1111/jcpp.12331.

Jaffee, S. R. (2007). Sensitive, stimulating caregiving predicts cognitive and behavioral resilience in neurodevelopmentally at-risk infants. *Development and Psychopathology, 19*(3), 631–647. https://doi.org/10.1017/S0954579407000326.

Kelly, Y. J., Nazroo, J. Y., McMunn, A., Boreham, R., & Marmot, M. (2001). Birthweight and behavioural problems in children: A modifiable effect? *International Journal of Epidemiology, 30*(1), 88–94. https://doi.org/10.1093/ije/30.1.88.

Kessler, R. C., Andrews, G., Mroczek, D., Ustun, T. B., & Wittchen, H. U. (1998). The World Health Organization composite international diagnostic interview short-form (CIDI-SF). *International Journal of Methods in Psychiatric Research, 7*(4), 171–185. https://doi.org/10.1002/mpr.47.

Landry, S. H., Smith, K. E., Miller-Loncar, C. L., & Swank, P. R. (1997). Predicting cognitive-language and social growth curves from early maternal behaviors in children at varying degrees of biological risk. *Developmental Psychology, 33*(6), 1040–1053. https://doi.org/10.1037/0012-1649.33.6.1040.

Landry, S. H., Smith, K. E., Swank, P. R., & Miller-Loncar, C. L. (2000). Early maternal and child influences on children's later independent cognitive and social functioning. *Child Development, 71*(2), 358–375. https://doi.org/10.1111/1467-8624.00150.

Landsem, I. P., Handegård, B. H., Ulvund, S. E., Tunby, J., Kaaresen, P. I., & Rønning, J. A. (2015). Does an early intervention influence behavioral development until age 9 in children born prematurely? *Child Development, 86*(4), 1063–1079. https://doi.org/10.1111/cdev.12368.

Martin, J. A., Hamilton, B. E., Osterman, M. J., & Driscoll, A. K. (2019). Births: Final data for 2018. *National Vital Statistics Reports, 68*(13), 1–47.

McCarton, C. (1998). Behavioral outcomes in low birth weight infants. *Pediatrics, 102*(5), 1293–1297.

McCormick, M. C., Workman-Daniels, K., & Brooks-Gunn, J. (1996). The behavioral and emotional well-being of school-age children with different birth weights. *Pediatrics, 97*(1), 18–25.

Monti, F., Neri, E., Trombini, E., Aureliano, F., Biasini, A., & Agostini, F. (2013). Prematurity: Parental stress, temperament and infant development. *European Journal of Child Development, Education and Psychopathology, 1*(3), 141–155.

Nordhov, S. M., Rønning, J. A., Ulvund, S. E., Dahl, L. B., & Kaaresen, P. I. (2012). Early intervention improves behavioral outcomes for preterm infants: Randomized controlled trial. *Pediatrics, 129*(1), e9–e16. https://doi.org/10.1542/peds.2011-0248.

Poehlmann, J., Hane, A., Burnson, C., Maleck, S., Hamburger, E., & Shah, P. E. (2012). Preterm infants who are prone to distress: Differential effects of parenting on 36-month behavioral and cognitive outcomes. *Journal of Child Psychology and Psychiatry, 53*(10), 1018–1025. https://doi.org/10.1111/j.1469-7610.2012.02564.x.

Pudasainee-Kapri, S., & Razza, R. A. (2019). Low birth weight and children's cognitive competence: The role of maternal warmth in early childhood. *Early Child Development and Care, 190*(16), 2551–2562.

Räikkönen, K., & Pesonen, A. K. (2009). Early life origins of psychological development and mental health. *Scandinavian Journal of Psychology, 50*(6), 583–591. https://doi.org/10.1111/j.1467-9450.2009.00786.x.

Reichman, N., Hamilton, E. R., Hummer, R. A., & Padilla, Y. C. (2007). Racial and ethnic disparities in low birth weight among urban unmarried mothers. *Maternal and Child Health Journal, 12*(2), 204–215. https://doi.org/10.1007/s10995-007-0240-1.

Reichman, N. E., Teitler, J. O., Garfinkel, I., & McLanahan, S. S. (2001). Fragile families: Sample and design. *Children and Youth Services Review, 23*(4), 303–326. https://doi.org/10.1016/S0190-7409(01)00141-4.

Robson, A. L. (1997). Low birth weight and parenting stress during early childhood. *Journal of Pediatric Psychology, 22*(3), 297–311. https://doi.org/10.1093/jpepsy/22.3.297.

Shah, P. E., Robbins, N., Coelho, R. B., & Poehlmann, J. (2013). The paradox of prematurity: The behavioral vulnerability of late preterm infants and the cognitive susceptibility of very preterm infants at 36 months post-term. *Infant Behavior & Development, 36*(1), 50–62. https://doi.org/10.1016/j.infbeh.2012.11.003.

Singer, L. T., Salvator, A., Guo, S., Collin, M., Lilien, L., & Baley, J. (1999). Maternal psychological distress and parenting stress after the birth of a very low-birth-weight infant. *JAMA: The Journal of the American Medical Association, 281*(9), 799–805. https://doi.org/10.1001/jama.281.9.799.

Spiker, D., Ferguson, J., & Brooks-Gunn, J. (1993). Enhancing maternal interactive behavior and child social competence in low birth weight, premature infants. *Child Development, 64*(3), 754–768. https://doi.org/10.2307/1131216.

Treyvaud, K., Anderson, V. A., Lee, K. J., Woodward, L. J., Newnham, C., Inder, T. E., ... Anderson, P. J. (2010). Parental mental health and early social-emotional development of children born very preterm. *Journal of Pediatric Psychology, 35*(7), 768–777. https://doi.org/10.1093/jpepsy/jsp109.

Tully, L. A., Arseneault, L., Caspi, A., Moffitt, T. E., & Morgan, J. (2004). Does maternal warmth moderate the effects of birth weight on twins' attention-deficit/hyperactivity disorder (ADHD) symptoms and low IQ? *Journal of Consulting and Clinical Psychology, 72*(2), 218–226. https://doi.org/10.1037/0022-006X.72.2.218.

Vaske, J., Newsome, J., & Boisvert, D. (2013). The mediating effects of verbal skills in the relationship between low birth weight and childhood aggressive behavior. *Infant and Child Development, 22*(3), 235–249. https://doi.org/10.1002/icd.1782.

Weiss, S. J., Jonn-Seed, M. S., & Wilson, P. (2004). The temperament of pre-term, low birth weight infants and its potential biological substrates. *Research in Nursing & Health, 27*(6), 392–402. https://doi.org/10.1002/nur.20038.

Whiteside-Mansell, L., Bradley, R. H., Casey, P. H., Fussell, J. J., & Conners-Burrow, N. A. (2009). Triple risk: Do difficult temperament and family conflict increases the likelihood of behavioral maladjustment in children born low birth weight and preterm? *Journal of Pediatric Psychology, 34*(4), 396–405. https://doi.org/10.1093/jpepsy/jsn089.

World Health Organization (2014). Global Nutrition Targets 2025: Low birth weight policy brief. https://www.who.int/nutrition/publications/globaltargets2025_policybrief_lbw/en/.

Zukerman, M. (1999). *Vulnerability to psychopathology: A biosocial model.* Washington DC: American Psychological Association. https://doi.org/10.1037/10316-000.