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Maternal depression and perceived social support as predictors of cognitive function trajectories during the first 3 years of life for preterm infants in Wisconsin

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Abstract

Background—Among families of infants born preterm, the association between postnatal depression and children's cognitive function is not well understood, but thought to be compromised. The purpose of this study is to investigate maternal depressive symptoms and perceived social support as predictors of children's cognitive function trajectories.

Methods—This is a longitudinal study of a sample of infants born preterm (less than 37 weeks) in Wisconsin. This study includes 130 infants who were hospitalized in one of three Wisconsin neonatal intensive care units in 2002–2005 and followed until 36 months of age. Maternal depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale. Social support was measured using the Maternal Support scale. Children's cognitive function was measured using the Bayley Scales of Infant Development, 2nd edition, and the Stanford-Binet Intelligence scale, 5th edition.

Results—Children's cognitive function trajectories declined initially and then increased. Being female [coefficient=5.14, s.e.=1.89] and non-poor [coefficient =11.26 s.e.=5.78], and having a mother who has a graduate degree [coefficient =7.67, s.e.=3.37] was associated with higher levels of cognition initially. Being white was associated with a more optimal cognitive trajectory. Although depression did not predict children's cognitive trajectories, the presence of clinically-elevated depressive symptoms at 9 months postterm was associated with lower cognitive functioning at 16 months when mothers reported low social support.

Conclusion—Postnatal depressive symptoms appear to have a meaningful, dynamic influence on the cognitive outcomes of children born preterm, above and beyond family socio-demographic risk when the presence and timing of perceived social support is considered. Interventions to ameliorate developmental risk associated with preterm birth should include repeated assessments of maternal social support and postnatal depression and be targeted toward socially disadvantaged families.

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Conflict of interest

The authors acknowledge no conflicts of interest.

Keywords

preterm birth; cognitive function; maternal depression; social support

Introduction

Children's cognitive function is a significant predictor of school readiness and later academic success (Miesels & Shonkoff 2000). Understanding family correlates of child outcomes, including neurodevelopment, has become a national pediatric health services priority in the United States (Wertlieb 2003). An influential family psychosocial predictor of child neurodevelopment is postnatal depression. Previous research suggests a consistent association between postnatal depression and children's emotional and behavioral development (Beck 1999), yet its association with cognitive function is less clear (Hay *et al.* 2001). Physiologic mechanisms have implicated lower cardiac vagal tone and reactivity in children of depressed mothers, which contributes to fewer facial expressions, vocalizations, decreased arousal and attention, and slower processing time among infants. Depressed mothers demonstrate difficulty with sensitivity, contingent responses, and modulation of environmental stimulation for their children, suggestive of social-interactional mechanisms (Beck 1999; Sohr-Preston & Scaramella 2006). Regardless of the pathway, depressed mothers struggle to address children's physical and social needs and to foster learning-rich environments (Lee *et al.* 2007; Sohr-Preston & Scaramella 2006).

Infants born preterm (<37 weeks) and their mothers are particularly vulnerable. Heightened psychosocial distress among mothers of preterm infants has been well- established (Eisengrat *et al.* 2003). While postnatal depression trajectories among mothers of preterm infants decline from birth to 24 months, this pattern is not seen in mothers of highest socioeconomic risk (Poehlmann *et al.* 2009). Neonatal morbidity appears less influential than maternal socio-demographic characteristics on postnatal depression trajectories (Poehlmann *et al.* 2009). However, above and beyond socioeconomic status, neurodevelopmental risk associated with prematurity may exacerbate the biological and social interactional pathways between postnatal depression and child cognitive function.

Although preterm infants, on average, experience less optimal cognitive development compared to full-term infants (Bhutta *et al.* 2002), there is significant variability across infants. Thus, it is important for researchers to examine protective factors that foster *resilience* in children born preterm (i.e., the development of positive outcomes despite the experience of risk) (Masten 2001). Maternal social support might be expected to buffer postnatal depression and, thus, foster children's cognitive function, even in preterm infants (Lee *et al.* 2007; Sohr-Prston *et al.* 2006). Receipt of emotional, financial, or instrumental assistance may ameliorate caregiving burdens and better equip mothers to address children's needs. Indeed, maternal social support among mothers of preterm infants dynamically influences postnatal depression in the first 2 postnatal years (Poehlmann *et al.* 2009), and is associated reduced psychosocial distress and more optimal infant neurodevelopment in the immediate postpartum (Browne & Talmi 2005). However, the influence of maternal social support on the relationship between postnatal depression and child cognitive function among preterm infants over time is unknown. The first three years are a time of rapid brain development and emergence of social skills required for school readiness (Thompson 2001). Understanding of the correlates of children's cognitive function trajectories may improve health/developmental service delivery for this vulnerable population.

The purpose of this study is to examine correlates of cognitive function trajectories among preterm infants. We hypothesize that 1) postnatal depression will be associated with lower

cognitive function over time, above and beyond social- demographic risk, and 2) children whose mothers report higher levels of social support over time will have more optimal cognitive function in the presence of postnatal depressive symptoms.

Methods

Study Population

The study sample included 181 preterm (<37 weeks) and low birth weight (<2500 grams) infants hospitalized in one of three Wisconsin neonatal intensive care units during 2002 and 2005. Families were invited to participate in the study if they met the following criteria: 1) infants were born at 35 weeks gestation or less or weighed less than 2,500 grams at birth, 2) infants had no known congenital malformations or prenatal drug exposure, 3) mothers were at least 17 years of age, 4) mothers could read English, and 5) mothers self-identified as the infant's primary caregiver. Of the recruited 186 mother-infant pairs, 181 (97%) participated. Infants were followed for 36 months and interviewed and evaluated at 6 time points: prior to NICU discharge, 4 months, 9 months, 16 months, 24 months, and 36 months. There was 17% attrition rate (Poehlmann *et al.* 2010) between hospital discharge and 36 months of age. Although this attrition rate is similar to previous studies (Miles *et al.* 2007) with similar populations, mothers lost to follow-up were more likely to be of lower education, non-white (Poehlmann *et al.* 2009). The present analysis is drawn from a sub-sample of 157 children for whom social support information was collected as part of a larger study. These 157 families did not differ from the original 181 on postnatal depressive symptom scores, socio-demographic characteristics, neonatal risk factors, or attrition rate. Of the 157 children, 27 were missing data on covariates of interest (i.e., 13 for maternal employment and 14 for marital status). Sensitivity analyses including these latter cases with missing data had no discernible effect on the results. Therefore, we restrict our analysis to 130 children with complete data.

Outcome Measure

Children's cognitive function was measured at three time points: 16 months, 24 months, and 36 months. At 16 months, the Bayley Scales of Infant Development, 2nd edition (Bayley 1993), Mental Developmental Index (MDI) was used. The Bayley is a widely used assessment of cognitive function appropriate for children ages 1 to 42 months. In the MDI, items are scored dichotomously (1=able to complete or 0=not able to complete) and summary scores are compared to a standardized distribution (mean =100 and SD=15). The MDI has excellent reliability ($\alpha=.91$), average stability coefficients of at least .80 across age groups, and moderate to high concurrent validity ($r=.59-.79$) (Bayley 1993). At 24 and 36 months corrected age, the Abbreviated Battery IQ scale (ABIQ) of the Stanford-Binet Intelligence Scale, 5th edition (Roid 2003), was used to measure cognitive function. The ABIQ is comprised of the sum of the Nonverbal Fluid Reasoning and Verbal Knowledge routing scaled scores. The Stanford- Binet is a widely used measure of cognitive function, appropriate for children over the age of 2, that measures reasoning, knowledge, processing (quantitative and visual- spatial) and memory. A summary score is compared to a standardized distribution (mean =100 and SD =15). The Stanford-Binet has excellent reliability ($\alpha=.95$ to .98) and moderate to high concurrent and criterion validity (Roid 2003). Since the ABIQ is not appropriate for children less than 24 months, our analyses needed to include different scales across time to measure cognitive function. However, limitations of this approach are offset by the fact that each is widely used in child neurodevelopmental literature and the combined use of the Bayley and ABIQ is consistent with a large, randomized controlled study of preterm and very low birthweight (i.e., Infant Health and Development Program) which allows for comparability across studies.

Maternal Depressive symptoms

Postnatal depressive symptoms were measured at each time point using the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff 1977). The CES-D asks mothers to report, on a 4-point scale (0=rarely/none of the time to 3=all of the time), their frequency of symptoms for 20 scale items. Scores of 16 or greater indicate clinically significant depressive symptoms. The CES-D has been used extensively in psychological and epidemiologic studies of postnatal women. In the present cohort, reliability for the CES-D was at least .85 across all measurement time points. We utilize time-varying CES-D scores at three time points: 9 months, 16 months, and 24 months to account for a priori hypothesized lagged effects of depressive symptoms on children's cognitive function (Sohr-Preston 2006). For these analyses, we chose to dichotomize (<16 or ≥ 16) continuous CES-D scores to increase interpretability and clinical meaningfulness.

Neonatal and Socio-demographic Characteristics

Child's race and ethnicity was categorized as white non-Hispanic or not (due to small numbers within minority sub-groups). Income was categorized as $<\$10,000$, $\$10,000$ to $\$30,000$, $\$30,000$ to $\$60,000$, and greater than $\$60,000$. Maternal education was categorized as high school or less, some college, college degree, and graduate degree. We also used maternal and paternal employment status (employed versus unemployed), parity (primiparous versus multiparous), and child's sex. We created a measure of presence of a partner (married/cohabitating versus not married/not cohabitating). Maternal smoking was categorized as present/former or never. Birth weight was dichotomized to reflect very low birth weight (<1500 grams) or not. We also included measures of gestational age (weeks), child's age (months), and mother's age at child's birth (years). All socio-demographic covariates with the exception of maternal employment (measured at 4 months) were collected at hospital discharge.

Maternal Social Support

Maternal perceived social support was measured using the Maternal Support scale (Poehlmann, et al, 2009) – an index of emotional, informational, household, child care, financial, respite, and other support – collected about the baby's father, mother's parents, in-laws, and extended family. A total perceived social support score was calculated by summing the scores of each type of support (7) across the four sources resulting in a range from 0 to 28. The reliability of the index scores was at least .83 across all study time points. Moreover, this scale has been used to provide evidence in support of hypotheses that more maternal support buffers social and biological associated with health and neurodevelopmental outcomes, thereby contributing to its validity. We utilized social support scores collected at three time points: 9 months, 16 months, and 24 months to test for effect modification between clinical depressive scores (collected at the same time point) and children's cognitive function by maternal perceived social support. To increase interpretability and clinical meaningfulness, total support was categorized as high (more than 1 SD above the mean), low (less than -1 SD below the mean), and otherwise middle.

Neonatal and socio-demographic characteristics of the study sample are presented in Table 1 and descriptive statistics of cognitive function, maternal depressive symptoms, and maternal social support are presented in Table 2.

Analytic Strategy

To answer our research questions we used latent growth models (Duncan *et al.* 1999). Latent growth models (LGM) model change over time that occurs within and between individuals, an advantage over autoregressive models that estimate the difference in outcome between

specific time points. Thus, the flexible modeling structure of latent growth curves gives rise to a hierarchical structure where the level 1 model describes individual children's trajectories and the level 2 model describes between-child differences in cognitive function trajectories. In LGM, change over time is categorized by an intercept (i.e., baseline cognitive function) and slope (i.e., change over time in cognitive function). These are considered latent variables with a mean (i.e., average growth curve in cohort) and variance (i.e., heterogeneity of growth curves).

We first fit an unadjusted model to determine the appropriate specification of the growth curve. We tested a linear specification and then a quadratic. The linear specification had poor overall model fit. However, we had only three timepoints of data, which restricts our ability to fit a quadratic model where the intercept, slope, and quadratic are allowed to freely correlate with each other. Therefore, we constrained the variance between latent variables to equality across timepoints. Since the constrained quadratic model had superior fit and was theoretically sound, we focus our interpretation and subsequent model-building based upon this well-fitting quadratic model.

In the second model we included time-invariant socio-demographic characteristics and time-varying postnatal clinical depressive symptoms. Preliminary analyses revealed that maternal and paternal employment and mother's age had small, insignificant effects that contributed to poorer overall model fit when included. Therefore, we excluded these covariates. Moreover, gestational age was highly collinear ($r=.70$) with birth weight so we only include birth weight. That is, including both would reduce the precision of model estimates. Since neither was a significant predictor of cognitive function trajectories, we chose to include birthweight and omit gestational age. In the final set of models we additionally included the interaction between time-varying covariates of postnatal clinical depressive symptoms and levels of maternal perceived social support.

For each model we report the mean, variance, and covariance of intercept, slope, and quadratic term. We also report the correlation between the time-invariant covariates and the slope, intercept, and quadratic term; the mean difference in children's cognitive function for time-varying covariates; and three measures of model fit. The mean intercept is interpreted as the average baseline cognitive function. The mean slope is interpreted as the average change over time in cognitive function. In the models we present, cognitive trajectories are influenced by both the slope (i.e., linear trend) and quadratic term (i.e., acceleration or deceleration of this trend). Effects of time-invariant covariates can be interpreted as correlations with the intercept (i.e., positive or negative association with baseline cognitive function), and cognitive function trajectories (i.e., slope and quadratic term). To assist with interpretation of cognitive function trajectories, we present figures for statistically significant covariates. We utilize three measures of model fit – the comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SMSR). CFI values greater than .95 and RMSEA and SMSR values less than .06 are considered acceptable (Hu & Bentler 1999).

Latent growth model analyses were conducted in Mplus v6 (Muthen & Muthen). The Institutional Review Board at all participating institutions approved this study. All parents provided written consent to participate.

Results

The first model (Table 3) estimates unadjusted cognitive function trajectories. Consistent with the data in Table 2, the mean intercept is 88.51 (s.e.=1.0). The mean slope is negative (−20.10, s.e.=2.55) and the quadratic term is positive (12.10, s.e.=1.22). Moreover, there is

significant variation in the mean slope (817.83, s.e.=106.75) indicating cognitive function trajectories of individual children vary substantially. The model fit statistics (CFI=1.00, RMSEA=<.001, and SMSR=<.001) indicate acceptable model fit.

The second model (Table 4) estimates the adjusted cognitive function trajectories. The results of the adjusted model suggest that being female (coefficient=5.14, s.e.=1.89), having a mother with a graduate degree (coefficient=7.66, s.e.=3.37), and having a family income of more than \$60,000 (coefficient=11.26, s.e.=5.78) is associated with higher initial cognitive function. Cognitive function trajectories vary by race and ethnicity whereby white, non-Hispanic children have a significantly less steep decline initially followed by consistently elevated rates of cognitive function (Figure 1) than their non-white peers. Presence of maternal clinical depressive symptoms does not have an independent influence on children's cognitive function. The model fit statistics (CFI=.984, RMSEA=.053, SMSR=.013) indicate acceptable model fit.

The third model (Table 5) tests the hypothesis that the influence of postnatal clinical depressive symptoms influences children's cognitive function differentially for mothers reporting varying levels of social support. Among mothers with low social support, presence of clinical depressive symptoms at 9 months postterm, but not other times, is associated with a 9-point (mean difference=-8.91, s.e.=3.71) lower cognitive function score at 16 months postterm. Among mothers with postnatal depression, the presence of middle or high perceived social support versus low social support is associated with significantly higher children's cognitive function. The model fit statistics (CFI=.974, RMSEA=.032, SMSR=.019) indicate acceptable model fit.

Discussion

In this paper we find that maternal clinical postnatal depressive symptoms are associated with lower cognitive function in preterm infants, particularly early in development, for infants whose mothers report low levels of perceived social support.

Whereas we expected to find a direct association, our finding of a null mean effect is consistent with a previous study (Tse *et al.* 2010) utilizing a cohort of full-term infants. In that study, the unadjusted influence of prenatal depression on cognitive function at age 3 was substantially attenuated after adjusting for socioeconomic characteristics. The authors hypothesized that social disadvantage, rather than depressive symptoms per se, operating through the provision of a developmentally supportive home environment, quality of the child's physical environment, and child morbidity, accounts for the association with cognitive function.

In the present study, we utilize a sample of children born preterm. Preterm infants represent a heterogeneous population characterized by social and biological risk (Msall *et al.* 2010) including neurological immaturity, parental psychosocial distress, and parent-infant interactional difficulties, all of which may adversely influence cognitive function. Thus, our measures of social disadvantage may not capture the heterogeneity of risk – both social and biological – within families. Indeed, previous research has highlighted differential risk and resilience among families of preterm infants within varying levels of social disadvantage (Msall *et al.* 2010; Werner 2000). Thus, maternal depressive symptoms – above and beyond social disadvantage – might be expected to differentially influence families based upon their unique risk or level of need.

Based upon theoretical models of risk and resilience (Sameroff & Fiese 2000), we examined a dynamically influential correlate of postnatal depression – perceived maternal social support – and its differential effects given the complexity of risk and need of the preterm

population. Indeed, we find evidence to support this. Perceived support in the form of social emotional encouragement, provision of information, assistance with childcare or household chores, financial help, or respite may buffer mothers' inability to meet children's physical and social needs, net of social disadvantage. Consistent with a multiple risk perspective, for mothers reporting low levels of this assistance, depressive symptoms appear to have a particularly detrimental influence on children's cognitive function. Moreover, social support seems particularly meaningful earlier rather than later in neurodevelopment. This finding is consistent with previous literature suggesting sensitive periods (Sohr-Preston & Scaramella 2006) in child development whereby the ill-effects of social circumstances may have more deleterious effects. Although we did not specifically test a sensitive period hypothesis, our findings are consistent with previous studies of preterm infants advocating for early screening and intervention for mothers and children. Indeed, maternal supports may contribute to or be an indicator of more optimal parent-child interactions or paternal involvement in play, both of which would contribute to improved cognitive function in children and future research should explore this.

We acknowledge the study's limitations. The relationships that we describe might be biased by unmeasured confounders. For example, we have no measure of current child health status. We investigated the influence of several measures of neonatal morbidity – gestational age, birth weight, days on mechanical ventilation, and days hospitalized in the NICU – and found, consistent with previous research (Poehlmann et al, 2009) using this sample, that none had a meaningful influence on the associations under study. However, it is possible that these measures did not fully capture children's health, which may influence maternal depression and children's cognitive function. However, we conducted sensitivity analyses to estimate the extent to which bias may be introduced. When we excluded the children with chronic lung disease (CLD, a marker for later asthma – the most prevalent and serious health condition associated with prematurity) from the analyses, the results of the latent growth models were nearly identical. While we cannot rule out the possibility of bias by omitted child health variables, we are confident that minimal bias was introduced by not having a measure of child's current health status. We have no information on prenatal depression. This has the potential to introduce bias if prenatal depression has a causal relationship with both postnatal depression and children's cognitive function (e.g., in utero hormonal fluctuations affecting neurological development). Future research should measure depression prior to, during, and post pregnancy to make firmer causal conclusions.

Our measure of postnatal depressive symptoms was collected via maternal report. This has the potential to introduce bias if mothers differentially report depressive symptoms in ways that coincide with trajectories of child cognitive function. Clinical diagnoses of depression were not made.

Families experiencing the most social disadvantage were more likely to be lost to attrition across the three years of study. This is of particular relevance given that socially disadvantaged families are more likely to experience postnatal depression and lower child cognitive function.

Finally, our measure of perceived social support only asked about the presence rather than the quality of social support. Thus, our findings may underestimate the true association between perceived social support, postnatal depressive symptoms, and children's cognitive function. Understanding what type of support is most helpful to mothers of preterm infants will assist in developing appropriate interventions.

Despite these limitations, the study has strengths. We utilized latent growth curve modeling to describe the effects of postnatal depression on children's cognitive function at multiple

timepoints in the presence of various levels of social support. We contribute to the limited literature on this topic by utilizing a preterm birth cohort, using repeat exposure and outcome measures, including a dynamic measure of perceived maternal social support.

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Key Messages

- Postnatal depression appears to have a dynamic influence on cognitive outcomes of infants born preterm (< 37 weeks) when the presence and timing of social support is considered.
- These results underscore the importance of frequent screening by pediatric, family medicine, and developmental medicine practitioners to evaluate family psychosocial issues, sources of social support, and child neurodevelopment.
- Socially disadvantaged and minority preterm infants are at particularly high risk for poorer cognitive outcomes over time.
- These results suggest the importance of understanding preterm infants' social circumstances and maternal mental health to facilitate referral for appropriate developmental interventions.

Figure 1.

Cognitive Function Trajectories for Children, by maternal race and ethnicity, in a sample (n=130) of infants born preterm in Wisconsin in 2002–2005.

*Measured by the Bayley Scales of Infant Development, Mental Developmental Index at 16 months postterm. Measured by the Abbreviated Battery IQ scale of the Stanford-Binet Intelligence Scale at 24 months and 36 months postterm.

Table 1

Characteristics of study sample (n=130) of preterm, low birth weight infants born in Wisconsin in 2003–2005.

Child and Family Characteristic	N (%)
Child's race and ethnicity	
White, non-Hispanic	107 (82.3)
Other race / ethnicity	23 (17.7)
Maternal Education	
High school or less	40 (30.8)
Some college	25 (19.2)
Bachelor's degree	41 (31.5)
Graduate degree	24 (18.5)
Family income	
Less than \$10,000	8 (6.2)
\$10,000 to less than \$30,000	17 (13.1)
\$30,000 to \$60,000	40 (30.8)
Greater than \$60,000	65 (50.0)
Maternal smoking	
Current or former	28 (21.5)
Never	102 (78.5)
Mom employment status	
Employed	92 (70.8)
Unemployed	38 (29.2)
Father's employment status	
Employed	115 (88.5)
Unemployed	15 (11.5)
Parity	
Multiparous	68 (52.3)
Primiparous	62 (47.7)
Partner status	
Married or cohabitating	107 (82.3)
Not married or cohabitating	23 (17.7)
Child's sex	
Male	65 (50.0)
Female	65 (50.0)
Birth weight category	
< 1500 grams	43 (33.1)
≥ 1500 grams	87 (66.9)

Child and Family Characteristic	N (%)
Mean (SD), range	
Birth weight (grams)	1778 (603), 490 – 3328
Family income (\$)	69, 988 (58,903), 3000 – 500,000
Maternal age at child's birth	32.8 (5.7), 20–44
Gestational age	31.7 (3.2), 24 – 37
Child's age at hospital discharge (days)	32.5 (28.8), 3 – 132

Table 2

Descriptive statistics of child cognitive function, maternal depressive symptoms, and maternal perceived social support between 9 and 36 months of age among a sample of preterm, low birth weight infants (n=130) in Wisconsin.

Variable	9 months	16 months	24 months	36 months
Child's cognitive function score ^A		88.4 (11.4), 50–122	80.7 (17.7), 50–121	97.1 (13.3), 61 – 130
Maternal Depression ^B				
CES-D score, mean (SD), range	9.1 (7.8), 0–30	7.2 (6.6), 0–40	8.0 (6.5), 0–32	
CES-D > 16, n(%)	35 (26.9)	27 (20.8)	27 (20.8)	
Total Social Support ^C				
Social support score, mean (SD), range	10.3 (4.0), 0–20	10.1 (4.0), 0–18	11.8 (5.1), 0–24	
High (> 1 SD above mean), n(%)	31 (23.9)	26 (20.0)	22 (16.9)	
Middle (between –1 and 1 SD from mean), n(%)	77 (59.2)	84 (64.6)	86 (66.2)	
Low (< –1 SD below mean), n(%)	22 (16.9)	20 (15.4)	22 (16.9)	

^A Measured by the Bayley Scales of Infant Development, Mental Developmental Index at 16 months postterm. Measured by the Abbreviated Battery IQ scale of the Stanford-Binet Intelligence Scale at 24 months and 36 months postterm.

^B Measured by the Center for Epidemiologic Studies Depression Scale (CES-D).

^C Measured by the Maternal Support Scale.

Results of null latent growth curve model of child’s cognitive function trajectories between 16 months and 36 months among a sample of preterm, low birth weight infants in Wisconsin (n=130).

Table 3

	Trajectory	
	Baseline	Slope
Mean	Intercept 88.51 (1.00)	Slope -20.10 (2.55)
Variance	127.77 (19.67)	817.83 (106.75)
Covariance		
With intercept	*****	*****
With slope	-30.30 (25.71)	*****
Model Fit ^A		
CFI		1.00
RMSEA		<.0001
SRMR		<.0001

^A CFI=Comparative fit index; RMSEA=Root mean square error of approximation; SRMR=Standardized root mean square residual

Table 4

Results of adjusted latent growth models predicting trajectories of child cognitive function between 16 and 36 months from temporal patterns of postpartum depression among a sample (n=130) of preterm, low birth weight infants in Wisconsin.

Adjusted			
		Baseline	Trajectory
Latent Variables		Intercept	Slope Quadratic
Mean		68.98 (7.15)	-41.50 (11.48) 21.74 (5.53)
Variance		102.08 (14.76)	675.56 (97.83) 159.14 (22.66)
Covariance			
With Intercept	*****		16.95 (11.28)
With Slope	-54.60 (24.231) *****		-320.50 (46.74)
Time-invariant covariates			
Covariates			
Child's Race and ethnicity			
White, non-Hispanic	-2.23 (2.25)	11.99 (4.74)	-4.88 (2.48)
Other race or ethnicity	Reference	Reference	Reference
Child's sex			
Female	5.14 (1.89)	3.49 (4.64)	-1.48 (2.26)
Male	Reference	Reference	Reference
Birthweight categories			
Less than or equal to 1500 grams	Reference	Reference	Reference
Greater than 1500 grams	2.73 (2.10)	5.49 (4.38)	-2.82 (2.12)
Marital status			
Married or cohabitating	-1.19 (2.44)	-3.55 (7.07)	2.70 (3.39)
Not married or cohabitating	Reference	Reference	Reference
Maternal education (years)			
High school or less	Reference	Reference	Reference
Some college	4.04 (3.08)	-8.70 (7.63)	2.49 (3.66)

Adjusted			
Baseline		Trajectory	
Latent Variables	Intercept	Slope	Quadratic
College degree	4.59 (2.94)	10.12 (8.22)	-6.29 (3.92)
Graduate degree	7.66 (3.37)	6.16 (8.83)	-3.92 (4.22)
Income			
Less than \$10,000	Reference	Reference	Reference
\$10,000 to \$30,000	8.21 (5.10)	-11.88 (9.48)	5.12 (4.47)
\$30,000 to \$60,000	6.96 (5.63)	-4.63 (9.42)	3.11 (4.49)
More than \$60,000	11.26 (5.78)	1.42 (10.45)	-40 (4.95)
Parity			
Primiparous	-.33 (2.03)	7.75 (4.95)	-2.90 (2.36)
Multiparous	Reference	Reference	Reference
History of smoking			
Current or former	0.25 (2.30)	-4.01 (6.39)	1.83 (3.19)
Never	Reference	Reference	Reference
Time-varying covariates			
Predicting Cognitive Function at 16 Months			
Postpartum clinical depressive symptoms ^A at 9 months			
Yes (CESD ≥ 16)			-0.36 (2.11)
No (CESD < 16)			Reference
Predicting Cognitive Function at 24 Months			
Postpartum clinical depressive symptoms at 16 months			
Yes (CESD ≥ 16)			-2.59 (2.98)
No (CESD < 16)			Reference
Predicting Cognitive Function at 36 Months			
Postpartum clinical depressive symptoms at 24 months			
Yes (CESD ≥ 16)			1.41 (2.38)
No (CESD < 16)			Reference

Adjusted			
Baseline		Trajectory	
Latent Variables	Intercept	Slope	Quadratic
<hr/>			
Model Fit ^B			
CFI			.984
RMSEA			.053
SRMR			.013

^A Postpartum clinical depressive symptoms measured by the Center for Epidemiologic Studies Depression Scale (CES-D).

^B CFI=comparative fit index; RMSEA=root mean square error of approximation; SRMR=standardized root mean square residual.

Table 5

Results of adjusted latent growth models predicting child cognitive function trajectories between 16 and 36 months of age from temporal patterns of postpartum depression and maternal perceived social support among a sample of preterm, low birth weight infants (n=130) in Wisconsin.

Latent Variables	Adjusted		
	Baseline		Trajectory
	Intercept	Slope	Quadratic
Mean	66.23 (7.40)	-41.99 (12.35)	22.57 (6.05)
Variance	98.83 (13.89)	620.64 (91.70)	148.47 (21.19)
Covariance			
With intercept	*****	*****	13.87 (10.85)
With slope	-47.83 (23.01)	*****	-296.08 (43.70)
Time-invariant covariates			
Child's Race and ethnicity			
White, non-Hispanic	-1.84 (2.15)	12.07 (4.95)	-5.45 (2.64)
Other race or ethnicity	Reference	Reference	Reference
Child's sex			
Female	4.35 (1.80)	5.19 (4.49)	-2.14 (2.23)
Male	Reference	Reference	Reference
Birthweight categories			
Less than or equal to 1500 grams	Reference	Reference	Reference
Greater than 1500 grams	2.18 (2.09)	7.73 (4.41)	-3.71 (2.17)
Marital status			
Married or cohabitating	-.70 (2.63)	-7.51 (7.23)	4.19 (3.60)
Not married or cohabitating	Reference	Reference	Reference
Maternal education			
High school or less	Reference	Reference	Reference
Some college	4.60 (3.06)	-9.90 (7.61)	3.04 (3.62)

Adjusted			
		Baseline	Trajectory
Latent Variables	Intercept	Slope	Quadratic
College degree	4.64 (2.75)	9.56 (7.21)	-5.89 (3.44)
Graduate degree	7.03 (3.24)	4.30 (8.08)	-2.82 (3.91)
Income			
Less than \$10,000	Reference	Reference	Reference
\$10,000 to \$30,000	9.09 (5.21)	-15.88 (10.35)	6.33 (5.13)
\$30,000 to \$60,000	7.63 (5.52)	-8.52 (9.52)	4.23 (4.74)
More than \$60,000	11.39 (5.62)	-0.15 (10.34)	-.30 (5.09)
Parity			
Primiparous	-.08 (1.99)	8.39 (4.93)	-3.29 (2.40)
Multiparous	Reference	Reference	Reference
History of smoking			
Current or former	-0.08 (2.26)	-6.71 (6.62)	3.25 (3.19)
Never	Reference	Reference	Reference
Time-varying covariates			
Predicting Children's Cognitive Function at 16 Months			
Postpartum clinical depressive symptoms (PPD) ^A at 9 months			
Yes (CESD ≥ 16)			-8.91 (3.71)
No (CESD < 16)			Reference
Social support (SS) ^B at 9 months			
Low (< -1 SD below mean)			Reference
Medium (Between -1 and 1 SD from mean)			-4.21 (2.76)
High (> 1 SD above mean)			-3.51 (3.17)
PPD*SS at 9 months			
PPD*Low SS			Reference
PPD*Med SS			10.89 (4.05)

Adjusted			
Baseline		Trajectory	
Latent Variables	Intercept	Slope	Quadratic
PPD*High SS			
10.49 (4.44)			
Predicting Children's Cognitive Function at 24 Months			
Postpartum clinical depressive symptoms (PPD) at 16 months			
Yes (CESD ≥ 16)			-2.29 (7.28)
No (CESD < 16)			Reference
Social support (SS) at 16 months			
Low (< -1 SD below mean)			Reference
Medium (Between -1 and 1 SD from mean)			-6.99 (4.98)
High (> 1 SD above mean)			-3.51 (3.17)
PPD*SS at 16 months			
PPD*Low SS			Reference
PPD*Med SS			-3.32 (7.87)
PPD*High SS			1.83 (10.14)
Predicting Children's Cognitive Function at 36 Months			
Postpartum clinical depressive symptoms (PPD) at 24 months			
Yes (CESD ≥ 16)			2.34 (3.65)
No (CESD < 16)			Reference
Social support (SS) at 24 months			
Low (< -1 SD below mean)			Reference
Medium (Between -1 and 1 SD from mean)			-3.23 (4.98)
High (> 1 SD above mean)			0.25 (2.18)
PPD*SS at 24 months			
PPD*Low SS			Reference
PPD*Med SS			-3.62 (4.64)
PPD*High SS			7.49 (4.84)
Model Fit ^C			
CFI			.974
RMSEA			.032

Adjusted			
Baseline		Trajectory	
Latent Variables	Intercept	Slope	Quadratic
SRMR			.019

^A Postpartum clinical depressive symptoms measured by the Center for Epidemiologic Studies Depression Scale (CES-D).

^B Social support measured by the Maternal Support Scale.

^C CFI=comparative fit index; RMSEA=root mean square error of approximation; SRMR=standardized root mean square residual.