Published in final edited form as:

Res Nurs Health. 2017 December ; 40(6): 528–540. doi:10.1002/nur.21816.

The Role of Sociodemographic Factors in Maternal Psychological Distress and Mother-Preterm Infant Interactions

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Abstract

Preterm birth has been associated with greater psychological distress and less positive mother infant interactions than were experienced by mothers of full-term infants. Maternal and infant sociodemographic factors have also shown a strong association with psychological distress and the mother-infant relationship. However, findings on their effects over time are limited. In this longitudinal analysis, we explored the relationship of maternal and infant sociodemographic variables (maternal age, maternal education, marital status, being on social assistance, maternal race, infant birth weight, and infant gender) to maternal psychological distress (depressive, posttraumatic stress, anxiety, parenting stress symptoms, and maternal worry about child's health) through 12 months corrected age for prematurity, and on the home environment, and mother-infant interactions through 6 months corrected age for prematurity. We also explored differences related to maternal obstetrical characteristics (gestational age at birth, parity, mode of delivery, and multiple birth) and severity of infant conditions (Apgar scores, need for mechanical ventilation, and infant medical complications). Although the relationship of maternal and infant characteristics with these outcomes did not change over time, psychological distress differed based on marital status, maternal education, infant gender, and infant medical complications. Older mothers provided more a positive home environment. Mother-infant interactions differed by maternal age, being on public assistance, maternal race, infant gender, and infant medical complications. More longitudinal research is needed to better understand these effects over time in order to identify and support at-risk mothers.

Keywords

depression; anxiety; post-traumatic stress; worry; mother-infant interactions; preterm infants; parenting

Psychological distress and less positive mother-infant interactions are common challenges for mothers of preterm infants. Mothers of preterm infants average higher depressive symptoms, post-traumatic stress (PTS), anxiety, and worry about the child's health than mothers of full-term infants (Brandon et al., 2011; Ghorbani, Dolatian, Shams, Alavi-Majd, & Tavakolian, 2014; Kersting et al., 2004). In turn, maternal psychological distress has been associated with difficulty in establishing positive interactions between mothers and their infants (Holditch-Davis, Schwartz, Black, & Scher, 2007; Korja, Latva, & Lehtonen, 2012). Less positive mother-infant interactions are more common among mothers and their preterm infants than mothers and their full-term infants (Korja et al., 2012). The home environment also has been shown to positively influence mother-infant interactions and infant development (Holditch-Davis, Tesh, Goldman, Miles, & D'Auria, 2000). Thus, maternal psychological distress, the home environment, and mother-infant interactions are interrelated. Maternal and infant sociodemographic characteristics might also explain variations in maternal psychological distress, the home environment, and mother-infant interactions.

To date, research on effects of sociodemographic variables has primarily focused on relationships at single time points, yet variables are likely to have different effects over time. Characteristics that exert an influence over a period of time would be the best targets for designing interventions. Understanding the stability of the impact of maternal and infant sociodemographic factors over time, therefore, is essential to design interventions to promote positive maternal and preterm infants' outcomes in mothers and infants at greatest risk.

Correlates of Maternal Distress and Mother-Infant Interaction

Maternal income and education are socioeconomic factors that have been linked to psychological distress, the home environment, and mother-infant interactions. In a cross-sectional study in China on mothers of unspecified gestation with children aged 0 to 3 years, mothers of low socioeconomic status reported more depressive symptoms than mothers of higher socioeconomic status (Chi, Zhang, Wu, & Wang, 2016). Similarly, a longitudinal study of American Black mothers of full-term infants in the first 18 months after birth showed strong positive correlations between low income or perception of family income as inadequate to meet family needs and elevated depressive symptoms (Beeghly et al., 2003). Lower maternal income has been related to less positive home environments (Bradley et al., 1994). Although higher maternal education has been linked to higher post-traumatic stress (PTS; Cohen & Marino, 2013; Seng, Kohn-Wood, McPherson, & Sperlich, 2011; Shaw, Bernard, Storfer-Isser, Rhine, & Horwitz, 2013) lower maternal education has been linked to elevated depressive symptoms (Chi et al., 2016). Mothers with higher educational attainment have been found to be more sensitive during interactions with their preterm infants than other mothers (Zelkowitz, Papageorgiou, Bardin, & Wang, 2009). Infants born to mothers

with higher education and with more child care support were more positive during interactions as they vocalized more and smiled more (Levine, Garcia Coll, & Oh, 1985).

Maternal psychological distress is also correlated with marital status. Single Black American mothers of full-term infants were more likely to have elevated depressive symptoms in the first 18 months than married mothers (Beeghly et al., 2003). Wei, Greaver, Marson, Herndon, and Rogers (2008) also reported an association between being unmarried and having elevated depressive symptoms, in North Carolina mothers of infants of unspecified gestational ages. In contrast, despite being married, poor marital relationships with spouses and in-laws could lead to elevated depressive symptoms (Chi et al., 2016). In other studies with contradictory results, in mothers of preterm infants, being married was associated with more depressive symptoms than being unmarried (Lee, Holditch-Davis, & Miles, 2007; Rogers, Kidokoro, Wallendorf, & Inder, 2013).

Conflicting results also were found in studies on maternal age. PTS symptoms were related to young maternal age (Callahan & Hynan, 2002; Holditch-Davis et al., 2009). Similarly, adolescent mothers have reported more parenting stress than non-adolescent mothers (Andreozzi, Flanagan, Seifer, Brunner, & Lester, 2002). However, in other studies, no relationship was seen between elevated depressive symptoms and maternal age (Ghorbani et al., 2014; Wei et al., 2008). Older mothers have also shown to have more positive mother-infant interactions than adolescent mothers, with older mothers showing more positive affect and talking more (Levine et al., 1985). Infants born to older mothers were also more interactive than infants born to adolescent mothers (Andreozzi et al., 2002). A positive correlation also exists between the quality of the home environment and older maternal age (Andreozzi et al., 2002).

Maternal race also has an unclear relationship with psychological distress, the home environment, and mother-infant interactions. Black American mothers of preterm infants showed higher levels of stress related to the sounds during infant hospitalization in the neonatal intensive care unit (NICU) than was experienced by mothers of other racial backgrounds (Miles, Burchinal, Holditch-Davis, Brunssen, & Wilson, 2002). Others found no significant effects of race, ethnicity, or native language on the risk of distress in mothers of preterm infants (Cohen & Marino, 2013; Seng, Kohn-Wood, McPherson, & Sperlich, 2011; Shaw, Bernard, Storfer-Isser, Rhine, & Horwitz, 2013; Shaw et al., 2014). Thus, additional studies are needed to clarify these results.

More positive mother-infant interactions occurred in White mothers than in Non-White mothers (Cho, Holditch-Davis, & Belyea, 2004, 2007; Docherty, Miles, & Holditch-Davis, 2002). White mothers also expressed more positive affect, talked more, spent more time with their infants, were more involved with their infants, and looked more than non-White mothers (Cho et al., 2004). In addition, non-White mothers also showed fewer transitions from “child talk” to “both mother and infant talk” and from “neither mother or infant talk” to “both mother and infant talk”, but they were more likely to transition from “child talk” to “neither talk” and from “neither of them talk” to “child talk” (Cho et al., 2007). White mothers also showed higher scores on the HOME Inventory sub-scales of emotional and verbal responsivity, acceptance of the child’s behaviors, organization of the environment,

and opportunity for variety in daily stimulation (Cho et al., 2004). These differences on the HOME Inventory may be due to poverty, as mothers with lower income showed lower scores on the HOME Inventory (Lotas, Penticuff, Medoff-Cooper, Brooten, & Brown, 1992; Watson, Kirby, Kelleher, & Bradley, 1996).

The infant's medical condition after birth has been related to maternal psychological distress and mother-infant interactions. Separation of the mother and preterm infant following birth may also affect maternal psychological distress and the mother-infant relationship because the mother may feel frustrated, empty, or angry at hospital staff. Mothers of preterm infants were concerned with their infants' low birth weight (Feeley et al., 2011) and the initial physical appearance of their infant (Goutaudier, Lopez, Séjourné, Denis, & Chabrol, 2011). Upon reunion with the infants, mothers expressed shock about their child's physical appearance (Goutaudier et al., 2011). With the longer hospitalization of preterm infants, mothers also incurred higher health care costs (Holditch-Davis & Miles, 2000). Thus, the infant's condition could indirectly influence the home environment as well.

The above evidence indicates that some sociodemographic variables, such as more positive socio-economic factors, are protective against psychological distress, while other factors, such as being unmarried or living in poverty, have been related to greater maternal psychological distress or less positive mother infant interactions. Some effects remain unclear.

Exploring the impact of maternal and infant factors on psychological distress and mother-infant interactions over time is necessary to understand motherhood for mothers with preterm infants, to target interventions at mothers at greatest risk, and to resolve the contradictions in the literature. The primary aim of this analysis was to explore the longitudinal trends in maternal psychological distress (depressive, PTS, anxiety, and parenting stress symptoms, and maternal worry about the child's health) in relation to maternal and infant socio-demographic variables (maternal age, maternal education, marital status, being on social assistance, maternal race, infant birth weight, and infant gender) following birth through 12 months corrected age for prematurity. The secondary aim was to explore the relationship between maternal and infant socio-demographic variables and the home environment and mother-infant interactions at 2 and 6 months corrected age for prematurity. For both aims, we controlled for maternal obstetrical characteristics (gestational age at birth, parity, mode of delivery, and multiple birth) and severity of infant medical condition (Apgar scores, need for mechanical ventilation, and other complications).

Method

Design

We conducted a secondary analysis of a dataset of a longitudinal study that was conducted in Illinois and North Carolina. The larger study was a test of the effects of two maternally administered interventions (kangaroo care [KC] and the auditory-tactile-visual-vestibular intervention [ATVV]) on maternal psychological distress and mother-infant interactions (Holditch-Davis et al., 2014). The mother administered the intervention to preterm infants in the NICU who were not critically ill for a minimum of 15 minutes per session and continued

at home until the infant was 2 months corrected age. Initial analyses showed minimal intervention effects on maternal psychological distress symptoms and the mother-infant interactions (Holditch-Davis et al., 2014).

The psychological distress data were collected at five points (enrollment during hospitalization, discharge, and 2 months, 6 months, and 12 months corrected age) and the interactive behaviors and home environment data were collected at 2 months and 6 months.

Participants

The sample was 239 mothers of preterm infants weighing <1750 grams. In the case of a multiple birth, one infant was randomly selected for the purposes of data collection. Eligibility criteria for mothers included being English-speaking, 15 years or older, with an infant born before 37 weeks gestation, and with custody of the child. Exclusion criteria were a maternal history of psychosis or bipolar disease or having a current major depression. Infants with congenital neurological problems or symptoms of substance exposure were excluded.

Table 1 presents the demographic characteristics of mothers and their infants. The majority of the mothers were unmarried, Black, and first-time mothers. Most had cesarean births of singleton infants. Most of the infants had one or more infections in the neonatal period, had size appropriate for gestational age (AGA), and were early preterm infants.

Measures

Maternal characteristics—Collected through self-report or medical record review, these variables included age (number of years), race (self-identified racial/ethnic group: Black, White, or Other), education (years the mother attended formal education), public assistance (whether a mother was on any form of public assistance), obstetrical characteristics (gestational age of pregnancy at birth, parity, mode of delivery, intervention group assignment (kangaroo care, ATVV, and the attention control groups), and site (Illinois or North Carolina).

Infant characteristics—Collected through self-report or medical record review, these included birth weight and gender (male or female), size (small for gestational age, average for gestational age, or large for gestational age), number of days of mechanical ventilation, surgery, infant infections, presence of necrotizing enterocolitis (NEC), Apgar score at 1 and 5 minutes, and whether or not the infant was a multiple-birth infant. Severity of the infant's condition was assessed using the Neurobiological Risk Score [NBRS] (Oehler, Goldstein, Catlett, Boshkoff, & Brazy, 1993) to assess the infant's potential neurological insults. In a 7-item instrument, mechanical ventilation, blood pH, presence of seizures, intraventricular hemorrhage (IVH), periventricular leukomalacia, infections, and hypoglycemia are scored on a scale of 0 (*none*) to 4 (*severe*) and the scores summed to a total score with a range of 0 – 28 (Oehler et al., 1993). Higher NBRS scores indicate more severe insults.

Psychological distress—The following measures were collected through self-report.

Depressive symptoms: The Center for Epidemiologic Studies Depression Scale [CESD] (Radloff, 1977) was administered at all five time points. The CESD is a 20-item instrument to measure depressive symptoms in the past week. Scores on each item range from 0–3, with total scores ranging from 0–60. Higher scores on the CESD indicate more depressive symptoms. In our study, internal consistency of the CESD was high, with Cronbach's alphas ranging from .90 at enrollment to .86 at 12 months (Holditch-Davis et al., 2014).

Anxiety symptoms: These were measured at all five time points using State-Trait Anxiety Inventory (STAI). The 40 items are measured on a 4-point Likert scale and assess situational maternal anxiety (Spielberger, Gorusch, Lushene, Vagg, & Jacobs, 1983). Internal consistency for this sample was high, with Cronbach's alphas ranging from .93 at enrollment to .88 at 12 months (Holditch-Davis et al., 2014).

Post-traumatic stress (PTS) symptoms: These were measured at all five time points using the Perinatal PTSD Questionnaire. The 14 items assess maternal post-traumatic symptoms, such as intrusiveness or re-experiencing, avoidance, and hyperarousal or numbing of responsiveness (Callahan & Hynan, 2002; Quinnell & Hynan, 1999). A score of 6 and above indicates elevated PTSD symptoms (Brandon et al., 2011). In this sample, this scale had high internal consistency with Cronbach's alphas ranging from .79 at enrollment to .86 at 6 months (Holditch-Davis et al., 2014).

Parenting stress: Parenting stress was measured at 2, 6, and 12 months corrected age using the Parental Stress Scale: Prematurely Born Child (PSS: PBC). This 20-item instrument measures stress due to parenting the child at home (Holditch-Davis et al., 2009; Holditch-Davis et al., 2014). In this sample, Cronbach's alphas were .91 at 2 and 6 months and .90 at 12 months (Holditch-Davis et al., 2014).

Maternal worry about the child's health: The Worry Index, a 7-item instrument, was administered at all five time points. The Worry Index measures the mother's worry about the infant's risk for poor health (Miles & Holditch-Davis, 1995). The instrument is scored on a 5-point-Likert scale ranging from 1–5 with total scores of 7–35. Higher scores indicate more maternal worry. In our study, the Cronbach's alpha ranged from .88 at enrollment to .83 at 2 months (Holditch-Davis et al., 2014).

Home environment—Collected through self-report and an observation in the home, this was measured at 2 and 6 months corrected age using the Home Observation for Measurement of the Environment (HOME; 0–3 version) by Caldwell and Bradley (1980). This 45-item examiner administered instrument measures social-emotional and stimulation characteristics of the home environment provided by the mother. Assessments are based on maternal self-report and the interviewer's observation of the home environment. Higher scores indicate a more positive environment. The HOME inventory had a high internal consistency, with Cronbach's alphas of .84 at 2 months and .83 at 6 months. The maternal involvement subscale had Cronbach's alphas of .70 at 2 and 6 months (Holditch-Davis et al., 2014).

Mother-preterm infant interactions—Mother-infant interactions were assessed at 2 and 6 months using a 45-minute video recording in the home when infant was awake and due for feeding (Holditch-Davis, Cox, Miles, & Belyea, 2003; Holditch-Davis et al., 2007). Research assistants blinded to the intervention groups coded the videotapes using a coding system that has been used for over 30 years (Holditch-Davis, Miles, Burchinal, & Goldman, 2011). Each 10-s interval was coded for maternal and infant behavior. The number of 10-s intervals during which a behavior occurred was divided by the total number of 10-s intervals in that total observation, to adjust for slight variation in observation length (Holditch-Davis, Cox, et al., 2003). In this study, the means and standard deviations for the number of 10-s epochs in an observation were 249.3 (49.3) at 2 months and 262.8 (30.3) at 6 months. Interrater reliability for each behavior ranged from .64 to .99, with a mean of .86 (Holditch-Davis et al., 2014).

Maternal interactive dimensions: Two dimensions were subscales developed from the interactive behaviors coded in the videos and HOME scale using a previously published approach (Holditch-Davis et al., 2007; Holditch-Davis et al., 2014). Dimensions included maternal positive involvement (positive, touch, hold, interaction, uninvolved with child [reversed], play with child, and the maternal involvement subscale from the HOME scale) and developmental stimulation (mother talk and teach). Internal consistency of the maternal positive involvement sub-scale was high, with a Cronbach's alpha of .78 (Holditch-Davis et al., 2014). Internal consistency of the developmental stimulation sub-scale was .69 (Holditch-Davis et al., 2014).

Child interactive dimensions included the child's social behaviors (expressing positive affect and gestures), developmental maturity (child vocalize, independent play with objects, and locomote/mobility), and irritability (child negative and fuss as a percent of time with mother) (Holditch-Davis et al., 2007; Holditch-Davis et al., 2014). Internal consistency was .68 for child social behaviors, .58 for child developmental maturity, and .91 for child irritability (Holditch-Davis et al., 2014).

Data Analysis

We calculated the frequencies for categorical variables and the means and standard deviations for continuous demographic variables. Linear regression models were used to examine factors associated with the home environment and mother-infant interactions. We assessed the effect of sociodemographic, maternal, and infant variables on the 6-month observation while controlling for the 2-months observation.

To examine longitudinal trends of effects of demographic and background variables on psychological distress variables, mixed effects models were used. Mixed effects models can deal with longitudinal missing values (or attrition) in the outcome variables. Missing data in demographic variables and other background variables (maternal age, birth weight, IVH, marital status, public assistance, maternal education, infant sex, whether mother is a first-time mother, infant surgery, infections, NEC, gestational age, and NBRS total score) ranged from 1.7 to 4.7%. When examined using Little's missing completely at random test in SPSS (Little, 1988; Little & Rubin, 2002), results showed that the missing data were missing at

random (X^2 = 760.085, *df* = 689, *p* = .03). Therefore, multiple imputation was used to obtain consistent, asymptotically efficient, and unbiased estimates (Allison, 2002).

Manual backward elimination was used to select the final model, with significance level for retaining the covariates in the final model set at .1. The multiple birth, intervention, and study site variables were considered in model selection process as possible controls, because they had shown effects in previous analyses (Gondwe, Yang, White-Traut, & Holditch-Davis, 2017; Holditch-Davis et al., 2014). Analyses were performed using Statistical Analysis Software (SAS) version 9.3. The level of significance was set at $\alpha = .05$.

Results

Changes in Psychological Distress over Time

In the longitudinal regression analysis of depressive symptoms, anxiety symptoms, PTS symptoms, parental stress, and maternal worry about the child's health (Table 2), a significant decrease over time was seen only in parenting stress. The random effects models for predictors of psychological distress showed no difference over the five time points. Thus, the effects of the interaction between time and sociodemographic variables on the rate of decrease in psychological distress over the five time points were not significant, indicating that the role of these predictor variables did not change over time.

Differences in Distress Variables based on Maternal and Infant Characteristics

Maternal and infant sociodemographic factors—Older mothers had higher depressive symptoms, more parenting stress, and more maternal worry than younger mothers. Mothers with more years of education had lower depressive symptoms than did those with fewer years of education. Married mothers had lower PTS symptoms, lower depressive symptoms, lower parenting stress, and lower maternal worry than did unmarried mothers. Mothers on any form of public assistance had less parenting stress than mothers who were not on public assistance. Mothers of boys had more parenting stress symptoms and worried more about their infants than did mothers of girls.

Maternal obstetrical history—First-time mothers reported more depressive symptoms than did mothers who had more than one child, although this difference was borderline. Mothers who had Cesarean births had less maternal parenting stress than those who delivered vaginally.

Severity of infant's condition—Mothers of infants who were average weight for their gestational age reported lower parenting stress symptoms and worried less about their infants than mothers of infants who were small for their gestational age. Mothers of infants who were large for their gestational age reported less posttraumatic stress symptoms, lower depressive symptoms, and lower anxiety symptoms than did mothers of infants who were small for their gestational age.

Neurological insults had a mixed relationship with maternal psychological stress. Mothers of infants with IVH had fewer depressive symptoms than mothers of infants who did not have IVH, and mothers of infants who had higher NBRS total scores reported lower anxiety

symptoms but worried more about their infants than did mothers of infants who had lower NBRS scores.

Differences in Quality of Home Environment

Table 3 presents findings of a regression analysis of influence of sociodemographic factors, obstetric factors, and infant factors on the home environment at 6 months, while controlling for baseline HOME score (2 months). Significant differences were only seen based on maternal age. Older mothers had higher HOME scores than younger mothers.

Differences in Mother-Infant Interactions based on Maternal and Infant Characteristics

When the relationship of sociodemographic factors, obstetric factors, and infant factors to mothers' contributions to infant interaction at 6 months after controlling for baseline interaction scores (2 months) was examined, mothers from other races had higher positive involvement than did Black mothers (Table 4). Infants with history of NEC had less maternal positive involvement. Mothers of boys provided more developmental stimulation than did mothers of girls. Mothers of infants with higher Apgar scores at 5 minutes provided less developmental stimulation than mothers of infants who had lower Apgar scores at 5 minutes, but mothers of infants with IVH also provided less developmental stimulation than mothers of infants who did not have IVH.

When influences on infants' interaction were examined, infants who required more days of mechanical ventilation showed more social behaviors than infants who required fewer days on mechanical ventilation, but infants with higher NBRS total scores showed fewer social behaviors than infants with lower NBRS total score (Table 5). Infants of mothers with more years of education were less irritable than infants of mothers with less education, but infants of White mothers were more irritable than infants of Black mothers. Infants whose birth weights were higher or were born by Cesarean delivery were less irritable than their counterparts, but infants born at higher gestational age were more irritable than children born at younger gestational ages. Infants with NEC showed more developmental maturity than infants without NEC (Table 6), but infants with higher NBRS total scores showed less developmental maturity than infants who had lower NBRS total scores.

Discussion

Maternal and infant sociodemographic variables were associated with maternal psychological distress, the quality of the home environment, and mother-preterm infant interactive behaviors over the first year, and those relationships did not change over time. Of all distress variables, only parenting stress decreased over time. However, mothers' distress differed based on sociodemographic, maternal and infant factors. Higher maternal education was also associated with a more positive home environment. Mother-infant interactions differed by maternal age, maternal race, maternal education, being on public assistance, infant gender, and severity of infant condition, but not always in the expected directions. With additional research to validate this exploratory analysis, these findings may help in identifying at-risk mothers who need more attention during screening and management of preterm infant health.

Socioeconomic status was related to maternal distress and mother-infant interactions. Mothers with more years of education had fewer depressive symptoms, consistent with other studies of mothers following preterm birth (Bener, 2013; Chi et al., 2016). Mothers with more education may have been more aware of the complications of preterm birth and have had access to information about their infant and his or her care, which may have lowered their risk of depression. We also found that infants of mothers with more years of education had infants with lower irritability, but given limited evidence on this relationship, more research is needed to confirm this finding. Public assistance was associated with lower parenting stress. Because high depressive symptoms have been linked to low income status or perceived inadequate income (Beeghly et al., 2003), the availability of public assistance might have increased mothers' perception of the adequacy of family income, but more research is needed.

Older maternal age was associated with higher depressive symptoms, more parenting stress, and more maternal worry about child's health. This is inconsistent with previous findings that adolescent mothers reported more parenting stress than non-adolescent mothers (Andreozzi et al., 2002) and that mothers with psychological distress were younger (Bener, 2013), although others found no relationship between depressive symptoms and maternal age (Ghorbani et al., 2014; Wei et al., 2008). In our study, the older mothers may have been more worried than younger mothers because they were more likely to have undergone infertility treatments and were worried about having a positive outcome of pregnancy. However, further study of the relationship between age and psychological distress is necessary to uncover the predisposing factors that come with age. Older mothers also created a more positive home environment, consistent with past research (Andreozzi et al., 2002), and had more maternal positive involvement.

Married mothers had lower PTS, depressive, and parenting stress symptoms and worried less about their infants than unmarried mothers. Others also found higher PTS symptoms in unmarried mothers than in married mothers (Beeghly et al., 2003; Wei et al., 2008). Beeghly et al. (2003) also found that being single was linked to higher depressive symptoms. However, others have found that being married was associated with higher depressive symptoms (Rogers et al., 2013) and PTS symptoms (Holditch-Davis, Bartlett, Blickman, & Miles, 2003). Lower psychological distress among married mothers might be related to presence of support from the father or partner; Lee et al. (2007) found that higher paternal helpfulness was related to lower maternal depressive symptoms. The contradictions in past research may be due to methodological differences, as Lee (2005) assessed psychological distress at two time points (6 and 12 months), whereas Rodgers (2013) and Holditch-Davis, Bartlett, et al. (2003) conducted cross-sectional studies.

Maternal race showed minimal relationships with psychological distress or mother-infant interactions. Mothers from other races provided more positive involvement behaviors than Black mothers, while the White mothers had more irritable infants than Black mothers. Our findings were contrary to those in which Non-White mothers (primarily Black) were less interactive with their infants than White mothers (Cho et al., 2007). The infants of White mothers in our sample were more likely to have medical complications than the infants of Black mothers, and this difference probably affected the findings.

Maternal obstetrical characteristics also showed minimal associations with psychological distress and the mother-infant relationship. First-time mothers reported more depressive symptoms than mothers with more than one child. Studies comparing first-time mothers of preterm infants with other mothers of preterm infants are limited. However, in another sample, a majority of low-risk first-time mothers of full-term infants experienced elevated depressive symptoms and anxiety (Murphey, Carter, Price, Champion, & Nichols, 2017). In our study, infants born through cesarean birth were more irritable than children born vaginally. Literature on the relationship between infant interactive behaviors and cesarean birth is limited. However, infants born through cesarean birth were less active than those born vaginally (Ward, 1999), which was explained by the assumption that the infants did not need to struggle through a vaginal birth and thus lacked self-empowerment (Ward, 1999). However, additional research is needed to support or refute these claims.

Infant gender was related to psychological distress and mother-infant interactions, with mothers of boys having more parenting stress symptoms and worrying more about their infants. Although studies on the influence of infant gender on parenting stress and worry are limited, in a Chinese study, the risk of postpartum depression was higher in mothers of girls (Xie et al., 2007). Mothers of boys in our study also provided more developmental stimulation, which included mother talk and teach behaviors (Holditch-Davis et al., 2007; 2014), while Cho et al. (2007) found no infant gender differences in mother talk behaviors.

Severity of infant's condition showed contradictory findings. Mothers who had infants with more serious medical problems (being small for gestational age, lower birthweight, higher NBRS scores, lower 5 minute Apgar scores, longer mechanical ventilation, having NEC) reported more psychological distress in at least one area or a higher interactive dimension (more infant irritability, more child social behaviors, more developmental maturity, more maternal developmental stimulation). On the other hand, having an infant with fewer serious medical problems (being an average gestational age infant, having higher gestational age, not having IVH, lower NBRS scores, no NEC) was associated with at least one maternal psychological distress variable or interactive dimension (greater infant irritability, more child developmental maturity, higher maternal positive involvement, higher developmental stimulation). In past research, mothers of fragile early preterm infants were concerned about their infants' birth weights (Feeley et al., 2011) and the initial physical appearance of their infants (Docherty et al., 2002; Goutaudier et al., 2011). Thus, there is need for further exploration of how mothers' perceptions of their infant's condition influence their psychological distress and interactive behavior, and whether infant interactive behavior differences are sustained over time.

Limitations

Our study was limited in some analyses by the relatively few mothers in some sub-groups. For example, the number of mothers in the racial category "other racial backgrounds" was small. Thus, the small sample size might have limited the variation of the mothers over time. Some demographic variables had missing data, and the outcome variables also had missing data points. However, multiple imputation should have reduced risk of bias in estimating replacement for missing data in demographic variables, and mixed effects modeling was

used to accommodate for missing data in the longitudinal outcome variables. The Cronbach alphas of some of the interactive dimensions, mainly infant behaviors, were small because behaviors of infants younger than 6 months are variable.

This study was exploratory, with the alpha set at .05. Thus, we did not control for multiple statistical testing order to control type I errors. As a result, the odds of having significant finding by chance were somewhat greater than 1 in 20. However, lowering the alpha to control for multiple testing would limit the study's ability to detect true differences, an essential need in an exploratory study. Future studies with larger sample sizes are needed to confirm the findings of the current study. Despite the limitations, this is one of the few studies of psychological distress, home environment, and mother-preterm-infant interactions longitudinally over the first year.

Conclusion

In this study we examined the relationships of sociodemographic factors to maternal psychological distress and mother-infant interactions. We explored maternal psychological distress longitudinally, but maternal-infant interaction outcomes were only measured twice. Samples with larger subgroups are needed to explore in-depth the longitudinal effects of sociodemographic variables, obstetric factors, and infant medical history on maternal and infant outcomes, to better determine if these factors indeed influence the outcomes, and whether the effects last longer than one time point. With further study, clinical applications can include identifying mothers at greatest risk of elevated psychological distress or less positive mother-infant interactions and developing interventions to reduce their risks.

Acknowledgments

This research was partially funded by R01 NR009418 from the National Institute for Nursing Research, NIH to the fifth author; by the Duke University School of Nursing PhD Student Fellowship to the first author; and the Harris Foundation grant to the second author.

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Table 1

Maternal and infant demographic characteristics (*N*=239).

	N	Mean	SD	Median	Range	*n*	%
Maternal Age	233	27.12	6.06	26.00	17–43		
Education	226	13.42	2.26	13.00	8–20		
Gestational age	236	27.19	2.86	27.00	21–35		
Infant birth weight	235	1010.3	327.45	975.00	410 – 1780		
Mechanical ventilation	235	16.42	26.45	7.00	0–298		
Apgar score							
1 minute	234	5.06	2.52	5.00	0–9		
5 minutes	233	7.23	1.66	8.00	1–10		
NBRS total	234	4.10	3.90	0	17		
Married	230					74	32.17
Race	233						
White						46	19.74
Black						166	71.24
Other						21	9.02
Public assistance	233					47	20.17
First time mothers	228					126	55.26
Prematurity	236						
Early <34 weeks						231	97.88
Late >34 weeks						5	2.12
Cesarean section	239					139	58.16
Infant Gender	239						
Female						130	54.39
Male						109	45.61
Multiple birth	235					42	17.87
IVH	234					77	32.91
With infections	239					186	77.82
With surgery	239					91	38.08
With NEC	233					36	15.45

	N	Mean	SD	Median	Range	*n*	%
Site	239						
Illinois						114	47.70
North Carolina						125	52.30
Infant Size	234						
LGA						4	1.71
AGA						189	80.77
SGA						41	17.52
Maternal Intervention	239						
Control						81	33.89
ATVV						78	32.64
Kangaroo						80	33.47

Note. SD= Standard deviation; freq. = frequency; %= column percentage; Mechanical ventilation = number of days on mechanical ventilation; Other races = Asian and other races than Black or White; AGA=average for gestational age; LGA=low for gestational age; SGA=small for gestational age; NEC=Necrotizing enterocolitis; IVH = intraventricular hemorrhage; NBRS total= Neurobiologic Risk Score; KC=Kangaroo Care; ATVV=Auditory-Tactile-Visual-Vestibular intervention. The varying *N* is due to missing data

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Table 2

Predictors of five types of maternal psychological distress at 6 months in mixed effects modeling (*N*=239).

	Posttraumatic Stress Symptoms				Depressive Symptoms			
Parameter	***β*Est**	**SE**	**DF**	***p***	***β*Est**	**SE**	**DF**	***p***
Intercept	2.17	1.96	771.16	.27	1.68	9.93	769.66	.86
Time	0.01	0.03	775	.67	0.001	0.08	773	.98
Maternal age	0.03	0.04	761.76	.43	0.28	0.11	768.47	.02*
Education	0.05	0.11	765.07	.67	−0.78	0.30	751.07	.01*
Marital status	−1.65	0.60	744.23	.01*	−5.01	1.65	765.14	.002*
Infant gender	0.73	0.42	772.29	.08	0.58	1.16	771.55	.61
Public welfare	−0.86	0.54	773.1	.11	−0.44	1.56	770	.78
White vs Black	.05	0.61	772.47	.93	0.86	1.67	771.43	.61
Others vs Black	−0.80	0.79	773.96	.31	−1.06	2.17	769.17	.63
First-time mother	0.60	0.46	620.15	.19	2.43	1.23	704.61	.049*
Multiple birth	1.54	0.54	773.71	.01*	4.72	1.49	772.23	.002*
NEC	-	-	-	-	−2.82	1.68	639.25	.09
IVH	-	-	-	-	−3.49	1.41	768.51	.01*
LGA vs SGA	−4.11	1.49	774.88	.01*	−9.78	4.15	772.23	.02*
NBRS total	0.10	0.06	774.01	.11	0.48	0.26	768.91	.08
Site	−0.70	0.43	772.32	.10	−2.03	1.24	767.9	.10

	Anxiety Symptoms				Parenting Stress			
Parameter	***β*Est**	**SE**	**DF**	***p***	***β*Est**	**SE**	**DF**	***p***
Intercept	34.21	7.25	767.91	<.0001	−61.43	11.17	354.04	<.0001*
Time	−0.11	0.09	769.01	.22	15.12	0.54	354.95	<.0001*
Maternal age	0.18	0.14	768.1	.18	0.30	0.12	354.12	.02*
Education	−0.64	0.36	765.93	.07	0.39	0.33	349.7	.24
Marital status	−1.81	2.00	759.38	.37	−3.72	1.74	353.76	.03*
Infant gender	−0.50	1.46	768.73	.73	2.54	1.25	354.68	.04*
Public welfare	−0.13	1.84	767.95	.94	−3.37	1.62	354.56	.04*
White vs Black	1.39	2.07	767.67	.50	1.52	1.79	354.83	.40
Others vs Black	2.15	2.64	767.18	.42	1.23	2.26	354.56	.58

	Anxiety Symptoms				Parenting Stress			
Parameter	**β Est**	**SE**	**DF**	***p***	**β Est**	**SE**	**DF**	***p***
Birthweight	0.01	0.003	768.55	.06	-	-	-	-
Multiple birth	4.01	1.82	768.63	.03*	3.70	1.59	354.75	.02*
First-time mother	-	-	-	-	2.27	1.33	349.14	.08
Cesarean	-	-	-	-	−3.93	1.28	354.71	.002*
AGA vs SGA	-	-	-	-	−3.94	1.63	354.66	.02*
LGA vs SGA	−11.62	5.01	768.94	.02*	-	-	-	-
NBRS total	−4.04	1.79	768.82	.02*	-	-	-	-

	Maternal Worry			
Parameter	**β Est**	**SE**	**DF**	***p***
Intercept	3.37	7.23	771	.64
Time	−0.01	0.04	775	.76
Maternal age	0.29	0.09	765.64	.003*
Education	0.14	0.24	665.68	.54
Marital status	−2.89	1.27	750.48	.02*
Infant gender	0.54	0.90	774.01	.005*
Public assistance	−0.49	1.17	773.51	.67
White vs Black	2.27	1.27	772.17	.08
Others vs Black	0.68	1.66	773.69	.68
AGA vs SGA	−2.56	1.11	773.61	.02*
NBRS total	0.42	0.19	773.25	.03*
Kangaroo vs control	−2.09	1.03	774.05	.04*

Note. Est = estimate; SE = standard error; –, variable was eliminated from the model; LGA = Large for gestational age; AGA = Average for gestational age; SGA = Small for gestational age; NBRS = Neurobiological Risk Score; ‘ – ‘not included in the final model or omitted in the table (see below). The following nonsignificant control variables included in models below but not in the table presentation and had p values > .05.

Posttraumatic stress – Apgar 5, AGA vs SGA, Kangaroo, ATVV

Depression – Apgar 5, Cesarean, AGA vs SGA, Kangaroo, ATVV

Anxiety – NBRS total, site, Kangaroo, ATVV, Apgar 5, and infection

Parenting Stress – gestational age, mechanical ventilation, infection, IVH grade, infant surgery, NBRS total, Kangaroo, ATVV

Worry – gestational age, Apgar 5, infection, first time, cesarean, multiple birth, IVH, LGA vs SGA, surgery, Site, ATVV.

Table 3

Sociodemographic, obstetric, and infant predictors of quality of the home environment at 6 months in regression analyses (*N*=239).

	HOME Inventory			
Parameter	**β Est**	**SE**	***DF***	***p***
Intercept	16.18	4.20	125	.0002*
Maternal age	0.17	0.07	125	.02*
Education	0.23	0.26	125	.37
Marital status	−1.09	1.07	125	.31
Infant gender	−0.36	0.78	125	.65
Public assistance	−0.53	0.91	125	.56
White vs Black	2.13	1.18	125	.07
Others vs Black	1.26	1.60	125	.43
NEC	2.01	1.05	125	.06
NBRS total	−0.28	0.15	125	.07
2 month value	0.47	0.10	125	<.0001

Note. All assessments conducted at 2 and 6 months. Est = estimate; SE = standard error; – dashes mean variable was eliminated from model; LGA = Large for gestational age; AGA = Average for gestational age; SGA = Small for gestational age; NBRS = Neurobiological Risk Score; '–' not included in the final model or omitted in the table (see below). The following control variables were included in model but not presented in the table ($p > .05$):

Positive involvement: first time, cesarean, LGA vs SGA, AGA vs SGA, surgery, site, Kangaroo, ATVV, NBRS total

Developmental stimulation: mechanical ventilation, infection, cesarean, multiple birth, NEC, LGA vs SGA, Site, Kangaroo, ATVV, NBRS total

Home total: mechanical ventilation, Apgar 5, infection, multiple birth, Site, Kangaroo, ATVV

Table 4

Sociodemographic, obstetric, and infant predictors of maternal interactive dimensions at 6 months in regression analyses (*N*=239).

	Positive Involvement				Developmental Stimulation			
Parameter	**β Est**	**SE**	***DF***	***p***	**β Est**	**SE**	***DF***	***p***
Intercept	−4.36	3.14	138	.16	0.34	1.52	125	.83
Maternal age	0.10	0.07	138	.17	0.06	0.03	125	.06
Education	0.14	0.23	138	.54	0.02	0.08	125	.78
Marital status	−0.46	1.04	138	.66	−0.02	0.40	125	.97
Infant gender	0.95	0.71	138	.19	0.68	0.26	125	.01*
Public assistance	0.18	0.88	138	.84	0.11	0.33	125	.75
White vs Black	−0.36	1.12	138	.74	−0.04	0.44	125	.93
Others vs Black	3.46	1.42	138	.02*	0.56	0.51	125	.27
NEC	−2.62	1.16	138	.03*	-	-	-	-
Apgar 5	-	-	-	-	−0.22	0.11	125	.04*
IVH	−1.73	0.92	138	.06	−0.93	0.36	125	.01*
First-time mother	-	-	-	-	0.57	0.30	125	.06
AGA vs SGA	-	-	-	-	−0.60	0.35	125	.09
2 month value	0.21	0.08	138	.01*	0.52	0.09	125	<.0001

Note. All assessments conducted at 2 and 6 months. Est = estimate; SE = standard error; – dashes mean variable was eliminated from model; LGA = Large for gestational age; AGA = Average for gestational age; SGA = Small for gestational age; NBRS = Neurobiological Risk Score; '–' not included in the final model or omitted in the table (see below). The following control variables were included in model but not presented in the table ($p > .05$):

Positive involvement: first time, cesarean, LGA vs SGA, AGA vs SGA, surgery, site, Kangaroo, ATVV, NBRS total

Developmental stimulation: mechanical ventilation, infection, cesarean, multiple birth, NEC, LGA vs SGA, Site, Kangaroo, ATVV, NBRS total

Home total: mechanical ventilation, Apgar 5, infection, multiple birth, Site, Kangaroo, ATVV

Table 5

Relationship of sociodemographic and obstetric and infant characteristics with child social and irritability behaviors at 6 months.

	Social Behaviors				Irritability			
Parameter	**β Est**	**SE**	***DF***	***p***	**β Est**	**SE**	***DF***	***p***
Intercept	−1.74	2.53	132	.49	−5.99	3.05	133	.05*
Maternal Age	0.01	0.03	132	.66	0.05	0.03	133	.18
Education	0.14	0.09	132	.11	−0.27	0.10	133	.01*
Marital Status	−0.18	0.43	132	.68	0.001	0.50	133	.99
Infant Gender	0.08	0.31	132	.78	0.40	0.35	133	.25
Public Assistance	−0.02	0.40	132	.96	−0.77	0.45	133	.09
White vs Black	−0.21	0.46	132	.65	1.15	0.53	133	.03*
Others vs Black	0.04	0.58	132	.95	1.03	0.65	133	.11
Gestational Age	-	-	-	-	0.39	0.12	133	.002*
Ventilation	0.03	0.01	132	.04*	-	-	-	-
Birth Weight	-	-	-	-	−0.002	0.001	133	.01*
Cesarean	-	-	-	-	−0.76	0.36	133	.04*
NBRS Total	−0.18	0.06	132	.003*	-	-	-	-
Kangaroo vs Control	−0.97	0.35	132	.01*	-	-	-	-
2 Month Value	0.37	0.12	132	.002*	0.16	0.09	133	.06

Note. All assessments conducted twice at 2 and 6 months. Est = estimate; SE = standard error; – variable was eliminated from the model; LGA = Large for gestational age; AGA = Average for gestational age; SGA = Small for gestational age; NBRS = Neurobiological Risk Score; '–' not included in the final model or omitted in the table (see below). The following nonsignificant control variables were included in model but not presented in the table presentation ($p > .05$):

Child social: gestational age, infection, NEC, surgery, site, ATVV

Child irritability: infection, multiple, surgery site, Kangaroo, ATVV, NBRS total.

Developmental maturity: gestational age, mechanical ventilation, first time, IVH, LGA vs SGA, AGA vs SGA, Site, Kangaroo, ATVV

Table 6

Relationship of sociodemographic and obstetric and infant characteristics with child developmental maturity at 6 months.

	Developmental Maturity			
Parameter	**β Est**	**SE**	***DF***	***p***
Intercept	2.48	4.08	125	.54
Maternal Age	0.07	0.04	125	.10
Education	0.14	0.13	125	.31
Marital Status	−0.49	0.63	125	.44
Infant Gender	−0.19	0.43	125	.66
Public Assistance	−0.28	0.58	125	.64
White vs Black	−0.17	0.68	125	.81
Others vs Black	0.07	0.80	125	.92
Multiple Birth	0.97	0.56	125	.09
NEC	1.79	0.67	125	.01*
NBRS Total	−0.28	0.11	125	.01*
2 Month Value	0.76	0.20	125	.0002*

Note. All assessments conducted twice at 2 and 6 months. Est = estimate; SE = standard error; – variable was eliminated from the model; LGA = Large for gestational age; AGA = Average for gestational age; SGA = Small for gestational age; NBRS = Neurobiological Risk Score; '–' not included in the final model or omitted in the table (see below). The following nonsignificant control variables were included in model but not presented in the table presentation ($p > .05$):

Child social: gestational age, infection, NEC, surgery, site, ATVV

Child irritability: infection, multiple, surgery site, Kangaroo, ATVV, NBRS total.

Developmental maturity: gestational age, mechanical ventilation, first time, IVH, LGA vs SGA, AGA vs SGA, Site, Kangaroo, ATVV