

A Correlational Study Regarding the Impact of Maternal and Infant Characteristics on Maternal–Infant Bonding in a Neonatal Intensive Care Unit

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Maternal and infant risk characteristics, including postpartum depression, infrequent neonatal intensive care unit (NICU) visitation, low gestational age, low birthweight, and prolonged NICU hospitalization, were examined as potential predictors of lower levels of maternal-infant bond or affective connection among mothers of NICU infants, while controlling for civil status and number of siblings. A correlational longitudinal design was used with a convenience sample of 101 mother-infant dyads in a university hospital NICU. Measures included the Maternal Attachment Inventory (MAI), the Edinburgh Postnatal Depression Scale, and medical record data. Multiple regression analyses, chi-square tests, and analyses of variance (ANOVA) were employed. Although the primary hypothesis was not supported, post hoc analyses showed that postpartum depression was associated with decreased maternal bond or affective connection. Mothers who developed clinical postpartum depression between Times 1 and 2 demonstrated the greatest decline in bond or connection compared to those with persistent or absent depression. Several MAI items were more normally distributed than total scores, highlighting specific attachment challenges in the NICU context. These findings suggest the need for targeted clinical interventions to address processes that may disrupt maternal-infant bond in high-risk NICU populations. The implications for disenfranchised populations, including non-White and lower socioeconomic status (SES) groups, are also discussed.

Keywords: NICU, bonding, postpartum

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Bowlby (1982) theorized that the attachment system is formed in infancy and early childhood and is rooted in the child's interactions and relationship with their primary caregiver. Infant attachment styles tend to remain stable and can impact cognitive abilities, emotional development, and behavior regulation across all areas of life (Mikulincer & Shaver, 2003). While attachment theory provides a framework for understanding the formative mother-child relationship, the present study focuses specifically on maternal-to-infant bonding. This early emotional connection influences later attachment processes. Bonding is the "maternal-driven process that occurs primarily throughout the first year of an infant's life but may continue throughout a child's life. It is an affective state of the mother; maternal feelings and emotions towards the infant are the primary indicator of maternal-infant bonding" (Altaweli & Roberts, 2010, p. 1319).

Maternal-infant bonding with premature infants warrants additional exploration, given the intensity and frequency of disruptions to the early bonding experience. Premature births and neonatal intensive care unit (NICU) admissions are atypical, adverse experiences. They can affect mothers' emotional states, their maternal representations and perceptions of the infant, and the quality of the dyadic relationship in early postpartum. Maternal-to-preterm infant bonding is a critically important, under-researched aspect of NICU life (Borghini et al., 2006). It is particularly limited in terms of subcategories of prematurity, corresponding birthweights, and NICU length of stay (Korja et al., 2008).

This gap in research necessitates further investigation, as gestational age has been suggested to affect self-regulation, the quality of mother-child interaction and attachment, and maternal anxiety (Gonçalves et al., 2020). While the NICU is a necessary environment for survival, a prolonged NICU stay is suboptimal for bonding. It has been associated with poor parent-infant relationships, parental grief, child neglect or abandonment, and the child's failure to thrive (Merritt et al., 2003). Trumello et al. (2018) note that mothers of preterm infants can demonstrate feelings of ambivalence about their relationship with their infant and struggle with their identity as mothers. Furthermore, mothers of very preterm (VPT) infants who spend more time in the NICU than moderate-late-preterm (MLPT) infants may be continuously exposed to and retraumatized by their infant's fragile state and risk of death. Traumatic deliveries and the immediate (and often prolonged) separation from the infant can affect the development of their mental representations, which, in turn, may affect maternal bond (Trumello et al., 2018).

Infants with greater degrees of prematurity may also be confined to incubators and attached to life-sustaining devices that restrict parental holding (Weiss et al., 2000). "As a result, some parents learn to withhold their touch to protect their baby and, thus, develop ingrained patterns of infrequent interaction which continue over time" (Weiss et al., 2000, p. 91). Physical separation and the inability to engage in normal bonding behaviors can place great strain on a mother's bond and even cause her to feel alienated from her baby and incompetent in her role as a parent (Flacking et al., 2012). Extreme prematurity also has a higher risk of mortality and long-term consequences for surviving infants, which carries implications for the bonding process (López-Maestro et al., 2017).

A comprehensive review of clinical and theoretical literature revealed that postpartum depression, maternal visitation, civil status, and number of siblings may also contribute to variability in bonding outcomes (Modak et al., 2023). Postpartum depression has been widely researched and poses several risks to the maternal bond, including dysfunctional parenting, conflict with the other parent of the infant, and disruptions in infant global development (Slomian et al., 2019). Furthermore, mothers of infants admitted to the NICU demonstrate a significantly increased risk of postpartum depression (28–40%) compared to mothers of full-term infants (Garfield et al., 2015). Proximity and involvement in care of the premature infant during visits has been associated with increased maternal bond and greater feelings of competence and confidence (Garten et al., 2013). Some mothers, however, may encounter barriers to regular visitation, including balancing additional childcare responsibilities, which has been cited as a contributor to NICU stress and reduced engagement (Klawetter et al., 2019). Additionally, while the disadvantages of single parenting, such as decreased support and financial insecurity, have been widely studied, data on civil status and mother-to-preterm infant bond are lacking.

Only two systematic reviews spanning the past twenty years have examined the NICU maternal-to-infant bond (Kim & Kim, 2022; Korja et al., 2008). Given the inconsistencies and limited generalizability identified in these reviews, the complex mother–preterm infant relationship warrants further examination to better forecast psychological risk (Korja et al., 2008). Researchers have emphasized that well-designed randomized controlled trials may improve infant and family outcomes by enhancing parental bonding, proximity, and parent–infant interaction during NICU hospitalization (Kim & Kim, 2022). Because early maternal bond influences both social-emotional development and health outcomes, identifying effective screening and assessment strategies is critical for informing early intervention and targeted psychological support for these vulnerable dyads (Mathews et al., 2019). Therefore, this study examined the following hypothesis: mothers and infants with higher-risk characteristics (postpartum depression, infrequent NICU visitation, low gestational age, low birthweight, and extended NICU stays) will experience a lower degree of maternal bond or affective connection than mothers and infants with fewer-risk characteristics (no postpartum depression, frequent visitation, moderate-to-late preterm status with higher birthweights and shorter lengths of stay) when controlling for civil status and number of siblings.

Methods

The study used a longitudinal correlational design to examine the relationship between maternal and infant characteristics and the degree of maternal bonding. Maternal Bond or Affective Connection (referred to as “Maternal Attachment”) and Postpartum Depression scores were collected at two points in time: within one week of NICU admission (Time 1) and between one and three months post-discharge (Time 2). Exact collection dates were not included in the facility's case files. Therefore, Time 1 and Time 2 do not represent a specific day or time; rather, they reflect time periods within the NICU experience (early in NICU admission and after release from NICU).

The study controlled for civil status (married, single parent, legal domestic partnership, cohabiting, non-cohabiting relationship) and the number of biological siblings. Demographics included mother's self-report of race, age, annual gross household income, gender identity, and sexual identity or sexual orientation. The hospital's Institutional Review Board approved the study. Data were de-identified and securely stored using password-protected, multifactor-authenticated systems to ensure confidentiality.

Setting and Recruitment

The study took place in the southeastern United States, and eligible participants were recruited in person or via telephone from one of the largest Level IV, tertiary care NICU's in the country. At collection, the NICU daily census averaged 120 infants, with approximately 60% meeting study eligibility criteria. The NICU population was predominantly Medicaid patients, 73% identifying as white.

Inclusion criteria were biological mothers ≥ 18 years; infants born at 24–36 weeks' gestation; English-speaking; medically stable mother–infant dyads; singleton births; and anticipated discharge home with the mother. Exclusion criteria were severe maternal mental illness, positive toxicology for nonprescribed substances, infants requiring comfort care, or Child Protective Services involvement.

Informed consent review was conducted in a private setting, and mothers completed the Qualtrics survey at the child's bedside or at home on personal cellular devices. A gas card incentive was offered to all mothers. Mothers were approached in a trauma-informed way, acknowledging the hardship of their experience. Participants understood that they may experience emotional discomfort when completing the scales and were informed of the minimal, yet possible, risk of a data breach. Mothers agreed that if their scores indicated suicidal thoughts or severe postpartum depression, they would be referred to the NICU social worker for follow-up.

Sample Size

Based on previous research (Bonacquisti et al., 2020; Korja et al., 2008), a medium effect size was expected and used to determine the sample size needed for 80% power and a significance level of $p \leq 0.05$ as indicated by Cohen (1992). A sample size of $N = 97$ was identified. A nonprobability convenience sample was employed, and 101 eligible participants provided consent and completed the pretest survey (Time 1). With an attrition rate of 23.8%, the final sample for purposes of hypothesis testing was $n = 77$.

Measures

Gestational age of prematurity and birthweight were categorized according to medical model: periviable preterm (PPT) 24–25 6/7 weeks or less, extremely preterm (EPT) 26–27 6/7 weeks, very preterm (VPT) 28–31 6/7 weeks, and moderate-late preterm (MLPT) 32–35 6/7 weeks (American College of Obstetricians and Gynecologists, 2016); low birthweight $< 2,500$ g,

very low birthweight < 1,500 g, and extremely low birthweight < 1,000 g. These characteristics and NICU length of stay were extracted from the medical record.

Postpartum depression scores were calculated from mothers' EPDS responses, self-administered within approximately one week of NICU admission and again up to three months post-discharge. The EPDS is consistently endorsed due to its widespread use among mothers of both full-term and preterm infants, extensive literature base, and satisfactory psychometric properties (Boyd et al., 2005). The Edinburgh Postnatal Depression Scale demonstrated acceptable internal consistency in the present sample (Time 1 Cronbach's $\alpha = 0.69$).

The Maternal Attachment Inventory (MAI) was utilized to capture maternal "bond" scores. Despite the use of the term "attachment," the MAI primarily examines maternal emotional connectedness and bonding experiences during early infancy. Consistent with instrument terminology, scores are referred to as "attachment scores" throughout the remainder of the study when discussing outcomes. Participants completed the MAI within one week of NICU admission and again up to three months post-discharge. The MAI demonstrated good internal consistency in the present sample (Time 1 Cronbach's $\alpha = 0.87$) and is reported to have adequate psychometric properties (Bonacquisti et al., 2020; Perrelli et al., 2014).

Data Preparation

Prior to analysis, new variables were created, the assumption of normality for continuous variables was tested using skewness and kurtosis, and multicollinearity among independent variables was assessed using multiple regression analysis.

Four new variables were created: a civil status binary, a maternal attachment change score, and two clinical cutoff binary scores for depression. *CivilStatusBinary* was created using *Civil Status* as a proxy for in-home support, with *married*, *legal domestic partnership*, and *cohabiting* responses collapsed into one category (1), and *single-parent* and *non-cohabiting relationship* responses collapsed into a second category (0). *MaternalAttachChangeScore* was created by subtracting Time2 Maternal Attachment scores from Time1 Maternal Attachment scores. Finally, *Time1ClinicalDepressBinary* and *Time2ClinicalDepressBinary* were created by recoding scores of 0-9 as 0 (no clinical depression) and scores of 10 and above as 1 (clinical depression).

Tests of Assumptions

Visitation hours were found to be skewed (2.65) and kurtotic (9.32). While a histogram showed several outliers, it was clear that the skew was due to a floor effect, with ~1/3 of the sample having 0 visitation hours. To address this non-normal distribution, Visitation Hours was used in descriptive statistics and in calculating average visitation hours for hypothesis testing. *AverageVisitationHours* was calculated by dividing *Visitation Hours* by *Days in the NICU*.

Several *VIF* scores suggested possible collinearity: Time 1 EPDS scores (*VIF* = 3.29), Time 2 EPDS scores (*VIF* = 3.25), Weeks of Gestation (*VIF* = 7.31), and Length of Stay NICU (*VIF* = 5.46). A series of models were subsequently tested, guided by correlational analysis, separating the depression variables [EPDS continuous Time 1, EPDS continuous Time 2, Clinical

Depression Time 1 (EPDS binary), and Clinical Depression Time 2 (EPDS binary)], Weeks of Gestation, and Length of Stay, which reduced all *VIF* scores to acceptable levels.

Analysis Plan

Descriptive statistics were calculated for all variables. Means, standard deviations, minimum, and maximum scores as well as correlations were calculated for all continuous variables: number of siblings, age of mother, household income, length of stay, total hours of visitation, birth weight, weeks of gestation, Time 1 EPDS score, and Time 1 Maternal to Infant Attachment score. Frequencies were calculated for all categorical variables: race, gender identity, sexual orientation, civil status, gestational age at prematurity, and classification of birthweight.

For hypotheses testing, four multiple regression models were tested to assess changes in maternal attachment between the two time points using models in which change in maternal attachment between time 1 and time 2 was employed as the dependent variable, with Time 1 depression (EPDS continuous or dichotomous), Time 2 depression (EPDS continuous or dichotomous), average hours of visitation, civil status (binary), and either length of stay in the NICU (days) or weeks of gestation included as independent variables; and maternal attachment score at time 1 as a control variable.

Model 1: *MaternalAttachmentChange* = *Time1_Depression (EPDS continuous)* + *Time2_Depression (EPDS continuous)* + *Length Time NICU* + *AveVisitation* + *CivilStatusBinary* + *MaternalAttachmentTime1*

Model 2: *MaternalAttachmentChange* = *Time1_Depression (EPDS continuous)* + *Time2_Depression (EPDS continuous)* + *WeeksGestation* + *AveVisitation* + *CivilStatusBinary* + *MaternalAttachmentTime1*

Model 3: *MaternalAttachmentChange* = *Time1_ClinicalDepress (EPDS Binary)* + *Time2_ClinicalDepress (EPDS Binary)* + *Length Time NICU* + *AveVisitation* + *CivilStatusBinary* + *MaternalAttachmentTime1*

Model 4: *MaternalAttachmentChange* = *Time1_ClinicalDepress (EPDS Binary)* + *Time2_ClinicalDepress (EPDS Binary)* + *WeeksGestation* + *AveVisitation* + *CivilStatusBinary* + *MaternalAttachmentTime1*

Results

A total of $N = 101$ mothers participated, whose ages ranged from 18 to 42 ($M = 28$, $SD = 5.59$). As shown in Table 1, almost all mothers identified as female and heterosexual or straight. Almost two-thirds identified as White and 26% identified as Black or African American. Over 80% were married, in a legal domestic partnership, or in a cohabitating relationship. There were no significant differences in demographic characteristics between those who were included (i.e., completed Time 1 and Time 2 measures) and those who were not included (i.e., did not complete Time 2 measures) in hypothesis testing.

Table 1
Demographic Characteristics

		Overall Sample		Included		Not Included	
		<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Gender	Female	99	98.0	72	97.3	27	100
	Non-binary	1	1.0	1	1.4		
	Trans Male	1	1.0	1	1.4		
	Total	101	100	74	100	27	100
$\chi^2 (2, N = 101) = 0.74, p = 0.7$							
Sexual Orientation	Bisexual	9	8.9	7	9.5	2	7.4
	Heterosexual/Straight	90	89.1	65	87.8	25	92.6
	Prefer not to disclose	2	2.0	2	2.7		
	Total	101	100	74	100	27	100
$\chi^2 (2, N = 101) = 0.87, p = 0.7$							
Race	Asian	3	3.0	2	2.7	1	3.7
	Black or African American	28	27.7	19	25.7	9	33.3
	White	65	64.4	49	66.2	16	59.3
	Other	4	4.0	3	4.1	1	3.7
	Total	100	99.1	73	98.7	27	100
	Missing	1	1.0	1	1.4	0	0.0
$\chi^2 (3, N = 101) = 1.01, p = 0.91$							
Ethnicity	Hispanic or Latinx	8	7.9	6	8.1	2	7.4
	White/Non-Hispanic	79	78.2	60	81.1	19	70.4
	Total	87	86.1	66	89.2	21	77.8
	Missing	14	13.9	8	10.8	6	22.2
$\chi^2 (1, N = 87) = 0.004, p = 0.95$							
Marital Status	Cohabitating Relationship	23	22.8	16	21.6	7	25.9
	Legal Domestic Partner	6	5.9	2	2.7	4	14.8
	Married	55	54.5	46	62.2	9	33.3
	Single Parent	16	15.8	9	12.2	7	25.9
	Total	100	99	73	98.6	27	100
	Missing	1	1	1	1.4	0	0
$\chi^2 (3, N = 100) = 10.36, p = 0.02$							

Per Table 2, almost 75% of the babies were very preterm or moderate-late preterm. Approximately 45% of the babies were low birthweight. Those who were not included in hypothesis testing had a higher percentage of extremely preterm babies, extremely low birthweight babies, and mothers who scored in the clinical range for depression at Time 1.

Table 2
Clinical Characteristics

		Overall Sample		Included		Not Included	
		<i>N</i>	%	<i>N</i>	%	<i>N</i>	%
Gestation Category	Perivable Preterm	11	10.9	6	8.1	5	18.5
	Extremely Preterm	14	13.9	6	8.1	8	29.6
	Very Preterm	32	31.7	24	32.4	8	29.6
	Moderate-late Preterm	43	42.6	37	50.0	6	22.2
	Total	100	99.1	73	98.6	27	100
	Missing	1	1.0	1	1.4	0	0.0
$X^2(3, N = 100) = 12.13\ p = 0.01$							
Birthweight Class	Low	45	44.6	37	50.0	8	29.6
	Very Low	27	26.7	21	28.4	6	22.2
	Extremely Low	25	24.8	13	17.6	12	44.4
	Total	97	96.1	71	96.0	26	96.2
	Missing	4	4.0	3	4.1	1	3.7
$X^2(2, N = 100) = 7.90\ p = 0.05$							
Clinical Depression at Time 1	No	62	61.4	52	70.3	10	37.0
	Yes	39	38.6	22	29.7	17	63.0
	Total	101	100	74	100	27	100
$X^2(1, N = 100) = 9.22\ p = 0.002$							

As seen in Table 3, the average maternal attachment score was $M = 100$ ($SD = 5.4$) on a scale ranging from a minimum score of 26 to a maximum of 104, with no baseline differences between those who were and were not included in hypothesis testing. There were significant differences between the two groups on several clinical and demographic characteristics, with those who were included in hypothesis testing having higher income, more weeks of gestation, lower days in the NICU, higher birth weight, and lower clinical depression scores at Time 1.

Table 3
Descriptive Statistics of Continuous Variables

	Overall Sample		Included in Analysis		Not Included in Analysis		<i>t</i> -value	<i>df</i>	<i>p</i> -value	Mean Diff
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>				
Age	28	5.59	28.65	5.553	26.11	5.352	2.05	99	0.04	2.54
Income	71831	59170	78856	61895	48999	43087	2.01	83	0.05	29857
Gestation	30.35	3.17	30.92	2.88	28.79	3.45	3.12	99	0.002	2.13
Birthweight	1491	601	1577	556	1255	665	2.44	99	0.02	321.55

	Overall Sample		Included in Analysis		Not Included in Analysis		<i>t</i> -value	<i>df</i>	<i>p</i> -value	Mean Diff
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>				
Length of Stay (Days)	51.94	39.91	45.68	34.52	69.11	48.60	-2.69	99	0.01	-23.44
Visitation (Hours)	149.32	155.05	141.53	155.16	170.67	155.62	-0.84	99	0.41	-29.14
Ave Visitation/Day	3.21	2.16	3.23	1.98	3.131	2.62	0.21	99	0.84	0.10
Siblings	0.80	1.15	0.76	1.10	0.93	1.30	-0.65	99	0.52	-0.17
Time1 EPDS Score	8.19	3.79	7.76	3.63	9.37	3.69	-1.97	99	0.05	-1.61
Time1 Maternal Attachment	100.21	5.40	100.41	4.69	99.65	7.12	0.61	98	0.54	0.75

Hypothesis Testing

Multiple regression analyses were conducted to examine predictors of change in maternal attachment between Time 1 and Time 2. Across all models, predictors accounted for approximately 46% of the variance in maternal attachment change scores (see Table 4). Contrary to the hypothesis, infant risk variables (e.g., gestational age, length of stay) and visitation were not significant predictors of changes in maternal attachment.

Postpartum depression at Time 2 consistently emerged as a significant predictor, with higher depression scores associated with decreased maternal attachment, controlling for maternal and infant characteristics. These findings were consistent regardless of whether gestational age or NICU length of stay was included in the model, and whether depression was examined as a continuous or categorical variable. Baseline maternal attachment (Time 1) was also a strong predictor of change in attachment ($\beta = -0.71$), with lower initial attachment associated with greater increases over time.

Table 4
Multiple Regression Analysis of Change in Maternal Attachment

	Model 1			Model 2			Model 3			Model 4		
	<i>B</i>	<i>SE</i>	β	<i>B</i>	<i>SE</i>	β	<i>B</i>	<i>SE</i>	β	<i>B</i>	<i>SE</i>	β
(Constant)	65.23	9.82		67.14	8.78		66.54	10.11		66.77	9.02	
T1 EPDS Score	0.16	0.13	0.13	0.15	0.13	0.12						
T2 EPDS Score	-0.32*	0.14	-0.25	-0.31*	0.14	-0.25						
T1 Clinical Depress							0.88	0.91	0.10	0.87	0.91	0.09
T2 Clinical Depress							-2.38*	1.11	-0.21	-2.36*	1.10	-0.21
Gestation	0.06	0.13	0.04				0.00	0.13	0.00			
LoS NICU (Days)				0.00	0.01	0.01				0.01	0.01	0.04
Hours Visitation / Day	0.12	0.20	0.05	0.13	0.20	0.06	0.21	0.20	0.10	0.22	0.20	0.10
Civil Status	-0.85	1.29	-0.06	-0.71	1.28	-0.05	-0.53	1.26	-0.04	-0.44	1.25	-0.03
T1 Attach	-0.64**	0.08	-0.71	-0.65**	0.08	-0.71	-0.65**	0.09	-0.72	-0.66**	0.09	-0.73
	<i>AdjR</i> ² = 0.46			<i>AdjR</i> ² = 0.46			<i>AdjR</i> ² = 0.46			<i>AdjR</i> ² = 0.46		
	<i>F</i> (6, 65) = 11.13, <i>p</i> < 0.001			<i>F</i> (6, 65) = 11.07, <i>p</i> < 0.001			<i>F</i> (6, 65) = 10.90, <i>p</i> < 0.001			<i>F</i> (6, 65) = 10.96, <i>p</i> < 0.001		

Note. **p* < 0.05; ***p* < 0.001

Post-hoc Analysis

To further explore clinical depression at Time 2 as an important predictor of change in maternal attachment, additional testing was conducted. First, a Chi-square Test of Independence was conducted that included clinical depression at Time 1 and Time 2, which indicated that there was a higher percentage of participants who had clinical depression at both Time 1 and Time 2 than would be expected if there was no relationship between clinical levels of depression across time points [$\chi^2(1, N = 73) = 8.23, p = 0.004, Std\ Res = 2.20$].

Second, a new variable, *ClinicalChange*, was created based on changes in clinical depression between Time 1 and Time 2: no clinical depression at Time 1 or Time 2 (NC/NC), clinical depression at Time 1 and Time 2 (C/C), clinical depression Time 1 with no clinical depression Time 2 (C/NC), and no clinical depression Time 1 with clinical depression Time 2 (NC/C). A One-way Analysis of Variance (ANOVA) was then conducted with maternal attachment change score as the DV and clinical change categories as the IV.

As shown in Table 5, those whose depression scores indicated no clinical depression at either time point (NC/NC) showed the smallest change in maternal attachment ($M = 0.93, SD = 3.20$). The only group with a decrease in maternal attachment between Time 1 and Time 2 was the group whose scores suggested that they did not have clinical depression at Time 1 but did so at Time 2 (NC/C: $M = -4.00, SD = 7.12$).

There was a significant mean difference in maternal attachment change scores among categories of clinical change between Time 1 and Time 2. Post hoc analysis indicated that those with no clinical depression at Time 1 but with clinical depression at Time 2 (NC/C) had over 8-point lower Maternal Attachment change scores compared to those who had clinical depression scores at both time points and over 6-point lower compared to those who moved from clinical depression at Time 1 to no clinical depression at Time 2.

Table 5

Bonferroni Corrected Post Hoc Analysis of Maternal Attachment Change Scores by Clinical Depression Categories

							95% CI	
	<i>N</i>	Mean	<i>SD</i>	Mean Diff	<i>SE</i>	<i>p</i> -value	Lower	Upper
Non-Clinical T1 to Clinical T2 (NC/C)	4	-4.00	7.12					
Non-Clinical T1 & T2 (NC/NC)	46	0.93	3.20	-4.93	2.11	0.13	-0.79	10.66
Clinical T1 & T2 (C/C)	8	4.13	4.58	-8.13	2.47	0.01	1.40	14.85
Clinical T1 to Non-Clinical T2 (C/NC)	14	2.29	5.20	-6.29	2.29	0.05	0.06	12.51

Discussion

The study aimed to examine the relationship between maternal characteristics, infant characteristics, and maternal bond among mothers with babies in the NICU. Contrary to the study hypothesis, higher-risk maternal and infant characteristics were not associated with lower maternal bond (“attachment” per MAI). Instead, maternal attachment scores were consistently high across the sample, suggesting a ceiling effect that may have limited the ability to detect group differences. Additionally, the study was limited by low statistical power due to the small sample size.

There was very little variation in the gestational categories, with almost 75% of the babies in the VPT and MLPT categories. Of the four gestational categories, these infants have the highest survival rates and shorter, less invasive NICU stays. Had our sample been equally stratified across categories, data from higher-risk infants may have more substantially impacted maternal attachment scores, as prolonged or complex NICU hospitalizations may evoke more bonding disruptions or maternal mental health crises. Of primary concern are the timing, accuracy, and respondent bias of our screening tools (EPDS, MAI). It was thought that mothers should not be screened if babies were actively decompensating or at high risk of death; however, this trauma-informed approach may have limited our study enrollment and results. Responses may have also been limited by the fear and stigma associated with postpartum depression and lack of bonding (Dennis & Chung-Lee, 2006; Fonseca et al., 2017). Overall, while the study did not have sufficient power to detect an effect, we were encouraged to learn that it is possible for mothers to report a bond with their infants, notwithstanding significant challenges to the typical attachment environment.

Post-hoc comparison of the relationship between clinical postpartum depression changes and changes in maternal attachment found that the only group experiencing a decrease in maternal attachment between Time 1 and Time 2 were mothers who started with no postpartum depression at Time 1 but moved to clinical levels by Time 2. This group had substantial and significantly lower maternal attachment change scores compared to those with clinical postpartum depression scores at both time points.

Previous postnatal mental health literature has found that most new mothers (approximately 80%) will experience mood changes and tearfulness within the first 2 weeks after giving birth, referred to as “baby blues.” Should symptoms persist longer than two weeks postpartum, postpartum depression may occur (Postpartum Support International [PSI], n.d.). These findings suggest that change in postpartum depression may be a crucial indicator of risk in NICU mothers regarding maternal attachment. As Time 2 surveys were administered at or around the time of the infant’s discharge, findings raise potential concerns regarding mothers with decreasing attachment scores returning home with their newborns—some of whom may be medically complex—into environments with reduced medical and mental health oversight and new stressors.

While most mothers demonstrated high maternal attachment scores, there were lower scores associated with specific domains of their bond, as well as a relationship between postpartum

depression and one's capacity to think about their baby. Examination of specific MAI items provided a more granular understanding of maternal-infant bonding within the NICU. In a full-term, healthy postpartum experience, it may be assumed that a mother has fun with her baby (Q15, MAI), knows her baby's personality, understands their signals, and has thoughts centered on them (Q19, MAI). The traumatic and highly medical nature of the NICU, however, may rob mothers of many playful, joyous, or bonding-promoting experiences.

Similarly, while new mothers are expected to have infant-centered thoughts, NICU mothers may engage in dissociative or protective behaviors to manage their overwhelm. In terms of "knowing" one's baby and understanding their signals (Q23, Q20, MAI), some NICU mothers may demonstrate lower scores due to their infant's critical condition and inability to demonstrate progressive developmental milestones. Some medical interventions render infants sedated and motionless, limiting the expression of emotion or temperament. Furthermore, parents may be unable to fully engage in caregiving tasks and instead rely heavily on bedside nurses. Both the literature and interactions throughout this study indicated that mothers often felt "helpless" or "useless" in relation to their infant's care.

Implications for Clinical Practice

Findings from this study highlight the importance of ongoing screening for postpartum depression among the NICU population. Standard single-timepoint screening may fail to identify mothers whose symptoms emerge later in the postpartum period or at discharge (Robbins et al., 2023). Given the often unexpected and traumatic nature of a NICU admission, the study hospital's policy of screening prior to mother's discharge (48-72 hours postpartum) may not capture her complete mental health picture. In fact, several mothers volunteered that the EPDS did not accurately depict their true mental health status and were curious about alternative screeners that are more contextual to the NICU. By employing two psychometrically sound mental health screening measures, this study addressed a gap in routine postpartum care and facilitated referrals to NICU social workers when clinically indicated. Many of the mothers in the study shared they would like to talk to their social worker and/or support staff about bonding and attachment, suggesting that screening for risk factors and offering additional psychoeducation may be helpful.

This research also measured visitation hours in the NICU. While there is a margin of error to consider (i.e., accuracy of documentation), this study confirmed what is routinely expressed among NICU providers—parents are not at the bedside as often as expected. Interestingly, lower visitation hours did not correlate with lower attachment scores. This finding conflicts with the assumption of some that if a mother is not physically at the bedside, then she cannot bond to her baby. It may be clinically relevant for nursing and social work staff to explore the quality of interaction at the bedside (versus quantity of hours logged) and consider alternative ways to foster maternal attachment if a mother cannot visit. Furthermore, it is important to recognize that a mother's absence from the bedside does not necessarily reflect a lack of desire to be present.

There are many social determinants of health to consider that may impact visitation. As this population was Medicaid predominant, less variance in reported income was expected; however,

we were surprised by the consistently low visitation hours. Lower income may be associated with infrequent visitation due to single-car or no car households, limited parental leave, lack of childcare, or reduced resources for gas. Although these data were not included in the study, NICU social workers gather information regarding social determinants of health through psychosocial assessments to facilitate access to resources that optimize NICU admission and discharge. This information also provides context for providers who may question families' behaviors or intentions. While this NICU is well suited to support families through strong social work and community partnerships, additional data and clinical discussion regarding the impact of NICU visitation on maternal bond may help other institutions to pursue additional resources and destigmatize families experiencing psychosocial stressors that limit visitation.

Strengths and Limitations

There are notable strengths of the study, particularly when compared with existing literature. The numerous variables that were analyzed (gestational age of prematurity, birthweight, length of NICU stay, presence of postpartum depression, sibling numbers, and civil status) allowed for a thorough and comprehensive examination of the nuances of these vulnerable dyads.

Though we did not achieve the intended sample size for purposes of analyses, our attrition rate was lower than comparable studies, and our final analytic sample was similar to, or exceeded, those featured in the literature (Bieleninik et al., 2016; Bonacquisti et al., 2020; Korja et al., 2008). The present sample included a greater number of non-white mothers when compared to the overall NICU population, and while there is a slight imbalance between the two populations, we feel this is a strength, as marginalized populations are not accurately reflected in the literature. This study represented a mostly Medicaid population that is, historically, underserved and underrepresented in NICU maternal attachment research.

Study limitations were nearly identical to those reported in the existing literature, which was unsurprising given the dynamics of the NICU and the overall functioning of a major university medical setting. Like Bonacquisti et al. (2020), we experienced challenges with the timing of questionnaire administration and attrition. Pre-test ("Time 1") questionnaires were intended to be collected within one week of admission and post-test ("Time 2") surveys within 48 hours of discharge; however, the unpredictable nature of the NICU and unavailability of mothers made this difficult and required ongoing modifications to timeframe and outreach. Non-completers of our study were also typically higher-risk dyads (higher acuity, elevated EPDS scores); therefore, our final sample represents more lower-risk dyads with stronger maternal bonds. As a result, generalizability is limited and not representative of the broader NICU population.

Future Research

While high MAI scores may indicate positive attachment feelings, maternal attachment-promoting interactions may not always reflect those scores. Specifically, feelings of attachment may not consistently translate into attachment behaviors, which may impact the mother-infant bond. The ceiling effect created by high MAI scores prompted consideration of additional methods for measuring maternal attachment beyond self-report alone. Inclusion of both self-

report and observational behavioral measures may provide a more comprehensive understanding of maternal-infant bonding by combining maternal perceptions with data regarding the quality and frequency of positive interactions.

It is also worth exploring alternative screening methods for postpartum depression. Although the EPDS remains the standard for assessing postpartum mood disorders, the Postpartum Depression Screening Scale (PDSS) may be more suitable for mothers experiencing NICU trauma because it assesses seven symptom domains (Vogeli et al., 2018). Though currently limited by cost, broader use of the PDSS may improve psychometric strength and standardization.

While this study focused specifically on postpartum depression, postpartum anxiety, postpartum psychosis, postpartum posttraumatic stress disorder (PPTSD), and postpartum obsessive-compulsive disorder (POCD) may also emerge during the postpartum period and remain underrepresented in both literature and obstetric care. Rates of NICU postpartum anxiety and PPTSD are particularly high, with approximately 40% of mothers experiencing postpartum anxiety within the first month of NICU admission and 25% experiencing PPTSD up to one year following delivery (March of Dimes, 2023). Future research should further examine these underrecognized and underdiagnosed postpartum disturbances (PSI, n.d.).

Additionally, some lower birthweight infants require high-frequency ventilation or umbilical lines that prevent mothers from holding their infants for extended periods. Given the therapeutic importance of physical touch and skin-to-skin/kangaroo care, future research focused on higher-risk infant subgroups and qualitative maternal experiences may provide a more comprehensive understanding of maternal-infant bonding processes in the NICU.

Conclusion

Although the primary hypothesis was not supported, this study contributes to the growing body of literature on maternal-infant bonding in the NICU by identifying postpartum depression, particularly the emergence of clinically significant symptoms following NICU admission, as a potentially important factor associated with changes in maternal bond or affective connection. The findings also suggest that maternal bonding is a multidimensional process that may not be fully captured by global self-report measures, highlighting the value of examining specific domains of maternal experience alongside observational assessments. Continued attention to maternal mental health, repeated screening throughout the NICU hospitalization and transition home, and interventions that support both psychological well-being and early parent-infant relationships may help optimize outcomes for these vulnerable families. Further research with larger, more diverse samples and multimethod assessment approaches is needed to better understand the complex processes that shape maternal-infant bonding following preterm birth.

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