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Maternal Bonding through Pregnancy and Postnatal: Findings from an Australian Longitudinal Study

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Abstract

Background Mother-infant bonding provides the foundation for secure attachment through the lifespan and organizes many facets of infant social-emotional development, including later parenting.

Aims To describe maternal bonding to offspring across the pregnancy and postnatal periods, and to examine a broad range of sociodemographic and psychosocial predictors of the maternal-offspring bond.

Methods Data were drawn from a sample of 372 pregnant women participating in an Australian population-based longitudinal study of postnatal health and development. Participants completed maternal bonding questionnaires at each trimester and 8 weeks postnatal. Data were collected on a range of sociodemographic and psychosocial factors.

Results Bonding increased significantly through pregnancy, in quality and intensity. Regression analyses indicated that stronger antenatal bonding at all time points (trimesters 1 through 3) predicted stronger postnatal bonding. Older maternal age, birth mother being born in a non-English speaking country, mother not working full time, being a first-time mother, breast-feeding problems, and baby's crying behavior all predicted poorer bonding at 8 weeks postpartum.

Conclusion These novel findings have important implications for pregnant women and their infant offspring, and for health care professionals working in perinatal services. Importantly, interventions to strengthen maternal-fetal bonding would be beneficial during pregnancy to enhance postnatal bonding and infant health outcomes.

Keywords
- maternal-fetal bonding
- postnatal bonding
- maternal antenatal attachment scale
- maternal postnatal attachment scale
- pregnancy

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The mother-infant relationship is central to infant social-emotional development.[1,2] Maternal-fetal bonding in the antenatal period is important because a mother's behaviors through pregnancy may be influenced by this bond. Problems with bonding have been associated with a broad range of outcomes, including negative health behaviors in pregnancy, such as alcohol and nicotine use[3,4]; traumatic states accompanied by alterations in the regulatory functions of the child's brain[5,6]; maladaptive childhood and adult mental health[7–9]; poorer attachment through life[10–12]; and later social and parenting relationships.[12,13] Little is known about the natural history of maternal-fetal bonding across pregnancy and its consequences in early postnatal life.

The progression of the mother's felt bond to the fetus across the gestational period has received some attention in recent years. Women who had fourth-dimensional (4D) ultrasound scanning of the fetus had stronger antenatal bonding between the first and second assessments in 44 couples.[14] Maternal-fetal bonding had also significantly risen between the first and third trimesters among women with a miscarriage history ($n = 24$).[15] Despite showing an increase in the quality of bonding through pregnancy, these studies considered only two time points during pregnancy, used small sample sizes, and were not focused specifically on the mother-fetal bond. Dutch researchers addressed these limitations in a study examining the antenatal bond in a larger sample of 403 expectant mothers[16] and found the quality of bonding increased through pregnancy as the fetus developed, a finding that has subsequently been replicated.[17] However, neither study considered potential consequences for the postnatal bond.

The bond a mother feels toward her fetus antenatally may also be important in determining the mother-infant relationship postnatally. Attitudes toward the unborn baby during pregnancy influence first impressions of the infant.[18] There is a significant correlation between ante- and postnatal bondings,[19,20] and prenatal bonding is a predictor of the early mother-infant relationship.[21] Mothers with stronger quality prenatal bonding are more sensitive to, and more stimulating in, interactions with their infants.[22] van Bussel and colleagues found that antenatal bonding predicted stronger bonding postnatally,[23] but they did not assess other predictors or their contribution to bonding. Other important variables include maternal age, education, income, parity, and ethnicity, which have primarily been assessed for their impact on maternal antenatal bonding.[24–26] In the majority of studies, inconsistent relationships have been found between these variables and prenatal bonding.[24–26] Few studies assess their contributions to *postnatal* bonding, and none across the pregnancy and postnatal period.

The aim of this paper was twofold: (1) to examine mothers' subjectively felt bond to their developing fetus/infant from trimesters 1 through 3 and at 8 weeks postpartum in a large sample of Australian women, and (2) to build a prognostic model of bonding quality based on sociodemographic factors (e.g., age, income, and country of birth) and postnatal factors (e.g., weeks gestation, breast-feeding problems, and crying behavior). It was hypothesized that both the quality and intensity of maternal antenatal bonding would increase through the course of pregnancy until the early postnatal period. Furthermore, it was expected that mother-fetal bonding in trimesters 1 through 3 would predict mother-infant bonding at 8 weeks postpartum, but that other important predictors would also emerge.

Method

This project is a substudy of the Triple B study ("Bumps, Babies, and Beyond"), a longitudinal pregnancy study conducted by the National Drug and Alcohol Research Centre (NDARC) at the University of New South Wales (UNSW), Sydney, and by the National Drug Research Institute (NDRI) at Curtin University, Perth, in collaboration with the University of Sydney. The study examines the impact of parental substance use on infant development and family functioning from the time of conception, taking into account the influence of a range of additional factors, including sociodemographic variables, diet and nutrition, psychological and physical health, and social support. A total of 1,604 women were recruited during pregnancy between 2008 and 2013, as well as their offspring and partners. The current study is based on a subsample of participants from NSW. Ethics approval for this study was obtained from the Human Research Ethics Committees of each participating hospital, the Area Health Services in which the hospitals were located and UNSW.

Participants

Participants were a subsample of 372 women recruited between November 2010 and June 2012, who had completed all requisite measures at the time of analysis. All families were approached during their pregnancy through the Royal Prince Alfred Hospital (RPA), Royal Hospital for Women (RHW), and Liverpool Hospital. Eligibility criteria included being pregnant (at any stage from conception to 40 weeks' gestation), being aged $\geq$ 16 years; having no major medical complications (mother or fetus), residence in NSW, intention of mother or both parents to be the primary caregiver/s, being mentally able to complete study measures (as assessed by the researcher), and possessing sufficient literacy in English. Women from specialist drug and alcohol clinics were included in this sample ($n = 9$). To assess generalization of findings, comparisons with women who gave birth during the same period of time, but who had not completed all required measures (i.e., recruited but not yet interviewed on all available measures relevant to this study; $n = 485$) showed similar sociodemographic characteristics, with the exception that those included in the sample were more likely to be used (χ^2 [$df = 2$, $n = 862$] $= 21.66$, $p < 0.01$).

Comparing our sample with the Australian population of women giving birth in 2012[27]: the average maternal age for our study was 32.6 years, similar to the average maternal age in the population of 30 years; 1.1% of women in our study were from an Indigenous background, whereas 4% of women were indigenous in the population; 58.9% of women in our study were born in Australia, whereas 68.8% of women giving birth in the population were Australian-born; it was the first pregnancy for 39.5% of women in our study, similar to the 42.4% of women in the population who gave birth for the first time; the average gestational age in our study was 39.3 weeks,

similar to the population average 38.8 weeks; and the average weight of babies in our study was 3.6 kg, which was also similar to the population average of 3.37 kg.

Procedure

Pregnant women were approached by trained researchers in waiting rooms at general antenatal clinics and specialist drug and alcohol antenatal clinics attached to major public hospitals and area health services. Women, partners, and children were followed up prospectively, and maternal data were collected during each trimester, and at 8 weeks and 12 months post-birth. The data for this study consist of structured interviews and self-complete questionnaires administered across the following four time points: trimester one (T1), trimester two (T2), trimester three (T3), and 8 weeks postnatal (8w).

Measures

Demographic and Postnatal Information

Demographic information was collected via structured interview in T3 (27 weeks birth) whereas postnatal information was collected at 8 weeks post-birth. Demographic variables included age; marital status, employment status, gross annual household income, highest level of education, country of birth, Aboriginal or Torres Strait Islander status, living arrangement, desire to be pregnant, and whether it was the mother's first pregnancy (yes/no). Postnatal variables included baby's birth weight, weeks gestation at birth, baby's daily time crying, problems during labor (e.g., breech birth, fetal distress, meconium during labor, retained placenta or postpartum hemorrhage), and breast-feeding problems (e.g., engorged breasts, blocked ducts, mastitis, thrush, cracked nipples, or low milk supply). Demographic and postnatal variables were chosen for inclusion in the present study based on prior research.

Bonding to the Fetus

Maternal antenatal bonding was assessed using the Maternal Antenatal Attachment Scale (MAAS).[28] The 19-item scale focuses on maternal attitudes, feelings, and behaviors toward the fetus. It has two dimensions measuring: (1) *quality* of maternal bonding (10 items); and (2) *intensity* of preoccupation with the fetus (8 items). The quality subscale assesses affective experiences, such as closeness, tenderness, and positive feelings about the fetus, a desire to know about it, as well as vivid internal representations of the future baby. The intensity subscale assesses the intensity of preoccupation with the fetus and the intensity of feeling, including the amount of time spent thinking about, talking to, and dreaming about the unborn baby. A 5-point response scale was used with higher values corresponding to stronger antenatal bonding. Generally, higher scores for both the subscales indicate the most adaptive mother-fetal bonding style.[28] The range of scores for the global total scale was 19–95 with the Quality and Intensity subscale scores ranging from 10–50 to 8–40, respectively. The MAAS is a widely used measure with reliability for the overall instrument reported to be 0.82, when used in the third trimester.[28] Internal consistency analyses for the current study yielded Cronbach alphas of 0.72, 0.68, and 0.76 in T1, T2, and T3, respectively.

Bonding to the Infant

The Maternal Postnatal Attachment Scale (MPAS; 19 items)[29] was used to measure a mother's reported feelings about her infant at 8 weeks of age. The measure consists of three factors: (1) *quality of bonding* (9 items; range 9–38): confidence and satisfaction in the interaction with the infant; (2) *absence of hostility* (5 items; range 5–22): the absence of hostile or angry feelings toward one's infant; and (3) *pleasure in interaction* (5 items; range 5–19): the desire for physical closeness and happiness in interaction with one's infant. Responses were provided on 2-, 4-, or 5-point scales. To ensure equal weighting of questions, all response options were recoded to represent a score of 1 (poor bonding) to 5 (strong bonding). The sum of the 19 items forms the total MPAS, with higher scores indicating the most adaptive mother-infant bonding style.[29] The scale has demonstrated reliability and construct validity.[29] Cronbach α for the total scale in this sample was 0.75.

Data Analysis

All data were analyzed with the Statistical Package for Social Sciences (SPSS; SPSS Inc., Chicago, IL[Q3]). Average (mean) bonding scores, as well as Z-scores, were calculated at each trimester during pregnancy and postnatally. Other predictor variables were considered in the analyses, including sociodemographic factors (maternal age, country of birth, employment status, household income before tax and parity) and postnatal factors (baby's birth weight, weeks gestation, problems during labor, breast-feeding problems, baby's crying time per day). These were assessed during the baseline and 8 week interviews.

A series of repeated measures analysis of variance (ANOVA) with Greenhouse-Geisser correction were run for both the MAAS and MPAS total scales and relevant subscales to determine whether differences between time points during pregnancy existed. Post hoc analysis with Bonferroni correction was conducted to determine more specifically where the differences existed. Correlation analyses were conducted on MAAS and MPAS Z-scores to determine the relationship between the scales. Repeated measures ANOVA with Greenhouse-Geisser correction were run for the MAAS and MPAS global total to see whether differences existed. Friedman analysis was conducted on the Z-scores of the quality subscale of the MAAS and MPAS to determine whether differences were present. A series of three multiple linear regression models for T1, T2, and T3 was then run to predict postnatal bonding, including sociodemographic and psychosocial predictors.

Missing Data

Person mean substitution (PMS) was conducted to impute missing data for MAAS and MPAS variables in the present research.[30] In this procedure, the imputed value for a variable with missing data was applied to cases with $< 20\%$ of data missing on the scale and derived from the non-missing items for the case.[31] When PMS was performed on

this dataset, 11 participants were excluded due to missing data on the MAAS and MPAS, resulting in a final sample of 372 women.

A relatively large proportion of participants did not disclose their income. Because of this, 28% of income data were missing ($n = 104$). There were also several participants with missing data for other variables ($n = 46$, 12.4%). Further detail on missing data is included in the Supplementary Analyses. The presence of missing data raises the possibility of introducing bias into the results if data are not missing completely at random. To counter this, multiple regression analyses were performed using multiple imputations of chained logit and mlogit equations to impute missing data.

Results

Descriptive Results

Demographic and Postnatal

►**Table 1** summarizes the demographic characteristics of the sample. The mean age of the sample was 33 years (range: 18–49 years). The majority of women were Australian born (59%), married or de facto (common law) (96%), and had completed a university/college education (67%). In this sample, 49% of women were working full time when they were pregnant. For over a third of the sample (40%), this was their first pregnancy and the majority of women in the sample reported wanting to become pregnant (81%). The mean infant birth weight was 3.6 kg (range: 1.4–5.5 kg), and gestation at birth was 39 weeks (range: 29–42). A lot of women reported one or more problems during their labor (42%), while breastfeeding problems were also common, with women either reporting no problems (25%) or one or more problems (42%). In this sample, it was found that babies averaged 86 minutes of crying per day at 8 weeks post-birth.

MAAS Antenatal Bonding

Descriptive statistics for the MAAS quality/intensity subscales and global scale are reported in ►**Table 2**.

MAAS Global Total

The global total scores increased over T1, T2, and T3 as shown in ►**Table 2**. To explore whether there was a significant difference in overall bonding scores as pregnancy progressed, repeated measures ANOVA was conducted with a Greenhouse-Geisser correction. Comparison of the repeated measures was performed first using the global total MAAS scores showing a statistically significant increase in mother-fetal bonding, $F(1.74, 629.81) = 200.19$, $p < 0.001$. Post hoc analysis with Bonferroni correction was conducted to test whether there was a significant difference between T1 and T2. Analyses showed that the increase from T1 (mean = 74.84) to T2 (mean = 78.53) was significant, $p < 0.001$. The same was done with the total MAAS scores between T2 (mean = 78.53) and T3 (mean = 80.58) which also indicated a significant increase in bonding scores, $p < 0.001$.

MAAS Quality Subscale

As ►**Table 2** shows, the quality subscale scores increased over T1, T2, and T3. Repeated measures ANOVA with a Greenhouse-Geisser correction was performed on the MAAS quality subscale and showed a statistically significant increase in quality of bonding through pregnancy, $F(1.65,598.45) = 141.60$, $p < 0.001$. Post hoc tests using Bonferroni correction revealed that the increase from T1 (mean = 44.25) to T2 (mean = 46.11) was significant, $p < 0.001$. The same was done with the MAAS quality scores between T2 (mean = 46.11) and T3 (mean = 46.75) that also indicated a significant increase in quality of bonding scores, $p < 0.001$.

MAAS Intensity Subscale

As ►**Table 2** shows, the intensity subscale scores increased over T1, T2, and T3. Repeated measures ANOVA with a Greenhouse-Geisser correction found a significant increase in intensity of bonding from T1 through T3, $F(1.634, 593.32) = 139.64$, $p < 0.001$. Post hoc analysis with Bonferroni correction showed that the increase from T1 (mean = 25.87) to T2 (mean = 27.64) was significant, $p < 0.001$, and scores between T2 (mean = 27.64) and T3 (mean = 29.12) also showed a significant increase in intensity of bonding scores, $p < 0.001$.

MPAS Postnatal Bonding

Descriptive statistics for the MPAS global total scale and the quality, absence of hostility and pleasure in interaction subscales, are reported in ►**Table 3**.

MAAS and MPAS Correlation Analysis

While both the MAAS and MPAS measure bonding, their items differ. The MAAS items focus on feelings toward the unborn baby, health during pregnancy, and expectations around seeing the baby after giving birth. The MPAS items refer to the infant after birth and focus on feelings of the mother, when with the baby or away from the baby, as well as confidence in rearing the infant. To compare bonding scores ante- and postnatally, Z-scores were computed for the global total scale for the MAAS and MPAS. ►**Table 4** details a correlation matrix of the Z-scores of the global total of the MAAS (T1, T2, and T3) and MPAS (8 weeks). The MAAS and MPAS global total scores at all time points (T1, T2, T3, and 8w) were significantly correlated. The correlations during pregnancy (MAAS) ranged from 0.51, between T1 quality and T3 total, to 0.83 between T1 quality and T1 total. Correlations from pregnancy (MAAS) through 8 weeks postnatal (MPAS) were in the small to moderate range. The smallest correlation ($r = 0.29$) was found between T1 MAAS and 8-week MPAS total scores. The highest correlation ($r = 0.78$) was found between T1 and T2 MAAS total scores.

MAAS and MPAS Global Total

Repeated measures ANOVA with Greenhouse-Geisser correction was used to test whether there were changes in bonding between pregnancy and the postnatal period. Comparison of the global total MAAS Z-scores across all three trimesters and MPAS Z-scores indicated no significant change over time, $F(2.15, 781.40) = 0.01$, $p = 0.99$.

Table 1 Sample antenatal demographic and postnatal obstetric characteristics

Antenatal characteristics	*n*	Mean (SD[a])
Mean age (y)	362	32.59 (5.00)
Marital status	*n*	%
Married or de facto (common law)	357	95.97
No partner or not living with partner	15	4.03
Employment status		
Full time	182	48.90
Part time/casual	90	24.20
Unemployed/student/home duties	100	26.90
Gross annual household income[b]		
$\geq$ $124,800	121	47.50
$78,000–124,799	96	37.60
$\leq$ $77,999	38	14.90
Highest level of education completed		
Some high school	27	7.30
High school	52	14.00
Diploma/certificate	45	12.10
Undergraduate/postgraduate university degree	248	66.70
Country of birth		
Australia	219	58.90
Other English speaking country (OESC)	61	16.40
Non-English speaking background (NESB)	92	24.70
Indigenous		
Aboriginal and/or Torres Strait Islander	4	1.10
Non-Aboriginal Torres Strait Islander	368	98.90
Living arrangement		
Renting	173	46.50
Privately own	176	47.30
Staying with friends/family	19	5.10
Other	3	0.80
Pregnancy characteristics		
Pregnancy feelings		
Wanted to become pregnant	302	81.20
Didn't want to become pregnant	14	3.80
Hadn't thought about becoming pregnant	39	10.50
Other	16	4.30
First pregnancy		
Yes	147	39.70
No	223	60.30
Labor		
Problems during labor		
None	147	57.60
One or more	108	42.40
Postnatal characteristics (8 weeks)	*n*	*Mean (SD)*

(*Continued*)

Table 1 (*Continued*)

Antenatal characteristics	*n*	Mean (SD[a])
Baby's birth weight (kg)	370	3.60 (*2.17*)
Gestation at birth (wk)	372	39.34 (*1.77*)
Baby's time crying (min/d)	369	86.34 (*87.15*)
Breast-feeding problems	*n*	%
None	63	24.70
One	145	56.90
Two or more	47	18.40

[a]SD: Standard deviation from the mean.
[b]*n*, = 268 due to a large number of respondents not wishing to report on this variable.
Note: Numbers vary across demographic variables due to missing data on these variables.

Table 2 Descriptive statistics for the MAAS quality and intensity subscales and the global total scale in pregnancy

		n	M	SD	95% CI	
					Lower	Upper
T1	Quality	370	44.25	4.27	43.80	44.68
	Intensity	370	25.87	4.99	25.36	26.38
	Global total	370	74.84	8.10	74.00	75.66
T2	Quality	370	46.11	3.19	45.78	46.43
	Intensity	370	27.64	4.57	27.17	28.11
	Global total	370	78.53	6.75	77.84	79.22
T3[a]	Quality	367	46.75	2.99	46.45	47.06
	Intensity	367	29.12	4.76	28.63	29.61
	Global total	367	80.58	7.03	79.86	81.30

Abbreviations: CI, confidence interval; MAAS, Maternal Antenatal Attachment Scale; SD, standard deviation.
[a]MAAS scores for three women were missing in T3.

Table 3 Descriptive statistics for the MPAS quality, absence of hostility and pleasure in interaction subscales, and the global total scale at 8 weeks postnatal

		n	M	SD	95% CI	
					Lower	Upper
8wk	Quality	372	41.65	3.09	41.34	41.97
	Absence of hostility	372	20.83	3.21	20.50	21.16
	Pleasure in interaction	372	22.72	2.07	22.51	22.93
	Global total	372	85.20	6.59	84.53	85.87

Abbreviations: CI, confidence interval; MPAS, Maternal Postnatal Attachment Scale; SD, standard deviation.

Table 4 Correlation matrix of MAAS global total Z-scores during pregnancy and the MPAS postnatally, $n = 372$

Measure	T1	T2	T3
T1 MAAS global total	–	–	–
T2 MAAS global total	0.78**	–	–
T3 MAAS global total	0.64**	0.76**	–
8w MPAS global total	0.29**	0.30**	0.41**

Abbreviations: MAAS, Maternal Antenatal Attachment Scale; MPAS, Maternal Postnatal Attachment Scale.
*Significant at $p < 0.05$. ** Significant at $p < 0.01$. *** Significant at $p < 0.001$[Q4].

MAAS and MPAS Quality Subscale

To explore whether there was a significant difference in quality of bonding scores through pregnancy and postnatally, Friedman analysis was conducted with the Z-scores. Comparison of the repeated measures on the quality subscale of the MAAS and MPAS Z-scores was not significant, F (2.28, 829.19) = 0.02, $p = 0.99$.

Regression Analysis

Separate multiple regression analyses were conducted using mother-fetal bonding scores in pregnancy (T1, T2, and T3) as the independent variables and postnatal bonding as the dependent variable (►**Table 5**). Demographic and postnatal predictors in the models included age (years), country of birth, employment status, gross household income, number of previous children, baby's birth weight (kg), weeks gestation, problems during labor, breast-feeding problems, and baby's crying time (min/d). Overall, the amount of variance in postnatal bonding explained by all variables in each model ranged from 20% (24% unadjusted) in T1 to 29% (32% unadjusted) in T3. The amount of variance in postnatal bonding explained by antenatal bonding scores independently was 7.1% (7.1% unadjusted) in T1, 8.4% (8.5% unadjusted) in T2, and 15.7% (15.7% unadjusted) in T3.

The multiple regression analyses revealed that antenatal bonding significantly predicted postnatal bonding at all time

Table 5 Regression analyses predicting mother-infant bonding at 8 weeks postnatal, by trimester ($n = 372$)

	Trimester 1			Trimester 2			Trimester 3		
	B	*t*	*p*	B	*t*	*p*	B	*t*	*p*
MAAS									
Antenatal bonding score	0.22	5.87	0.00***	0.33	7.31	0.00***	0.38	9.02	0.00***
Demographic variables									
Age	−0.17	−2.48	0.01**	−0.15	−2.27	0.02*	−0.15	−2.30	0.02*
Country of birth									
Australia (reference)									
OESC	−0.10	−0.11	0.91	−0.51	−0.60	0.55	−0.44	−0.53	0.60
NESB	−1.62	−2.15	0.03*	−2.08	−2.80	0.01**	1.79	−2.51	0.01**
Employment status									
Full-time (reference)									
Part-time	−1.80	−2.12	0.03*	−2.22	−2.70	0.01**	2.06	2.59	0.01**
Other[a]	−2.60	−2.81	0.01**	−2.51	−2.82	0.01**	2.37	−2.73	0.01**
Household income									
≥ $2,400 (reference)									
$1500–$2,400	0.27	0.32	0.75	0.49	0.63	0.53	0.55	0.75	0.45
≤ $1,500	0.15	0.14	0.89	0.26	0.27	0.79	0.34	0.34	0.73
Other children (0 = No, 1 = Yes)	2.46	3.07	0.00***	3.17	4.02	0.00***	2.88	3.78	0.00***
Postnatal variables									
Babies birth weight	−0.16	−1.08	0.28	−0.14	−0.95	0.34	−0.17	−1.24	0.21
Weeks gestation	−0.25	−1.41	0.16	−0.20	−1.15	0.25	−0.20	−1.19	0.24
Problems during labor (0 = No, 1 = Yes)	0.88	1.33	0.18	0.88	1.36	0.18	0.90	1.44	0.15
Breast-feeding problems									
No problems (reference)									
One	−1.02	−1.30	0.20	−0.94	−1.23	0.22	−0.64	−0.87	0.38
Two or more	−2.65	−2.65	0.01**	−2.69	−2.76	0.01**	2.35	−2.50	0.01**
Baby's time crying per day	−0.02	−5.98	0.00***	−0.02	−6.26	0.00***	−0.02	−5.92	0.00***
	$R^2 = 0.24$ ($R^2_{adj} = 0.20$)			$R^2 = 0.28$ ($R^2_{adj} = 0.24$)			$R^2 = 0.32$ ($R^2_{adj} = 0.29$)		
	$F = 7.35$			$F = 9.00$			$F = 11.24$		
	$p = 0.00$			$p = 0.00$			$p = 0.00$		

*Significant at $p < 0.05$. **Significant at $p < 0.01$. ***Significant at $p < 0.001$.[Q5]

[a]*Other* includes home duties, unemployed, student.

points (t [T1] = 5.87, t [T2] = 7.31, and t [T3] = 9.02; $p < 0.001$) including demographic and postnatal predictors. Significant demographic and postnatal variables predicting postnatal bonding, across all trimester time points, include maternal age (t [T1] = − 2.48, $p < 0.01$; t [T2] = − 2.27; and t [T3] = − 2.30, $p < 0.05$), NESB (t [T1] = − 2.15, $p < 0.05$; t [T2] = − 2.80; and t [T3] = − 2.51; $p < 0.01$), employment status part time compared with full time (t [T1] = − 2.12, $p < 0.05$; t [T2] = − 2.70; and t [T3] = − 2.59, $p < 0.01$), employment status "home duties," unemployed or student compared with full time (t [T1] = − 2.81, t [T2] = − 2.82, and t [T3] = − 2.73; $p < 0.01$), other children (t [T1] = 3.07, t [T2] = 4.02; and t [T3] = 3.78; $p < 0.001$), two or more breast-feeding problems (t [T1] = − 2.65, t [T2] = − 2.76, and t [T3] = − 2.50; $p < 0.01$), and baby's time crying per day (t [T1] = − 5.98, t [T2] = − 6.26, and t [T3] = − 5.92; $p < 0.001$).

Discussion

Bonding through Pregnancy and Postnatally

This study addresses gaps in the present bonding literature by documenting the progression of the mother-fetal/infant bond through all trimesters of pregnancy and into the postnatal period, while also considering sociodemographic and postnatal factors. Findings show that mother-fetal bonding increases in quality and intensity across the pregnancy period and is related to a range of psychosocial and sociodemographic factors. Like van Bussel (2010), this study found that the relative increase in overall bonding from the second to the third trimester was not as large as the increase between the first to the second trimester. A possible explanation lies in the motherhood constellation theory.[32] According to Stern, maternal bonding representations emerge in the mother before the birth of the baby and increase in quality and richness from the fourth until the seventh month of pregnancy.[32] During the last 2 months of pregnancy, however, Stern (1995) postulates that mothers "loosen" their more positive representations to avoid a "potential discordance between the real baby and a too specifically represented baby" (page 23). In this sample, an increase in bonding was still evident during this period (albeit nonsignificant), indicating a plateauing of overall bonding representations.

The current findings also extend the work of van Bussel et al (2010) by examining the postnatal mother-infant bond. The results showed that mother-infant bonding remained consistent from pregnancy to postnatal. There was no significant increase in overall bonding strength from pregnancy to 8 weeks postnatally. It appears that bonding to the fetus late in pregnancy is strong and remains so postnatally. Given the long-term effects of problems in the mother-infant relationship[33] and the relative stability of bonding pre- and postnatally, interventions aimed at developing the bond should ideally be initiated during pregnancy through antenatal clinics and services. Encouraging the development of the antenatal bond would have potentially far-reaching effects.

Predictors of Postnatal Bonding

Multiple regression analyses revealed that antenatal bonding significantly predicted postnatal bonding at all time points. Past research has focused on observational and structured interviewing techniques for determining the mother-infant relationship postnatally.[18–22] The postnatal bond is foundational for the development of a secure attachment style[10,12] and protecting against maladaptive mental health into adulthood.[7–9,11] Therefore, because antenatal bonding is critical, antenatal care has an important role to play in identifying key points during pregnancy to promote the maternal-fetal bond. Targeted interventions specifically aimed at enhancing and strengthening the development of the maternal-fetal bond should, where appropriate, be integrated into the current model of care pregnant women receive.

Several demographic variables were also found to predict the postnatal bond. Higher maternal age predicted poorer bonding scores, possibly because older women disrupt established careers or delay pregnancy due to less desire for a maternal role. Previous research has not found a significant relationship between postnatal bonding and maternal age.[19,20,34] Poorer bonding was also associated with being a mother for the first time. Perhaps the company of other children mediates the mother-infant relationship to promote bonding or a care giving disposition associated with enhanced bonding. The presence of other children has received little attention in the bonding literature and could be examined in future research. There is growing research that explores the transition to parenthood for older, first time mothers who are more likely to require assisted reproductive technology due to infertility as well as caesarean sections.[35] These factors could play a role but were beyond the scope of this study.

Being from a non-English speaking family also predicted poorer bonding. No previous studies have examined how country of birth affects postnatal bonding; however, in the antenatal bonding literature ethnicity has been weakly associated with maternal-fetal attachment ($r = 0.11$–0.14).[26] This may well reflect poor access to services rather than cultural issues, and this is an important area for future research. Compared with mothers who were employed full time, mothers who were part time or reported "other" had poorer bonding scores through pregnancy. These findings require replication but suggest that women employed part time or "other" may be at higher risk of reporting low bonding postnatally.

Postnatal factors that predicted the postnatal bond included presence of two or more breast-feeding problems and baby's crying time per day. Specifically, the results indicated that two or more breast-feeding problems predicted poorer bonding postnatally. There are several theoretical mechanisms through which breast-feeding may enhance the maternal bond, but few empirical studies show support for these and the findings are inconclusive.[36] It is plausible that breast-feeding might be related to maternal bonding through oxytocin,[37]; however, this was not considered in the present study. The current work is consistent with the extant literature that has found a positive association between breast-feeding and maternal bonding, indicating that breast-feeding

enhances the bond between a mother and child whereas breast-feeding problems appear to interrupt the bonding process.

The results also indicated that increased crying time in babies predicted poorer bonding at 8 weeks. Although this result makes pragmatic sense, it is difficult to tease out whether crying leads to poor bonding or poor bonding creates distress for the infant—an important matter worthy of further investigation. Baby's crying is the primary reason parents seek health care for their infant child[38] and is particularly stressful for parents as crying can be perceived as a negative reflection on their ability to parent or an indication of infant distress or illness. Further research incorporating postnatal variables in the prediction of the postnatal bond is needed to replicate these findings.

Strengths and Limitations

This study extends previous work on the maternal felt bond to her developing child[16,18–23] by using a larger sample of Australian women than has been used in previous work; documenting the pattern of this bond at three time points in pregnancy and at 8 weeks postnatally; and by examining the extent to which antenatal bonding, demographic, and postnatal variables are critical in the formation of the postnatal bond.

These results should, however, be interpreted in the context of several limitations. First, the subsample represented a somewhat advantaged group of families in NSW, consisting of predominantly Anglo-Saxon Australians, which possibly reduces generalizability to other more diverse populations. Despite this, comparisons with women who gave birth during the same period of time but who had not completed all requisite measures showed similar sociodemographic characteristics, including age, country of birth, education, and employment status. This sample is also similar to the Australian population of women giving birth on a range of demographic factors.

Second, the bonding measures used in the study assessed the mother's felt or perceived bond to her developing child. While these measures have been validated[23,28,29] and the results appear consistent with both theory and past empirical research, confirmation of these patterns using clinical observational tools (e.g., emotional availability scales) is recommended.

Third, the ante- and postnatal measures were not directly comparable, which makes it difficult to assess differences in ante- and postnatal bonding. It should be noted that items on each measure represent a qualitatively different bond. The MAAS represents the felt bond toward the developing fetus, whereas the MPAS represents the felt bond toward the infant. Doubt might therefore be raised about the validity of a direct comparison between ante- and postnatal bondings. Condon's ante- (MAAS) and postnatal (MPAS) measures differ in their composition. While the scales were converted to Z-scores for comparison over time, it may be the case that methodologic differences in the measurement items meant that differences in bonding, if they did exist, were not able to be detected. Nevertheless, in regression analysis, assessments of antenatal bonding in each trimester accounted for significant variance in postnatal bonding. Despite some limitations, the strength of this study lies in its longitudinal nature that allowed for the examination of maternal-fetal/infant bonding at several time points, taking into account several other important sociodemographic and postnatal confounders. Last, demographic variables were collected prenatally for the present study. Postnatal demographic variables were not considered in the analysis.

Conclusion

This study contributes to the body of research on maternal bonding by showing that mother-fetal bonding strengthens in quality and intensity across the course of pregnancy. The mother-infant bond, which in this sample was strong in pregnancy, showed consistency from pregnancy through to infant age 8 weeks. Importantly, results from this study show antenatal bonding in trimester's 1 through 3 predicted bonding to the infant at 8 weeks post-birth. Additionally, results indicate that older maternal age, birth mother being born in a non-English speaking country, mother not working full time, being a first-time mother, breast-feeding problems, and baby's crying all predicted poorer bonding at 8 weeks postnatal. It is recommended that future research include other factors likely to influence bonding, for example, maternal well-being and partner bonding, the latter of which has only recently been investigated.[39] This study results have important implications for pregnant women and their unborn children, as well as for health care professionals working in ante- and postnatal services. Additional care may be beneficial for older and first-time mothers, and mothers who were born overseas, who are not working full time, and/or who have infants with feeding problems and crying, to enhance their bonding and the health outcomes for the infant.

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