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Original Research Article

The association of mother-infant attachment with cognitive development in infancy using the Bayley scale of infant development: a cross-sectional study

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ABSTRACT

Background: Maternal attachment is deep-rooted in humans and primates. Both are designed to protect and preserve the species through nurturing behaviors. Early childhood attachment is foundational to an individual's adult attachment style, affecting parenting and social relationships across generations. Thus, mother–infant attachment is fundamental to optimal child development and future outcomes.
Methods: This was a cross-sectional study conducted at the Pediatric Outpatient Department, Bharati Vidyapeeth Medical College Hospital & Research Centre, Pune, from April 2022 to September 2022. A total of 34 mother–infant dyads with children aged 1±3 months were included in the study. Dr. Bhakoo's Mother–Infant Attachment Scale was used to evaluate attachment between mothers and children. The higher the score, the greater the mother–infant attachment.
Results: Working mothers (p=0.027), separation from the mother (p=0.022) and socioeconomic status (p=0.042) significantly affected mother–infant attachment. Mother–infant attachment was not significantly associated with cognitive development in infancy (p=0.80). Studies with larger samples may be required to explore further associations.
Conclusions: We found no significant correlation between mother–infant attachment and cognitive development. The results provided further evidence that studies with larger samples are required to determine the impact of attachment and overall development.

Keywords: Association, Bayley scale, Cognitive development, Mother infant attachment

INTRODUCTION

Infancy is crucial to a person's development, establishing the neurological foundation of affective, psychological and relational functioning. Attachment and developmental theories contribute to a greater knowledge and understanding of early childhood relationships' importance and the impact of interactional disruption on children's development.

Mother–infant attachment

Maternal attachment is the development of reciprocal relationships between mother and infant. This aspect of the relationship between parent and child has the exclusive function of making the child feel secure and protected.[1] Rubin et al introduced the concept of mother–infant attachment and Klaus and Kennell popularized it. Klaus and Kennell also developed a concept they called

"bonding," and stated that attachment was not the same as bonding.[2] Bowlby et al described attachment theory as "dealing with the affectional bonds between individuals, their origins in childhood, affecting adolescent relationships and the distress caused by involuntary severance or dissolution of such bonds or by their faulty development".[3]

Bowlby et al speculated that an individual's early experiences with their primary caregiver would eventually lead to the configuration of an internal working model, which determined their attachment, caregiver expectations and the development of their self-perception.[3] Once formed, this model appeared to be stable, having an important and persistent impact on all of an individual's developmental aspects in later life.[2]

Attachment develops through three phases: the "pre-attachment phase," "attachment-in-the-making," and "clear-cut attachment." Integration of dopamine and oxytocin in the brain striatum sustains maternal bond formation. During bond formation, dopamine and oxytocin systems enable neuroplasticity of the brain reward system and reorganization of neural networks.[4] Some mothers may experience turmoil in forming emotional connections with their children. Studies have reported impaired maternal–infant attachment in 6–41% of mother–child dyads.[5] Therefore, it is vital to determine factors affecting maternal–infant attachment, including maternal, child and environmental factors.

Aim and objectives

This study aimed to investigate the association of mother–infant attachment with cognitive development in infancy. Assessed mother–infant attachment using the mother–infant attachment Scale. Next, we analyzed infants' cognitive developmental outcomes using the bayley scale of infant and toddler development, version four (BSID-4). Finally, we evaluated the association of mother–infant attachment and cognitive development in infants.

METHODS

Design, duration and population

This was a cross-sectional study conducted at the Pediatric Subspeciality Outpatient Department, Bharati Hospital, Bharati Vidyapeeth deemed to be University Medical College and hospital, Pune. The study was six months long (April to September 2022) and included a total of 34 mother–child dyads. Assuming a moderate correlation (r=0.4) with 95% confidence interval and ±0.2 precision, the requisite sample size was 32. Of note, the Institutional Ethical Committee (BVDUMC/IEC/46) approved the study.

Inclusion criteria consisted of mother–infant dyads with children aged 12±3 months, who were recruited through convenience sampling. Mothers with chronic physical or mental health illnesses were excluded. Children with chronic health conditions or developmental disorders or with perinatal issues requiring a level II/III neonatal intensive care unit (NICU) stay were also excluded. Finally, parents who did not consent to the study were excluded.

Procedures and scales

We recruited all consenting mother–child dyads who presented to the hospital within the study period with their children aged 12±3 months who met the inclusion criteria. We took detailed histories of each child's age, sex and birth history (including gestational age, birth weight and need for NICU stay). Maternal history included age, education, gravida, family support, separation of mother and baby, type of feeding given and caregiver support.

Bhakoo et al's mother–infant attachment scale was used to investigate the attachment between young infants and their mothers.[6] Responses to each statement are rated on a five-point scale ranging from "strongly agree," "agree," "do not know," "disagree," to "strongly disagree." A score of five is assigned to the most favorable response and a one is assigned to the most unfavorable. Eight items, 2, 4, 7, 8, 10, 13, 14 and 15 are positive statements and seven items, 1, 3, 5, 6, 9, 11, 12 are negative statements. The Mother–Infant Attachment Scale is scored by summing up individual items for the total score. Notably, items 1, 3, 6, 9, 11 and 12 are reverse scored. The higher the score, the greater the mother–infant attachment.[6] The split-half reliability of the test was 0.83, with high internal consistency and high face and construct validity.[7]

The BSID-4, which was published in 2019, was used to evaluate early childhood cognitive development. Nancy Bayley published the first BSID in 1969 and the updated BSID-4 is an elaborate, domain-wise, formalistic developmental assessment tool for diagnosing developmental delays in early childhood. The test takes about 30–70 minutes to complete.8 The target group is children aged from 16 days to 42 months. Reliability is r=0.95 for normative samples and r=0.99 for special group samples. The test-retest reliability for the cognitive scale for all ages is r=0.78 (corrected r=0.82, standard difference=0.27). Standard errors of measurement of the normative sample are 0.69. The BSID-4 has 81 items on the cognitive scale. In the present study, we used only the cognitive scale and calculated the total scores. Figure 1 exhibits a study flowchart.

Statistical analysis

The data were entered in Microsoft Excel 2021 for further analysis. Descriptive analysis of demographic features like age, sex, term and socioeconomic status was conducted using the Modified Kuppuswamy Scale, 2020 edition. Continuous variables were assessed using descriptive statistics. Categorical variables were given as

frequency and percentage. Graphs were added where necessary.

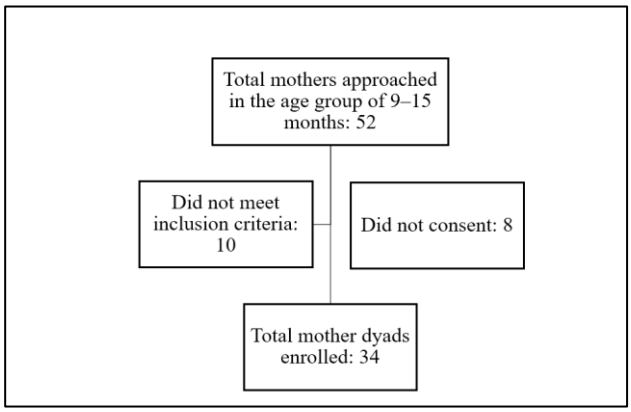

Figure 1: Study flowchart.

Statistical analysis was conducted using descriptive and inferential statistics. Authors used Pearson's correlation coefficient and regression analysis. The software used for the analysis was SPSS Version 27 and GraphPad Prism Version 7. We used a significance level of $p<0.05$.

RESULTS

Infant factors

Of the 34 children enrolled, 16 males (47.1%) and 18 females (52.9%), ranging from 9 to 15 months. Their mean ages ranged from 9.17 to 15.17 months (11.67±2.02) and 24 children (70%) were aged between 9 and 12 months. Their mean birth weight was 2.87±0.50 kg (1.80–4 kg), with 10 (29.4%) of low birth weight. Out of the total children enrolled, 31 (91%) were term infants and the rest were late preterm children. Only 44% were delivered vaginally. About 20% of children required admission to level I NICU for hyperbilirubinemia, which inevitably separated the mother–child dyad and may have caused stress to the mother and family.

Maternal factors

The age range of the mothers was 21–35 years, without two-thirds (70%) aged 26–30 years. 74% of mothers held bachelor's degrees and 15% had an education of high school certificate or less. A total of 76.5% of mothers did not work outside of the home. The remaining mothers worked outside the home, leading to some separation from their children during the workweek. Notably, separation from the mother was a significant factor affecting mother–infant attachment in our study ($p=0.022$). About 12% of the mothers had undergone in vitro fertilization conception and 18% had experienced a high-risk pregnancy. Of the children enrolled, 59% had been breastfed. Mothers were the primary caregiver of 82% of the children. The rest had multiple caregivers.

Socioeconomic factors

Socioeconomic status was found to be a significant factor affecting mother–infant attachment ($p=0.042$). Around 53% of mothers came from families with upper-middle-class socioeconomic status and the rest came from lower-middle-class families. Table 1 exhibits participants' basic demographic details and factors affecting mother–infant attachment scores and multiple regression.

Table 1: Basic demographic details and factors affecting the mother–infant attachment scale score and multiple regression.

Model		Unstandardized coefficients		Standardized coefficients	t	P value
		B	Std. error	Beta		
Regression	MIA*	110.404	21.799	-	-	-
	Gender	3.165	2.195	0.355	1.442	0.171, NS†
	Term	-19.359	11.554	-1.235	1.676	0.116, NS
	Birth weight	2.519	2.349	0.280	1.072	0.302, NS
	Type of delivery	$6.334E^{-5}$	3.164	0.000	0.000	1.000, NS
	NICU** admission	0.476	5.245	0.043	0.091	0.929, NS
	Mother's age	-0.564	0.473	-0.385	1.194	0.252, NS
	Mother working/not working	23.630	9.563	2.255	2.471	0.027, S††
	Separation from mother	-25.972	10.065	-2.793	2.580	0.022, S
	Type of family	-2.394	1.972	-0.299	1.214	0.245, NS
	Consanguinity	-1.510	2.753	-0.130	0.548	0.592, NS
	Birth order	3.270	3.051	0.325	1.072	0.302, NS
	Conception	-7.818	8.190	-0.567	0.955	0.356, NS
	Pregnancy risk	9.605	5.082	0.824	1.890	0.080, NS
	Breastfeed initiation	2.260	2.723	0.460	0.830	0.420, NS
	Feeding type	-1.990	1.238	-0.441	1.607	0.130, NS
	Caregiver	0.668	3.469	0.057	0.193	0.850, NS
	Socioeconomic status	-5.820	2.603	-0.654	2.235	0.042, S

Continued.

Model		Unstandardized coefficients		Standardized coefficients	t	P value
		B	Std. error	Beta		
	Mother's education	0.516	1.877	0.085	0.275	0.787, NS
	Age in months	-1.088	0.687	-0.488	1.583	0.136, NS

*MIA: Mother–Infant Attachment; **NICU: Neonatal Intensive Care Unit; †NS: not significant; ††S: significant

Table 2: Distribution of infants according to the mother–infant attachment scale scores.

MIA* score	No. of infants	(%)
15–30	0	0
31–45	0	0
46–60	16	47.06
61–75	18	52.94
Total	34	100
Mean±SD**	61.20±4.51(52–72)	

*MIA: Mother–Infant Attachment; **SD: standard deviation

Table 3: Distribution of children according to the BSID-4.

BSID-4 score	Score range	No. of infants	(%)
Extremely low	≤69	0	0.00
Borderline	70–79	5	14.71
Low average	80–89	8	23.53
Average	90–109	18	52.94
High average	110–119	3	8.82
Superior	120–129	0	0.00
Very superior	≥130	0	0.00
Total		34	100
Mean±SD*	91.61±11.78 (70–115)		

*SD: standard deviation.

Table 4: Correlation between the mother–infant attachment scale scores and BSID-4 scores using Pearson's correlation coefficient.

	Mean	Std. deviation	N	r	P value
MIA* score	61.20	4.51	34	-0.043	0.80, NS**
Standard score for cognitive development on BSID-4	91.61	11.78	34		

*MIA: Mother–Infant Attachment; **NS: not significant.

The mean attachment score for infants enrolled in the study was 61.20±4.51 (52–72), as exhibited in Table 2. The mean score of cognitive development by BSID-4 was 91.61±11.78 (70–115), as demonstrated in table 3. About 52.94% of infants had an average score, 8.82% had high average scores, 23.53% had low average scores and 14.71% had borderline scores. Finally, Authors found no significant correlation between mother–infant attachment scores and cognitive development (p=0.8), as displayed in Table 4.

DISCUSSION

Winnicott et al stated, "Mother exists and continues to exist in all ways possible. She loves in a way which provides contact, body warmth, movement and peace, according to the baby's needs".[9] According to Bowlby et al a satisfactory mother–infant relationship serves as a secure base for infants to explore the world confidently. It plays a consistent role in cognitive development.[10] Shieh et al identified three major cognitive, emotional and altruistic aspects in maternal-fetal attachment: the tendency to know the baby, enjoyment from interacting with the baby and the tendency to care for the baby, respectively.[11] Herein, we attempted to find an association between mother–infant attachment and cognitive development in early childhood. Notably, three infants (9%) in the study were born late preterm and 20% underwent a level I NICU stay. Sahar et al found that negative attachment was associated with postnatal women with premature infants (68.4%) or with babies receiving NICU care (51%).[12] Mothers of infants requiring intensive care initiate their parenthood experience in unexpected and unfamiliar ways, resulting in delayed or disrupted maternal attachment. Feldmann et al found that early separation of the mother–child dyad

during long stays in the neonatal care unit strains the relationship. Additionally, because parents are not in close proximity with their newborns, early bonding and attachment may be hampered.[13] Bhakoo et al found that long mother–infant dyad separation reduced attachment. A longer period of separation leads to a decline in the mother's expectations for the child due to the mother's suspicion about the child's normal development.[6] In our study, separation from the mother significantly negatively affected mother–infant attachment ($p<0.05$). According to Farah et al complications from separation of the mother and child or lack of care include failure to thrive, separation anxiety disorder, psychosocial dwarfism, borderline intellectual functioning, educational problems, avoidant personality disorder and criminality.[11] Determining the factors associated with attachment empowers healthcare providers to identify mothers who are experiencing difficulties in bonding and require individualized attention during the immediate and later postpartum period.[14]

In the study, about 23.5% participants were working mothers. This substantially increased the mother–child dyad's physical separation, leaving the child dependent on multiple caregivers. However, when parents are involved in childcare and communicate openly with the child, this helps the children gain confidence and satisfaction.[13] The role of the caregiver is important because children need a secure support system when their mother is not the primary caretaker. In terms of social and family support, 47.1% of mothers in the study enjoyed family support. Concerning sociodemographic characteristics, Sahar et al revealed that positive attachment was encountered more among educated (50.7%) and employed (52.7%) mothers, mothers living in urban areas (53%) and mothers having a support system (61.1%).12 Of the mothers enrolled in our study, 74% held graduate degrees, 77% (26) did not work outside the home and 50% received family support. Mickelson et al, also reported that mother–infant attachment was associated with sociodemographic factors like age, income and race.[15]

In the study, 88% of mothers experienced spontaneous conception and 12% achieved pregnancy through in vitro fertilization. Six mothers experienced a high-risk pregnancy. It is important to consider these mothers' mental health during and after pregnancy. Alhusen et al also found an association between depressive symptoms in pregnancy and lower mother–infant attachment.[16] In the study, only 44% of mothers experienced normal labor; the rest underwent a caesarean section. Breastfeeding was initiated in 80% mothers on day one of birth; 20% failed to latch their babies for various reasons. Only 60% continued breastfeeding exclusively until six months of age; the rest provided mixed feeding. Sahar et al found that 66% of postnatal women experienced positive attachment. They were more likely to have boy infants (63.5%) or to be breastfeeding (61.4%). Meanwhile, mothers with negative attachment had girls (51%) or bottle-fed infants (50%). Thus, they found a statistically significant relationship among gender, maturity, feeding pattern and type of care received ($p<0.01$).[12] When we correlated the factors that may affect mother–infant attachment in the study, we found that socioeconomic status, mother's working status and separation were significantly associated with mother–infant attachment.

Concerning the connection between mother–infant attachment and cognitive development, our data revealed no significant correlation between the two ($p=0.8$). However, Ding et al found that mother–infant attachment had a substantial impact on cognitive and overall general development in China.[17] Thus, there is a need for further longitudinal studies to study potential associations between maternal-fetal attachment and cognitive development. The results of such studies will help develop measures to avoid cases of poor mother–infant attachment.

Limitations

The study was limited by a modest sample size and a low-risk, normative sample. We did not investigate or analyze the possibility of confounding factors such as infant temperament, maternal mental health and postpartum depression on children's development, which might decrease the reliability of the conclusions. A longitudinal follow-up study should be conducted to examine these factors' effects on children's cognitive and overall development.

CONCLUSION

Authors conducted an initial cross-sectional study in India to evaluate the relationship between early mother–infant attachment and children's cognitive development. Of the factors we studied, working mothers, socioeconomic status and mother–infant separation were significantly associated with mother–infant attachment. We found no significant correlation between mother–infant attachment and cognitive development. The results have provided further evidence that more studies are required to determine the impact of attachment and overall development.

A longitudinal follow-up study with an older child cohort will help discover further associations so that necessary interventions can be conducted for improving developmental outcomes. Further studies could explore a wide range of developmental outcomes associated with mother–infant attachment. Early identification of factors associated with suboptimal developmental outcomes may improve early intervention. Future research should also evaluate children's development across a wider age range.

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