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Maternal Sensitivity and Its Association with Cognitive and Socio-Emotional Development in Infants in Indonesia: A Cross-Sectional Study

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ABSTRACT

Background: The first six months of life represent a critical period for brain development, emotional regulation, and early caregiver–infant bonding. Maternal sensitivity plays an important role in supporting early cognitive and socio-emotional development. However, empirical evidence from Southeast Asian populations, particularly Indonesia, remains limited. **Objective:** This study aimed to examine the association between maternal sensitivity and cognitive and socio-emotional development among infants aged 0 to 6 months in Bandung, Indonesia. **Methods:** A cross-sectional study was conducted involving 120 mother–infant dyads recruited through consecutive sampling from urban and semi-urban maternal and child healthcare centers in Bandung, Indonesia. Maternal sensitivity was assessed through structured observation using the Maternal Behavior Q-Sort (MBQS) Short Version. Infant development was measured using the Ages and Stages Questionnaire, Third Edition (ASQ-3), focusing on the communication and personal-social domains. Data were analyzed using descriptive statistics, Pearson’s correlation, multiple linear regression, and path analysis. **Results:** Maternal sensitivity was positively associated with infant cognitive development ($r = 0.42$, $p = 0.001$) and socio-emotional development ($r = 0.38$, $p = 0.002$). After adjusting for maternal education, infant age, and parity, maternal sensitivity remained significantly associated with both developmental outcomes. Path analysis showed direct associations between maternal sensitivity and infant cognitive and socio-emotional development, with good model fit ($\chi^2 = 2.45$, RMSEA = 0.041, CFI = 0.981, TLI = 0.965). **Conclusion:** Maternal sensitivity was associated with better cognitive and socio-emotional development among infants in the first six months of life. These findings contribute evidence from Indonesia to the international literature on early child development and highlight the importance of culturally responsive pediatric nursing interventions. Because of the cross-sectional design, causal conclusions cannot be drawn. Longitudinal and intervention studies are needed to confirm these associations and evaluate strategies to strengthen responsive caregiving in maternal and child healthcare services.

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1. INTRODUCTION

The first six-months of life represents a pivotal stage in infant development, marked by rapid neurological growth and the emergence of fundamental emotional capacities. Experiences during this sensitive period significantly influence an individual's long-term cognitive, behavioral, and emotional trajectory (Shonkoff et al., 2021). One of the most influential factors during this developmental window is the quality of caregiving, particularly the mother's responsiveness to her infant's needs commonly referred to as maternal sensitivity. This form of caregiving is crucial in shaping both the neurological and psychological foundations of a child.

Despite its recognized importance, maternal sensitivity is not routinely assessed in maternal and child healthcare services, particularly during the first six months after birth. In many low- and middle-income countries, including Indonesia, postnatal services primarily emphasize infant growth monitoring, nutrition, and immunization, while structured assessment of caregiver responsiveness receives relatively little attention. Consequently, opportunities for early identification of suboptimal caregiver–infant interactions and timely supportive interventions may be missed. Strengthening evidence regarding maternal sensitivity during early infancy is therefore essential for informing pediatric nursing practice and promoting responsive caregiving as part of comprehensive early childhood development programs.

Maternal sensitivity is broadly described as a caregiver's capacity to detect, interpret, and respond appropriately and promptly to an infant's cues (Ainsworth et al., 2015). This attunement encompasses more than emotional warmth, it involves behavioral responsiveness and adaptability, fostering the development of secure attachment. Such early relational experiences are vital in nurturing a child's emotional stability, social engagement, and ability to regulate affect (Dawson, 2022). Furthermore, sensitivity is not a fixed trait; it is dynamic and evolves in response to a child's changing developmental needs (Goodman et al., 2021). Sensitive mothers often encourage exploration and learning, which in turn enhances cognitive stimulation and supports key processes such as attention, memory, and problem-solving (Bernier et al., 2010; Riva Crugnola et al., 2021). These early experiences are foundational for later academic achievement and executive functioning (Olson et al., 2021; Tacana et al., 2024).

Research in developmental neuroscience also supports the significance of maternal sensitivity. Infants who receive responsive care tend to show healthier physiological stress regulation, such as lower cortisol reactivity, and more adaptive development of brain regions responsible for emotional and cognitive control, specifically the amygdala and prefrontal cortex (Feldman, 2015; Hostinar et al., 2013). Given its wide-ranging impact, enhancing maternal sensitivity through early interventions can be an effective and low-cost strategy for improving developmental outcomes. Nurse-led programs and early parenting support initiatives have demonstrated positive effects, particularly when integrated into maternal and child health services (Jeong et al., 2023; Juffer et al., 2023).

Cognitive and socio-emotional domains during infancy are deeply intertwined. Cognitive functions such as attention regulation, information processing, and early language perception develop in tandem with socio-emotional skills like emotion expression, affect modulation, and social responsiveness. These processes are heavily influenced by caregiver-infant interactions (Deans, 2020; Feldman, 2015). Infants whose mothers exhibit higher levels of sensitivity are often

more socially engaged and demonstrate stronger problem-solving abilities, with lower risks of behavioral difficulties as they grow (Dawson, 2022; Raby et al., 2015).

Nevertheless, a considerable portion of the current evidence comes from longitudinal studies conducted in Western, industrialized nations, where parenting norms and support structures differ significantly from those in many parts of the world (Bornstein et al., 2015; Riva Crugnola et al., 2021). Limited attention has been given to the early months of infancy and to cultural contexts such as Southeast Asia, where caregiving practices may differ in both form and meaning. Additionally, cross-sectional studies focusing on infants aged 0–6 months remain scarce, despite this being a period when attachment relationships and neural pathways are rapidly forming. In response to these gaps, this study investigates the association between maternal sensitivity and both cognitive and socio-emotional development in infants during their first six months of life. Utilizing a cross-sectional design, the findings are expected to provide evidence to guide pediatric nursing practice, including screening, anticipatory guidance, and culturally sensitive parenting support interventions tailored to early infancy.

Although maternal sensitivity has been consistently associated with positive developmental outcomes across diverse populations, caregiving behaviors are also shaped by cultural values, family structures, and community expectations. In Southeast Asian societies, caregiving commonly involves extended family members and reflects collectivist cultural values that emphasize interdependence, close family relationships, and shared caregiving responsibilities. These characteristics may influence how maternal sensitivity is expressed and how infants experience responsive caregiving, highlighting the importance of examining these relationships within local cultural contexts rather than assuming direct generalizability from Western populations.

Furthermore, understanding maternal sensitivity during the first six months of life is particularly important because this developmental period represents the earliest opportunity for preventive intervention before developmental delays become clinically apparent. Evidence generated during this stage may support earlier identification of at-risk mother–infant dyads and facilitate timely implementation of family-centered pediatric nursing interventions.

Although numerous studies have demonstrated positive associations between maternal sensitivity and child development, most evidence has been generated from longitudinal studies conducted in high-income Western countries and has primarily focused on older infants and toddlers. Evidence involving infants during the first six months of life remains limited, particularly in Southeast Asia, where caregiving practices, family structures, and healthcare delivery differ substantially from Western settings. To our knowledge, few studies have simultaneously examined maternal sensitivity in relation to both cognitive and socio-emotional development among young infants in Indonesia using observational assessment methods. Therefore, this study aimed to examine the associations between maternal sensitivity and infant cognitive and socio-emotional development among infants aged 0–6 months in Bandung, Indonesia. By providing evidence from an underrepresented cultural setting, this study contributes to the international literature on early child development and offers evidence to support culturally responsive pediatric nursing assessment, early developmental screening, and family-centered interventions within maternal and child healthcare services.

2. METHODS

Study Design

This research applied a cross-sectional design to examine how maternal sensitivity relates to infants' cognitive and socio-emotional development during their first six months of life. The cross-sectional approach was appropriate for capturing a single-time-point view of both caregiving behavior and developmental outcomes, without implementing experimental manipulation.

Although the study employed a cross-sectional design, path analysis was used to examine the hypothesized relationships among variables based on established theoretical and empirical evidence rather than to infer causality. Path analysis is appropriate for evaluating complex direct and indirect associations among observed variables within a conceptual framework and has been widely applied in observational health research. Therefore, the findings should be interpreted as evidence of associations rather than causal pathways.

Participants

The study took place in several maternal and child healthcare centers across both urban and semi-urban districts of Bandung, West Java, Indonesia. These centers cater to postpartum mothers attending regular check-ups and infant monitoring sessions. Participants were mother-infant pairs who met the eligibility criteria: mothers aged 18 years or older, infants between 0 and 6 months of age, born at term (≥ 37 weeks of gestation), and under the primary care of their mothers. Dyads were excluded if the infant had congenital or neurological abnormalities or if the mother had a documented serious psychiatric disorder.

Sample size estimation was performed using G*Power 3.1 software. Assuming a medium correlation effect size ($r = 0.30$), with a 5% level of significance and 80% power, a minimum of 84 participants was required. To account for possible non-responses or incomplete data, the final sample was expanded by roughly 30%, resulting in a total of 120 dyads. A consecutive sampling strategy was used to recruit participants from the clinic attendees. Consecutive sampling was selected because it allows recruitment of all eligible mother–infant dyads attending the participating healthcare centers during the study period, thereby minimizing selection bias under routine clinical conditions.

Instruments

Maternal sensitivity was measured using the Maternal Behavior Q-Sort (MBQS) – Short Version. This observational tool captures core aspects of sensitive caregiving, including the mother's attunement to, interpretation of, and responses to her infant's cues. The MBQS short version contains 25 behavioral descriptors observed during a semi-structured interaction between the mother and infant. Observers, trained in the Q-sort methodology, distributed these items across five categories according to how closely they matched a theoretically sensitive caregiving profile. Scoring involved correlating each participant's distribution with a criterion sort, producing scores ranging from -1.00 to +1.00. Higher scores indicate greater sensitivity. The MBQS has shown reliable performance across diverse cultures, including in low-resource contexts. In Indonesia, it has been culturally adapted and tested for feasibility, with inter-rater reliability exceeding 0.80 when administered by trained coders. Prior to implementation, the MBQS Short Version

underwent a standardized cultural adaptation process following internationally accepted guidelines. The instrument was independently translated into Bahasa Indonesia by two bilingual experts, synthesized into a single version, and back-translated into English by an independent translator. An expert panel consisting of pediatric nursing lecturers, developmental psychologists, and child health specialists reviewed semantic, conceptual, and cultural equivalence. A pilot study involving 20 mother–infant dyads was subsequently conducted to evaluate clarity, feasibility, and cultural appropriateness. Minor wording adjustments were made without altering the conceptual meaning of the original instrument.

Infant developmental milestones were evaluated using the Ages and Stages Questionnaire, Third Edition (ASQ-3). This caregiver-completed screening tool assesses development across five domains; however, the current study focused on communication (cognitive proxy) and personal-social (socio-emotional proxy). Each ASQ-3 age-specific form comprises 30 questions covering five areas, with six items per domain. Caregivers mark responses as “Yes,” “Sometimes,” or “Not Yet,” which are scored as 10, 5, and 0 respectively. Total domain scores are compared with age-specific cutoffs to flag potential developmental concerns. The ASQ-3 has undergone cultural translation and validation in Bahasa Indonesia, showing strong internal consistency (Cronbach’s $\alpha > 0.80$), high test-retest reliability, and appropriate content validity for community and clinical use. The Indonesian version of the ASQ-3 had previously undergone linguistic translation, cultural adaptation, and psychometric evaluation. The instrument demonstrated satisfactory content validity and internal consistency, supporting its suitability for developmental screening among Indonesian infants.

Additional data on maternal and infant characteristics such as maternal age, level of education, employment status, number of children, as well as infant gender, birth weight, and feeding practices were obtained through a structured demographic form.

Data Collection Procedure

Following ethics approval from the STIKep PPNI Jawa Barat Institutional Review Board (No. 089/KEPK/STIKep/PPNI/Jabar/IV/2024), data collection was conducted between May and July 2024. Potential participants were informed about the study during their scheduled clinic visits. Written consent was obtained from all mothers who agreed to participate. Each dyad was observed for a 20-minute structured interaction, during which maternal behavior was assessed. Afterward, mothers completed the ASQ-3 and demographic questionnaire, assisted by research personnel. Observer fidelity in MBQS scoring was maintained above 85% through regular calibration sessions.

Data Analysis

Quantitative data analysis began with descriptive statistics including means, standard deviations, and frequency distributions to summarize participant characteristics. Pearson’s correlation test examined pairwise associations between maternal sensitivity and developmental scores. To adjust for potential confounding variables such as maternal education, infant age, and parity, multiple linear regression models were applied. Path analysis was also conducted to assess direct and indirect pathways between maternal sensitivity, demographic predictors, and infant

developmental outcomes. Theoretical frameworks and empirical evidence guided model construction. Model fit was evaluated using standard indices, including chi-square, RMSEA, CFI, and TLI. All statistical analyses were conducted using SPSS version 26, while path analysis was executed in AMOS version 24.

3. RESULTS

A total of 120 mother-infant dyads were included in the analysis. The average maternal age was 28.6 years ($SD = 5.2$), and infant age averaged 3.2 months ($SD = 1.5$). Half of the mothers (50.0%) had completed higher education (college or above). The sample comprised slightly more male infants (54.2%) than females (45.8%). Most participants were primiparous (58.3%), while 41.7% had more than one child. Detailed demographic data are presented in Table 1.

Table 1. Demographic characteristics

Variable	n	%
Maternal Age (years), Mean (SD)	28.6 (5.2)	
Maternal Education		
High school or less	60	50.0%
College or higher	60	50.0%
Infant Age (months), Mean (SD)	3.2 (1.5)	
Infant Gender		
Male	65	54.2%
Female	55	45.8%
Parity		
Primiparous	70	58.3%
Multiparous	50	41.7%

Pearson's correlation analysis revealed a statistically significant moderate positive association between maternal sensitivity and both cognitive ($r = 0.42$, $p = 0.001$) and socio-emotional development scores ($r = 0.38$, $p = 0.002$) of infants. These findings indicate that higher levels of observed maternal sensitivity were associated with better developmental outcomes. Results are summarized in Table 2.

Table 2. Bivariate correlation analysis

Variables	r	p-value
Maternal Sensitivity vs Cognitive Score	0.42	0.001
Maternal Sensitivity vs Socio-emotional Score	0.38	0.002

To adjust for potential confounders, multiple linear regression models were applied. Maternal sensitivity remained a significant predictor of both cognitive and socio-emotional development after controlling for maternal education, infant age, and parity. Maternal education and infant age also showed significant associations with developmental outcomes, while parity did not. Full regression results are shown in Table 3.

Table 3. potential confounders

Predictor	B	SE	Beta	p-value
Maternal Sensitivity	1.24	0.3	0.41	1
Maternal Education (College+)	0.88	0.34	0.25	15
Infant Age (months)	0.45	0.18	0.19	42
Parity (Multiparous)	-0.32	0.27	-0.1	0.26

Path analysis was conducted to explore direct and indirect pathways between maternal sensitivity, demographic variables, and developmental outcomes. Maternal sensitivity showed strong direct effects on both cognitive ($\beta = 0.39$, $p = 0.001$) and socio-emotional development ($\beta = 0.36$, $p = 0.002$). Maternal education was indirectly associated with developmental outcomes through its positive influence on maternal sensitivity ($\beta = 0.29$, $p = 0.005$). Infant age also had a direct association with cognitive development ($\beta = 0.22$, $p = 0.028$). These paths are detailed in Table 4.

Table 4. Direct and indirect correlation of maternal sensitivity, demographic variables, and developmental outcomes

Path	Standardized Coefficient	p-value
Maternal Sensitivity → Cognitive Development	0.39	0.001
Maternal Sensitivity → Socio-emotional Development	0.36	0.002
Maternal Education → Maternal Sensitivity	0.29	0.005
Infant Age → Cognitive Development	0.22	0.028

Table 5. Model fit indices

Fit Index	Value	Acceptable Threshold	Interpretation
Chi-square (χ^2)	2.450	$p > 0.05$	Good model fit if $p > 0.05$; non-significant chi-square suggests model matches data well.
Root Mean Square Error of Approximation (RMSEA)	0.041	< 0.06	RMSEA < 0.06 indicates a close fit between model and data; lower values reflect better fit.
Comparative Fit Index (CFI)	0.981	> 0.95	CFI > 0.95 indicates excellent fit compared to a null (independence) model.

Fit Index	Value	Acceptable Threshold	Interpretation
Tucker-Lewis Index (TLI)	0.965	> 0.95	TLI > 0.95 reflects a well-fitting model with a penalty for complexity.

The theoretical model demonstrated good fit with the observed data. Fit indices showed a non-significant chi-square value ($\chi^2 = 2.45$, $p > 0.05$), a Root Mean Square Error of Approximation (RMSEA) of 0.041, and high values for both the Comparative Fit Index (CFI = 0.981) and the Tucker-Lewis Index (TLI = 0.965), all of which indicate a well-fitting model. The model fit indices are presented in Table 5.

4. DISCUSSION

This study examined the association between maternal sensitivity and cognitive and socio-emotional development among infants aged 0–6 months in Bandung, Indonesia. The findings demonstrated that higher maternal sensitivity was significantly associated with better developmental outcomes in both domains, even after adjustment for maternal education, infant age, and parity. These results suggest that responsive caregiving is an important developmental factor during early infancy and reinforce the concept that the quality of early caregiver–infant interactions contributes substantially to infant developmental trajectories. Rather than functioning solely as a source of emotional support, maternal sensitivity appears to facilitate the infant's emerging cognitive abilities while simultaneously promoting emotional security and social engagement.

The present findings are consistent with a growing body of international literature demonstrating that sensitive caregiving represents one of the strongest predictors of healthy child development. Dawson (2022) reported that children raised by highly sensitive mothers experienced fewer behavioral and emotional problems, whereas Raby et al. (2015) showed that maternal sensitivity during infancy predicted social competence and academic functioning extending into adulthood. Likewise, systematic reviews by Deans (2020) concluded that interventions designed to enhance maternal sensitivity consistently improve children's cognitive, emotional, and behavioral outcomes. The consistency between the present findings and previous research suggests that the developmental benefits of maternal sensitivity are robust across different populations despite variations in socioeconomic conditions and cultural contexts.

Several mechanisms may explain these relationships. From the perspective of attachment theory, maternal sensitivity enables caregivers to accurately perceive infant signals and respond promptly and appropriately, thereby fostering secure attachment. Securely attached infants develop greater confidence in exploring their environment because caregivers provide both emotional security and a reliable base for exploration. Such interactions encourage infants to engage in increasingly complex social exchanges that stimulate attention, early communication, learning, and problem-solving abilities (Deans, 2020). Consequently, maternal sensitivity contributes simultaneously to cognitive growth and socio-emotional competence rather than influencing these domains independently.

Neuroscientific evidence further supports these findings. Early responsive caregiving influences brain maturation during periods of heightened neuroplasticity, particularly within the first six months of life when neural connections are rapidly forming. Sensitive maternal behavior has been associated with healthier development of the prefrontal cortex, hippocampus, and amygdala, brain regions responsible for executive functioning, emotional regulation, memory, and stress adaptation (Feldman, 2020; Hostinar et al., 2013). Responsive caregiving also moderates activation of the hypothalamic-pituitary-adrenal (HPA) axis, reducing prolonged cortisol exposure that may negatively affect neuronal development. Through these neurobiological pathways, maternal sensitivity provides an environment that optimizes both emotional regulation and cognitive functioning during early infancy.

An important contribution of this study lies in extending evidence on maternal sensitivity to the Indonesian context. Most previous investigations have been conducted in high-income Western countries, where parenting styles, family structures, healthcare systems, and social support differ considerably from those in Southeast Asia. In Indonesia, caregiving often involves extended family members, including grandparents and other relatives, reflecting collectivist cultural values emphasizing shared caregiving responsibilities. Although these cultural characteristics may influence caregiving behaviors, the present findings indicate that maternal sensitivity remains positively associated with infant development. This suggests that the developmental importance of responsive caregiving transcends cultural differences while acknowledging that culturally specific expressions of sensitivity may vary across societies.

The findings also support the global emphasis on the first 1,000 days of life as a critical developmental window. Experiences during this period establish the biological and psychological foundations for later health, learning, and social functioning (Shonkoff et al., 2021). Because maternal sensitivity is modifiable rather than fixed, interventions delivered during early infancy may generate long-lasting developmental benefits. Conversely, maternal stress, inadequate parenting knowledge, postpartum psychological difficulties, and limited family support may compromise maternal responsiveness, increasing the risk of suboptimal developmental outcomes. These observations reinforce the importance of preventive approaches that strengthen caregiver–infant relationships before developmental delays become clinically evident.

From a pediatric nursing perspective, these findings have important implications for maternal and child healthcare services. Assessment of maternal sensitivity could be incorporated into routine postnatal care alongside existing growth monitoring and developmental screening. Pediatric nurses, midwives, and community health workers are well positioned to identify mothers experiencing difficulties in responding to infant cues and to provide early guidance on responsive caregiving. Evidence indicates that parenting education, home-visiting programs, coaching during infant interactions, and video-feedback interventions can effectively improve maternal sensitivity and strengthen parent–infant relationships (Juffer et al., 2023). Integrating these approaches into primary healthcare services may represent a cost-effective strategy to promote optimal early childhood development, particularly in low-resource settings.

This study also contributes to the international literature by providing empirical evidence from an underrepresented Southeast Asian population using observational assessment of maternal sensitivity during the earliest months of life. While previous studies have predominantly focused

on older infants or toddlers, the present study demonstrates that meaningful associations between maternal sensitivity and developmental outcomes are already detectable within the first six months after birth. These findings therefore highlight the importance of initiating developmental promotion efforts immediately after childbirth rather than waiting until developmental problems become apparent during later infancy.

5. CLINICAL IMPLICATIONS

From a clinical standpoint, these findings suggest that early screening and intervention related to maternal sensitivity could be incorporated into maternal and child health services. Healthcare professionals, particularly pediatric nurses and midwives, are well-placed to identify early signs of disengaged caregiving and offer supportive interventions. Programs such as home visits, group education, and video-based feedback sessions have shown promise in improving mother-infant interactions (Deans, 2020; Juffer et al., 2023). In regions with limited access to mental health care, empowering frontline health workers to promote responsive caregiving could be both feasible and impactful.

6. STUDY LIMITATIONS

This study has certain limitations. The use of a cross-sectional design prevents establishing causal relationships. While the tools used were standardized and validated, maternal sensitivity was assessed in a structured setting rather than in natural environments, which may limit the generalizability of findings. Additionally, infant development was measured using maternal reports, which may be subject to reporting bias. Finally, other influential factors such as family income or paternal involvement were not analyzed and could influence the relationships found.

7. CONCLUSION

In summary, this study highlights a meaningful association between maternal sensitivity and early child development outcomes. These findings reinforce the importance of caregiver-infant interactions in the earliest months of life. Prioritizing maternal sensitivity within health policy and early intervention programming may offer a powerful means to improve developmental outcomes and reduce disparities in child health.

8. DECLARATION

Conflict of Interest:

With respect to this article's publishing, the writers affirm that they are not involved in any conflict of interest.

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Sekolah Tinggi Ilmu Keperawatan PPNI Jawa Barat's Institutional Review Board examined and authorised this research (Approval No. 089/KEPK/STIKep/PPNI/Jabar/IV/2024). Before any data was collected, all participants were asked to sign an informed consent form. All participants were guaranteed complete anonymity, and their participation was entirely voluntary.

Availability of Data and Materials:

Any reasonable request may be made to the corresponding author to get the datasets used and/or analysed during the current investigation.

Authors' Contributions:

The study's idea, data collection and analysis, and manuscript draughting were all done by D.S. T.S. oversaw the study team, helped analyse the results, and revised the article. I.A.A. helped with the methodology and statistics, and they also helped with the critical review of the final version. The final manuscript was reviewed and approved by all writers.

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