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Association Between Family Caregivers' Cognitive Bias and Maternal Negative Affect: The Mediating Role of Family Functioning

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Abstract

Background: Postpartum women undergo substantial physiological, psychological, and social changes that may increase their vulnerability to emotional difficulties. As core sources of emotional and practical support, family caregivers play an important role in postpartum adjustment. However, discrepancies between caregivers' perceptions and mothers' experienced emotions may influence family interactions and maternal psychological well-being.

Methods: A cross-sectional dyadic study was conducted between October 2023 and October 2024. A convenience sample of 426 postpartum women – family caregiver pairs was recruited from three tertiary hospitals in Jiangsu Province, China. Maternal and caregiver-reported emotional states were assessed using the Positive and Negative Affect Schedule (PANAS). Caregiver cognitive bias was calculated as the signed difference between maternal self-reported negative affect and caregiver-perceived maternal negative affect. Family functioning was assessed using the Family Adaptability, Partnership, Growth, Affection, and Resolve (APGAR) Index. Generalized linear models were used to identify factors associated with caregiver cognitive bias. Structural equation modeling was performed to explore the statistical associations among caregiver cognitive bias, family functioning, and maternal negative affect.

Results: Significant discrepancies were observed between maternal self-reported emotions and caregivers' perceptions. A total of 426 mother-caregiver pairs were included in the data analysis. There was a significant difference in the perception of maternal emotions between mothers (negative affect: 25.25 ± 7.92 ; positive affect: 29.46 ± 7.65) and family caregivers (negative affect: 22.21 ± 5.94 ; positive affect: 32.60 ± 6.03), with family caregivers generally underestimating maternal negative affect and overestimating maternal positive affect ($p < 0.001$). Multivariable analysis identified seven factors significantly associated with caregiver cognitive bias, including infant care duration, educational level, occupation, personality type, medical payment method, mother-in-law and daughter-in-law relationship, and acute mastitis. Structural equation modeling indicated that caregiver cognitive bias was significantly associated with family functioning, and family functioning was significantly associated with maternal negative affect. The indirect association through family functioning accounted for 28.85% of the total statistical association.

Conclusion: Caregiver cognitive bias between postpartum women and family caregivers are common and are associated with sociodemographic, family relationship, and health-related factors. Family functioning may represent an important factor involved in the association between emotional perception discrepancies and maternal negative affect.

Keywords: family caregivers; postpartum women; negative affect; cognitive bias; family functioning

Introduction

Pregnancy and childbirth represent a critical transitional period in women's lives, characterized by substantial physiological, psychological, and social changes that may increase vulnerability to postpartum emotional disturbances^{[1]-[3]}. Maternal emotional well-being during the postpartum period is closely associated with psychological adjustment, physical recovery, and early mother–infant interactions. Previous studies have demonstrated that postpartum women are particularly susceptible to emotional problems due to hormonal fluctuations, sleep disruption, childcare-related stress, and adaptation to new maternal roles^[4]. Negative emotional states, including anxiety and depression, are common during this period and may adversely affect maternal quality of life, breastfeeding practices, and family relationships^{[5],[6]}. A study encompassing 45 countries across five continents reported a global pooled prevalence of postpartum depression of 26%^[7], while the prevalence in Mainland China stands at 14.8%^[8]. These psychological issues not only compromise maternal physical and mental health but also significantly hinder breastfeeding outcomes and undermine family cohesion^{[9],[10]}. Consequently, the accurate assessment and effective support of maternal emotional states constitute a crucial component of postnatal care^[11].

Family caregivers, as primary providers of postnatal care and pivotal sources of emotional support, play a critical role in regulating maternal psychological well-being^{[12],[13]}. Positive responsiveness from caregivers not only fosters maternal positive affect and enhances their sense of happiness but also actively mobilizes their confidence in navigating various challenges^{[14],[15]}. Conversely, inadequate emotional responsiveness or difficulties in family communication may be associated with increased maternal psychological distress and poorer family adjustment^[16]. However, the effectiveness of family support may depend not only on the availability of support but also on whether caregivers accurately perceive and understand mothers' emotional experiences.

In everyday family interactions, postpartum women's self-reported affect may differ from caregivers' perceptions of maternal affect. In the present study, caregiver cognitive bias refers to the discrepancy between maternal self-reported affect and caregiver-perceived maternal affect. Caregivers may underestimate maternal negative affect when distress is not openly expressed or when fatigue, irritability, withdrawal, and reduced interest are interpreted as normal consequences of childbirth and infant care. Conversely, caregivers may overestimate maternal negative affect when observable physical discomfort or interpersonal tension is interpreted as evidence of more severe emotional distress. Such discrepancies may influence whether appropriate emotional reassurance, practical assistance, or professional support is provided^{[13],[17]}. Although previous research has increasingly examined perinatal mental health literacy, social support, and partner responsiveness, caregiver – mother discrepancies in the perception of maternal affect remain comparatively underexplored.

Family functioning may provide an important interpersonal context for understanding the relationship between caregiver cognitive bias and maternal negative affect^[18]. Consistent with a family-systems perspective, maternal emotional experiences and caregiver responses are embedded within broader patterns of communication, emotional responsiveness, role coordination, problem solving, and mutual support. Inaccurate recognition of maternal emotional needs may impede effective communication and reduce perceived responsiveness, potentially contributing to poorer family functioning. Conversely, families characterized by adaptability, emotional closeness, shared responsibility, and collaborative problem solving may be better able to recognize maternal distress and mobilize appropriate emotional and practical support. Recent evidence ^{[19],[20]}has shown that family relationships, perceived social support, partnership quality, and partner responsiveness are closely associated with maternal psychological adjustment during the perinatal period, while preliminary intervention evidence ^[21]suggests that family-oriented treatment may improve both depressive symptoms and family functioning. On this basis, the present study hypothesized that family functioning would mediate the relationship between caregiver cognitive bias and maternal negative affect.

To date, most research has focused on the risk factors or neurobiological mechanisms of postpartum negative emotions^[22], while studies exploring the

influencing factors of emotional cognitive bias between postpartum women and their family caregivers remain relatively scarce and underdeveloped. Therefore, this study aimed to examine caregiver–mother discrepancies in ratings of maternal affect, identify factors associated with caregiver cognitive bias in perceiving maternal negative affect, and explore the indirect association through family functioning.

Methods

2.1 Study Design and Participants

A cross-sectional survey design was employed in this study, with a convenience sampling method used to recruit pairs of postpartum women and their family caregivers from the postnatal rehabilitation clinics of three Grade A tertiary hospitals in Jiangsu Province, namely the Affiliated Hospital of Jiangnan University, Wuxi People's Hospital Affiliated to Nanjing Medical University, and Wuxi Maternity and Child Health Hospital. All participants provided informed consent prior to enrollment in the study. Participants were included only when meeting all the following inclusion criteria. For postpartum women, the criteria were aged ≥ 20 years, primiparity, singleton full-term delivery, being between 1 and 6 months postpartum, absence of severe physical illness or major psychiatric disorders, and the ability to read, understand, and complete the questionnaires independently. The inclusion criteria for family caregivers were cohabitation with the postpartum woman for more than 1 month while providing daily care, being the woman's spouse, parent-in-law, or biological parent, having adequate communication abilities, and providing informed consent for voluntary participation. For postpartum women, the exclusion criteria were severe physical illness, mother–infant separation lasting more than 1 month, severe pregnancy-related comorbidities or postpartum complications, language, hearing, or visual impairments that prevented questionnaire completion, and a history of psychiatric disorders or cognitive impairment. The exclusion criteria for family caregivers were a history of psychiatric disorders or cognitive impairment, communication difficulties that prevented participation in the study, severe physical illness, and employment as a paid professional caregiver.

2.2 Measures

2.2.1 General Information Questionnaire

A study-specific general information questionnaire was developed based on the relevant literature and clinical experience. The maternal section collected sociodemographic, obstetric, postpartum, health-related, and family-relationship characteristics, including age, body mass index, educational attainment, occupation, household income, medical payment method, pregnancy and delivery characteristics, infant-care duration, sleep status, personality type, acute mastitis, living arrangement, marital relationship, and mother-in-law–daughter and in-law relationship. The family-caregiver section collected sociodemographic characteristics, relationship to the postpartum woman, cohabitation and caregiving characteristics, health behaviors, knowledge of postpartum care, physical health status, and perceptions of maternal negative affect. Clinical information was verified against medical records where available.

2.2.2 Positive and Negative Affect Scale (PANAS)

The PANAS was developed by Watson, Clark, and Tellegen and consists of 20 adjectives assessing positive and negative affect^[23]. It uses a 5-point Likert scale (1 = "never" to 5 = "always") and comprises two dimensions (positive/negative affect) with Cronbach' s alpha coefficients of 0.887 and 0.773, suitable for clinical and research use.

The caregiver cognitive bias score was calculated by subtracting the caregiver-perceived maternal negative-affect score from the maternal self-reported negative-affect score. Positive values indicated caregiver underestimation, whereas negative values indicated caregiver overestimation.

2.2.3 Family APGAR Index

The concept of family care was first proposed by American scholar Smilkstein, referring to the support and care individuals perceive within their family units. This construct reflects family members' overall satisfaction with the family system—higher family care is associated with more proactive coping with life challenges. To quantify individuals' overall satisfaction with their family, the Family APGAR Index was utilized. This concise, user-friendly scale includes five items, each representing a critical dimension of family functioning: Adaptability (the family' s ability to adjust to changes), Partnership (shared decision-making and responsibility among family

members), Growth (support for individual development), Affection (emotional closeness and expression), and Resolve (commitment to addressing family problems). Due to its brevity and psychometric rigor, the Family APGAR Index is widely employed to evaluate family relationship quality and individual family satisfaction in academic research.

2.3.Data Collection Procedure

Data collection strictly adhered to the study protocol, with informed consent obtained from mothers and caregivers prior to enrollment, and background information plus emotional scale data collected by researchers and professionally trained assistants at postpartum rehabilitation clinics. Participants completed the questionnaire independently, and the research instruments included electronic questionnaires (via Questionnaire Star, requiring completion of all items for submission) and paper-based questionnaires (with on-site assistance and cross-verification against medical records), allowing participants to select an appropriate completion mode.

2.4.Statistical analysis

Statistical analysis were performed using SPSS 26.0 software. Non-normal quantitative data were described as median and interquartile range [M (P25, P75)]. Univariate analyses—including independent samples t-tests, analysis of variance (ANOVA), or nonparametric tests—were conducted to explore the effects of potential covariates on maternal negative affect, caregivers' perceived maternal negative affect, and the magnitude of discrepancies between these two constructs. Variables yielding statistical significance ($P < 0.05$) in univariate analyses were incorporated into a generalized linear model (GLM) to identify independent predictors of the cognitive bias in negative affect perception between mothers and caregivers. Mixed linear models were applied to compare intergroup variations in negative affect cognitive bias across different caregiver subgroups (e.g., spouses, mothers-in-law, mothers). Structural equation modeling (SEM) was conducted to examine the relationships among emotional cognitive bias, family functioning, and maternal negative affect. Hierarchical SEM frameworks were constructed stratifying by caregiver type — encompassing husbands, mothers-in-law, and other familial

caregivers—to interrogate intergroup heterogeneities in the underlying mediating mechanisms. The statistical significance level was set at $\alpha = 0.05$ for all analyses.

Results

3.1 Characteristics of Postpartum Women and Family Caregivers

3.1.1 Maternal Sociodemographic and Clinical Characteristics

A total of 438 postpartum woman–caregiver pairs were approached, of whom 426 completed valid paired questionnaires and were included in the analysis, yielding a response rate of 97.26%. (Supplementary Figure 1) Among the postpartum women, 66.7% were aged 20–30 years, 53.5% had a normal BMI, 55.9% cared for their babies 9–16 h/day, and 32.2% held a bachelor's degree. The most common personality type was peaceful (44.8%). Additionally, 52.6% lived with their husbands only, 54.7% had vaginal deliveries, 26.3% had experienced acute mastitis, and 39.0% reported sleep issues. All participants had living mothers-in-law. (Supplementary Figure 2)

3.1.2 Sociodemographic and Clinical Characteristics of Family Caregivers

Among the family caregivers, 41.1% were husbands, 31.2% were mothers-in-law, and 18.5% were the postpartum women's biological mothers. A total of 40.8% were aged 41–60 years, 56.6% had a normal BMI, and 76.1% provided infant care for 1–8 h per day. In addition, 41.1% had completed junior or senior high school education, 42.2% were retired, 40.8% had insufficient knowledge of postpartum care, and 50.0% reported physical discomfort during the caregiving period. (Supplementary Figure 3).

3.2. Caregiver Cognitive Bias in Perceiving Maternal Affect

Postpartum women's self-reported affect scores differed significantly from family caregivers' perceptions of maternal affect. For positive affect, the mean self-reported score of postpartum women was 29.46 ± 7.65 . The mean score perceived by caregivers was 32.60 ± 6.03 . This difference was statistically significant ($t = -9.19$, $P < 0.001$), indicating that caregivers substantially overestimated the positive affect of postpartum women. For negative affect, the mean self-reported score of postpartum

women was 25.25 ± 7.92 . The mean score perceived by caregivers was 22.21 ± 5.94 . Caregivers significantly underestimated the negative affect of postpartum women, with the difference also reaching statistical significance ($t = 7.287$, $P < 0.001$). Furthermore, the range of discrepancies in positive affect between women and their caregivers was -8.00 to 1.00, while the range for negative affect discrepancies was -3.00 to 10.00. Collectively, these results confirm that family caregivers tend to overestimate postpartum women's positive affect and underestimate their negative affect. Detailed data are presented in Table 1.

3.2.1 Univariate Analyses of Factors Associated With Caregiver Cognitive Bias

Univariate analyses identified significant associations between caregiver cognitive-bias scores and hours of infant care, educational level, occupation, personality trait, monthly household income, resident, unplanned pregnancy, medical payment method, fetal gender expectation, satisfaction with fetal gender, marital relationship, mother-in-law and daughter-in-law relationship, consistency of dietary habits with family caregivers, adaptation to postpartum role transition, acute mastitis, sleep status, and knowledge of postpartum care. Additionally, living arrangement (e.g., cohabitation with extended family vs. nuclear family) and the infant's surname (whether it followed the father's or mother's family) were also significantly associated with cognitive-bias scores ($P < 0.05$). In contrast, variables such as age, BMI, religious belief, conception method, infant gender, family structure, postpartum month, and maternal exercise frequency showed no significant association with cognitive bias scores ($P > 0.05$) (Supplementary Figure 4). To clarify the strength of associations between individual variables and negative affect cognitive bias, as well as correlations among the included variables, a Spearman correlation coefficient heatmap was generated (Supplementary Figure 5).

3.2.2 Multivariable Analysis of Factors Associated With Caregiver Cognitive Bias

Variables that were statistically significant in the univariate analyses were entered into the generalized linear model. Seven factors remained independently associated with caregiver cognitive-bias scores, including hours of infant

care, education level, occupation, personality type, medical payment method, the mother-in-law and daughter-in-law relationship, and acute mastitis. (Table 2)

3.2.3 Differences in Caregiver Cognitive-Bias Scores Across Caregiver Groups

Results from mixed linear models indicated that caregiver subgroup membership had a significant effect on the discrepancy in negative affect scores ($F=6.466$, $p<0.001$). Specifically, the cognitive bias among biological mothers was significantly greater than that among mothers-in-law, with a mean difference of 5.228 ($SE=1.202$, $p<0.001$). No statistically significant differences were observed between other caregiver subgroups ($P > 0.05$) (Supplementary Figure 6 and Figure 7).

3.2.4 Mediating Effect of Family Functioning on the Relationship Between Caregiver Cognitive Bias and Maternal Negative Affect

Structural equation modeling was conducted to examine the mediating effect of family functioning on the relationship between caregiver cognitive bias and maternal negative affect. Caregiver cognitive bias was specified as the independent variable, Family APGAR score as the mediator, and maternal negative-affect score as the dependent variable.

Caregiver cognitive bias was negatively associated with Family APGAR scores (path coefficient = -0.214 , $P<0.001$), indicating that greater caregiver underestimation of maternal negative affect was associated with poorer perceived family functioning. Family APGAR scores were negatively associated with maternal negative-affect scores (path coefficient = -1.174 , $P<0.001$), indicating that better family functioning was associated with lower maternal negative affect.

The mediating effect of family functioning was statistically significant. The indirect effect was 0.251 (95% CI, 0.185–0.323), accounting for 28.85% of the total effect. The direct effect was 0.619 (95% CI, 0.511–0.727), accounting for 71.15% of the total effect. These findings indicated that family functioning partially mediated the relationship between caregiver cognitive bias and maternal negative affect (Supplementary Figure 8a and Table 3).

Separate mediation models were subsequently constructed for husbands, mothers-in-law, and other family caregivers. Among husband caregivers, cognitive bias was negatively associated with Family APGAR scores (path coefficient = -0.186 , $P < 0.001$), and Family APGAR scores were negatively associated with maternal negative-affect scores (path coefficient = -0.868 , $P < 0.001$). The indirect effect through family functioning was 0.161 (95% CI, 0.069 – 0.257), accounting for 20.83% of the total effect. Family functioning therefore partially mediated the relationship between husbands' cognitive bias and maternal negative affect (Supplementary Figure 8b and Table 4).

Among mother-in-law caregivers, cognitive bias was negatively associated with Family APGAR scores (path coefficient = -0.321 , $P < 0.001$), while Family APGAR scores were negatively associated with maternal negative-affect scores (path coefficient = -1.085 , $P < 0.001$). The indirect effect through family functioning was 0.348 (95% CI, 0.195 – 0.530), accounting for 32.43% of the total effect. Family functioning partially mediated the relationship between mothers-in-law's cognitive bias and maternal negative affect (Supplementary Figure 8c and Table 5).

Among other caregivers, including fathers-in-law, biological mothers, and biological fathers, cognitive bias was negatively associated with Family APGAR scores (path coefficient = -0.121 , $P < 0.001$), and Family APGAR scores were negatively associated with maternal negative-affect scores (path coefficient = -1.663 , $P < 0.001$). The indirect effect through family functioning was 0.201 (95% CI, 0.077 – 0.351), accounting for 26.48% of the total effect. Family functioning partially mediated the relationship between other caregivers' cognitive bias and maternal negative affect (Supplementary Figure 8d and Table 6).

Overall, statistically significant mediating effects of family functioning were observed across all caregiver groups. The proportion mediated was 20.83% among husbands, 32.43% among mothers-in-law, and 26.48% among other caregivers.

3.3 Factors Associated With Caregiver Cognitive Bias Across Caregiver Groups

Exploratory subgroup analyses were conducted to identify factors associated with caregiver cognitive-bias scores within different caregiver groups. Among husbands, perception of maternal negative affect during the previous week was the only factor significantly associated with cognitive-bias scores. Among mothers-in-law, personality type and perception of maternal negative affect during the previous week were significantly associated with cognitive-bias scores. Among other caregivers, educational level, household monthly income, alcohol consumption, maternal role attainment, and perception of maternal negative affect during the previous week were significantly associated with cognitive-bias scores. No other significant associations were observed within the respective caregiver groups (Supplementary Figure 9).

Discussion

This study examined discrepancies between postpartum women's self-reported affect and family caregivers' perceptions of maternal affect, identified factors associated with caregiver cognitive bias, and explored the indirect association through family functioning. First, family caregivers generally underestimated maternal negative affect while overestimating their positive affect, indicating systematic disagreement between maternal self-reports and caregiver perceptions. Second, the direction and magnitude of cognitive bias in the perception of maternal negative affect varied according to infant-care duration, maternal educational level, occupation, personality type, medical payment method, mother-in-law and daughter-in-law relationship, and acute mastitis. Third, greater caregiver underestimation of maternal negative affect was associated with poorer perceived family functioning, while poorer family functioning was associated with higher maternal negative affect. The statistical indirect association through family functioning accounted for 28.85% of the total association. Differences were also observed across caregiver subgroups, suggesting that caregiver role and family context may shape the recognition of maternal emotional needs.

Family caregivers generally overestimated maternal positive affect and underestimated maternal negative affect, indicating a systematic discrepancy between maternal self-reports and caregiver perceptions. This finding suggests that maternal emotional distress may not always be readily recognized within the family environment. Postpartum women may not always disclose their emotional distress or actively seek help because of perceived stigma, concerns about being judged as inadequate mothers, uncertainty about whether their symptoms warrant professional attention, or reluctance to burden family members^[24]. Meanwhile, caregivers may focus primarily on observable aspects of postpartum recovery, such as physical symptoms, breastfeeding, infant feeding, household responsibilities, and childcare tasks, while paying comparatively less attention to less visible emotional experiences. A mixed-methods systematic review showed that women during the perinatal period require emotional, instrumental, informational, and appraisal support, whereas insufficient support from partners and family members is associated with greater symptoms of depression and anxiety and with difficulties mobilizing appropriate support^[13]. In addition, limited perinatal mental health literacy among women and the general public may hinder the recognition of psychological symptoms and appropriate help-seeking^[17]. Evidence from a systematic review and meta-analysis further indicates that partner communication, emotional closeness, and the provision of emotional and instrumental support are potentially modifiable factors associated with maternal depression and anxiety during the perinatal period^[25]. Consequently, when maternal distress is not explicitly expressed or accurately recognized, caregivers may interpret the absence of visible symptoms as evidence of psychological well-being. Such under-recognition may delay appropriate emotional responses and leave maternal needs for reassurance, rest, communication, practical assistance, or professional psychological support unmet. These findings therefore highlight a potentially important mismatch between postpartum women's emotional experiences and their caregivers' understanding and responses.

Longer maternal infant-care duration was associated with greater caregiver underestimation of maternal negative affect. Intensive childcare demands may contribute to physical fatigue, sleep disruption, and emotional strain among

postpartum women ^{[26],[27]}. However, family members may interpret these experiences as expected consequences of motherhood rather than as signs of emotional distress. As childcare demands increase, caregivers may also focus more heavily on task-oriented assistance, such as feeding, bathing, and soothing the infant, while paying comparatively less attention to maternal emotional cues^[28]. Consequently, maternal fatigue, irritability, or emotional withdrawal may be normalized or overlooked, contributing to greater disagreement between maternal self-reports and caregiver perceptions^{[29],[30]}.

Educational level was also independently associated with caregiver–mother disagreement. Educational attainment may influence emotional health literacy, communication patterns, and the ability to identify and articulate psychological needs^[31]. Higher educational attainment may facilitate access to postpartum health information, improve emotional health literacy, and enable women to articulate their psychological needs more explicitly^[32].

In the Chinese postpartum context, mothers-in-law commonly participate in maternal and infant care, and the quality of the mother-in-law and daughter-in-law relationship is associated with maternal marital satisfaction, family support, and postpartum mental health ^{[33]-[35]}. Differences in postpartum customs, childcare beliefs, communication styles, and expectations regarding maternal responsibilities may generate tension within intergenerational caregiving relationships ^{[28],[36]}. In strained relationships, postpartum women may be less willing to disclose vulnerable emotions, while caregivers may interpret emotional withdrawal, irritability, or disagreement as interpersonal dissatisfaction rather than psychological distress ^[13]. Conversely, supportive family relationships may facilitate open communication, emotional validation, and more responsive assistance ^[12]. These findings suggest that the quality of family interaction may be as important as the amount of practical support provided.

Acute mastitis was associated with lower cognitive-bias scores, indicating reduced caregiver underestimation or a relative shift toward overestimation of maternal negative affect. Lactational mastitis is commonly accompanied by pain,

inflammation, feeding difficulties, antibiotic treatment, and interruption or concern regarding breastfeeding [37],[38]. Breastfeeding difficulties and mastitis are also associated with poorer maternal emotional well-being [39],[40]. These observable symptoms may make maternal distress more apparent to family caregivers and increase their awareness of negative emotional experiences.

Previous reviews have identified socioeconomic disadvantage, psychosocial stress, and inadequate social support as important correlates of adverse perinatal mental health outcomes [30],[41],[42]. Occupational status may shape financial security, daily routines, role demands, and opportunities for family interaction, all of which may influence how maternal emotions are expressed and perceived. Personality type may affect mothers' emotional expression and caregivers' sensitivity to affective cues, whereas medical payment method may serve as a proxy for socioeconomic status, healthcare access, or perceived financial burden.

Greater caregiver cognitive bias was associated with poorer perceived family functioning. This may be attributed to the fact that inaccurate recognition of maternal emotional needs may hinder effective communication, reduce perceived responsiveness, and intensify tension within family interactions, thereby weakening postpartum women's perceptions of family support and cohesion^[43]. Conversely, better family functioning was associated with lower levels of maternal negative affect, which is consistent with family systems theory and previous evidence highlighting the protective role of supportive family relationships in maternal psychological adjustment^{[44],[45]}. Families characterized by emotional understanding, practical assistance, shared responsibility, and psychological security may be better able to buffer postpartum stress and respond to maternal emotional needs. The mediation analysis further indicated that family functioning partially mediated the relationship between caregiver cognitive bias and maternal negative affect, accounting for 28.85% of the total effect. This finding suggests that caregiver misperception may be linked to maternal negative affect not only directly but also through broader family processes involving communication, emotional responsiveness, role coordination, and perceived support. It therefore extends current understanding of postpartum emotional health by

emphasizing the relational and family context in which maternal negative affect occurs^[46]. From a practical perspective, interventions should not focus exclusively on maternal symptoms but should also strengthen caregivers' emotional recognition, improve family communication, clarify caregiving responsibilities, and promote responsive family support. Such family-centered strategies may contribute to more timely identification of maternal distress and more appropriate emotional and practical assistance^[44].

Different patterns of factors associated with caregiver cognitive bias were observed across caregiver groups. Among husbands, recent perception of maternal negative affect was the only factor significantly associated with cognitive-bias scores, possibly reflecting spouses' more frequent opportunities for emotional communication and their reliance on recent interpersonal cues when evaluating maternal well-being. Among mothers-in-law, cognitive bias was associated with personality type and recent perception of maternal negative affect, which may reflect generational differences in emotional expression, communication, and postpartum-care beliefs. Among other caregivers, cognitive bias was associated with a broader range of socioeconomic and behavioral characteristics. Recent research indicates that partner responsiveness, social support, and the emotional well-being of both parents are relevant to the wider perinatal family context ^{[12],[13],[16],[47]}. Caregiver cognitive bias may therefore be shaped by family role, personal characteristics, living conditions, and patterns of interaction with postpartum women.

These findings have several implications for postpartum care. Recent systematic reviews and clinical guidelines emphasize early identification, routine assessment, accessible referral pathways, family and partner involvement, and evidence-based psychological or digital interventions for perinatal mental-health difficulties ^{[17],[48]-[50]}. Healthcare professionals could encourage postpartum women and caregivers to discuss emotional experiences directly rather than infer well-being solely from observable behavior. Family-based education may strengthen caregivers' recognition of less visible manifestations of negative affect, including persistent worry, irritability, emotional exhaustion, withdrawal, loss of interest, and difficulty adapting to the

maternal role. Particular attention may be warranted in families characterized by strained intergenerational relationships, prolonged infant-care demands, limited mental-health literacy, or inadequate family functioning. Relevant strategies may include education about postpartum emotional changes, training in responsive communication, clarification of caregiving responsibilities, and guidance regarding when professional support should be sought.

Limitations & Future Directions

Several limitations should be considered when interpreting these findings. First, participants were recruited through convenience sampling from three tertiary hospitals in Jiangsu Province, and the sample was limited to primiparous women with singleton, full-term births. These characteristics may restrict the generalizability of the findings to multiparous women, women with preterm or multiple births, and those receiving care in community or primary healthcare settings. Second, the cross-sectional design did not allow the temporal or causal relationships among caregiver cognitive bias, family functioning, and maternal negative affect to be established. Therefore, although family functioning showed a statistically significant mediating effect, the proposed pathway should not be interpreted as a confirmed causal mechanism. Third, maternal affect, caregiver-perceived maternal affect, and family functioning were assessed using self- or proxy-reported questionnaires, which may have introduced recall bias, social-desirability bias, and common-method variance. The proxy application of the PANAS also requires further psychometric validation. In addition, the signed cognitive-bias score reflected the direction of caregiver–mother disagreement but did not directly indicate the absolute accuracy of caregivers’ perceptions. Finally, potentially relevant caregiver characteristics, including caregivers’ own anxiety and depressive symptoms, caregiving burden, and emotional-recognition ability, were not assessed.

Future studies should adopt multicenter longitudinal dyadic designs, recruit more diverse populations, validate proxy measures of maternal affect, and incorporate caregiver psychological characteristics, qualitative interviews, and behavioral

assessments to clarify the proposed relationships and inform family-oriented interventions.

Conclusion

These findings support the incorporation of family-oriented components into postpartum care. Healthcare professionals could encourage postpartum women and caregivers to discuss emotional experiences directly rather than relying solely on observable behavior. Brief family-based education may help caregivers recognize less visible manifestations of maternal negative affect, including persistent worry, irritability, emotional exhaustion, withdrawal, and loss of interest. Particular attention may be warranted in families characterized by strained intergenerational relationships, intensive childcare demands, limited emotional health literacy, or poorer family functioning. Interventions may also clarify caregiving responsibilities and provide guidance on when professional psychological support should be sought.

Ethics declarations

Ethics approval and consent to participate

Permission to use the measurement instruments was obtained from the original authors. Ethical approval for the study was received from the Ethics Committee of Nantong University (Approval No: Lun Shen (2022) 25). Written institutional permissions were obtained from the three Grade A tertiary hospitals involved in this research. The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all puerperae and their family caregivers who voluntarily agreed to participate. Participants were informed that their responses would be kept confidential, participation was entirely voluntary, and they had the right to withdraw from the study at any time without any consequences.

Consent for publication

Not applicable

Competing interests

All authors declare that they have no competing interests.

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Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author

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