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Cross-lagged panel model of depressive mood and influencing factors in high-risk perinatal depression

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Abstract

Background While research has uncovered intricate relationships between cognitive reactivity (CR), sleep quality, perceived stress, family function, mindfulness, and perinatal depression (PND), their temporal dynamics remain unclear. Previous studies have focused primarily on cross-sectional analyses or single-time-point associations and lack longitudinal exploration of the bidirectional relationships and temporal precedence between these variables.

Methods The study was conducted in Fujian Province, China, from December 2021 to January 2023. A cross-lagged panel model was used to examine the temporal relationships among CR, sleep quality, perceived stress, family function, mindfulness, and PND in pregnant women at high risk for depression. A total of 329 participants completed a baseline questionnaire during the third trimester (T1) and completed follow-up assessments three months postpartum (T2). Standardized scales were used to measure key variables. Statistical analyses were performed using IBM SPSS 26 and R 4.2.3 software, with the "lavaan" package employed for cross-lagged panel model construction.

Results The findings revealed that the relationship between CR and depression among women at high risk of PND persisted over time due to autoregressive effects. PND at T1 was prospectively associated with changes in CR, family function, perceived stress, mindfulness, and sleep quality at T2 ($B = 2.467$, -0.473, 0.878, -0.306, 0.393, $P < 0.05$). However, the cross-lagged effects of CR, family function, mindfulness, and sleep quality at T1 on the PND total score at T2 were not significant. The only exception was the significant positive cross-lagged effect of perceived stress at T1 on PND at T2. ($B = 0.102$, $P < 0.05$).

Conclusion This study among high-risk women with PND found that late-pregnancy depression was prospectively associated with higher postpartum cognitive reactivity, perceived stress, and depressive symptoms, and with poorer family function, mindfulness, and sleep quality. These findings advance understanding of the dynamic interplay between perinatal psychological and interpersonal factors and highlight the need for early intervention during pregnancy. Clinically, strengthening depression screening and adopting targeted strategies—such as cognitive-

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behavioral therapy, family counseling, mindfulness training, and sleep optimization—may aid in the prevention, early detection, and treatment of PND, thereby safeguarding maternal mental health and infant well-being.

Keywords Cross-lagged panel analysis, Depression, Perinatal Care, Psychology, Longitudinal Studies

Introduction

The WHO's 2022 guidelines highlight that approximately one in five maternal individuals globally may experience depression during pregnancy or within the first year postpartum [1]. Global estimates place the prevalence of perinatal depression (PND) between 13 and 30% [2], with the rate among Chinese women being 16.3%, which is particularly high in regions with lower socioeconomic development [3]. The incidence of PND is increasing by 9% annually [4], underscoring PND as a growing global issue. PND, encompassing prenatal and postpartum depression, affects women from pregnancy through the first year postpartum [5]. Symptoms include reduced interest, lack of focus, and feelings of depression, particularly in late pregnancy and the first three months postpartum [6]. A cohort study of 3,009 mothers revealed the peak incidence of physical and mental health issues at three months postpartum, with a gradual decline thereafter [7].

PND is intimately linked to numerous adverse outcomes for both mothers and infants, imposing a significant burden on perinatal women, their families, and society at large. Previous cross-sectional studies [8, 9] have documented the distress and social dysfunction incurred by PND among pregnant and postpartum women. Furthermore, it has been shown to adversely affect the cognitive, emotional, and behavioral development of infants and young children. In extreme cases, women suffering from PND may even engage in suicidal or infanticidal behaviors [10]. Thus, PND has emerged as a matter of grave concern for public health professionals and clinical researchers alike.

Bronfenbrenner's Health Ecological Model emphasizes the impact of various ecosystems on individual development [11]. This model, as supported by McLeroy et al. [11], can be used to identify factors influencing perinatal depressive symptoms and provides a comprehensive framework for preventing and treating PND [12]. In terms of psychological behavior, cognitive reactivity, perceived stress, mindfulness, and quality of sleep have been shown to be associated with PND, although the focus has primarily been on postpartum women [3, 13]. CR refers to the phenomenon where negative cognitions, which are dormant in certain individuals, can be triggered by life events, stress, or negative emotions [14]. Studies [15, 16] have indicated that CR serves as a stable predictor for the onset and recurrence of depression. Although current research on CR predominantly focuses on adolescents [17], the study [18] has revealed that CR in late pregnancy positively predicts depression levels at six weeks postpartum, this finding suggests that CR may serve as a sensitive predictor of PND to some extent. However, its underlying mechanisms require further investigation.

Research has shown that individuals who perceive higher levels of stress are prone to developing mental and physical illnesses, including depressive symptoms [3]. Pregnancy-related stress primarily arises from various stressful events that inflict psychological distress or threats on pregnant women, manifesting as physical and emotional tension along with various types of discomfort [3].Studies [19, 20] have demonstrated that high levels of stress during pregnancy play a pivotal role in the onset of PND. Furthermore, sleep is a vital process for human recovery and regulation and is crucial to mental health. A Chinese study [21] has shown that the quality of sleep among women during late pregnancy directly impacts their postpartum depression mood levels. Additionally, individuals with higher levels of mindfulness reportedly exhibit lower CR and a reduced likelihood of developing or relapsing into depression [15]. However, research [22, 23] exploring the correlation between mindfulness and PND tends to focus more on postpartum women, the better an individual's trait—level mindfulness, with findings indicating that individuals with higher trait-level mindfulness exhibit lower CR in response to low mood, thereby reducing the likelihood of developing depression or experiencing a depressive relapse [23]. There may be a lack of comprehensive longitudinal studies on mindfulness and PND. Further investigation is needed to determine if such longitudinal studies exist and to clarify their findings.

In terms of interpersonal factors, family function refers to the ability of a family, as a collective unit, to meet the diverse needs of its members. This is reflected in mutual affection, support, emotional communication, and the shared ability to cope with life events and stressors [24]. Although research [25] indicates that positive family functioning has a beneficial effect on maternal mental health, helping reduce both the occurrence and severity of depressive symptoms, it should be considered a crucial target in interventions aimed at reducing the prevalence of PND [26]. Evidence from both cross-sectional and recent longitudinal studies has consistently identified family functioning as a significant predictor of PND [25, 26]. However, most investigations have focused on single associations in isolation. A recent longitudinal network analysis has begun to examine the interplay

among multiple psychosocial factors, including family functioning [27], yet such evidence remains limited. Consequently, the dynamic role of family functioning in relation to other psychosocial factors is still not fully understood within the broader mechanisms of PND and the development of targeted interventions.

The selection of cognitive reactivity, perceived stress, mindfulness, sleep quality, and family function as research factors is based on their well-documented associations with PND in prior studies [3, 13, 15–23, 25]. Specifically, cognitive reactivity serves as a stable predictor of depressive onset [15, 16], perceived stress influences HPA axis regulation [3, 19, 20], mindfulness modulates emotional responses [15], sleep quality directly impacts postpartum mood [21], and family support provides a buffer against stress [25]. Bronfenbrenner's model further integrates these factors within a multilevel ecological framework, highlighting their interactive effects on PND development [11]. Based on this model, the examined variables can be conceptualized across different systemic levels: cognitive reactivity, mindfulness, and sleep quality primarily pertain to the individual microsystem; family functioning operates within the mesosystem of interpersonal relationships; and perceived stress often arises from interactions with the broader exo- and macrosystems (e.g., societal norms, economic factors) as well as the chronosystem (transition to parenthood). We hypothesize dynamic, potentially bidirectional relationships between PND and these multi-level factors across the perinatal period.

As mentioned above, while there appears to be a link between the five influencing factors (CR, perceived stress, sleep quality, family function, and mindfulness) and PND, the temporal sequence remains unclear. Previous studies have failed to simultaneously examine the bidirectional associations between these factors or prioritize their temporal precedence. Furthermore, the current research focuses primarily on the status quo at a single time point, with insufficient longitudinal tracking of depressive factors across various perinatal stages, particularly during the high-risk periods for PND onset (late pregnancy and two–three months postpartum) [6]. The Cross-Lagged Panel Model is a longitudinal research method commonly used to explore the reciprocal influences between variables over time. By employing the Cross-Lagged Panel Model, researchers can simultaneously examine the bidirectional associations between variables and prioritize their temporal precedence. This model is particularly suitable for studying complex phenomena such as PND, which involves multiple influencing factors and requires consideration of their temporal sequence [28].

Therefore, our study focused on high-risk PND populations and employed a longitudinal research approach to investigate factors such as CR, depression, family function, perceived stress, mindfulness, and sleep quality among women during late pregnancy and three months postpartum. By constructing a cross-lagged model (Appendix 1), we hypothesize that there is a reciprocal cross-lagged effect between PND and CR during late pregnancy and three months postpartum, and that similar reciprocal effects exist for family function, mindfulness, perceived stress, and sleep quality.

Methods

Design

This prospective study was conducted in Fujian Province, China, from December 2021 to January 2023. The research protocol was thoroughly reviewed and approved by the Institutional Review Board of the Second Affiliated Hospital of Fujian Medical University (No. 2022085). This study followed the reporting guidelines set out in the Observational Longitudinal Research Checklist by Tooth, L. et al. [29].

Participants

We employed convenience sampling to recruit 1426 pregnant women from obstetrical clinics and inpatient departments of three tertiary hospitals (level 3) in Fuzhou and Quanzhou City, Fujian Province, China. The inclusion criteria were as follows: (1) pregnant women aged ≥ 20 years in their late trimesters (gestational age ≥ 28 weeks confirmed by type-B ultrasonography), (2) identified as high-risk for PND with a score ≥ 58 on the 26—item modified Leiden Index of Depression Sensitivity—Chinese version (LEIDS—RR—CV) [30] and a score ≤ 12 on the 10—item Edinburgh Postnatal Depression Scale (EPDS), and (3) willingness to participate in a follow—up period of up to three months postpartum. Women with pre—existing mental disorders or cognitive impairments were excluded. To determine the presence of mental disorders or cognitive impairments, participants were screened using the Mini International Neuropsychiatric Interview (MINI) 7.0, a structured diagnostic interview tool. The MINI covers a wide range of psychiatric disorders and provides a reliable and efficient way to assess mental health status. Trained research assistants conducted the interviews, and any positive findings were further reviewed by a psychiatrist for confirmation. It should be noted that detailed demographic information was not collected from women who were screened but did not meet the inclusion criteria, which limits our ability to assess potential selection bias.

The sample size [31] for longitudinal data requires 80% power which depends on the intraclass correlation coefficient. The effect sizes were denoted as SL for small (0.14), M for medium (0.39), L for large (0.59), and H for halfway (0.26). In this study, we selected an ICC of 0.2. With the

effect size SL indicating $\beta a = 0.14$ and $\beta b = 0.59$, we opted for the most powerful bootstrapping method. The minimum sample size required was 278 women. Factoring a 15% attrition rate, we established that the required sample size should be at least 320.

Measures

At baseline (T1), participants in the third trimester completed the questionnaire online via Wenjuanxing (https://www.wjx.cn/), a popular survey platform in China. At follow-up (T2), data were collected through telephone interviews, during which trained research assistants read each item aloud and filled in responses based on participants' answers. This approach ensured standardized data collection and minimized missing data. The switch to telephone interviews was due to postpartum women's limited mobility and time constraints. To ensure data quality, questionnaires were pre-tested, clear instructions were provided, and 10% of responses were randomly verified. Participants without T1 data were excluded to maintain consistency.

Exposure measures

Perceived stress scale (PSS) The 10-item PSS assesses various dimensions of life stress, including the ability to manage unexpected events, feelings of nervousness or stress, and the capacity to cope with difficulties [32]. Scores on the PSS range from 0 to 40, with higher scores indicating higher levels of perceived stress. The scale has demonstrated acceptable internal consistency (Cronbach's alpha of 0.82–0.85) and has been validated as an effective measure for assessing perinatal stress. In this study, the Cronbach's α values for women at T1 and T2 were 0.822 and 0.848, respectively.

Cognitive and affective mindfulness scale-revised (CAMS-R) The CAMS-R is a self-report questionnaire designed to assess the relationship between mindfulness and mood [33]. It uses a 4-point Likert scale ranging from "never" to "always," with scores from 1 to 4. The total score ranges from 12 to 48, with higher scores indicating a higher level of mindfulness. The CAMS-R has demonstrated satisfactory internal consistency, with Cronbach's alpha values ranging from 0.87 to 0.91, establishing its reliability in measuring perinatal mindfulness. In this study, the Cronbach's α values for women at T1 and T2 were 0.905 and 0.868, respectively.

Adaptation, partnership, growth, affection, and resolve scale (Family APGAR scale) Family function information was obtained via maternal self-reports using the family APGAR scale [34]. The APGAR is a 5-item tool rated on a 2-point Likert scale ranging from 0 to 10, where higher scores indicate better family function. It has been validated through clinical diagnostic interviews during the perinatal period, demonstrating adequate sensitivity, specificity, and predictive value. The scale showed acceptable reliability in this study, with Cronbach's α ranging from 0.89 to 0.91 for the overall score.

Athens insomnia scale (AIS) The Chinese adaptation of the AIS is a widely recognised self-assessment tool used to evaluate sleep quality [35]. It consists of eight items designed to assess both sleep quality and insomnia symptoms in individuals. Each item is scored on a scale of 0 to 3, indicating the severity of symptoms comprehensively from "none" to "severe". The total score ranges from 0 to 24, with higher scores indicating more severe insomnia symptoms. In this study, the Cronbach's α values for women at T1 and T2 were 0.813 and 0.799, respectively.

Chinese version of the modified leiden index of depression sensitivity (LEIDS-RR-CV) Authorized by the author of the original LEIDS scale, our research team adapted and validated the LEIDS-RR in 2017 to create the Chinese version, LEIDS-RR-CV [36]. This self-assessment tool is designed to evaluate individuals' cognitive and behavioral symptoms of grief, also known as the CR level. This scale comprises 26 items across five dimensions. The responses are rated on a 5-point Likert scale, ranging from "not at all" (1 point) to "very strongly" (5 points).

Notably, the acceptance/coping dimension employs reverse scoring, where 5 points indicate "not at all" and 1 point indicates " very strongly." A higher total score reflects a higher CR level in individuals, suggesting a greater likelihood of depression occurrence or recurrence. In this study, the Cronbach's α values for women at T1 and T2 were 0.875 and 0.895, respectively.

Outcome measures

Edinburgh postnatal depression scale (EPDS) Depression symptoms were assessed using the Chinese version of the EPDS [37]. The EPDS is a widely used 10-item questionnaire in which each item is scored on a 4-point scale from 0 to 3. The total score, ranging from 0 to 30, indicates the severity of depressive symptoms, with higher scores indicating more severe symptoms. In this study, the EPDS showed good internal consistency (Cronbach's $\alpha = 0.870$). A cutoff score of greater than 12 on the EPDS was used to screen for PND in women, with a score of ≤ 12 indicating the absence of PND (This cutoff was selected to identify women who were at high risk for depression (based on cognitive reactivity) but were not experiencing clinically significant depressive symptoms at baseline, allowing for the observation of incident or worsening symptoms postpartum.) In this study, the Cronbach's α values for women at T1 and T2 were 0.767 and 0.857, respectively.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics (version 26) and R 4.2.3 software. The frequency and percentage (%) were used to describe the count data, while the non-normally distributed measurement data were expressed as the median M (P25-P75), and the Wilcoxon rank sum test was used for the analysis of differences between groups. Pearson correlation coefficients were employed to assess linear relationships in normally distributed variables, whereas Spearman rank correlations were used for non-normally distributed data. Univariate linear regression analysis was performed using the 'lm' function in R. A significance level of $P < 0.1$ [38] was used as a criterion for variable selection in multivariate regression analysis. The 'leaps' package in R was employed to identify optimal subset features and determine the best-fitting multivariate regression model.

For data analysis of the Cross-Lagged Panel Model, the " lavaan" package in R was utilized. Fit indices that minimize the likelihood of type I and type II errors were employed: the chi-square test (χ^2), chi-square to test for degrees-of-freedom ratio (χ^2/df), Comparative Fit Index, Tucker Lewis Index, Root Mean Square Error of Approximation, and Akaike's Information Criteria. The study's general modeling strategy involved 6 pathways with their respective coefficients. The cross-lagged pathways included 2 coefficients: the rX1Y2 coefficient represented the influence of variables (CR, sleep quality, family function, perceived stress, and mindfulness) at T1 on the total postpartum depression score at T2, whereas the rY1X2 coefficient represented the impact of the depression score at T1 on the variables (CR, sleep quality, family function, perceived stress, and mindfulness) at T2 (see Appendix 1).

Measurement and modeling considerations

The scales used in this study demonstrated acceptable internal consistency at both T1 and T2 (see Sect. 2.3). However, internal consistency does not guarantee measurement invariance. Due to the two-wave design, we could not formally test for measurement invariance across time for key constructs (e.g., CR, mindfulness, sleep quality). This means we cannot rule out the possibility that the structure or meaning of these scales may have shifted between the late pregnancy and postpartum periods. Consequently, interpretations of longitudinal score changes should be made with caution. Furthermore, the traditional cross-lagged panel model (CLPM) used with two waves of data yields estimates that blend *between-person* (stable trait) differences and *within-person* changes over time. Thus, the reported "predictive" effects should be interpreted primarily as evidence of temporal precedence rather than strict within-person causality. Additionally, as the specified CLPMs are saturated models (degrees of freedom = 0), they fit the data perfectly by definition; thus, model fit indices are not reported, which limits independent assessment of model adequacy.

Variable selection and causal assumptions

To transparently guide the selection of covariates and clarify the assumed causal relationships among variables, we constructed a Directed Acyclic Graph (DAG) based on prior clinical knowledge and existing literature [3, 13–27] (see Fig. 1). The DAG delineated the causal paths between exposures, outcomes, and potential confounders, and was used to identify the minimal sufficient set of covariates for adjustment in the models to minimize bias.

Results

Participant characteristics

Among the 1,426 women contacted during late pregnancy, 368 met the inclusion criteria. At T2, a total of 329 participants completed all the assessments, resulting in a follow-up loss rate of 10.6% ($n = 39$). The reasons for loss to follow-up included refusal to participate ($n = 12$), physical discomfort ($n = 10$), childcare responsibilities ($n = 10$), and loss of contact ($n = 7$). Among the participants at three months postpartum, 123 women scored > 12 on the EPDS and were referred for further psychiatric evaluation. The recruitment and follow-up process is presented in a flowchart (see Appendix 2). Table 1 presents an overview of the participants' basic demographic and clinical characteristics.

Variable correlations

As indicated in Appendices 3, 4 and 5, the results present descriptive statistics on assessment scores of women at time points T1 and T2. Between the third trimester and three-months postpartum, the participants' CR recovered, while the risk of postpartum depression increased. Pearson correlation analysis revealed several relationships. At T1, the total PND score was positively correlated with CR (T1, $r = 0.376$, $P < 0.001$), perceived stress (T1, $r = 0.565$, $P < 0.001$), and sleep quality (T1, $r = 0.397$, $P < 0.001$) but negatively correlated with family function (T1, $r = -0.564$, $P < 0.001$). However, there was no significant correlation between mindfulness (T1) and PND score (T1, $r = -0.078$, $P > 0.05$). At T2, the PND score was significantly correlated with all five variables: CR ($r = 0.791$, $P < 0.001$), family function ($r = -0.689$, $P < 0.001$), perceived stress ($r = 0.691$, $P < 0.001$), mindfulness ($r = -0.239$, $P < 0.001$), and sleep quality ($r = 0.472$, $P < 0.001$).

Cross-lagged panel model findings

The specified cross-lagged models are saturated (with zero degrees of freedom) and thus fit the data perfectly.

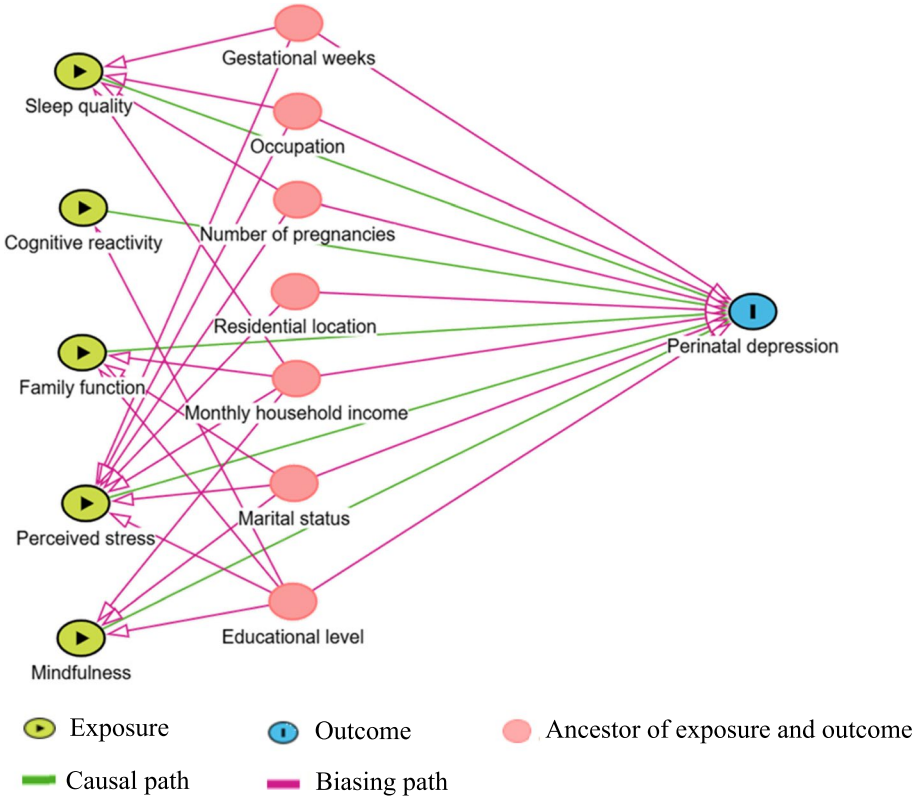

Fig. 1 Directed acyclic graph of perinatal depression and related factors

Therefore, conventional model fit indices are not presented. However, reliance on saturated models limits the ability to evaluate model adequacy beyond the examination of the estimated temporal paths.

(1) CR–PND cross-lagged panel model

As shown in Fig. 2 and Table 2, a reciprocal and longitudinal relationship was found between the CR and PND. A high PND at T1 had a significant positive effect on CR at T2 ($B = 2.467$, $P < 0.05$), but CR at T1 had no significant effect on PND levels at T2 ($B = -0.001$, $P > 0.05$).

(2) Family function–PND cross-lagged panel model

As shown in Fig. 2 and Table 2, the longitudinal relationship between family function and PND was examined. PND at T1 negatively predicted family function at T2 ($B = -0.473$, $P < 0.05$). However, neither the autoregressive effect of family function ($B = -0.005$, $P > 0.05$) nor its cross-lagged effect on PND at T2 ($B = -0.047$, $P > 0.05$) was statistically significant.

(3) Mindfulness–PND cross-lagged panel model

As shown in Fig. 2 and Table 3, a reciprocal and longitudinal relationship was found between mindfulness and PND. PND at T1 negatively predicted mindfulness at T2 ($B = -0.306$, $P < 0.05$), but mindfulness at T1 had no significant effect on mindfulness or PND levels at T2 ($B = -0.077$ & -0.037, $P > 0.05$).

(4) Sleep quality–PND cross-lagged panel model

As showed in Fig. 2 and Table 3, a reciprocal and longitudinal relationship was found between sleep quality and PND. A high PND at T1 had a significant positive effect on sleep quality at T2 ($B = 0.393$, $P < 0.05$), but sleep quality at T1 had no significant effect on sleep quality or PND at T2 ($B = 0.076$ & 0.047, $P > 0.05$).

(5) Perceived stress–PND cross-lagged panel model

As shown in Fig. 2 and Table 4, a reciprocal and longitudinal relationship was found between perceived stress and PND. The standardized path coefficient from PND scores at T1 to perceived stress at T2 ($B = 0.878$, $P < 0.05$) was substantially stronger than the opposite direction, which is from perceived stress (T1) to PND scores (T2) ($B = 0.102$, $P < 0.05$). However, perceived stress at T1 had no significant effect on perceived stress levels at T2 ($B = 0.064$, $P > 0.05$).

The above cross-lagged models are all identified as saturated models; therefore, no fit indices are reported.

Table 1 The socio-demographic and clinical characteristics of participants ($n = 329$)

Variables	*n* (%)
Age (years)	
18–24	19 (5.78)
25–29	140 (42.55)
30–34	156 (47.42)
≥ 35	14 (4.25)
Gestational weeks	
≤ 31 + 6	14 (4.26)
32–36 + 6	111 (33.74)
≥ 37	204 (62.00)
Only daughter	
No	280 (85.11)
Yes	49 (14.89)
Marital status	
Unmarried	7 (2.13)
Married	317 (96.35)
Remarried	5 (1.52)
Educational level	
Middle school degree or below	34 (10.33)
High school/technical school degree	53 (16.11)
Bachelor/college degree	222 (67.48)
Master's degree or above	20 (6.08)
Residential location	
Urban	258 (78.42)
Rural	71 (21.58)
Occupation	
Civil servant	5 (1.52)
Enterprise manager	25 (7.60)
Clerk	90 (27.36)
Teacher/technician	77 (23.40)
Medical staff	15 (4.56)
Service industry worker	18 (5.47)
Other	99 (30.09)
Monthly household income (RMB, ¥)	
≤ 1000	3 (0.91)
1001–3000	20 (6.08)
3001–5000	125 (37.99)
5001–8000	121 (36.78)
≥ 8001	60 (18.24)
Number of pregnancies	
One	158 (48.02)
Two	121 (36.78)
Three or more	50 (15.20)
Number of children	
1	196 (59.57)
2	121 (36.79)
≥ 3	12 (3.64)

Discussion

This study focused on high-risk women with PND and preliminarily supported the directional longitudinal relationships among PND, CR, family function, mindfulness, perceived stress, and sleep quality. Our findings indicate that the relationships between CR, family function, and PND were maintained over time through an autoregressive effect. Notably, depression levels during late pregnancy (T1) positively predict postpartum levels of CR, perceived stress, and depression but negatively predict family function, mindfulness, and sleep quality at three months postpartum (T2). Additionally, worsening PND increased perceived stress over time through a cross-lagged effect.

These insights offer a comprehensive understanding of the dynamic relationships among these factors over time and provide robust theoretical support for PND prevention and treatment. An important consideration in interpreting these findings is that the estimates from our two-wave cross-lagged panel models may reflect a blend of stable differences between individuals (between-person effects) and changes within individuals over time (within-person effects). Therefore, the observed temporal associations should not be interpreted solely as evidence of causal processes operating within individuals, as they may also be influenced by pre-existing, time-invariant traits. Viewed through Bronfenbrenner's ecological model, our findings illustrate how depressive symptoms at the individual level (microsystem) can predict subsequent functioning across multiple ecosystem levels, including perceived stress (which may interface with the exosystem), family dynamics (mesosystem), and sleep patterns (which reflect biopsychosocial processes). Specifically, healthcare providers should enhance depression screening during late pregnancy and implement targeted measures to reduce depressive symptoms, alleviate CR and stress, improve family support and mindfulness, and enhance sleep quality. These strategies are crucial for reducing the incidence of PND and facilitating early detection and intervention.

First, among high-risk women with PND, both CR and depression persist over time due to autoregressive effects. Various complex factors contribute to the rise in CR levels and worsening PND, with each variable carrying its own risk factors. Research highlights multiple influences on CR among perinatal women [39, 40]. Elevated CR levels are particularly evident postpartum [41], and individuals with high CR scores who are never depressed are at increased risk of a first depressive episode within two years [42]. Previous studies on maternal depression [43] have demonstrated a strong correlation between depression in late pregnancy and postpartum, with prenatal depression significantly raising the risk of postpartum depression [39]. The deterioration of both cognitive function and depression are critical to prognosis, and early assessment of these factors can help healthcare providers and policymakers identify at-risk women and implement timely intervention or prevention strategies.

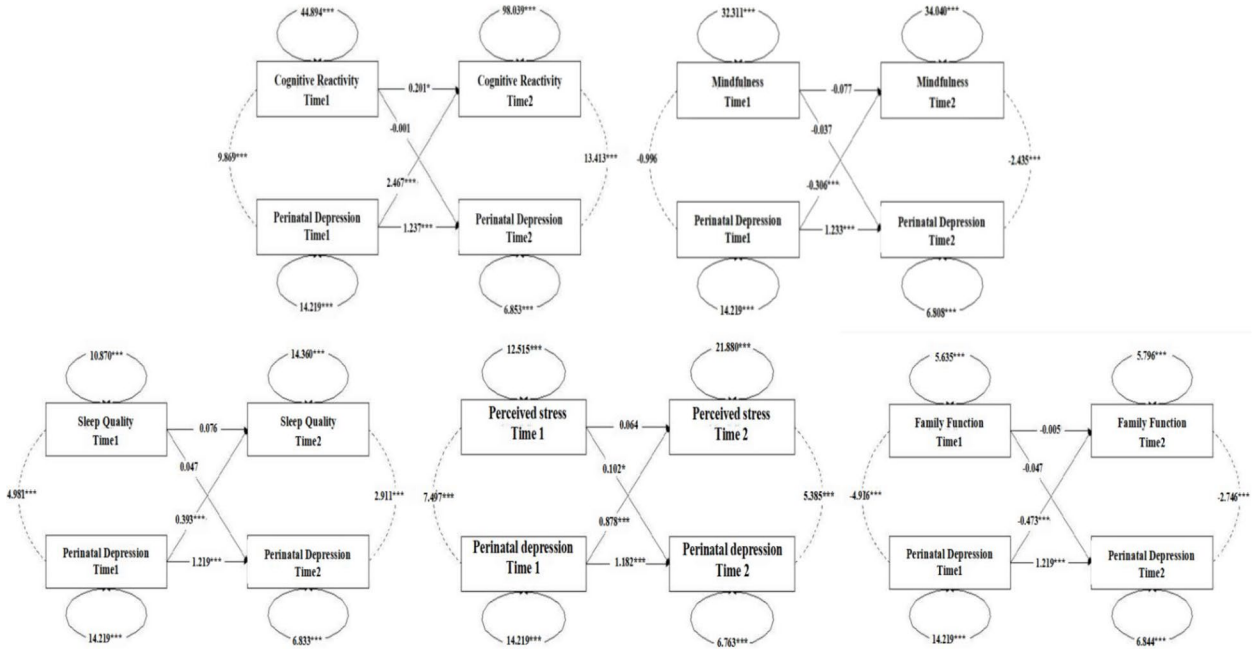

Fig. 2 Cross-lagged Panel Models of Various Factors and Perinatal Depression. Note: The covariates of the model have been controlled.*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$

Second, worsening PND increased perceived stress over time through a cross-lagged effect. Possible explanations for this finding include an elevated stress can disrupt the hypothalamic–pituitary–adrenal (HPA) axis, leading to abnormal cortisol secretion and an increased risk of psychosomatic disorders such as depression [44]. Additionally, prenatal stress often persists into the postpartum period, exacerbating the likelihood of postpartum depression [19]. Higher prenatal stress may also trigger anxiety and other forms of psychological distress, further predicting elevated postpartum depressive symptoms [20]. Furthermore, if depression during late pregnancy remains unresolved and is coupled with a lack of parenting experience postpartum, women may feel incapable of caring for their newborns [45]. As family members' attention shifts toward the baby, mothers may perceive a lack of appreciation, which can negatively impact positive parent-infant interactions [24]. This, in turn, increases the stress associated with caring for and meeting the needs of the infant, thereby elevating overall postpartum stress levels. Therefore, healthcare providers should emphasize pre-evaluating the levels of perceived stress and depression during late pregnancy among high-risk women and implement interventions to prevent and reduce PND.

Third, depression during late pregnancy (T1) predicts elevated CR levels at three months postpartum (T2), extending findings from our prior study [30] that demonstrated its impact at 42 days postpartum. This aligns with the Vulnerability-Stress Model of depression and cognition [46], which suggests that the lasting effects of late-pregnancy depression stem from persistent negative thought patterns—such as pessimism, anxiety, and self-reflection—that may intensify postpartum, leading to heightened emotional responses to the challenges of motherhood. Similarly, the Differential Activation Hypothesis proposed by Lau, M. A. et al. [47] posits those individuals with a history of depression experience stronger negative cognitive shifts when facing minor emotional stressors. Late-pregnancy depression may also lead to a heightened focus on negative self-related information, amplifying emotional responses postpartum. Together, these mechanisms explain its lasting influence on maternal emotional health.

Fourth, within our longitudinal model, depression levels during late pregnancy (T1) showed a negative prospective association with family functioning and mindfulness at three months postpartum (T2), and were linked to poorer sleep quality. Consistent with previous studies, women who exhibited more severe depressive symptoms during late pregnancy reported a poorer perception of family care postpartum. This may be attributed to the emotional burden intensified by late-pregnancy depression, which impairs their perception of family support. As a result, women with high levels of depression may feel inadequately supported by their families, exacerbating feelings of loneliness and weakening social connections [24]. Furthermore, depressive moods can diminish interest and libido, potentially leading to distancing in intimate relationships and a reduction in

Table 2 Parameter estimation of CR, family function and PND cross-lagged model

Pathway	*B* (Unstandardized Estimate)	SE	Z	*P*
CR* T2—CR T1	0.201	0.084	2.381	0.017
CR T2—PND* T1	2.467	0.182	13.567	< 0.001
PND T2—CR T1	−0.001	0.024	−0.051	0.959
PND T2—PND T1	1.237	0.057	21.805	< 0.001
CR T1—PND T1	9.869	1.294	7.628	< 0.001
CR T2—PND T2	13.413	3.222	4.163	< 0.001
CR T2—CR T2	98.039	9.454	10.370	< 0.001
PND T2—PND T2	6.853	1.433	4.782	< 0.001
CR T1—CR T1	44.894	5.585	8.039	< 0.001
PND T1—PND T1	14.219	0.664	21.399	< 0.001
CR T2—T1	42.029	5.144	8.171	< 0.001
PND T2—PND T2	3.522	1.457	2.417	0.016
CR T1—T1	64.802	0.369	175.426	< 0.001
PND T1—PND T1	5.693	0.208	27.385	< 0.001
Family function* T2—Family function T1	−0.005	0.067	−0.074	0.941
Family function T2—PND T1	−0.473	0.044	−10.688	< 0.001
PND T2—Family function T1	−0.047	0.062	−0.768	0.443
PND T2—PND T1	1.219	0.055	22.173	< 0.001
Family function T1—PND T1	−4.916	0.408	−12.036	< 0.001
Family function T2—PND T2	−2.746	0.682	−4.026	< 0.001
Family function T2—Family function T2	5.796	0.441	13.136	< 0.001
PND T2—PND T2	6.844	1.442	4.748	< 0.001
Family function T1—Family function T1	5.635	0.292	19.307	< 0.001
PND T1—PND T1	14.219	0.664	21.399	< 0.001
Family function T2—T1	8.541	0.664	12.867	< 0.001
PND T2—PND T2	3.889	0.577	6.740	< 0.001
Family function T1—T1	7.322	0.131	55.950	< 0.001
PND T1—PND T1	5.693	0.208	27.385	< 0.001

Note. CR = cognitive reactivity; PND = perinatal depression; T1 = the third trimester (first wave); T2 = three months postpartum (second wave). *B* denotes unstandardized regression coefficients for paths indicated by arrows (→), the specific type of each estimate (e.g., covariance, variance) is indicated in the "Pathway" column

*Cognitive reactivity was assessed using the Chinese Version of the modified Leiden Index of Depression Sensitivity. Perinatal depression was assessed using the Edinburgh Postnatal Depression Scale

Table 3 Parameter estimation of mindfulness, sleep quality and PND cross-lagged model

Pathway	*B* (Unstandardized Estimate)	SE	Z	*P*
Mindfulness* T2—Mindfulness T1	−0.077	0.054	−1.423	0.155
Mindfulness T2—PND T1	−0.306	0.087	−3.498	< 0.001
PND T2—Mindfulness T1	−0.037	0.021	−1.776	0.076
PND T2—PND T1	1.233	0.055	22.501	< 0.001
Mindfulness T1—PND T1	−0.996	1.266	−0.787	0.431
Mindfulness T2—PND T2	−2.435	0.805	−3.025	0.002
Mindfulness T2—Mindfulness T2	34.040	2.795	12.178	< 0.001
PND T2—PND T2	6.808	1.415	4.811	< 0.001
Mindfulness T1—Mindfulness T1	32.311	2.813	11.488	< 0.001
PND T1—PND T1	14.219	0.664	21.399	< 0.001
Mindfulness T2—T1	33.657	1.588	21.198	< 0.001
PND T2—PND T2	4.530	0.704	6.438	< 0.001
Mindfulness T1—T1	28.578	0.313	91.190	< 0.001
PND T1—PND T1	5.693	0.208	27.385	< 0.001
Sleep quality* T2—Sleep quality T1	0.076	0.068	1.124	0.261
Sleep quality T2—PND T1	0.393	0.065	6.026	< 0.001
PND T2—Sleep quality T1	0.047	0.033	1.420	0.156
PND T2—PND T1	1.219	0.057	21.49	< 0.001
Sleep quality T1—PND T1	4.981	0.669	7.441	< 0.001
Sleep quality T2—PND T2	2.911	0.698	4.170	< 0.001
Sleep quality T2—Sleep quality T2	14.360	1.052	13.650	< 0.001
PND T2—PND T2	6.833	1.431	4.773	< 0.001
Sleep quality T1—Sleep quality T1	10.87	0.903	12.037	< 0.001
PND T1—PND T1	14.219	0.664	21.399	< 0.001
Sleep quality T2—T1	7.437	0.510	14.580	< 0.001
PND T2—T1	3.227	0.266	12.127	< 0.001
Sleep quality T1—T1	6.690	0.182	36.804	< 0.001
PND T1—PND T1	5.693	0.208	27.385	< 0.001

*Mindfulness was assessed using Cognitive and Affective Mindfulness Scale-Revised. Sleep quality was assessed using Athens Insomnia Scale

spousal interactions [48]. A similar effect is observed in mindfulness, which emphasizes acceptance and attention to present-moment experiences rather than dwelling on past pain or future worries [49]. However, depressive emotions can easily lead women to hold negative views of their circumstances, foster pessimistic thinking, and make it difficult for them to actively engage in the present moment. This negative spiral hinders the cultivation of mindfulness.

Additionally, sleep disorders are often linked to negative emotions, with depression being the most prevalent [50]. This study confirms that higher levels of depressive emotions during late pregnancy are associated with poorer sleep quality three months postpartum. Depression often results in anxiety and worry, making it difficult for women to relax and fall asleep, leading to frequent awakenings, difficulty falling asleep, light sleep, and nightmares [51]. Physiological changes, such as hormonal fluctuations and metabolic shifts, further disrupt sleep patterns and the body's circadian rhythm [52]. Moreover, pregnancy-related depression may reduce a woman's ability to manage postpartum activities such as exercise, which is linked to better sleep. Research [53] suggests that pregnant women who exercise more than six hours per week have a significantly lower risk of sleep disorders than those who exercise less. Reduced physical activity

Table 4 Parameter estimation of perceived stress and PND cross-lagged model

Pathway	*B* (Unstandardized Estimate)	SE	Z	*P*
Perceived stress* T2—Perceived stress T1	0.064	0.081	0.783	0.434
Perceived stress T2—PND T1	0.878	0.094	9.383	< 0.001
PND T2—Perceived stress T1	0.102	0.047	2.184	0.029
PND T2—PND T1	1.182	0.063	18.622	< 0.001
Perceived stress T1—PND T1	7.497	0.684	10.963	< 0.001
Perceived stress T2—PND T2	5.385	1.139	4.729	< 0.001
Perceived stress T2—Perceived stress T2	21.88	1.813	12.068	< 0.001
PND T2—PND T2	6.763	1.427	4.741	< 0.001
Perceived stress T1—Perceived stress T1	12.515	1.041	12.027	< 0.001
PND T1—PND T1	14.219	0.664	21.399	< 0.001
Perceived stress T2—T1	13.259	1.112	11.927	< 0.001
PND T2—T1	2.082	0.634	3.286	0.001
Perceived stress T1—T1	16.38	0.195	83.983	< 0.001
PND T1—PND T1	5.693	0.208	27.385	< 0.001

*Perceived stress was assessed using Perceived Stress Scale

and disrupted sleep–wake cycles can further impair sleep quality. These findings highlight the need for healthcare providers to prioritize screening for depression during late pregnancy, especially in high-risk women, and to implement interventions focused on reducing cognitive reactivity, enhancing mindfulness, and improving sleep quality.

In clinical practice, to translate these research conclusions into intervention measures: For reducing CR, healthcare providers can offer cognitive—behavioral therapy (CBT) programs during late pregnancy. CBT can help women identify and challenge negative thought patterns, which are characteristic of high CR [54]. For example, conducting group CBT sessions where women share and correct each other's negative self—evaluations [54]. To enhance family function, family—centered interventions can be implemented. This could involve family counseling sessions that focus on improving communication within the family, especially during the transition to parenthood [55]. Family members can be educated on how to provide effective emotional support to the pregnant woman. These steps are crucial for reducing the incidence of PND and facilitating early detection and intervention.

Limitations

Despite these significant findings, several limitations should be noted. First, participants were recruited through convenience sampling from only three hospitals in Fujian Province, and the high exclusion rate (> 50%) without demographic comparison data raises concerns about selection bias, limiting generalizability. Second, extending follow-up periods and increasing measurement frequency—such as assessments during early and mid-pregnancy and one year postpartum—would provide more comprehensive insights. Third, the two-wave design and use of the traditional CLPM preclude tests of measurement invariance and the disentanglement of within-person from between-person effects, which cautions against strong causal interpretations. Fourth, this study relied solely on the EPDS for assessing perinatal depressive symptoms. Future studies should consider incorporating clinician-administered diagnostic interviews to confirm depression diagnoses and further investigate the mechanisms underlying cognitive reactivity. Fifth, refining the analysis by distinguishing differences among population subgroups would allow for more nuanced findings. Finally, the LEIDS-RR-CV cutoff, while based on our prior validation study [30], requires further validation in broader populations.

Implications

Our study reveals the causal relationships and dynamic interaction patterns between perinatal depression and various variables, elucidating the evolutionary trajectories of these factors over time. In particular, our findings underscore the ability of late—pregnancy depression to predict postpartum CR, family function, mindfulness, sleep quality, and perceived stress levels. Primarily, these findings emphasize the importance of early identification and treatment of depressive symptoms during late pregnancy to help avert postpartum issues. Furthermore, on the basis of the intricate relationship between late—pregnancy depression and several pivotal postpartum domains, this study has offered precise targets for the development of future intervention measures. At the heart of these targets lies the focus on intervening during late pregnancy to effectively alleviate maternal stress levels, markedly enhance family functioning, optimize sleep quality, and, more importantly, emphasize the promotion of postpartum health. Finally, by integrating assessments of psychological state during late pregnancy into routine screening procedures and coupling them with postpartum follow—ups, we can identify potential high—risk women earlier and intervene, potentially reducing the incidence and severity of PND, thereby safeguarding the health and well—being of both mothers and infants.

Conclusion

This study found that, in this observational cohort, higher depression levels during late pregnancy (T1) were prospectively associated with higher postpartum levels of CR and perceived stress, and with poorer family function, mindfulness, and sleep quality at T2. Additionally, worsening PND increased perceived stress over time through

a cross—regressive effect. Theoretically, this study enriches the understanding of the dynamic relationships among perinatal depression, CR, family function, mindfulness, perceived stress, and sleep quality, providing a robust theoretical framework for further research in this area. Practically, it highlights the importance of early intervention during late pregnancy to prevent postpartum depression.

For clinical practice, it is recommended that healthcare providers enhance depression screening during late pregnancy. Interventions should be targeted at reducing cognitive reactivity (e.g., through cognitive—behavioral therapy), enhancing family function (e.g., via family counseling), improving sleep quality (e.g., by promoting appropriate exercise and sleep hygiene), and fostering mindfulness (e.g., through mindfulness—based stress reduction programs). These measures can help in the prevention, early detection, and treatment of perinatal depression, safeguarding the mental health of mothers and the well—being of infants.

Abbreviations

CR	Cognitive reactivity
PND	Perinatal depression
PSS	Perceived Stress Scale
CAMS-R	Cognitive and Affective Mindfulness Scale-Revised
AIS	Athens Insomnia Scale
EPDS	Edinburgh Postnatal Depression Scale
HPA	Hypothalamic-pituitary-adrenal

Supplementary Information

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Supplementary Material 1.

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Authors' contribution

FFH: study design, revision, and writing of the manuscript. STL, HLH, and HYZ: data acquisition, analysis and interpretation, and writing of the manuscript. JQZ: data analysis and interpretation. Rachel Arbing and Wei-Ti Chen: proofreading of the paper. All authors have read and approved the final manuscript.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. Furthermore, informed consent was obtained from all participants in this study and personal identifiers were removed to ensure confidentiality.

Declarations

Ethics approval and consent to participate

The study received approval from the Institutional Review Board of the Second Affiliated Hospital of Fujian Medical University (No. 2022085), and all procedures were conducted in accordance with theDeclaration of Helsinki. All the participants provided informed consent.

Consent for publication

All participants provided informed consent for publication of the data included in this study.

Competing interests

The authors declare no competing interests.

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References

1. World Health Organization. WHO guide for integration of perinatal mental health in maternal and child health services. Geneva: World Health Organization; 2022. Available from: https://www.who.int/publications/i/item/9789240057142.
2. Lancet T. Perinatal depression: a neglected aspect of maternal health. Lancet. 2023;402(10403):667.
3. Nisar A, Yin J, Waqas A, Bai X, Wang D, Rahman A, et al. Prevalence of perinatal depression and its determinants in Mainland China: A systematic and meta-analysis. J Affect Disord. 2020;277:1022–37.
4. Cheng CY, Chou YH, Chang CH, Liou SR. Trends of perinatal stress, anxiety, and depression and their prediction on postpartum depression. Int J Environ Res Public Health. 2021;18(17):9307.
5. Chen J, Zou T, Zhao DQ, Xiao ZW, XQ W. Expert Consensus on Screening, Diagnosis and Treatment of Perinatal Mental Disorders. Chin Gen Pract. 2023;26(28):3463–70.
6. Lu QR, Ding L, Wang YL, Y W. Moderating effect of psychological resilience between prenatal perceived stress and postnatal depression among perinatal women. Chin Nurs Res. 2019;33(11):5.
7. Hannon S, Gartland D, Higgins A, Brown SJ, Carroll M, Begley C, et al. Maternal mental health in the first year postpartum in a large Irish population cohort: the MAMMI study. Arch Womens Ment Health. 2022;25(3):641–53.
8. Yu J, Zhang Z, Deng Y, Zhang L, He C, Wu Y, et al. Risk factors for the development of postpartum depression in individuals who screened positive for antenatal depression. BMC Psychiatry. 2023;23(1):557.
9. Wang H, Zhou H, Zhang Y, Wang Y, Sun J. Association of maternal depression with dietary intake, growth, and development of preterm infants: a cohort study in Beijing, China. Front Med. 2018;12(5):533–41.
10. Mongan D, Lynch J, Hanna D, Shannon C, Hamilton S, Potter C, et al. Prevalence of self-reported mental disorders in pregnancy and associations with adverse neonatal outcomes: a population-based cross-sectional study. BMC Pregnancy Childbirth. 2019;19(1):412.
11. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. Health Educ Q. 1988;15(4):351–77.
12. Cheng XJ. Interpretation of the health ecological model for self-management behaviors and influencing factors in hypertensive patients [Master's thesis, in Chinese]. Qingdao: Shandong University; 2014.
13. Xu H, Edge BD, Gui YQ, Zhao MD, Zhang S, Zhang ZZ, et al. Research progress on biological mechanisms of postpartum depression. World J Tradit Chin Med. 2023;18(22):3289–93.
14. Van der Does W. Cognitive reactivity to sad mood: structure and validity of a new measure. Behav Res Ther. 2002;40(1):105–20.
15. de Klerk-Sluis JM, Huijbers MJ, Löcke S, Spijker J, Spinhoven P, Speckens AEM, et al. Factors associated with relapse and recurrence of major depressive disorder in patients starting mindfulness-based cognitive therapy. Depress Anxiety. 2022;39(2):113–22.
16. Huang FF, Wen ZP, Li Q, Chen B, Weng WJ. Factors influencing cognitive reactivity among young adults at high risk for depression in China: a cross-sectional study. BMC Public Health. 2020;20(1):703.
17. Guhn A, Sterzer P, Haack FH, Köhler S. Affective and cognitive reactivity to mood induction in chronic depression. J Affect Disord. 2018;229:275–81.
18. Fu YQ. A longitudinal study on cognitive reactions to depression among pregnant and postpartum women [Master's thesis, in Chinese]. Fuzhou: Fujian Medical University; 2021.

19. Redinger S, Norris SA, Pearson RM, Richter L, Rochat T. First trimester antenatal depression and anxiety: prevalence and associated factors in an urban population in Soweto, South Africa. J Dev Orig Health Dis. 2018;9(1):30–40.
20. Chen J, Cross WM, Plummer V, Lam L, Sun M, Qin C, et al. The risk factors of antenatal depression: a cross-sectional survey. J Clin Nurs. 2019;28(19–20):3599–609.
21. Zhu JN, Sun QQ, Chen QQ, Zhang YN, Wang Z. Sleep disorders and pregnancy. Chin J Clinicians. 2018;46(02):127–30.
22. He JL. Effectiveness of a web-based prenatal mindfulness intervention in preventing postpartum depression among perinatal women [Master's thesis, in Chinese]. Shenyang: China Medical University; 2023.
23. Raes F, Dewulf D, Van Heeringen C, Williams JM. Mindfulness and reduced cognitive reactivity to sad mood: evidence from a correlational study and a non-randomized waiting list controlled study. Behav Res Ther. 2009;47(7):623–7.
24. Guerrero-Muñoz D, Salazar D, Constain V, Perez A, Pineda-Cañar CA, García-Perdomo HA. Association between family functionality and depression: a systematic review and meta-analysis. Korean J Fam Med. 2021;42(2):172–80.
25. Zhu Y, Yin X, Gong Y. Prevalence and risk factors of postpartum depressive symptoms in Central China: a longitudinal, real-world study. J Affect Disord. 2026;392:120217.
26. Huang Y, Liu Y, Wang Y, Liu D. Family function fully mediates the relationship between social support and perinatal depression in rural Southwest China. BMC Psychiatry. 2021;21(1):151.
27. Huang J, Lin Y, Fu Y, Xu Z, Hong H, Arbing R, et al. A longitudinal network analysis of interaction factors among Chinese women at high risk for perinatal depression. Midwifery. 2024;139:104187.
28. Yuan S, Cao W, Zhang MY, Wu S, Wei X. Towards more accurate causal analysis: recent advances in cross-lagged models. Human Resources Development of China. 2021;38(02):23–41.
29. Tooth L, Ware R, Bain C, Purdie DM, Dobson A. Quality of reporting of observational longitudinal research. Am J Epidemiol. 2005;161(3):280–8.
30. Fu Y, Lin YA, Zheng J, Hong H, Huang S, Li J, et al. Supporting routine cognitive reactivity assessment during the perinatal period: psychometric testing of the Chinese version of the Leiden Index of Depression Sensitivity. BMC Pregnancy Childbirth. 2022;22(1):911.
31. Shi YF, Shi SH, Huang XM. Application of structural equation model based on R in ecology. Chin J Ecol. 2022;41(05):1015–23.
32. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983;24(4):385–96.
33. Feldman G, Hayes A, Kumar S, Greeson J, Laurenceau JP. Mindfulness and emotion regulation: the development and initial validation of the cognitive and affective mindfulness scale-revised (CAMS-R). J Psychopathol Behav Assess. 2007;29(3):177–90.
34. Smilkstein G. The family APGAR: a proposal for a family function test and its use by physicians. J Fam Pract. 1978;6(6):1231–9.
35. Soldatos CR, Dikeos DG, Paparrigopoulos TJ. Athens insomnia scale: validation of an instrument based on ICD-10 criteria. J Psychosom Res. 2000;48(6):555–60.
36. Huang FF, Li H, Lei Y, Li Q, Chen B. Adaptation and validation of the Chinese version of the modified Leiden index of depression sensitivity. J Affect Disord. 2019;256:458–67.
37. Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. Br J Psychiatry. 1987;150:782–6.
38. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. Source Code Biol Med. 2008;3(1):17.
39. Yakupova V, Suarez A. Postpartum PTSD and birth experience in Russian-speaking women. Midwifery. 2022;112:103385.
40. Ertan D, Hingray C, Burlacu E, Sterlé A, El-Hage W. Post-traumatic stress disorder following childbirth. BMC Psychiatry. 2021;21(1):155.
41. Fu Y, Lin X, Li Y, Zhang M, Chen WT, Huang F. Trajectories of cognitive reactivity and its predictive value on postpartum depression in Chinese women: a latent class growth modeling analysis. J Psychosom Obstet Gynaecol. 2023;44(1):2256470.
42. Kruijt AW, Antypa N, Booij L, de Jong PJ, Glashouwer K, Penninx BW, et al. Cognitive reactivity, implicit associations, and the incidence of depression: a two-year prospective study. PLoS ONE. 2013;8(7):e70245.
43. Wang Y. Status and influencing factors of maternal cognitive decline [Master's thesis, in Chinese]. Tangshan: North China University of Science and Technology; 2020.
44. Underwood L, Waldie KE, D'Souza S, Peterson ER, Morton SM. A longitudinal study of pre-pregnancy and pregnancy risk factors associated with antenatal and postnatal symptoms of depression: evidence from growing up in New Zealand. Matern Child Health J. 2017;21(4):915–31.
45. Griggs KM, Hrelic DA, Williams N, McEwen-Campbell M, Cypher R. Preterm labor and birth: a clinical review. MCN Am J Matern Child Nurs. 2020;45(6):328–37.
46. Zhou T, SQ Y. Cognitive Vulnerability-Stress Model of Depression: Origin, Development and Integration. 2006;(05):762–8.
47. Lau MA, Segal ZV, Williams JM. Teasdale's differential activation hypothesis: implications for mechanisms of depressive relapse and suicidal behaviour. Behav Res Ther. 2004;42(9):1001–17.
48. Xu MS, Wang JJ, Weng QY, Fang XL. Analysis of the current status and influencing factors of postpartum depression among women under the new reproductive policy. Pract Prev Med. 2023;30(6):737–40.
49. Baer RA, Smith GT, Hopkins J, Krietemeyer J, Toney L. Using self-report assessment methods to explore facets of mindfulness. Assessment. 2006;13(1):27–45.
50. Xiao YY. Effect of meticulous nursing on parturient's psychological state, sleep status and postpartum blood loss. Lab Med Clin. 2020;17(08):1044–6+50.
51. Vargas I, Nguyen AM, Haeffel GJ, Drake CL. A negative cognitive style is associated with greater insomnia and depression symptoms: the mediating role of sleep reactivity. J Affect Disord Rep. 2020;1:100010.
52. Zhang J, Tong Y. Research on sleep disorders during pregnancy. Med Recapitul. 2013;19(13):2398–400.
53. Wu P. Investigation on influencing factors of sleep quality among pregnant women in late pregnancy in Chongqing area. Matern Child Health Care China. 2017;32(9):3.
54. Dooley RL, McAloon J. The efficacy of antenatal cognitive behavioural therapy for antenatal and postnatal depression: a PRISMA based systematic review and meta-analysis. J Affect Disord. 2025;376:225–40.
55. He L, Soh KL, Yu J, Chen A, Dong X. Effect of family-centered interventions for perinatal depression: an overview of systematic reviews. Front Psychiatry. 2023;14:1094360.

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