Article

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Effect of Mindfulness-Based Stress Reduction Combined With Family Support on Depressive Symptoms and Sleep Quality in Patients With Postpartum Depression: A Retrospective Cohort Study Based on Propensity Score Matching

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Abstract

Background: To explore the association between mindfulness-based stress reduction nursing combined with family support nursing and depressive symptoms, sleep quality, related physiological indicators in patients with postpartum depression using a retrospective propensity score-matched design.

Methods: A total of 472 patients with postpartum depression admitted to Nanjing Medical University Affiliated Women's and Children's Hospital between October 2022 and October 2025 were included. After propensity score matching, 106 patients who received family support nursing alone (control group) and 106 who received mindfulness-based stress reduction nursing combined with family support nursing (observation group) were analysed. Outcomes were assessed before nursing, at 4 and 8 weeks after nursing. Repeated measures analysis of variance (ANOVA) and post-hoc tests with Bonferroni correction were applied. The primary outcome was the Edinburgh Postnatal Depression Scale (EPDS) score. Secondary outcomes included Pittsburgh Sleep Quality Index (PSQI) scores, sleep architecture parameters, inflammatory markers (IL-1β, TNF-α, IL-6), salivary cortisol, heart rate variability (HRV) parameters, and nursing satisfaction rate.

Results: Repeated measures ANOVA revealed significant time, group, and time $\times$ group interaction effects for EPDS scores, PSQI scores, and sleep architecture ($p < 0.001$). At 4 and 8 weeks, EPDS and PSQI scores were lower than baseline values in both group ($p < 0.0167$, Bonferroni corrected), and scores at week 8 were further reduced compared with those at week 4 ($p < 0.0167$). The observation group showed significantly lower EPDS and PSQI scores than the control group ($p < 0.0167$). Similar patterns were observed for inflammatory markers, salivary cortisol, and HRV parameters. The observation group also had a higher satisfaction rate (86.79% vs. 73.58%, $p = 0.016$).

Conclusions: In this retrospective matched cohort, mindfulness-based stress reduction nursing combined with family support nursing was associated with greater improvements in depressive symptoms, sleep quality, and stress-related physiological parameters compared with family support nursing alone. These associations warrant confirmation in prospective randomised controlled trials.

Keywords

mindfulness-based stress reduction; family support; postpartum depression; sleep quality; heart rate variability

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Introduction

Postpartum depression is a multifaceted condition. Patients not only face persistent negative emotions and disrupted sleep architecture but may also exhibit deep physiological stress responses, including abnormal cortisol secretion, impaired heart rate variability (HRV), and increased in pro-inflammatory cytokine levels [1]. Family support nursing has been commonly used in clinical practice, aiming to reduce maternal physical and psychological burden by optimising the external environment and sharing caregiving responsibilities [2,3]. However, external support alone may be insufficient to reverse ruminative thinking and physiological hyperarousal from an endogenous perspective, potentially limiting its effects on sleep disorders and endocrine imbalances. Mindfulness-based stress reduction (MBSR) emphasises purposeful, non-judgmental awareness of the present moment and may help interrupt negative cognitive patterns, showing potential benefits for autonomic function and inflammatory stress [4].

Currently, few studies have combined MBSR nursing with family support nursing or evaluated its effects using multidimensional objective indicators. Therefore, this retrospective propensity score-matched cohort study explored the associations between these two nursing models and depressive symptoms, sleep quality, HRV, inflammatory markers, and salivary cortisol in patients with postpartum depression, aiming to provide a basis for optimising psychological nursing strategies for postpartum women.

Materials and Methods

Inclusion and Exclusion Criteria

Inclusion criteria: (1) singleton, full-term delivery; (2) age 20–45 years; (3) diagnosis of postpartum depression according to the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) [5], and an Edinburgh Postnatal Depression Scale (EPDS) score $\geq$10 at the 6-week postpartum screening [6]; (4) complete medical records and receipt of either family support nursing alone or the combined nursing protocol.

Exclusion criteria: (1) a history of severe mental illness such as schizophrenia, bipolar disorder; (2) severe somatic diseases, including cardiovascular and cerebrovascular diseases; (3) neurological disorders, such as epilepsy or dementia; (4) severe postpartum complications, such as postpartum haemorrhage or severe infection; (5) major diseases in the newborn.

Study Design and Participants

This retrospective observational study initially included 869 postpartum women between October 2022 and October 2025. Of these, 216 were excluded for not meeting inclusion criteria: 12 due to non-singleton pregnancy or preterm delivery, 17 due to age outside 20–45 years, 163 due to absence of a DSM-5 diagnosis of postpartum depression or an EPDS score $<$10, and 24 due to incomplete records or receipt of other nursing protocols. A further 181 patients were excluded based on exclusion criteria: 9 due to severe mental illness, 24 due to severe somatic disease, 15 due to neurological disorders, 92 due to severe postpartum complications, and 41 due to major neonatal disease. Thus, 472 patients were included and classified into two groups according to nursing records: 271 had received family support nursing (control group) and 201 had received MBSR nursing combined with family support nursing (observation group). To reduce selection bias, propensity score matching was performed using a calliper of 0.2 based on the following baseline variables: age, parity, gestational age, maternal type, mode of delivery, education level, employment status, marital status, and feeding method. After matching, 106 patients remained for each group, yielding a final sample of 212. The flow diagram of patient selection is presented in Fig. 1.

The study was approved by the Ethics Committee of Nanjing Medical University Affiliated Women's and Children's Hospital (NO. 2025KT-109), was conducted in accordance with the Declaration of Helsinki, and obtained informed consent from the patients.

Nursing Protocols

Both groups received nursing interventions over an 8-week period. The observation group undertook at least 20 minutes of daily mindfulness practice, 7 days per week, for 8 weeks. Weekly telephone follow-ups were conducted to monitor adherence and address any difficulties encountered.

Control Group (Family Support Nursing)

Family support nursing comprised three components.

(1) Family support system assessment and health education: At the early stage of admission, postpartum women were comprehensively evaluated for their family structure, primary caregivers, and quality of family relationships. Based on this assessment, systematic health education re-

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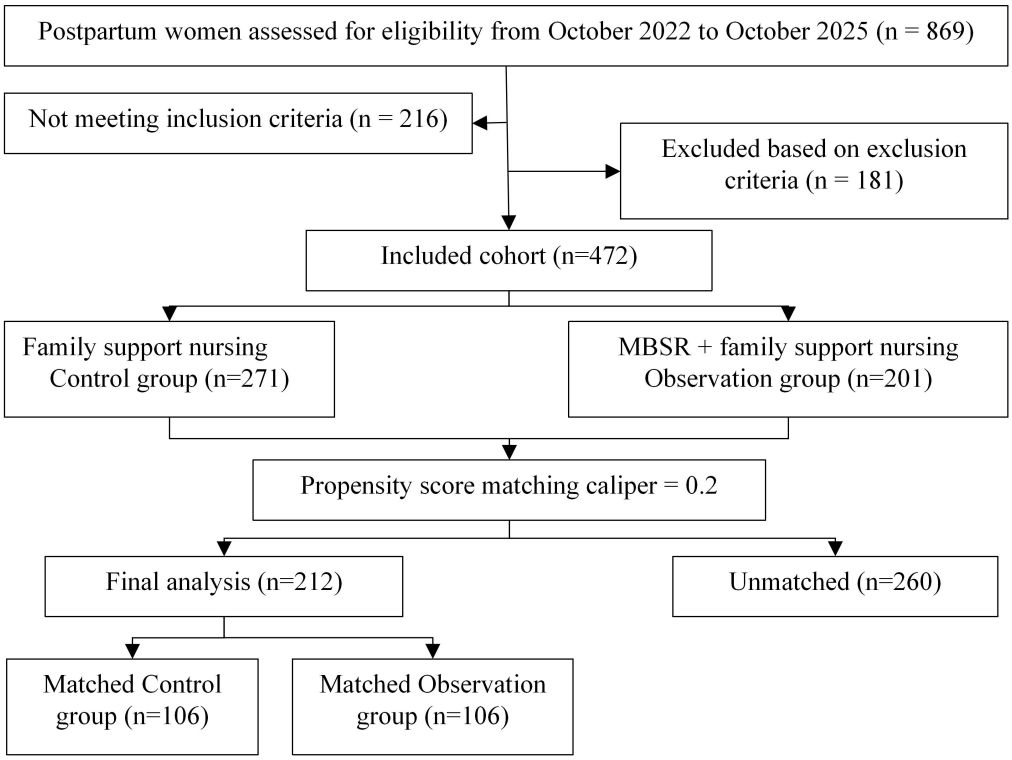


Fig. 1. Flow diagram of patient selection. MBSR, Mindfulness-based stress reduction.

garding postpartum depression was provided to the spouse and other key family members, covering its neuroendocrine mechanisms, typical manifestations, and potential harm to maternal and infant health. The nursing process focused on correcting families' inherent misconceptions about postpartum mood swings, emphasising that the postpartum woman may be psychologically vulnerable and require external emotional support. Family members were encouraged to accept and prioritise the patient's psychological distress and were guided to clarify their respective roles in caregiving. A stable family support network centred on the spouse and supported by other immediate family members was thereby established to facilitate the subsequent implementation of supportive nursing measures.

(2) Emotional support and communication skills training: Through brochures and audio materials, family members were guided to master listening and empathic communication skills and to engage in in-depth conversations with the postpartum woman during quiet periods daily. Family members were instructed to maintain a neutral and accepting attitude, avoid criticism or excessive advice, and encourage patients to fully express their anxiety and depression. Spouses were trained to provide timely physical comfort (e.g., hugging) and verbal reassurance. Family members were encouraged to offer positive affirmation and praise when patients completed breastfeeding or infant soothing tasks.

(3) Instrumental support and daily living care: To address sleep deprivation and physical exhaustion, an internal family schedule for newborn care was established. Apart from exclusive breastfeeding, which required the patient's direct involvement, tasks such as diaper changing, burping, bathing, and nighttime soothing were primarily taken over by the spouse and other family members. Patients were encouraged to obtain sufficient and continuous rest time daily, particularly adequate nighttime sleep. Additionally, based on patient's constitution a scientific nutritious diet was designed, and a quiet, comfortable home environment with appropriate temperature and humidity was maintained.

Observation Group (MBSR + Family Support Nursing)

In addition to the family support nursing, the observation group received a structured MBSR nursing program delivered by nurses with a bachelor's degree in nursing, ≥3 years of psychological nursing experience, and 40 hours of MBSR training. Intervention fidelity was maintained by a detailed protocol manual, and inter-rater consistency was

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ensured through regular team meetings and review of audio-recorded sessions.

The program included: (1) Concurrent family support nursing—The observation group received the same family support nursing measures as the control group. Family members also served as supervisors and companions for mindfulness practice, actively shielding the patient from external noise and managing unexpected household tasks during home-based mindfulness practice, creating a private and quiet environment. (2) Introduction to mindfulness and mindful breathing (Week 1)—via video conferencing, the core concept of non-judgmental present-moment awareness was introduced. Patients practiced mindful breathing for at least 20 minutes each morning and whenever they experienced emotional distress. A standardised audio guide developed by the hospital psychology department was provided for home practice. Daily practice logs were maintained, and the mean completion rate was 78%. (3) Body scan and sleep optimisation (Weeks 2–8)—patients followed a guided body scan recording each night before sleep, systematically shifting their attention from toes to head, promoting parasympathetic activation and reducing pre-sleep rumination. (4) Mindfulness in daily life and emotional acceptance—patients were guided to integrate mindfulness into daily activities, including breastfeeding, holding the baby, and eating, and to use a "pause–deep breath–notice–respond" strategy when facing negative emotions triggered by infant crying.

Observation Indicators

The primary outcomes were the EPDS score, PSQI score, and polysomnographic sleep architecture parameters (total sleep time, sleep efficiency, rapid eye movement [REM] sleep percentage). Secondary/exploratory outcomes included serum concentrations of IL-1β, TNF-α, and IL-6, salivary cortisol, HRV parameters (SDNN and LF/HF), and nursing satisfaction rate. All outcomes were assessed before nursing and at 4 and 8 weeks of nursing.

EPDS and PSQI Scores

EPDS [6] scores (0–30) and PSQI [7] scores (0–21) were extracted from medical records. The PSQI includes seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction, each scored 0–3. Higher scores of EPDS and PSQI represent more severe depression and poorer sleep quality, respectively.

Sleep Architecture

An overnight polysomnography was performed using a BS-01A portable device (Xi'an Boshi Medical Technology Co., Ltd., Xi'an, Shaanxi, China) from 22:00 to 06:00. Scoring followed the American Academy of Sleep Medicine (AASM) criteria. Sleep parameters were independently recorded by two trained technicians who were blinded to group assignment; inter-rater reliability was assessed using intraclass correlation coefficients (ICC $>$0.90 for all parameters). Nighttime breastfeeding and infant-care behaviours were documented by bedside nurses and considered during scoring to differentiate physiological awakenings from infant-related interruptions [8].

Inflammatory Markers

Fasting venous blood was collected between 06:00 and 08:00 before nursing and at 4 and 8 weeks of nursing. Approximately 3–5 mL of blood was drawn from the cubital vein into coagulation-promoting tubes, centrifuged (radius 10 cm, 3500 r/min, 12 min), and serum was stored at −80 °C until analysis. IL-1β, TNF-α, and IL-6 levels were measured using chemiluminescence or magnetic particle chemiluminescence assays, with kits from Jiangxi Youwei Biotechnology Co., Ltd. (Nanchang, Jiangxi, China), Shanghai Tongxin Biotechnology Co., Ltd. (Shanghai, China), and Zhengzhou Autobio Diagnostics Co., Ltd. (Zhengzhou, Henan, China), respectively.

Salivary Cortisol

Saliva samples were collected within 30 minutes of morning awakening using dedicated collection tubes, after 30 minutes of fasting and with no drinking, no tooth brushing, and no strenuous activity. Samples were stored at −80 °C and analysed by enzyme-linked immunosorbent assay (Roche Diagnostics).

HRV

The standard deviation of normal-to-normal intervals (SDNN) and low-frequency to high-frequency (LF/HF) ratio were recorded using an HRVD-21 analysis system (Jinan Huiyironggong Technology Co., Ltd., Jinan, Shandong, China) between 09:00 and 11:00 after 10–15 minutes of seated rest. Electrocardiogram (ECG) signals were continuously recorded for at least 5 minutes in a quiet, temperature-controlled environment.

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Nursing Satisfaction

A self-designed nursing satisfaction questionnaire (total score 0–100) was used. Items covered nursing attitude, professional skills, health education effectiveness, and humanistic care. Content validity was established through two rounds of expert review (content validity index = 0.92), and internal consistency was satisfactory (Cronbach's $\alpha = 0.88$). The satisfaction rate was defined as the proportion of patients scoring "very satisfied" or "satisfied" ($\geq$80 points).

Statistical Analysis

All analyses were performed using SPSS 26.0 (IBM Corp., Armonk, NY, USA). A two-sided significance level of $\alpha = 0.05$ was adopted. Continuous variables were expressed as mean $\pm$ standard deviation ($\bar{x} \pm s$) and categorical variables as frequencies (%). After confirming normal distribution and homogeneity of variance, baseline comparisons were conducted with independent-samples *t*-tests or χ^2 tests. Outcomes measured repeatedly were analysed with repeated measures analysis of variance (ANOVA); when Mauchly's test indicated a violation of sphericity, Greenhouse–Geisser correction was applied. Post-hoc pairwise comparisons were adjusted using the Bonferroni method. For the within-group comparisons among the three time points (baseline, week 4, and week 8), the Bonferroni-adjusted significance level was set at $\alpha' = 0.0167$ (0.05/3). The same adjusted α' was applied to between-group comparisons at each of the three time points. For single-time-point multiple comparisons (EPDS dimension scores and PSQI component scores), α' was set at 0.05 divided by the number of comparisons (0.0167 for three comparisons and 0.0071 for seven comparisons, respectively). Propensity score matching was performed with a calliper of 0.2, and balance after matching was assessed by standardised mean differences (SMD), with SMD <0.1 considered indicative of adequate balance.

Results

Baseline Characteristics and Matching

Before matching, there were differences in age, gestational age, and maternal type between groups ($p < 0.05$). No other baseline variables showed significant differences (all $p > 0.05$). After matching, all baseline characteristics were well balanced, with all SMD values <0.1 and no significant differences between groups (all $p > 0.05$). Baseline data are presented in Table 1 and Table 2.

Primary Outcome: EPDS Scores

Intragroup comparisons showed that EPDS scores at weeks 4 and 8 were significantly lower than baseline in both groups, and scores at week 8 were further significantly lower than those at week 4 (all $p < 0.0167$, Bonferroni corrected). Intergroup comparisons revealed that the observation group had significantly lower EPDS scores than the control group at both weeks 4 and 8 ($p < 0.0167$). The time $\times$ group interaction was significant ($F = 42.658$, $p < 0.001$), indicating a greater improvement in the observation group. Mauchly's test of sphericity was not significant ($p > 0.05$), and residuals were normally distributed with homogeneous variances (Table 3).

Analysis of EPDS subscales at week 8 showed that the observation group had significantly lower scores on the anhedonia, anxiety, and depression dimensions compared with the control group (all $p < 0.0167$, Bonferroni corrected, Table 4).

Comparison of PSQI Scores Between the Two Groups

Intragroup comparisons showed that PSQI scores at weeks 4 and 8 were significantly lower than baseline in both groups, and scores at week 8 were further significantly lower than those at week 4 (all $p < 0.0167$, Bonferroni corrected). Intergroup comparisons revealed that the observation group had significantly lower PSQI scores than the control group at both weeks 4 and 8 ($p < 0.0167$). The time $\times$ group interaction was significant ($F = 18.437$, $p < 0.001$), indicating a greater improvement in the observation group. Mauchly's test of sphericity was not significant ($p > 0.05$), and residuals were normally distributed with homogeneous variances (Table 5).

At week 8, all seven PSQI component scores were significantly lower in the observation group than in the control group (all $p \leq 0.001$, Table 6).

Comparison of Sleep Architecture Between the Two Groups

Intragroup comparisons showed that total sleep time, sleep efficiency, and REM sleep percentage at 4 and 8 weeks of nursing were higher than those before nursing in both groups, and week 8 values were further significantly higher than week 4 values (all $p < 0.0167$). Intergroup comparisons showed that total sleep time, sleep efficiency, and REM sleep percentage at 4 and 8 weeks of nursing were higher in the observation group than in the control group (*p*

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Table 1. Baseline characteristics before matching (Original 472 patients).

Baseline data	Control (n = 271)	Observation (n = 201)	t/χ^2	p
Age ($\bar{x} \pm$ s, years)	29.74 ± 4.01	28.88 ± 3.69	2.383	0.018
Parity ($\bar{x} \pm$ s, times)	1.91 ± 0.33	1.89 ± 0.37	0.618	0.537
Gestational age ($\bar{x} \pm$ s, weeks)	38.79 ± 1.30	39.11 ± 1.25	–2.688	0.007
Maternal type [n (%)]			6.460	0.011
Primipara	189 (69.74)	161 (80.10)		
Multipara	82 (30.26)	40 (19.90)		
Delivery mode [n (%)]			0.099	0.754
Vaginal delivery	167 (61.62)	121 (60.20)		
Cesarean section	104 (38.38)	80 (39.80)		
Education level [n (%)]			0.533	0.766
High school or below	92 (33.95)	62 (30.85)		
College/Bachelor's degree	143 (52.77)	110 (54.73)		
Master's degree or above	36 (13.28)	29 (14.43)		
Occupational status [n (%)]			1.109	0.574
Employed	151 (55.72)	116 (57.71)		
Unemployed/Housewife	59 (21.77)	36 (17.91)		
Other	61 (22.51)	49 (24.38)		
Marital status [n (%)]			1.242	0.265
Married/Cohabiting	249 (91.88)	190 (94.53)		
Single/Divorced/Separated	22 (8.12)	11 (5.47)		
Feeding method [n (%)]			0.937	0.626
Exclusive breastfeeding	147 (54.24)	118 (58.71)		
Mixed feeding	102 (37.64)	68 (33.83)		
Formula feeding	22 (8.12)	15 (7.46)		

Note: Only age, gestational age, and maternal type were significantly different before matching.

< 0.0167). The time × group interaction effects indicated significant differences in the changing trends of sleep architecture between the two groups, with a greater change in the observation group ($p < 0.001$). Mauchly's test of sphericity was not significant ($p > 0.05$), and residuals were normally distributed with homogeneous variances (Table 7).

Comparison of Inflammatory Markers Between the Two Groups

Intragroup comparisons showed that IL-1β, TNF-α, and IL-6 levels at 4 and 8 weeks of nursing were lower than those before nursing, and week 8 levels were further significantly lower than week 4 levels (all $p < 0.0167$). Intergroup comparisons showed that IL-1β, TNF-α, and IL-6 at 4 and 8 weeks of nursing were lower in the observation group ($p < 0.0167$). The time × group interaction effects indicated significant differences in the changing trends of inflammatory markers between them, with a greater change in the observation group ($p < 0.001$). Mauchly's test of sphericity was not significant ($p > 0.05$), and residuals were normally distributed with homogeneous variances Table 8.

Comparison of Salivary Cortisol Between the Two Groups

Repeated measures ANOVA showed significant differences in the main effects of time, between-group effects, and time × group interaction for salivary cortisol ($p < 0.001$). Intragroup comparisons showed that salivary cortisol at 4 and 8 weeks of nursing was lower than that before nursing, and week 8 level was further lower than week 4 level ($p < 0.0167$). Intergroup comparisons showed that salivary cortisol at 4 and 8 weeks of nursing was lower in the observation group ($p < 0.0167$). The time × group interaction effects indicated significant differences in the changing trends of salivary cortisol between the two groups, with a greater change in the observation group ($p < 0.001$). Mauchly's test of sphericity was not significant ($p > 0.05$), and residuals were normally distributed with homogeneous variances (Fig. 2).

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Table 2. Baseline characteristics after matching (n = 212).

Baseline data	Control group (n = 106)	Observation group (n = 106)	t/χ^2	*p*	SMD
Age ($\bar{x} \pm$ s, years)	28.35 ± 3.87	28.62 ± 4.01	–0.499	0.618	0.068
Parity ($\bar{x} \pm$ s, times)	1.89 ± 0.32	1.94 ± 0.38	–1.036	0.301	0.092
Gestational age ($\bar{x} \pm$ s, weeks)	38.94 ± 1.23	39.02 ± 1.18	–0.483	0.629	0.066
Maternal type [n (%)]			0.232	0.630	0.066
Primipara	79 (74.53)	82 (77.36)			
Multipara	27 (25.47)	24 (22.64)			
Delivery mode [n (%)]			0.178	0.673	0.058
Vaginal delivery	63 (59.43)	66 (62.26)			
Cesarean section	43 (40.57)	40 (37.74)			
Education level [n (%)]			1.136	0.567	0.059
High school or below	38 (35.85)	35 (33.02)			
College/Bachelor's degree	52 (49.06)	59 (55.66)			
Master's degree or above	16 (15.09)	12 (11.32)			
Occupational status [n (%)]			0.535	0.765	0.079
Employed	68 (64.15)	72 (67.92)			
Unemployed/Housewife	21 (19.81)	17 (16.04)			
Other	17 (16.04)	17 (16.04)			
Marital status [n (%)]			0.353	0.552	0.082
Married/Cohabiting	101 (95.28)	99 (93.40)			
Single/Divorced/Separated	5 (4.72)	7 (6.60)			
Feeding method [n (%)]			0.843	0.656	0.076
Exclusive breastfeeding	59 (55.66)	63 (59.43)			
Mixed feeding	36 (33.96)	30 (28.30)			
Formula feeding	11 (10.38)	13 (12.26)			

Note: A SMD value <0.1 indicates good balance. SMD, standardised mean difference.

Table 3. Comparison of EPDS scores ($\bar{x} \pm$ s).

		EPDS score		
Group	n	Before nursing	Week 4	Week 8
Control group	106	13.89 ± 2.11	10.14 ± 1.89*	8.69 ± 1.41*†
Observation group	106	13.94 ± 2.07	9.22 ± 1.76*$^{\#}$	6.33 ± 1.07*$^{\#\dagger}$
F		$F_{time} = 256.374$, $F_{group} = 38.921$, $F_{time \times group} = 42.658$		
p		$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$		

Note: Bonferroni-corrected post-hoc tests were used. The adjusted significance level for pairwise comparisons among the three time points is $\alpha' = 0.0167$ (0.05/3). *$p < 0.0167$ vs. Before nursing within group; $^{\dagger}p < 0.0167$ vs. Week 4 within the same group; $^{\#}p < 0.0167$ vs. Control group at the same time point. All significant comparisons remained significant at the corrected α'. EPDS, Edinburgh Postnatal Depression Scale.

Table 4. Comparison of EPDS dimension scores at week 8 ($\bar{x} \pm$ s).

EPDS dimension	Items	Control group (n = 106)	Observation group (n = 106)	t	*p*
Anhedonia	1–2	1.52 ± 0.64	1.08 ± 0.55	5.368	<0.0167
Anxiety	3–6	3.84 ± 1.12	2.76 ± 0.94	7.592	<0.0167
Depression	7–10	3.33 ± 1.08	2.49 ± 0.87	6.244	<0.0167

Note: EPDS dimensions are based on the three-factor structure (Anhedonia: items 1–2; Anxiety: items 3–6; Depression: items 7–10) [9]. Bonferroni-corrected P values; the adjusted significance level for 3 comparisons is α'=0.0167. All *p* values were <0.0167. EPDS, Edinburgh Postnatal Depression Scale.

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Table 5. Comparison of PSQI Scores ($\bar{x} \pm s$).

Group	n	PSQI score		
		Before nursing	Week 4	Week 8
Control group	106	13.21 ± 2.12	11.15 ± 1.75*	9.21 ± 1.26*†
Observation group	106	12.98 ± 2.45	9.81 ± 1.26*#	8.07 ± 1.21*#†
F		F_{time} = 187.362, F_{group} = 24.581, $F_{time\times group}$ = 18.437		
p		$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time\times group} < 0.001$		

Note: Bonferroni-corrected post-hoc tests were used. The adjusted significance level for pairwise comparisons among the three time points is α'=0.0167 (0.05/3). *$p < 0.0167$ vs. Before nursing within group; †$p < 0.0167$ vs. Week 4 within the same group; #$p < 0.0167$ vs. Control group at the same time point. All significant comparisons remained significant at the corrected α'. PSQI, Pittsburgh Sleep Quality Index.

Table 6. Comparison of PSQI component scores at week 8 ($\bar{x} \pm s$).

PSQI component	Control group (n = 106)	Observation group (n = 106)	t	*p*
Subjective sleep quality	1.45 ± 0.52	1.12 ± 0.41	5.124	<0.001
Sleep latency	1.38 ± 0.49	1.05 ± 0.38	5.478	<0.001
Sleep duration	1.29 ± 0.46	0.98 ± 0.35	5.516	<0.001
Habitual sleep efficiency	1.33 ± 0.47	1.02 ± 0.39	5.225	<0.001
Sleep disturbances	1.41 ± 0.50	1.15 ± 0.42	4.182	<0.001
Use of sleep medication	0.62 ± 0.48	0.45 ± 0.38	2.863	0.005
Daytime dysfunction	1.73 ± 0.58	1.30 ± 0.46	5.981	<0.001

Note: *Bonferroni-corrected P values; the adjusted significance level for 7 comparisons is α' = 0.0071 (0.05/7). All *p* values were <0.0071, confirming statistically significant differences. PSQI, Pittsburgh Sleep Quality Index.

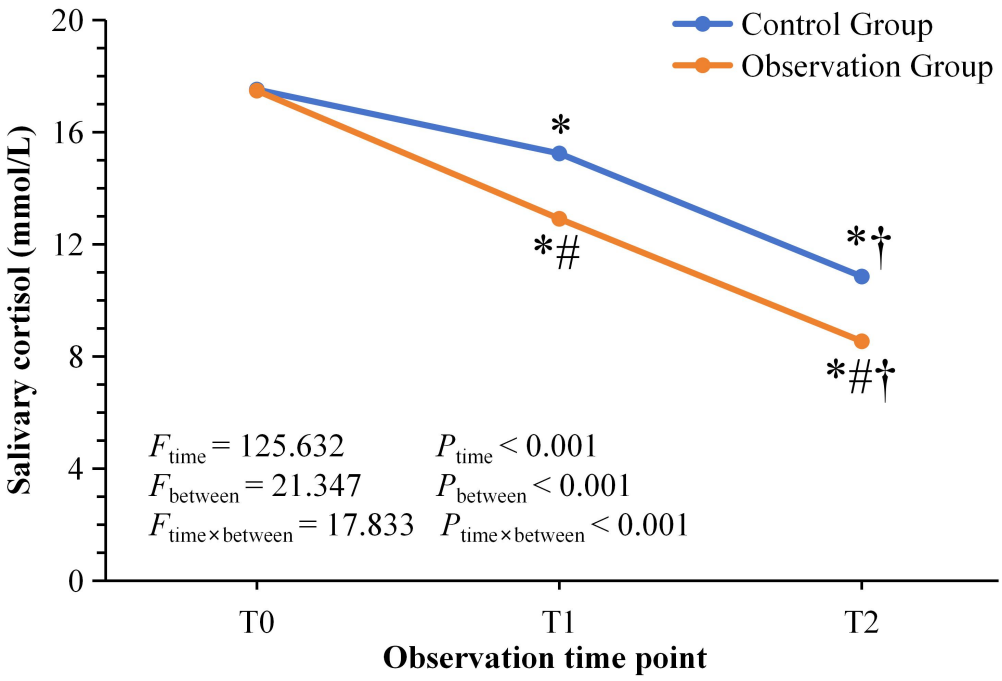


Fig. 2. Salivary cortisol levels at baseline, week 4, and week 8 in the two groups. Note: T0, Before nursing; T1, Nursing for 4 weeks; T2, Nursing for 8 weeks; *$p < 0.0167$ vs. Before nursing within group; #$p < 0.0167$ vs. Control group at same time point; †$p < 0.0167$ vs. Week 4 within the same group. All post-hoc comparisons Bonferroni corrected.

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Table 7. Comparison of sleep architecture ($\bar{x} \pm s$).

Group	n	Total sleep time (h)			Sleep efficiency (%)			REM sleep percentage (%)		
		Before nursing	Week 4	Week 8	Before nursing	Week 4	Week 8	Before nursing	Week 4	Week 8
Control group	106	6.25 ± 0.72	6.47 ± 0.78*	6.73 ± 0.81*†	70.14 ± 3.95	72.84 ± 4.02*	74.74 ± 4.26*†	13.25 ± 2.14	14.14 ± 2.38*	14.93 ± 2.51*†
Observation group	106	6.31 ± 0.69	6.82 ± 0.96*#	7.11 ± 1.04*#†	69.89 ± 4.18	74.53 ± 4.27*#	76.58 ± 4.33*#†	13.17 ± 2.26	14.82 ± 2.41*#	15.66 ± 2.46*#†
F		$F_{time} = 98.256$, $F_{group} = 12.347$, $F_{time \times group} = 16.782$			$F_{time} = 175.632$, $F_{group} = 22.415$, $F_{time \times group} = 28.963$			$F_{time} = 145.876$, $F_{group} = 18.234$, $F_{time \times group} = 23.547$		
p		$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$			$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$			$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$		

Note: Bonferroni-corrected post-hoc tests were used. The adjusted significance level for pairwise comparisons among the three time points is $\alpha' = 0.0167$ (0.05/3). *$p < 0.0167$ vs. Before nursing within group; †$p < 0.0167$ vs. Week 4 within the same group; #$p < 0.0167$ vs. Control group at the same time point. All significant comparisons remained significant at the corrected α'. REM, rapid eye movement.

Table 8. Comparison of inflammatory marker levels ($\bar{x} \pm s$).

Group	n	IL-1β (pg/mL)			TNF-α (pg/mL)			IL-6 (pg/mL)		
		Before nursing	Week 4	Week 8	Before nursing	Week 4	Week 8	Before nursing	Week 4	Week 8
Control group	106	6.86 ± 1.05	5.36 ± 1.14*	4.92 ± 0.97*†	14.52 ± 2.32	12.14 ± 2.06*	9.85 ± 1.89*†	9.14 ± 2.04	8.26 ± 1.85*	6.93 ± 1.69*†
Observation group	106	6.79 ± 1.12	4.78 ± 1.03*#	4.36 ± 0.88*#†	14.46 ± 2.67	10.83 ± 1.89*#	8.56 ± 1.54*#†	9.07 ± 2.15	7.05 ± 1.69*#	5.85 ± 1.54*#†
F		$F_{time} = 230.149$, $F_{group} = 30.582$, $F_{time \times group} = 36.428$			$F_{time} = 312.875$, $F_{group} = 42.136$, $F_{time \times group} = 48.793$			$F_{time} = 185.294$, $F_{group} = 25.681$, $F_{time \times group} = 30.947$		
p		$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$			$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$			$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$		

Note: Bonferroni-corrected post-hoc tests were used. The adjusted significance level for pairwise comparisons among the three time points is α'=0.0167 (0.05/3). *$p < 0.0167$ vs. Before nursing within group; †$p < 0.0167$ vs. Week 4 within the same group; #$p < 0.0167$ vs. Control group at the same time point. All significant comparisons remained significant at the corrected α'. IL-1β, interleukin-1β; IL-6, interleukin-6; TNF-α, tumor necrosis factor-α.

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Table 9. Comparison of HRV parameters ($\bar{x} \pm s$).

Group	n	SDNN (ms)			LF/HF		
		Before nursing	Week 4	Week 8	Before nursing	Week 4	Week 8
Control group	106	27.96 ± 2.74	29.74 ± 2.89*	33.29 ± 3.07*†	2.20 ± 0.41	1.89 ± 0.33*	1.76 ± 0.36*†
Observation group	106	28.05 ± 2.69	32.22 ± 3.25*$^{\#}$	34.52 ± 3.13*$^{\#\dagger}$	2.18 ± 0.46	1.80 ± 0.31*$^{\#}$	1.62 ± 0.29*$^{\#\dagger}$
F		$F_{time} = 174.835$, $F_{group} = 28.467$, $F_{time \times group} = 20.192$			$F_{time} = 156.247$, $F_{group} = 21.583$, $F_{time \times group} = 14.976$		
p		$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$			$p_{time} < 0.001$, $p_{group} < 0.001$, $p_{time \times group} < 0.001$		

Note: Bonferroni-corrected post-hoc tests were used. The adjusted significance level for pairwise comparisons among the three time points is $\alpha' = 0.0167$ (0.05/3). *$p < 0.0167$ vs. Before nursing within group; $^{\dagger}p < 0.0167$ vs. Week 4 within the same group; $^{\#}p < 0.0167$ vs. Control group at the same time point. All significant comparisons remained significant at the corrected α'. SDNN, standard deviation of normal-to-normal intervals; LF/HF, low-frequency to high-frequency ratio; HRV, heart rate variability .

Table 10. Comparison of nursing satisfaction rates (n (%)).

Group	n	Very satisfied	Satisfied	Neutral	Dissatisfied	Very dissatisfied	Satisfaction rate
Control group	106	57 (53.77)	21 (19.81)	15 (14.15)	13 (12.26)	0 (0.00)	78 (73.58)
Observation group	106	72 (67.92)	20 (18.87)	10 (9.43)	4 (3.77)	0 (0.00)	92 (86.79)
χ^2							5.820
p							0.016

Comparison of HRV Parameters Between the Two Groups

Repeated measures ANOVA showed significant differences in the main effects of time, between-group effects, and time × group interaction for HRV parameters ($p < 0.001$). Within-group comparisons showed that SDNN was higher and LF/HF was lower at weeks 4 and 8 than at baseline ($p < 0.0167$). Intergroup comparisons showed that SDNN at 4 and 8 weeks of nursing was higher in the observation group, whereas LF/HF was lower, with week 8 values significantly different from week 4 values (all $p < 0.0167$). The time × group interaction effects indicated significant differences in the changing trends of HRV parameters between the two groups, with a greater change in the observation group ($p < 0.001$). Mauchly's test of sphericity was not significant ($p > 0.05$), and residuals were normally distributed with homogeneous variances (Table 9).

Comparison of Nursing Satisfaction Rates Between the Two Groups

The nursing satisfaction rate in the observation group was significantly higher than that in the control group (86.79% vs. 73.58%; $p < 0.05$; Table 10).

Discussion

Postpartum depression is closely associated with hyperfunction of the Hypothalamic-Pituitary-Adrenal (HPA) axis. Sustained high cortisol levels may damage hippocampal neurons and exacerbate negative cognitive biases [10]. MBSR training, by guiding postpartum women to maintain non-judgmental awareness of present-moment experiences, may help interrupt automated negative rumination, reduce psychological stress responses, and subsequently decrease corticotropin-releasing hormone secretion, potentially alleviating excessive HPA axis activation [11]. This study observed that EPDS scores at 4 and 8 weeks of nursing in the observation group were lower than those in the control group, with greater reductions observed with the combined nursing approach. Yang *et al.* [12] reported that depression levels in the mindfulness group were lower than those in the conventional nursing group, with optimal effects achieved through daily 30-minute mindfulness practice for at least 4 weeks. A systematic review by Trapani *et al.* [13] also suggested that mindfulness initiated during pregnancy may exert long-term protective effects against postpartum depression. In the combined nursing model of the present study, family support nursing provided emotional acceptance and parenting assistance, reducing external stressors and creating a relatively stable psychological environment for mindfulness practice, and their synergistic interaction may contribute to a greater improvement in depressive symptoms.

Patients with postpartum depression often experience difficulties with sleeping. Deteriorated sleep quality, in turn, may form a vicious cycle by increasing inflammatory cytokine release and exacerbating emotional dysregulation [14]. Qi *et al.* [15] pointed out that family relationships indirectly affect postpartum sleep quality through social support pathways, suggesting that improving family interaction patterns could be a key entry point for sleep care.

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Polysomnography showed that the observation group had longer total sleep time, higher sleep efficiency, and a larger proportion of REM sleep than the control group. At week 8, the observation group had lower scores across all seven PSQI components than the control group, particularly for subjective sleep quality and daytime dysfunction. These findings may be explained by the potential effects of mindfulness on physiological hyperarousal [16] and by greater paternal involvement in infant caregiving, which has been associated with more consolidated maternal sleep [17]. Furthermore, the body scan mindfulness practice, by guiding attention sequentially through sensations in different body parts, may induce parasympathetic activation, reduce physical tension, and shorten sleep latency. Concurrently, mindfulness training may reduce pre-sleep cognitive rumination, decrease nocturnal awakenings, and improve sleep continuity [18,19].

Postpartum depression is not merely a psychological event; sustained stress can induce immune activation, increasing inflammatory marker levels, which subsequently affect central neurotransmitter balance, sleep homeostasis, and emotional response thresholds [20]. This study found that inflammatory marker levels decreased after nursing, suggesting a potential regulatory association of the combined nursing model on inflammation-related stress states. The mechanism may involve family support nursing improving the caregiving environment, reducing long-term psychological burden and role conflict, and decreasing stressor input [2]. Additionally, MBSR nursing may reduce the intensity of neuroendocrine activation by decreasing sustained vigilance and negative emotional responses, thereby inhibiting excessive activation of inflammatory pathways [21]. Değirmenci *et al*. [22], in a systematic review and network meta-analysis, suggested that non-pharmacological treatments have regulatory effects on stress, anxiety, and depression, with MBSR being one of the more effective nursing approaches. Extending such treatments to the postpartum depression population in this study yielded results consistent with their overall findings.

Salivary cortisol reflects the stress level of the HPA axis and serves as a direct indicator of the translation from psychological stress to physiological responses. Patients with postpartum depression experiencing chronic sleep deprivation, role-related stress, and emotional distress may exhibit HPA axis hyperresponsiveness, with consequent disruption of cortisol secretion rhythms [23]. This study showed that salivary cortisol levels decreased at 4 and 8 weeks of nursing, with a greater reduction in the observation group, suggesting that the combined nursing model may provide greater buffering against psychological stress than family support nursing alone. Family support may alleviate external pressure through practical caregiving assistance and emotional containment, whereas MBSR nursing may enable patients to avoid rapidly entering a state of high vigilance and high consumption when facing challenges such as infant crying, feeding difficulties, and family role conflicts, thereby reducing sustained HPA axis activation [24].

Patients with postpartum depression often exhibit relatively hyperactive sympathetic nervous activity and reduced vagal tone. An elevated LF/HF ratio reflects autonomic nervous system imbalance [25]. Mindful breathing training, by prolonging the expiratory phase and regulating respiratory rate, may activate the dorsal vagal complex, enhance cardiac parasympathetic modulation, and increase SDNN [26]. This study observed increased SDNN and decreased LF/HF in the observation group. This finding suggests that mindfulness training may help rebuild the dynamic balancing capacity of the autonomic nervous system, enhancing the physiological foundation for emotional regulation. Aljhani *et al*. [27] found that postpartum women lacking social support experienced more severe depression and sleep disturbance, suggesting an interaction between external support resources and internal physiological regulatory capacity. The combined nursing model in the current study may reduce external stress through family support while potentially enhancing internal regulatory reserves through mindfulness training, possibly promoting autonomic nervous system recovery from two levels.

In addition, postpartum depression essentially involves a continuous interplay between negative emotions, sleep disturbances, HPA axis hyperactivation, autonomic nervous system imbalance, and inflammatory activation. The observation group showed more obvious improvements in EPDS scores, PSQI scores and subscales, sleep architecture, inflammatory markers, salivary cortisol, and HRV parameters, suggesting that MBSR nursing combined with family support nursing may be associated with systemic regulatory effects along pathways of psychological stress, sleep disruption, neuroendocrine dysregulation, and inflammatory activation. Family support primarily reduces external stress exposure through emotional acceptance, role sharing, and caregiving assistance. MBSR, through non-judgmental awareness, breathing exercises, and body scans, diminishes ruminative thinking and sustained vigilance, improving parasympathetic activity and stress axis function. Their combination is not merely additive but manifests as external support enhancing the sustainability of mindfulness practice. Meanwhile, mindfulness training strengthens the patient's ability to accept and utilise supportive resources, forming synergistic nursing effects at physiological, psychological, and social levels.

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This study has certain limitations. First, its retrospective design, even with propensity score matching, cannot exclude residual confounding from unmeasured variables such as baseline depression severity, treatment motivation, and clinician referral bias. Therefore, causal conclusions cannot be drawn, and the reported associations should be interpreted with caution. Second, the observation period was only 8 weeks, without longer-term follow-up data to assess the durability of the observed benefits. Third, the single-centre setting and lack of blinding further limit generalisability. Future research should adopt prospective randomised controlled designs, extend follow-up periods, and incorporate rigorous assessments of intervention fidelity and adherence to confirm these preliminary findings.

Conclusions

In this retrospective propensity score-matched cohort of postpartum depression patients, the combination of MBSR and family support nursing was associated with greater improvements in depressive symptoms, overall sleep quality, inflammatory markers, salivary cortisol, and HRV compared with family support nursing alone. Because of the retrospective design, causal relationships cannot be inferred. Well-designed prospective randomised controlled trials with long-term follow-up are needed to confirm these findings and establish the efficacy of this combined nursing approach.

Availability of Data and Materials

All data included in this study can be obtained by contacting the corresponding author if needed.

Author Contributions

QSY conceived the research design, supervised the study implementation, drafted and revised the manuscript. XXW conducted the research, collected and analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study has been approved by the Ethics Committee of Nanjing Medical University Affiliated Women's and Children's Hospital (NO. 2025KT-109), was conducted in accordance with the Declaration of Helsinki, and obtained informed consent from the patients.

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Conflict of Interest

No conflicts of interest for this article.

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