BMC Pregnancy and Childbirth

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The role of breastfeeding self-efficacy in the relationship between perinatal depressive symptoms and exclusive breastfeeding: a longitudinal mediation analysis

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Abstract

Background Perinatal depressive symptoms are associated with exclusive breastfeeding; however, the longitudinal mediating process of this relationship remains unclear. Breastfeeding self-efficacy may be an important variable in understanding the complex process involved in their co-occurrence. Therefore, we aimed to explore the role of breastfeeding self-efficacy in the relationship between perinatal depressive symptoms and exclusive breastfeeding using both between- and within-person approaches.

Methods A prospective longitudinal study was conducted from October 2021 to January 2024 at a tertiary hospital in Hunan, China. Depressive symptoms were measured at 36 gestational weeks and 1 week, 6 weeks, 3 months, and 6 months postpartum. Exclusive breastfeeding and breastfeeding self-efficacy were evaluated at the same postpartum intervals. Cross-lagged panel models, random intercepts cross-lagged panel models, and longitudinal mediation models were used to analyze their relationships.

Results A total of 334 participants were included. Longitudinal mediation models revealed that breastfeeding self-efficacy mediated the prospective negative effect of perinatal depressive symptoms on exclusive breastfeeding at the between-person level ($b=-0.017$, SE = 0.008, 95% CI (−0.032, −0.001), $P=0.036$), and suppressed the positive effect of exclusive breastfeeding on depressive symptoms at the within-person level ($b=-0.044$, SE = 0.022, 95% CI (−0.087, 0.000), $P=0.047$).

Conclusions Mothers with perinatal depressive symptoms may face challenges in exclusive breastfeeding due to reduced breastfeeding self-efficacy. While increasing exclusive breastfeeding might help reduce depressive symptoms over time, this positive effect can be hindered if breastfeeding self-efficacy remains low. Our findings highlight breastfeeding self-efficacy as a critical target for future interventions.

Keywords Breastfeeding, Breastfeeding self-efficacy, Cross-lagged panel model, Perinatal depression, Random intercepts cross-lagged panel model

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Background

Exclusive breastfeeding (EBF) is recommended as the most optimal feeding practice because of its numerous advantages for infants and mothers [1–3]. The World Health Organization (WHO) advises mothers to exclusively breastfeed their babies for at least 6 months [4]. However, few women are able to follow this recommendation [5]. The global rate of EBF practices for infants at 6 months is 43% [4], which is higher than the 29.2% in China [6]. Identifying the key modifiable factors is necessary to effectively address the suboptimal EBF situation.

Perinatal depressive symptoms (PNDs) are a common perinatal psychological disorder whose prevalence reaches 11.9% globally and 16.3% in China [7, 8]. PNDs are a serious threat to the health of mothers and infants [9]. Some researchers have reported the negative impact of PNDs on EBF [10–13]. A meta-analysis by Kim et al. (2021) [12] revealed that mothers with postpartum depressive symptoms had a 33% reduction in EBF within 3 months postpartum. Others suggested that EBF preceded and predicted subsequent depressive symptoms [14, 15]. The meta-analysis by Alimi et al. (2022) [14] showed that women who did not exclusively breastfeed had 89% higher odds of postpartum depressive symptoms. Previous studies suggested a complex relationship between PNDs and EBF; however, the temporal directionality of this relationship remains ambiguous [10–12, 14, 15]. Haga et al. (2018) [16] and Zhu et al. (2023) [17] attempted to use an emerging analytical approach (i.e., cross-lagged panel model, CLPM) to analyze the longitudinal and bidirectional connection among PNDs and EBF and elucidate the temporal causality between them. Zhu et al. (2023) [17] conducted a study in central China and suggested that depressive symptoms at 3 and 6 months postpartum predicted EBF at 6 and 12 months postpartum, and EBF were not found to predict PNDs.

How PNDs and EBF may interact remains unclear, and the possible mediating effect of breastfeeding self-efficacy (BSE) between them has not been examined. BSE reflects the degree of confidence that perinatal women perceive in their ability to breastfeed infants [18]. The strong relationship of BSE with both EBF and PNDs has been widely explored. BSE is a pivotal protective factor for EBF [19–21]. Tuthill et al. (2020) [21] showed that the rate of early EBF cessation was predicted to decrease by 2% for every point increase in BSE score. Meanwhile, a negative correlation was found between BSE scores and depressive symptom levels at 42 days postpartum [22] or 2–12 weeks postpartum [23]. PNDs have been reported as a risk factor for BSE [24–27]. A recent review of the relationships and potential mechanisms of breastfeeding and postpartum depression identified BSE as an important variable in understanding the relationship between breastfeeding and depressive symptoms and suggested that it might mediate this relationship [28]. Therefore, understanding the potential mediating role of BSE in the relationship between PNDs and EBF could aid in uncovering the intricate mechanisms of their co-occurrence and identifying prospective intervention targets for PNDs that impact EBF.

Although Haga et al. (2018) [16] and Zhu et al. (2023) [17] offered insights into the temporal causality linking PNDs and EBF, their statistical approaches (e.g., CLPM) were unable to disaggregate intraindividual differences from interindividual differences [29, 30]. Bandura's self-efficacy theory posits that individuals' beliefs in their capabilities (i.e., self-efficacy) vary across different contexts (intraindividual) and exhibit stability between different individuals (interindividual) [31]. Intraindividual fluctuations may reflect moment-to-moment adaptations to situational challenges (e.g., postpartum physiological changes), while interindividual differences represent enduring cognitive schemas shaped by cumulative life experiences [31, 32]. In the context of breastfeeding, this suggests that BSE's mediating role between PNDs and EBF may operate through distinct mechanisms at different analytical levels: transient efficacy appraisals mediating acute mood-behavior interactions (within-person), versus stable efficacy beliefs moderating long-term depression-parenting pathways (between-person). Previous research also confirmed the necessity of considering both intraindividual and interindividual variations in studying the trajectories of PNDs [33, 34]. Therefore, comparing intraindividual and interindividual variations allowed for more substantial conclusions than using either method alone.

Taken together, this study aimed to explore the possible mediating role of BSE in the relationship between PNDs and EBF by considering both intraindividual and interindividual differences.

Methods

Study design and samples

A prospective longitudinal study was conducted at a tertiary hospital in Hunan Province, China, spanning from October 2021 to January 2024. All eligible women who take routine checks were invited to participate in our study between October 2021 and December 2022. A total of 751 pregnant women volunteered to participate. The eligibility criteria were as follows: (1) age above 18 years, (2) being in the first trimester (7–13 weeks and 6 days of gestation), (3) first-time mothers with a singleton pregnancy, and (4) natural conception. The exclusion criteria were as follows: (1) experiencing abortion, stillbirth, or embryo damage during pregnancy; (2) having suicidal tendencies or severe mental illness diagnosed by a psychiatrist; (3) having an illness that would limit breastfeeding after delivery; and (4) not undergoing routine checks or delivering at the study hospital.

Sample size was estimated using a web-frontend for "semPower 2" (an R-package providing a collection of functions to perform a-priori, post-hoc, and compromise power analyses for structural equation models (SEMs)) [35]. The calculations determined that a sample of 112 participants was required to achieve sufficient power (1-β = 0.80) to detect an effect size of 0.05 for the effect measure, root mean square error of approximation (RMSEA) [36, 37]. The alpha was 0.05. In consideration of a potential 20% non-response rate, the minimum sample size required was set as 140.

Procedures

The participants were recruited during their first trimester and followed up for 6 months postpartum. The five follow-up time points were around 36 gestational weeks (T0), 1 week postpartum (T1), 6 weeks postpartum (T2), 3 months postpartum (T3), and 6 months postpartum (T4). Measures of PNDs were collected at each of these time points (T0–T4), and those of BSE and EBF were collected at four time points (T1–T4). The collection of participants' characteristics and covariates was distributed across three time points (at inclusion, T0, and T1) to minimize the burden on the participants.

In the longitudinal survey, the participants were approached by researchers at the obstetric clinic. Once informed consent was obtained from the pregnant women, online questionnaires were sent to them via Wenjuanxing (a professional online survey platform) through WeChat messages. A week before the participants' scheduled routine checks (T0, T2) or their babies' routine checks (T3, T4), a QR code for the questionnaire was sent to the participants' WeChat via Wenjuanxing. If the participants did not complete the questionnaire before their routine clinical visit, then a face-to-face reminder was given to them during the visit. For T1, the participants enrolled at T0 were retrieved from the post-delivery discharge roster in the medical record and sent a QR code for the questionnaire. A telephone reminder was also given to those who did not complete the questionnaire on time. The entire recruitment and follow-up was conducted by our research team. All team members received training before the survey and were familiarized with the study's purpose, content, and implementation.

Measures

Sociodemographic variables

The participants were invited to complete two self-administered questionnaires (one for antenatal information and one for post-delivery) to report their sociodemographic information. The questionnaires were developed based on literature review [16, 17, 27]. To ensure content validity, a panel of experts in obstetrics, epidemiology, and survey methodology reviewed the questionnaires. Feedback from experts led to minor modifications before the final implementation. Given that the questionnaires were used to collect sociodemographic and general variables that have been widely verified and has a high degree of consistency [38], we did not conduct additional reliability and validity tests. The following general characteristics were obtained: age, pre-pregnancy BMI, residence, educational status, occupation, marital status, spousal educational status, household income, and passive smoking during pregnancy, number of classes at maternity school, pregnancy complications, adverse maternal history, mode of delivery, gestational age, infant birthweight, gender, and type of hospitalization.

Perinatal depressive symptoms

The Edinburgh Postnatal Depression Scale (EPDS) was used to assess PNDs [39]. This scale is a self-report questionnaire comprising 10 items. Higher scores indicate more severe depressive symptoms. A cut point of 10 is used in Chinese women to obtain maximum specificity [40]. The EPDS Chinese version has demonstrated sufficient validity and reliability (Cronbach's alpha was 0.78) [41]. The Cronbach's α values of EPDS were 0.83, 0.85, 0.84, 0.88, and 0.89 across the five time points (T0–T4).

Breastfeeding self-efficacy

The Breastfeeding Self-Efficacy Scale-Short Form (BSES-SF) was used to measure BSE. This scale comprises 14 positively-worded items regarding mothers' self-efficacy in their ability to breastfeed [42]. Higher scores indicate better BSE. The Chinese version of BSES-SF has demonstrated sufficient validity and reliability (Cronbach's alpha was 0.93) [43]. The Cronbach's α values of BSES-SF at T1 to T4 were 0.96, 0.96, 0.97, and 0.98.

Exclusive breastfeeding

The participants' exclusive breastfeeding degree index was scored with a single item: "Which of the following types of breastfeeding have you practiced for your child in the past 24 h?" (5 = EBF, 4 = almost EBF, 3 = partial breastfeeding, 2 = token breastfeeding, and 1 = exclusive artificial feeding) [44]. The participants were provided with a detailed explanation of each conceptual option before they made their choice. The definitions of breastfeeding used in our study were based on the WHO's set of breastfeeding definitions [45]. This variable was handled as a continuous variable [46] because our aim was to test the temporal relationship among the EBF degree index, the level of BSE, and the level of PNDs, rather than to investigate the current status of the population in terms of EBF.

Covariates

The following covariates selected a priori based on the existing literature were obtained: breastfeeding intention, knowledge, and attitudes. Herein, breastfeeding knowledge was evaluated using the Chinese Breastfeeding Knowledge Questionnaire [47], and breastfeeding attitude was evaluated by the Iowa Infant Feeding Attitude Scale [48]. Both scales consist of 17 items each and have been implemented across various countries and regions and applied to diverse populations. Their Cronbach's α coefficients were 0.87 [49] and 0.62 [50]. In this study, the Cronbach's α values of them were 0.88 and 0.63.

Statistical analysis

Statistical methods

This study explained further knowledge on the possible mediating role of BSE in the relationship between PNDs and EBF using both between- and within-person approaches [51]. Derived from interindividual score differences, between-person associations have traditionally been estimated using the CLPM. In contrast, within-person associations, reflecting intraindividual score changes over time, are estimated using a random intercepts cross-lagged panel model (RI-CLPM) [29, 30]. Although the CLPM is well-suited for analyzing between-person associations, it does not capture within-person associations. Conversely, the RI-CLPM is designed to estimate within-person associations but is not applicable for between-person associations [52]. The decision to use CLPM or RI-CLPM should align with the specific research objectives. When both between- and within-person associations are expected, the application of both models is recommended for a comprehensive analysis [51].

Data analysis

First, preliminary analyses were conducted using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Participant characteristics were detailed through categorical variables presented as frequencies and percentages, and continuous variables were summarized by reporting the mean and standard deviation. Bivariate correlations and descriptive statistics of key variables (PNDs, BSE, and EBF) within each time points were then conducted. Furthermore, the Missing Completely at Random (MCAR) testwas conducted [53]. The result was χ^2 (236) = 262.299, $P = 0.115$, indicating that sample attrition throughout the study was random. Hence, full information maximum likelihood (FIML) was employed for model estimations to address missing data. This approach leverages all available information to provide accurate parameter estimates [54].

Second, the EPDS items associated with anhedonia, anxiety, and depression were averaged to form three parcels [54, 55]. Invariance tests were then performed to assess the stability of the measurement model over time [56]. These tests involved applying increasingly strict equality constraints to model parameters and enabling comparisons among the configural, metric, and scalar models. Invariance can be assumed when the change in RMSEA (ΔRMSEA) between subsequent models remains below 0.015 or the change in standardized root mean square residual (ΔSRMR) remains below 0.010 [57].

Finally, CLPMs and RI-CLPMs were run in Mplus 8.7 to test the temporal associations of PNDs, BSE and EBF and the mediating role of BSE. Our models included latent variable (PNDs) and manifest variables (BSE and EBF). Given that the BSES-SF is a single-dimensional scale [42], BSE was used as manifest variables in our models. For reasons of parsimony and considering the lack of specific hypotheses regarding nonstationarity of the underlying within-person processes in our study, the auto-regressive paths, cross-lagged paths, and within-wave covariances across time points were constrained to be equal. Model fit was compared with the freely estimated models and assessed using chi-square statistics, RMSEA, comparative fit index (CFI), Tucker-Lewis index (TLI), and SRMR. RMSEA and SRMR values below 0.080, CFI and TLI values above 0.900 were considered acceptable model fit [58]. Chi-square difference testing was conducted to examine differences in model fit. The following three criteria were used to assess whether the model fits differ significantly among the different models: statistically significant changes in χ^2 ($\Delta\chi^2$) at $P < 0.05$, changes in CFI (ΔCFI) with values lower than 0.010, and changes in RMSEA (ΔRMSEA) with values higher than 0.015 [59]. Lastly, mediation analyses were run with both CLPMs and RI-CLPMs to examine whether BSE mediates the longitudinal relationship between PNDs and EBF. Breastfeeding intention, knowledge, and attitudes were included as covariates for all models. Statistical significance was set at two-sided $P < 0.05$.

Results

Participant characteristics

As shown in Fig. 1, we enrolled 751 eligible women in their first trimester between October 2021 and December 2022. As of August 2023, 427 (56.9%) pregnant women delivered at the study hospital. After 93 participants lost connection (88), refused to participate (2), and had duplicated data (3) were excluded, 334 participants who reported both PNDs and postpartum breastfeeding information at least once were included in the

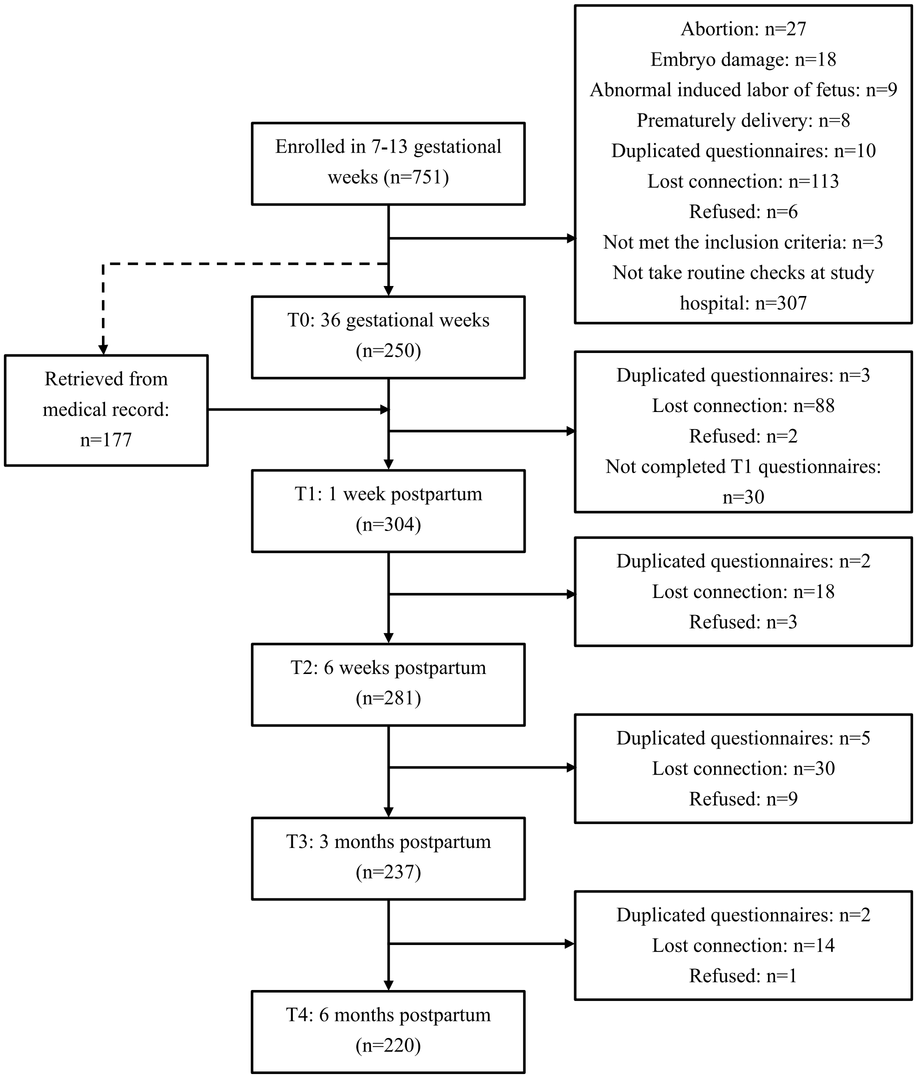

Fig. 1 Inclusion and exclusion process of participants

final analysis. As of January 2024, the questionnaire response rates of these 334 participants were 74.9%, 91.0%, 84.1%, 71.0%, and 65.9% at 36 gestational weeks, 1 week, 6 weeks, 3 months, and 6 months postpartum, respectively.

The participant characteristics are detailed in Table 1. Among the 334 participants, the mean age was 28.50 ± 3.19 years, the mean pre-pregnancy BMI was 21.21 ± 3.02 kg/m^2, 93.7% were living in the urban area, 67.4% had a bachelor's degree or higher, 88.9% were employed, and 96.1% were married. During pregnancy, the passive smoking rate was 31.7%, 10.5% attended maternity school sessions four times or more, and pregnancy complications occurred in 24.8%. At delivery, 55.8% were delivered vaginally. The average birth weight of infants was 3203.92 ± 436.33 g, 53% were male babies, and 20.0% were separated from their mothers after birth. The mean scores for breastfeeding intention, knowledge, and attitude were 3.71 ± 0.98, 9.87 ± 4.61, and 55.46 ± 5.60, respectively.

Preliminary analyses

The bivariate correlations, means, standard deviations, and number of participants are presented in Table 2. The correlations between PNDs and BSE and between BSE and EBF were statistically significant at all time points. The correlations between PNDs and EBF were not statistically significant at all time points.

Table 1 Sample characteristics

Characteristics	Total sample	n	%
Age, years (mean, SD)	334	28.50	3.19
Pre-pregnancy BMI, kg/m^2 (mean, SD)	334	21.21	3.02
< 18.50		54	16.2
18.50–23.99		222	66.5
≥ 24		58	17.4
Residence	334		
Urban		313	93.7
Rural		21	6.3
Educational status	334		
High school		21	6.3
Junior college		88	26.3
Bachelor's degree		193	57.8
≥ Master's degree		32	9.6
Occupation	334		
Staff		57	17.1
Self-employed		31	9.3
Medical workers		25	7.5
Others		184	55.1
Unemployed		37	11.1
Marital status	334		
Not married		13	3.9
Married (live with a spouse)		315	94.3
Married (live without a spouse)		6	1.8
Spousal educational status	321		
High school		30	9.3
Junior college		76	23.7
Bachelor's degree		178	55.5
≥ Master's degree		37	11.5
Household income, yuan (RMB)	334		
≤ 3,000 (poor)		7	2.1
3,000–5,000 (moderate)		76	22.8
> 5,000 (good)		251	75.1
Passive smoking during pregnancy	334		
Yes		106	31.7
No		228	68.3
Number of classes at maternity school	304		
0		164	53.9
1 – 3		108	35.5
≥ 4		32	10.5
Pregnancy complications	330		
Yes		82	24.8
No		248	75.2
Adverse maternal history	334		
Yes		59	17.7
No		275	82.3
Mode of delivery	330		
Vaginal delivery		184	55.8
Cesarean delivery		146	44.2
Gestational age, week	330		
< 37		16	5.0
≥ 37		314	95.0
Birthweight, g (mean, SD)	330	3203.92	436.33
< 2500		11	3.3
≥ 2500		319	96.7
Infant gender	330		
Male		178	53.9
Female		152	46.1
Type of hospitalization	330		
Mother-infant rooming-in		264	80.0
Mother-infant separation		66	20.0
Breastfeeding intention (mean, SD)	334	3.71	0.98
Exclusive breastfeeding		96	28.7
Almost exclusive breastfeeding		67	20.1
Partial breastfeeding		159	47.6
Token breastfeeding		3	0.9
Exclusive artificial feeding		9	2.7
Breastfeeding knowledge (mean, SD)	250	9.87	4.61
Breastfeeding attitudes (mean, SD)	250	55.46	5.60

Abbreviations: BMI Body mass index, *SD* Standard deviation

Measurement invariance and model comparisons

Table 3 indicates that the measures of PNDs demonstrated scalar invariance, implying that the observed changes in these constructs over time were meaningful and not due to measurement artifacts or item biases.

The fit indices and model comparisons for constrained and unconstrained CLPMs and RI-CLPMs are presented in Additional Table 1 in the Supplemental Information. The findings indicated that setting the cross-lagged paths and all T2–T4 correlated changes between all variables (i.e., M1f, M2f) to be equal over time did not significantly decline the fit of the unconstrained model (M1a, M2a). For reasons of parsimony, Models 1f and 2f were selected as the final CLPM and RI-CLPM.

Between-person effects: Cross-lagged panel model

The temporal relations among PNDs, BSE, and EBF were examined by running a CLPM with PNDs at T0 predicting PNDs at T1 (autoregressive path), BSE at T1 (cross-lagged path), EBF at T1 (cross-lagged path), and EBF at T2 (cross-lagged path). We used BSE at T1 to predict BSE (autoregressive path), PNDs at T2 (cross-lagged path), and EBF (cross-lagged path) at T2. Similarly, we used EBF at T1 to predict EBF at T2 (autoregressive path), BSE at T2 (cross-lagged path), PNDs at T2 (cross-lagged path), and PNDs at T3 (cross-lagged path). The predicted paths of these three variables between subsequent time points

Table 2 Bivariate correlations and descriptive statistics for key variables

	Variables	M (SD)	*n*	1	2	3	4	5	6	7	8	9	10	11	12	13
1	T0 PNDs	6.16 (4.27)	250	—												
2	T1 PNDs	6.92 (4.55)	304	0.506***	—											
3	T2 PNDs	7.37 (4.64)	281	0.550***	0.579***	—										
4	T3 PNDs	7.12 (5.16)	237	0.605***	0.544***	0.704***	—									
5	T4 PNDs	6.73 (5.24)	220	0.371***	0.354***	0.531***	0.565***	—								
6	T1 BSE	45.22 (11.62)	304	−0.160*	−0.292***	−0.322***	−0.386***	−0.213**	—							
7	T2 BSE	44.65 (13.13)	281	−0.162*	−0.157*	−0.278***	−0.236***	−0.187**	0.548***	—						
8	T3 BSE	46.03 (14.33)	237	−0.126	−0.174*	−0.292***	−0.277***	−0.242***	0.533***	0.735***	—					
9	T4 BSE	44.05 (15.59)	220	−0.101	−0.084	−0.184**	−0.180*	−0.218**	0.364***	0.486***	0.676***	—				
10	T1 EBF	3.84 (1.14)	304	−0.030	−0.017	−0.056	−0.062	−0.063	0.434***	0.403***	0.316***	0.246***	—			
11	T2 EBF	3.86 (1.23)	281	−0.112	0.003	−0.041	0.005	0.009	0.329***	0.675***	0.557***	0.350***	0.488***	—		
12	T3 EBF	3.91 (1.40)	237	−0.048	−0.095	−0.105	−0.072	−0.091	0.382***	0.604***	0.707***	0.478***	0.447***	0.737***	—	
13	T4 EBF	3.25 (1.49)	220	0.013	0.031	−0.034	−0.070	−0.073	0.207**	0.288***	0.486***	0.574***	0.232**	0.352***	0.554***	—

Abbreviations: T0 Time 0 (36 weeks of gestation), *T1* Time 1 (1 week postpartum), *T2* Time 2 (6 weeks postpartum), *T3* Time 3 (3 months postpartum), *T4* Time 4 (6 months postpartum), *PNDs* Perinatal depressive symptoms, *BSE* Breastfeeding self-efficacy, *EBF* Exclusive breastfeeding, *M* Mean, *SD* Standard deviation

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Table 3 Fit indices for the measurement invariance of perinatal depressive symptoms

Model	χ^2 (*df*)	RMSEA	CFI	TLI	SRMR	ΔRMSEA	ΔSRMR
Configural invariance	70.710 (50) *	0.035	0.988	0.975	0.044	—	—
Metric invariance	77.318 (58) *	0.032	0.989	0.980	0.046	0.003	0.002
Scalar invariance	107.374 (66) **	0.043	0.976	0.962	0.050	0.011	0.004

Abbreviations: χ^2 chi-square statistic, *df* degrees of freedom, *RMSEA* Root mean square error of approximation, *CFI* Comparative fit index, *TLI* Tucker-Lewis index, *SRMR* Standardized root mean square residual

* $P<0.05$, ** $P<0.01$

were determined. Cross-sectional correlations among PNDs, BSE, and EBF were computed for all measurement points.

The model fit indices indicated an acceptable fit of the model, with χ^2 (229) = 336.445, $P<0.001$, RMSEA = 0.043, CFI = 0.961, TLI = 0.946, and SRMR = 0.064. As illustrated in Fig. 2, the autoregressive paths of PNDs (Tn) on PNDs (Tn + 1), BSE (Tn) on BSE (Tn + 1) and EBF (Tn) on EBF (Tn + 1) suggested the strong stability of the three constructs over the 6 months postpartum ($P<0.001$). PNDs (T0) predicted lower BSE (T1), $\beta=-0.08$, SE = 0.04, $P=0.030$; did not predict EBF (T1), $\beta=0.06$, SE = 0.05, $P=0.200$; and did not predict EBF (T2), $\beta=-0.07$, SE = 0.05, $P=0.136$. Meanwhile, BSE (T1) predicted higher EBF (T2), $\beta=0.18$, SE = 0.05, $P<0.001$; did not predict PNDs (T2), $\beta=-0.08$, SE = 0.05, $P=0.076$. In turn, EBF (T1) predicted higher BSE (T2), $\beta=0.16$, SE = 0.04, $P<0.001$; did not predict PNDs (T2), $\beta=0.01$, SE = 0.05, $P=0.851$; and did not predict PNDs (T3), $\beta=0.04$, SE = 0.05, $P=0.400$. The standardized coefficients, standard errors, and *P*-values for the predicted paths of these three variables between subsequent time points were similar to those described above.

The mediating effect was confirmed by the observed significant indirect effects of PNDs on EBF through BSE ($b=-0.017$, SE = 0.008, 95% CI (−0.032, −0.001), $P=0.036$). No indirect effects of EBF on PNDs through BSE ($b=-0.013$, SE = 0.008, 95% CI (−0.028, 0.002), $P=0.090$) were observed. Table 4 lists the direct and indirect effects of the mediation models.

Within-person effects: Random intercepts cross-lagged panel model

As presented in Fig. 3, we ran a RI-CLPM to test the longitudinal associations among PNDs, BSE, and EBF at the within-person level. The model showed a good fit, χ^2 (223) = 296.257, $P<0.001$, RMSEA = 0.036, CFI = 0.974, TLI = 0.962, SRMR = 0.053. The autoregressive effects were almost similar to the results obtained using CLPM. However, PNDs at T0 did not

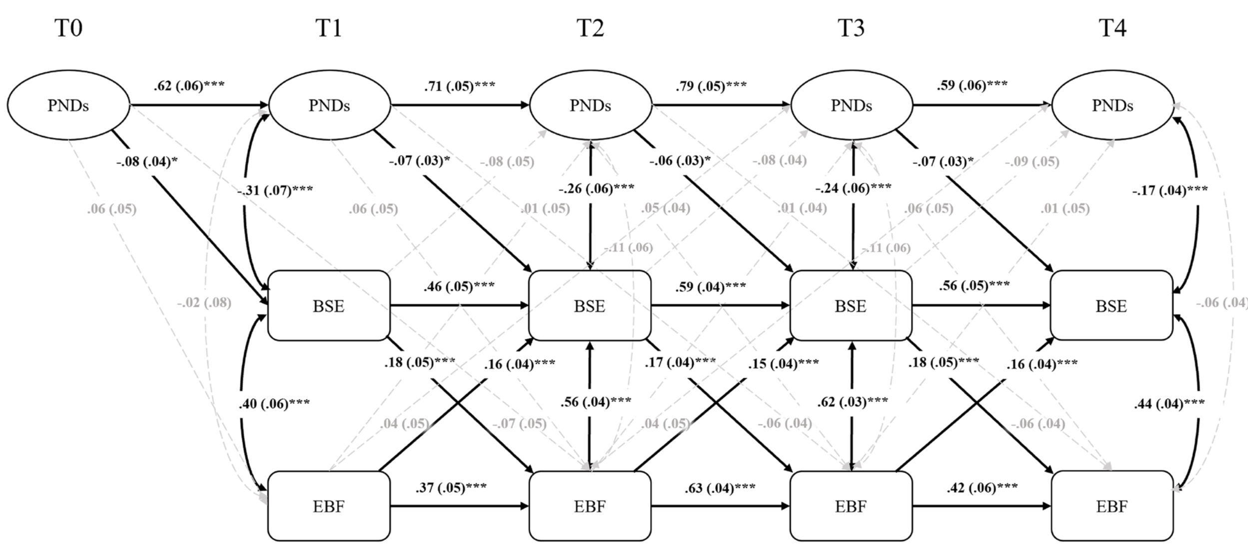

Fig. 2 CLPM depicting the longitudinal associations among perinatal depressive symptoms, breastfeeding self-efficacy, and exclusive breastfeeding. PNDs = Perinatal depressive symptoms; BSE = Breastfeeding self-efficacy; EBF = Exclusive breastfeeding. Gray dashed lines and gray numbers represent the non-significant paths. For clarity, the effects of controlled variables (breastfeeding intention, knowledge, and attitudes) were estimated but not shown in the figure. Standardized path coefficients and (SE) were reported. T0: 36 weeks of gestation; T1: 1 week postpartum; T2: 6 weeks postpartum; T3: 3 months postpartum; T4: 6 months postpartum. * $P<0.05$, ** $P<0.01$, *** $P<0.001$

Table 4 Direct and indirect effects from cross-lagged panel models (CLPMs) and random intercepts cross-lagged panel models (RI-CLPMs)

Models	CLPMs				RI – CLPMs			
	b	**SE**	**95% CI**	***P***	***b***	**SE**	**95% CI**	***P***
Mediation Model 1								
PNDs → EBF	−0.085	0.057	(−0.197, 0.026)	0.134	−0.169	0.095	(−0.356, 0.018)	0.077
PNDs → BSE → EBF	−0.017	0.008	(−0.032, −0.001)	**0.036***	−0.009	0.028	(−0.064, 0.046)	0.750
Mediation Model 2								
EBF → PNDs	0.047	0.055	(−0.062, 0.155)	0.400	0.059	0.054	(−0.046,0.164)	0.271
EBF → BSE → PNDs	−0.013	0.008	(−0.028, 0.002)	0.090	−0.044	0.022	(−0.087, 0.000)	**0.047***

Abbreviations: PNDs Perinatal depressive symptoms, *BSE* Breastfeeding self-efficacy, *EBF*Exclusive breastfeeding, *SD* Standard error, *95% CI* 95% Confidence Interval. Values are unstandardized path coefficients

* $P < 0.05$

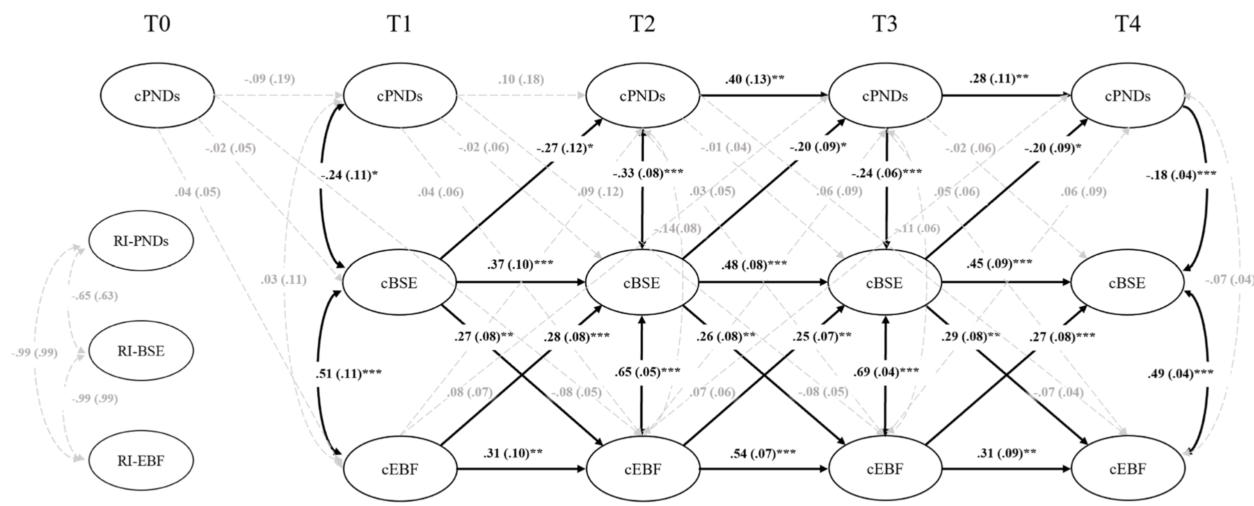

Fig. 3 Simplified illustration of RI-CLPM depicting the longitudinal associations among perinatal depressive symptoms, breastfeeding self-efficacy, and exclusive breastfeeding. PNDs = Perinatal depressive symptoms; BSE = Breastfeeding self-efficacy; EBF = Exclusive breastfeeding. cPNDs, cBSE, cEBF = within-person level variables; RI-PNDs, RI-BSE, RI-EBF = between-person level factors (random intercepts). Gray dashed lines and gray numbers represent the non-significant paths. For clarity, the effects of controlled variables (breastfeeding intention, knowledge, and attitudes) were estimated but not shown in the figure. Standardized path coefficients and (SE) were reported. T0: 36 weeks of gestation; T1: 1 week postpartum; T2: 6 weeks postpartum; T3: 3 months postpartum; T4: 6 months postpartum. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$

predicted BSE at T1 ($\beta = -0.02$, SE = 0.05, $P = 0.754$), EBF at T1 ($\beta = 0.04$, SE = 0.05, $P = 0.469$), and EBF at T2 ($\beta = -0.08$, SE = 0.05, $P = 0.102$). In turn, BSE at T1 predicted lower PNDs at T2 ($\beta = -0.27$, SE = 0.12, $P = 0.030$) and higher EBF at T2 ($\beta = 0.27$, SE = 0.08, $P = 0.001$). Therefore, individuals with increased BSE (relative to their trait level) experienced a subsequent decrease in PNDs. Meanwhile, EBF at T1 predicted higher BSE at T2 ($\beta = 0.28$, SE = 0.08, $P < 0.001$), did not predict PNDs at T2 ($\beta = 0.09$, SE = 0.12, $P = 0.469$), and did not predict PNDs at T3 ($\beta = 0.08$, SE = 0.07, $P = 0.270$). The standardized coefficients, standard errors, and *P*-values for the predicted paths of these three variables between subsequent time points were similar to those described above.

In contrast to the findings obtained using CLPM, the mediating effects of EBF on PNDs through BSE ($b = -0.044$, SE = 0.022, 95% CI (−0.087, 0.000), $P = 0.047$) were observed. Nevertheless, no indirect effects of PNDs on EBF through BSE ($b = -0.009$, SE = 0.028, 95% CI (−0.064, 0.046), $P = 0.750$) were found. Given that the mediating effect of BSE was not in the same direction as the direct effect ($b = 0.059$, SE = 0.054, 95% CI (−0.046, 0.164), $P = 0.271$), this finding was interpreted as a suppressing effect [60, 61].

Discussion

To our knowledge, this is the first study that researchers extended prior studies and filled important methodological gaps in the literature by examining the longitudinal mediating role of BSE in the relationship between PNDs and EBF using both between- and within-person approaches (i.e., CLPM and RI-CLPM). The methodological approaches revealed new and unexpected findings. Longitudinal mediation models using CLPM showed that BSE mediated the prospective negative effect of PNDs on EBF at the between-person level, and RI-CLPM showed that BSE suppressed the positive effect of EBF on PNDs at the within-person level. No direct longitudinal association between PNDs and EBF was observed either at the between- or within-person level.

Our study showed that BSE mediated the longitudinal relationship between PNDs and EBF, elucidating how PNDs and EBF interact. At the interindividual level, the populations with higher levels of PNDs might have lower BSE levels, thereby exhibit lower EBF scores. At the intraindividual level, in the group with low EBF scores, if an individual had an increased score of EBF but her BSE was not elevated at the next time point, the levels of PNDs would not decrease. Therefore, the benefit of increased EBF scores on PNDs was suppressed by the low levels of BSE, resulting in no reduction in PNDs and vice-versa. Although no study has explored the mediating role of BSE in the relationship between PNDs and EBF, our findings share some similarities to those of Rosenbaum et al. (2020) [62], who reported that an interaction of self-compassion and negative feelings toward the body mediated the association between early unwanted discontinuation of breastfeeding and depressive symptoms. Self-compassion, also a dimension of individual self-concept, is strongly related to self-efficacy [63]. Therefore, our findings provide empirical support for Henshaw's theoretical belief that BSE is a vital element in understanding breastfeeding and depressive symptoms relationship [28]. This concept points toward future directions of conceptualizing interventions and strategies that address common factors for PNDs and EBF.

Our results initially verified the between-person mediating role of BSE, contributing to the existing literature on the mechanisms by which PNDs affects EBF. In concordance with the findings summarized in the introduction, earlier studies supported that depressed women lack confidence and self-efficacy in their ability to overcome barriers to breastfeeding, thereby leading to their reduced EBF [24–26, 64, 65]. Papinczak et al. (2000) [64] suggested that a longer duration of EBF was most significantly linked to increased breastfeeding self-confidence and lower scores of postpartum depressive symptoms. Flores-Quijano et al. (2008) [65] also suggested a significant relation between women's depressive symptoms and lack of confidence in breastfeeding between 2 and 12 weeks postpartum, and both of these variables were associated with EBF. All of the above studies used general statistical analyses such as logistic regression models, linear regression models, and path analysis, illustrating research questions mainly at the between-person level [29, 30]. Thus, between individuals, PNDs might indirectly negatively affect EBF scores by decreasing BSE levels. Furthermore, the between-person level can indicate "who is at high risk for heightened X" and "who should get an intervention to reduce Y" [66]. Our findings based on the between-person level suggested that in a general population, the individuals with higher levels of PNDs are at a high risk for lower EBF scores.

Our study also revealed the within-person suppressing effect of BSE, indicating that the effect of EBF on PNDs within individuals might be completely mediated by BSE [61]. In particular, the within-person suppressing effect of BSE meant that if a woman had a higher EBF score at a certain time point, but her subsequent BSE remained low, it would prevent any reduction in her PND levels. Conversely, if her EBF score was lower but her subsequent BSE remained high, she could still maintain lower levels of PNDs. Individuals with high BSE have high confidence and ability to face breastfeeding challenges [19, 20], thereby reducing the impact of changes in EBF on PNDs. Some past studies partially supported this result [67, 68]. For example, Haga et al.'s (2012) [67] multilevel growth curve analyses revealed that BSE predicted the rate of postpartum depression and the changes in depressive symptoms over time. Jiang et al. (2022) [68] reported that postpartum depressive symptoms were significantly associated with BSE but not with EBF, implicitly suggesting the potential suppressing effect of BSE. A suppression effect refers to a situation where the inclusion of a variable (suppressor) weakens or hides the direct effect of the independent variable on the dependent variable [60]. After the suppressor variable is controlled, the direct effect of the independent variable on the dependent variable becomes apparent or even stronger [60, 61, 69]. The findings of this study were consistent with our previous results that the negative effect of PNDs on EBF became statistically insignificant when the effect of BSE was not controlled in the generalized linear mixed model [70]. According to previous interpretation [60, 61] of the "suppressing effect," the main effect of EBF on PNDs was positive but the indirect effect through BSE was negative. This finding suggested a broader positive mechanism between EBF and PNDs that was not included in the present study, providing a novel direction for subsequent research on the relationship between EBF and PNDs. Moreover, within-person associations may help identify modifiable targets for intervention [66]. Our findings at the within-person level also suggested that future studies could consider BSE as an intervention target to construct effective intervention strategies in PNDs.

In contrast to our expectations, no direct longitudinal association was found between PNDs and EBF. This finding was consistent with the CLPM results of Haga et al.'s (2018) [16] population-based study, which also reported no significant concurrent associations between EBF and depressive symptoms at 4, 6, or 12 months postpartum, and contradicted the previous findings of Zhu et al. (2023) [17]. This variation could be partially attributed to the differences in measurement timing and confounding factors, particularly with the inclusion of our third variable, BSE. It also underscored the complexity of the relationship between PNDs and EBF. On the one hand, a longitudinal relationship might exists between PNDs and EBF but is masked by the mediating variable BSE, resulting in the lack of statistical significance in the results [49, 71, 72]. In addition, PNDs and EBF have many other potential influences not addressed in this study [73, 74], and these factors might modify or mediate their relationship, resulting in statistical insignificance. On the other hand, there might be no direct effect of PNDs and EBF but only an indirect effect through BSE. This study validated both of these possibilities through the between- and within-person results.

Strengths and limitations

This study is the first to verify the longitudinal mediating or suppressing role of BSE on the longitudinal association between PNDs and EBF. Given that the longitudinal processes mediating the association between PNDs and EBF remain largely unexplored, this study extended existing literature on the temporal relationship between PNDs and EBF by assessing the potential mediating mechanisms. By using a combination of CLPMs and RI-CLPMs, we found robust empirical evidence supporting the temporal relationships between PNDs and EBF. This methodology has advantages over cross-sectional and longitudinal designs that do not account for between-person variance or control for the prior level of outcomes. Furthermore, the differences between the results at the between- and within-person levels illustrated the importance of distinguishing among between- and within-person associations [75]. Lastly, we quantitatively clarified the longitudinal reciprocal associations between EBF and BSE. Bidirectional associations between BSE and EBF were observed at both the between- and within-person levels. Although the strong relationship between BSE and EBF has been widely reported [21, 76], our study was the first to validate their temporal relationship. Moreover, we found that the cross-lagged effects of EBF and BSE on each other were similar, and the effect sizes were large effect ($\beta > 0.12$) [77].

Our study also has some limitations. First, for ethical considerations, all women with EPDS scores ≥ 10 were informed of their screening results and prompted on how to self-regulate their emotions, and those with EPDS scores ≥ 13 were advised to visit the psychiatric department of the survey hospital. This phenomenon might have had an impact on the natural progression of PNDs. Second, even though we observed the interesting and significant results on the longitudinal associations among PNDs, EBF, and BSE, the sample size of the study was small. Third, although participants were provided with detailed explanations of EBF criteria in the questionnaire, the EBF degree index was based on a single self-reported question about breastfeeding types. This might miss subtle practices like occasional water or liquid supplementation, risking misclassification. Future research should use objective feeding logs or multi-item assessments for greater accuracy. Fourth, we examined mother-infant hospitalization type (rooming-in vs. separation) rather than directly assessing skin-to-skin contact, early breastfeeding initiation, or prelacteal feeding. In China, these practices are standardized under Baby-Friendly Hospital Initiative (BFHI) accreditation for hospitals implementing rooming-in [78, 79]. Although the surveyed hospital was BFHI-certified, indirect assessment may limit the generalizability of findings. Lastly, cultural differences influence the association between PNDs and EBF [16, 17], and the flexibility of individuals' levels of PNDs over time vary across cultures [33]. Given that the samples were all drawn from Chinese women, readers should exercise caution when generalizing the findings to other contexts.

Relevance for clinical practice

This study has implications for clinical work in the improvement of EBF and PNDs. By understanding the mediating effect of BSE at the between-person level and its suppressing effect at the within-person level, health professionals can develop more effective intervention strategies targeting different dimensions. First, health professionals must identify the subpopulation within the general population that has higher PND levels and therefore at a high risk for lower EBF scores. Next, for individuals in this high-risk population, BSE can be targeted for intervention. Our within-person results indicated that BSE suppresses the relations from EBF to PNDs, and there is a bidirectional reciprocal relationship between BSE and EBF. Therefore, improving the BSE levels of a woman in the high-risk group can increase her subsequent EBF and PNDs. Enhancing BSE levels also can reveal the benefits of increased

EBF in subsequently reducing PNDs, thereby decreasing long-term PND levels. When developing intervention strategies, an interim evaluation of BSE must be designed. This is because even if EBF increases shortly after the intervention, long-term PND reduction will not be achieved unless the increase in BSE is sustained.

Conclusions

Our study demonstrates that BSE mediates the relationship between PNDs and EBF. Specifically, BSE explains why mothers with depressive symptoms are less likely to exclusively breastfeed. However, when examining individual changes over time, we observed that the mental health benefits of breastfeeding are likely to be lost unless BSE improves. These findings emphasize the importance of considering both population-level patterns and individual-level changes. Improving BSE could simultaneously address both low breastfeeding rates and depressive symptoms. Interventions targeting BSE may offer dual benefits for both breastfeeding outcomes and mental health, but progress should be regularly monitored during implementation. Future studies should test practical strategies to boost BSE in mothers experiencing depression.

Abbreviations

EBF	Exclusive breastfeeding
PNDs	Perinatal depressive symptoms
BSE	Breastfeeding self-efficacy
CLPM	Cross-lagged panel model
RI-CLPM	Random intercept cross-lagged panel model
SEM	Structural equation models
EPDS	Edinburgh Postnatal Depression Scale
BSES-SF	Breastfeeding Self-Efficacy Scale-Short Form
RMSEA	Root mean square error of approximation
CFI	Comparative fit index
TLI	Tucker-Lewis index
SRMR	Standardized root mean square residual
SD	Standard deviation
MCAR	Missing completely at random

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-025-07481-8.

Additional file 1. Table 1. Model fits and comparisons for cross-lagged panel models (CLPMs) and random intercepts cross-lagged panel models (RI-CLPMs).

Acknowledgements

The authors would like to express their sincere gratitude to the instructors, Qirong Chen, Jiarui Chen, Jinnan Xiao, and Ci Zhang, from the English Medical Paper Editing and Writing course. Their excellent teaching and guidance, especially the constructive feedback from Associate Professor Qirong Chen, significantly contributed to the writing and revision of this manuscript. The authors also acknowledge the support of the Obstetric Departments of the Third Xiangya Hospital of Central South University and the participants, nurses, midwives, and the hard work of the team members of the study.

Authors' contributions

LL: Conceptualization, formal analysis, funding acquisition, investigation, methodology, project administration, writing – original draft. SF: Investigation, methodology, project administration, validation, writing – review & editing. YZ: Investigation, methodology, validation, writing – review & editing. GX: Data curation, investigation, validation, writing – review & editing. MZ: Investigation, methodology, writing – review & editing. XL: Investigation, project administration, writing – review & editing. YL: Methodology, project administration, resources, supervision, writing – review & editing. CQ: Funding acquisition, project administration, resources, supervision, writing – review & editing.

Funding

This work was supported by the National Natural Science Foundation of China (grant number 72074225), the Key Research and Development Program of Hunan Province of China (grant number 2021SK2024), and the Fundamental Research Funds for the Central Universities of Central South University (grant number 2024ZZTS0184). The funding sources played no role in conducting the research and preparing the article.

Data availability

The datasets generated during this study are not publicly available due to the desire to protect patient confidentiality in this small longitudinal study but de-identified data may be made available from the corresponding author on reasonable request and with institutional permission regarding data sharing.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Ethics Review Committee of Xiangya Nursing School of Central South University (approval number: E202159). Informed written consent was explained in detail to all the participants to ensure that they were fully aware of the project and agree completely voluntarily. All procedures were conducted in strict compliance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 30 November 2024 Accepted: 17 March 2025
Published online: 27 March 2025

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