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ORIGINAL ARTICLE

Association between postpartum depressive symptom trajectories and breastfeeding patterns: results from the Mothers, Infants and Lactation Quality-Brazil study

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Objective: To investigate the association between postpartum depression (PPD) symptom trajectories and breastfeeding patterns (BFP) from 1 to 8.5 months.
Methods: In this prospective cohort study, 97 healthy mother-infant pairs from Brazil were followed at 1-3.49, 3.5-5.9, and 6-8.5 months. PPD symptoms were assessed using the Edinburgh Postnatal Depression Scale (EPDS). BFP patterns were characterized using longitudinal clusters based on breast milk volume (dose-to-mother technique), feeding frequency/duration, and infant age at complementary food introduction (CFI). PPD trajectories were identified using growth mixture modeling, and latent classes were selected based on the Akaike and Bayesian information criteria. Multinomial logistic regression assessed associations with BFP.
Results: Two PPD symptom trajectories were identified. The "lower score" (87%) indicated PPD stability throughout follow-up, while the "higher score" (12%) showed more transitions, mainly to PPD remission in later stages. Three BF clusters (C) were identified: C1, with moderate volume/frequency and later CFI (n=37; 38%); C2, with lower volume/frequency and intermediate CFI (n=34; 35%); and C3, with higher volume/frequency and earlier CFI (n=26; 27%). Women with higher PPD symptoms showed a trend toward significance in being associated with C3 (OR = 4.17; 95%CI 0.96-18.50; p = 0.055) compared with C1.
Conclusions: Although the association between higher PPD symptoms and less favorable BF practices presented only a trend toward significance, it suggests that PPD symptoms may influence BF behaviors. Larger samples are needed to confirm these findings, and the use of diagnostic tools rather than EPDS, a screening tool, may strengthen future studies. Clinically, the findings underscore the need for early PPD screening in primary care and stronger BF support.
Clinical trial registration: ClinicalTrials.gov NCT03254329 (September 1, 2017)

Keywords: Maternal mental health; breastfeeding; milk volume; lactation; postpartum depression; longitudinal study

Introduction

Depression ranks among the leading chronic diseases affecting people of all ages worldwide, with women of reproductive age being the most affected.[1] Depression during pregnancy and the postpartum period represents a significant public health concern. The global pooled prevalence of postpartum depression (PPD) was 17.7%, and countries with high levels of income inequality tend to exhibit elevated prevalence of PPD.[2] In Brazil, data from the nationwide Nascer no Brasil survey (2011-2012) of 23,894 women revealed that PPD symptoms may affect 25% of women within 6 months of delivery.[3] A more recent analysis from the Nascer no Brasil II survey, focusing exclusively on the state of Rio de Janeiro (2021-2023), revealed a prevalence of 17.9% among postpartum women.[4]

Multiple risk factors have been identified for PPD, including psychosocial (prenatal depression or anxiety,

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limited social support, relationship difficulties, exposure to violence), sociodemographic (low educational attainment, financial dependence), and obstetric (e.g., multiparity) factors.[5-7] Depressive symptoms during this period can impair the mother-infant relationship, compromising the child's nutritional care, as well as their physical and mental development.[8]

Early cessation of breastfeeding (BF) is widely recognized as a critical public health issue.[9-11] Despite the numerous documented benefits of BF for both mother and child, national BF rates in Brazil still fall short of the targets set by the World Health Organization (WHO). For example, data from the 2019 Brazilian National Infant Nutrition Survey revealed that the prevalence of exclusive BF (EBF) at 6 months was 45%,[9] while WHO targets for 2030 are 70%.[12] Although the positive impact of BF is undeniable, the challenges in achieving these targets underscore the need for a deeper understanding of the factors that influence BF practices. One such factor is PPD, whose relationship with BF has been investigated. A systematic review of 38 studies from 20 countries (n=68,794) reported that most investigations examining the PPD-BF relationship were conducted in high-income countries (63%), with limited evidence from low- and middle-income countries (LMICs).[13]

Studies have shown that mothers with depressive symptoms are more likely to discontinue EBF, have BF difficulties, and report lower BF self-efficacy, meaning less confidence in their ability to breastfeed.[14,15] Additionally, higher scores of PPD symptoms have been associated with early discontinuation of EBF.[16,17] Wouk et al.,[18] using data from the Pregnancy Risk Assessment Monitoring System from 2010 to 2011 (n=44,294), observed that women with PPD were 0.58 times as likely (95%CI 0.50-0.68) to practice EBF at 3 months postpartum compared to those without reported PPD symptoms.

Identifying and assessing maternal psychological issues and providing support to lactating women may help improve longer-term BF adherence.[19] The literature on PPD and BF practices generally explores the association between maternal depressive symptoms and BF duration. However, few studies have examined how distinct trajectories of PPD symptoms over time may relate to different BF practices. This gap in the literature presents an opportunity to investigate the relationship between depression and BF and how longitudinal PPD symptoms may influence BF patterns (BFPs) over time.

This study aims to explore the trajectory of PPD symptoms throughout the lactation period (1-8.5 months), develop clusters of BFPs based on longitudinal data, and examine the association between the trajectory of PPD symptoms and BFPs.

Methods

Study design and participants

This study uses Brazilian data from the Mothers, Infants and Lactation Quality (MILQ) multicenter prospective cohort study, which includes participants from Bangladesh, Brazil, Denmark, and The Gambia. The cohort encompasses participant recruitment during the 3rd gestational trimester between 28 and 35 weeks (baseline), followed by four subsequent follow-up stages: within 72 hours after birth (C), from 1 to 3.49 months (M1), from 3.5 to 5.9 months (M2), and from 6 to 8.5 months (M3). Detailed information is available in the MILQ publications.[20,21]

This study analyzed a subsample of Brazilian participants from the MILQ cohort for whom breast milk volume data were available (n=140). To derive BFP using longitudinal cluster analysis, participants were required to have sufficient data for at least two time points across the variables of interest (milk volume, BF frequency and duration, and age at complementary food introduction [CFI]). Forty-three women were excluded due to missing data for the mentioned variables. Therefore, 97 mother-infant pairs met these criteria and comprised the final analytical sample.

All participants in this research were recruited from a maternity hospital located in the city of Rio de Janeiro, Brazil, between January 2018 and March 2020. The hospital is integrated into the Cegonha Carioca program, provides care for pregnant women referred from 11 primary health units within Rio de Janeiro, and holds Baby-Friendly Hospital designation.

Eligibility criteria for recruitment included being a healthy mother-infant pair with gestational ages between 37 and 42 weeks, singleton pregnancies, maternal age between 18 and 40 years, absence of vitamin or mineral supplementation (except for iron and folic acid) during the 3rd trimester of pregnancy or lactation, intention to breastfeed, a pre-pregnancy body mass index (BMI) $\geqslant$ 18.5 and $<$ 30 kg/m^2, maternal height $>$ 145 cm, a non-vegan or macrobiotic diet, non-smoker status, and alcohol consumption $<$ 30 g per week.

Exclusion criteria comprised infants born pre- or post-term, congenital malformations, birth weight $<$ 2,500 g or $>$ 4,200 g, cessation of EBF before M2, weaning before M3, infant z scores $<$ -2 for length-for-age, weight-for-age, or weight-for-length,[22] severe maternal or infant illness, and maternal micronutrient supplementation during lactation (except for iron and folic acid).

Postpartum depression symptoms

PPD symptoms were assessed at M1, M2, and M3 using the validated Brazilian version of the Edinburgh Postnatal Depression Scale (EPDS).[23] The EPDS is one of the most widely used screening tools during the perinatal period.[24,25] It consists of 10 items, each with four response options scored from 0 to 3, based on the presence and intensity of depressive symptoms during the 7 days before the interview. The maximum score on the scale is 30, with higher scores indicating greater symptom severity. A cutoff value of $\geqslant$ 11 was considered, based on evidence from a systematic review and meta-analysis indicating that this cutoff is frequently used in the literature[26] and according to the validation study conducted with a Brazilian population.[23]

Breastfeeding patterns

BFPs were defined based on the following BF characteristics: breast milk volume (mL/day), BF frequency (number of times in 24 hours), BF duration (minutes per feeding), and infant age at CFI (days). The variables were collected at the three follow-up points (M1, M2, M3).

Breast milk volume

The 24-hour breast milk volume was estimated using the deuterium oxide dose-to-mother (DTM) technique, following the International Atomic Energy Agency (IAEA) protocol.[27] For this purpose, a 30-g dose of deuterium oxide (product: 99.8% S17385, Sercon, UK) was prepared on a calibrated analytical scale (AD3300, Marte Científica, Brazil). Saliva samples from the mother and infant were collected before the administration of deuterium oxide (day 0). Subsequently, the mother received a dose of deuterium oxide, and post-dose saliva samples from the mother and infant were collected on the following days: 1, 2, 3, 4, 13, and 14. This procedure was performed at M1, M2, and M3. Infant weight was measured using a digital pediatric scale (SECA 376, Hamburg, Germany) on days 0 and 14 of sample collection.

Approximately 0.5 mL of saliva was collected and stored at -80 °C. Samples were shipped on dry ice to St. John's Research Institute (Bengaluru, India) for analysis. Deuterium concentration was measured using Fourier-transform infrared spectroscopy (4500t FTIR, Agilent Technologies, USA), and the results were entered into an IAEA spreadsheet (Excel 2013) to calculate 24-hour milk volume (mL) using multiexponential equations.[27]

Breastfeeding frequency

The BF frequency over 24 hours was obtained through a structured questionnaire and calculated as the total number of times the participant reported BF during the daytime (6:00 a.m. to 9:59 p.m.) and nighttime (10:00 p.m. to 5:59 a.m.) in each follow-up period.

Breastfeeding duration

The duration of BF was determined based on the participant's self-report of the average time spent BF during each feeding. This variable was expressed in minutes.

Infant age at complementary food introduction

The infant's age at the introduction of liquids and foods was obtained from a BF practices questionnaire. This age was based on the self-reported month and week when any liquid, solid, or semi-solid food was introduced into the infant's diet (excluding oral rehydration solutions, drops, vitamin or mineral syrups, and medications, as their use does not indicate a deviation from EBF as defined by WHO).[28] The reported infant ages in months and weeks were converted to days, considering 1 month = 30.44 days and 1 week = 7 days.

Breastfeeding status

Data on BF status were self-reported by the mother in the follow-up periods (M1, M2, and M3) and categorized as EBF (yes/no). The "yes" category indicated exclusive intake of breast milk, whereas the "no" category encompassed any intake of liquids (e.g., water, teas, juices), formula, or solid/semi-solid foods in addition to breast milk, according to WHO.[28]

Sociodemographic, anthropometric, and obstetric covariates

The following sociodemographic and health variables were collected at baseline: maternal age (years), educational attainment ($<$ 8, 8-12, or $>$ 12 years of formal schooling), pre-pregnancy weight (kg), and height (m). The pre-pregnancy BMI was calculated in kg/m^2 from self-reported pre-pregnancy weight (kg) and height (m). Values between $\geqslant$ 18.5 and $<$ 25.0 kg/m^2 were classified as normal weight, while values between 25.0 and $<$ 30.0 kg/m^2 were classified as overweight.[29] Data on parity (primiparous/multiparous) and mode of delivery (vaginal/cesarean section) were collected within 72 hours postpartum.

Data analysis

The distribution of continuous variables was evaluated using histograms, the Shapiro-Wilk test, and measures of skewness and kurtosis. Maternal and infant characteristics were described using absolute and relative frequencies for categorical variables and means/SDs and medians/interquartile ranges for continuous variables. Outliers and implausible values for the outcome were assessed visually using boxplots and histograms. Values $\pm$ 3 SD of the mean were classified as outliers.

Missing data were assessed for the continuous EPDS scores, BFP variables (breast milk volume, BF frequency, duration, and age of CFI), and all covariates. Missingness patterns were explored through cross-tabulations and visual inspection of missingness across visits, and no indications of violations of the missing-at-random assumption were identified. No variable exceeded 25% missingness.

A latent class growth model, a specialized type of growth mixture model (GMM), was employed to develop the trajectories of PPD symptoms using EPDS scores. This approach allows for identifying distinct latent classes of trajectories before conducting the GMM. The model accounts for repeated measures over time, aiming to identify latent classes that reflect the heterogeneity of longitudinal depressive symptom trajectories within the population.[30] This technique facilitated the identification of latent classes of women who exhibited similar depressive symptom score trajectories throughout the study based on inter-individual differences and latent patterns in the population. The selection of the appropriate number of latent classes was guided by the lowest absolute value of

the Akaike information criterion (AIC) and Bayesian information criterion (BIC) while also considering the proportion of individuals in each latent class, ensuring that each class contained at least 5% of the sample.[31] Two trajectories were identified in our study.

An alluvial plot, a type of flow diagram, was used to visualize transitions in PPD symptom data across study visits. A cutoff point of $\geqslant 11$ was used to determine the prevalence of PPD symptoms within each of the identified trajectories.[23]

A longitudinal multivariate K-means clustering technique was applied to group women into homogeneous subgroups based on similarities in BF trajectories. All continuous variables were standardized using a z score transformation before clustering to ensure comparability across different measurement scales. The R software package "kml3d" was used to perform longitudinal trajectory clustering. The number of clusters was determined using AIC and BIC, complemented by the evaluation of the Calinski-Harabasz and Davies-Bouldin indices. The choice of three clusters was further supported by the clinical interpretability of the resulting patterns and the adequate distribution of participants across groups.

Multinomial models were fitted to test for association between PPD symptom trajectories and BFP. Odds ratios (OR) with 95%CI were estimated. The models were adjusted for maternal age, parity, maternal education, and pre-pregnancy BMI, based on a priori theoretical evidence of the relationship between PPD and BF. Statistical significance was set at $p < 0.05$. All analyses were performed using R software version 4.1.0.

Ethics statements

Ethical approval for the MILQ study was obtained by the coordinating center from the Institutional Review Board of the University of California, Davis (IRB ID: 920618-1; protocol HRP-503-MILQ; DHHS FWA No. 00004557). In Brazil, the study received authorization from the National Commission for Research Ethics, under protocols 2.086.708, 2.875.218, and 4.865.685. Local approval was granted by the research ethics committee under CAAE 64767717.4.3001.5279, with additional approval from the research ethics committees of the Maternity Teaching Hospital of the Federal University of Rio de Janeiro (Maternidade Escola, Universidade Federal do Rio de Janeiro) (protocols 1.948.992, 2.769.611, and 4.449.007) and from the Municipal Health Department of Rio de Janeiro (protocol 2.100.255). The project was conducted in accordance with the guidelines of the Helsinki Declaration.[32]

Results

The mean age of participants was 27 years, and 87.6% had $\geqslant 8$ years of education. A total of 56.7% had a pre-pregnancy BMI classified as normal, while 43.3% were classified as overweight. Additionally, 60.8% reported having > 1 child. The mean EPDS score was 7.6 at M1 and declined to 6.0 at M3. EBF prevalence was 100% at M1, 42.5% at M2, and 0% (i.e., all women had discontinued EBF practices) at M3 (Table 1).

The estimated depressive symptom trajectories indicated that 87% (n=85) of participants were in the lower score class, corresponding to those who exhibited lower PPD symptom scores over time. The higher score class represented the 13% (n=12) of participants who maintained elevated PPD symptom scores throughout the study period (Figure 1A and B). Across visits, the lower-score class exhibited low and stable EPDS scores (M1: 6.1 95%CI 5.45-6.83; M2: 5.5, 95%CI 4.76-6.21; M3: 5.4, 95%CI 4.66-6.13), whereas the higher-score class showed persistently elevated values (M1: 17.0, 95%CI 14.6-19.4; M2: 14.5, 95%CI 12.24-16.76; M3: 11.6, 95% CI 8.17-15.08).

Women in the lower-scoring class showed stability, with a higher frequency of participants maintaining their initial EPDS < 11 trajectory throughout the follow-up periods.

Table 1 Descriptive maternal characteristics of MILQ-Brazil study participants (n=97)

Variable	
Continuous variables, mean (SD)	
Maternal age, years	27 (5.8)
EPDS score by visit	
M1 (1-3.5 months postpartum)	7.6 (4.9)
M2 (3.5-5.9 months postpartum)	6.7 (4.6)
M3 (6-8.5 months postpartum)	6.0 (4.0)
Categorical variables, n (%)	
Maternal education, years	
< 8	12 (12.4)
8-12	77 (79.4)
> 12	8 (8.2)
Pre-pregnancy BMI, kg/m^2	
Normal weight ($\geqslant$ 18.5-24.9)	55 (56.7)
Overweight ($\geqslant$ 25.0 to < 30.0)	42 (43.3)
Parity	
Primiparous	38 (39.2)
Multiparous	59 (60.8)
Delivery mode	
Vaginal	78 (80.4)
Cesarean	19 (19.6)
Exclusive breastfeeding,[†] months postpartum	
M1 (1-3.5 months postpartum)	
Yes	97 (100.0)
No	0 (0.0)
M2 (3.5-5.9 months postpartum)	
Yes	34 (42.5)
No	46 (57.5)
M3 (6-8.5 months postpartum)	
Yes	0 (0.0)
No	63 (100.0)

Sample size at M1 (1-3.5 months postpartum): 94 individuals; M2 (3.5-5.9 months postpartum): 95 individuals; M3 (6-8.5 months postpartum).
BMI = body mass index; EPDS = Edinburgh Postnatal Depression Scale; MILQ-Brazil = Mothers, Infants, and Lactation Quality-Brazil SD = standard deviation.
[†] Yes: indicated exclusive intake of breast milk; No: any intake of liquids (e.g., water, teas, juices), formula, or solid/semi-solid foods in addition to breast milk.

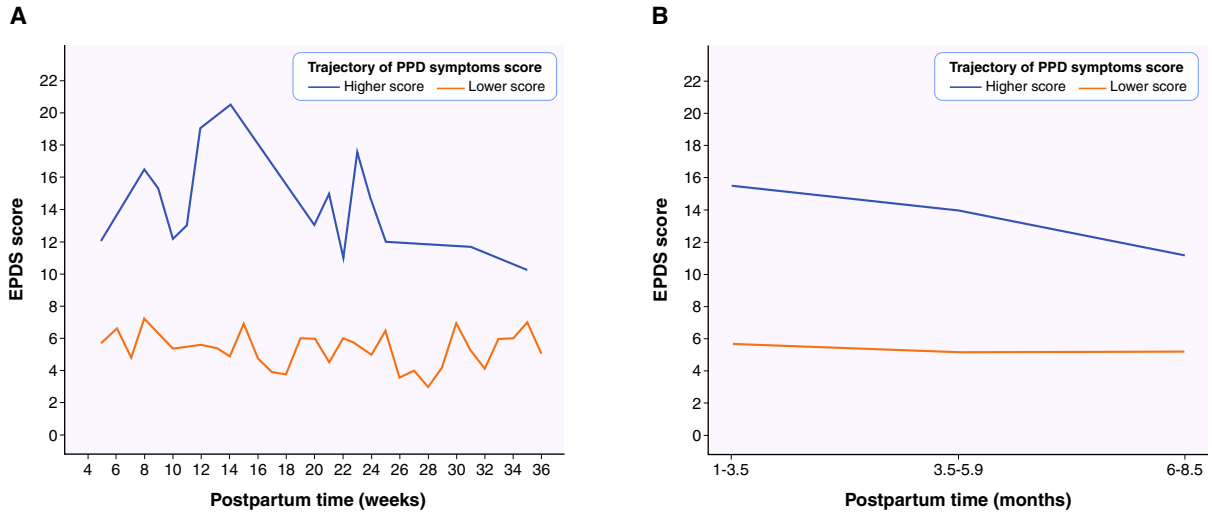


Figure 1 Trajectories of PPD symptom scores in lactating women from the Mothers, Infants, and Lactation Quality-Brazil study. Trajectories were estimated by latent class analysis. Lower score indicates consistently lower PPD symptom levels (n=85), while higher score indicates elevated levels (n=12) throughout the study, according to the EPDS score. A) Trajectories presented according to postpartum weeks. B) Trajectories presented according to time point of assessment (study follow-up visits M1, M2, and M3). EPDS = Edinburgh Postnatal Depression Scale; PPD = postpartum depression.

The higher-scoring class showed more transitions, particularly from presence to absence of PPD symptoms, especially in later study stages (Figure 2).

BF cluster 1 was characterized primarily by women with an average breast milk volume of 842 mL, a longer BF duration per session (28 minutes), and CFI at 177 days postpartum. Cluster 1 was selected as the reference group because it exhibited a balanced profile of breast milk volume, BF frequency, and duration, providing a stable benchmark for comparison. Moreover, this cluster presented the latest CFI, indicating maintenance of EBF up to 6 months. Cluster 2 consisted of women with a lower average breast milk volume (761 mL) and CFI at 126 days postpartum. Cluster 3 comprised women with a higher breast milk volume (920 mL) and BF frequency (20 times/24 hours), and CFI at approximately 109 days postpartum (Supplementary Table S1).

In the unadjusted model (Model 1), a trend toward significance was observed, with higher PPD symptom scores potentially associated with greater odds of being in Cluster 3 of the BFP rather than Cluster 1 (OR = 4.17; 95%CI 0.96-18.50; p = 0.055), while no significant association was found for Cluster 2 (OR = 1.95; 95%CI 0.42-8.88; p = 0.386). In the adjusted model (Model 2), the suggestive association between high PPD symptom scores and Cluster 3 did not reach statistical significance after adjusting for confounders (OR = 3.95; 95%CI 0.84-10.18; p = 0.081) (Table 2).

Discussion

This longitudinal study identified two PPD symptom trajectories, with 87% of women showing low and stable scores over time. In addition, three BFP clusters were observed: Cluster 1, characterized by a balanced BF profile and the latest CFI; Cluster 2, marked by lower milk volume and earlier CFI; and Cluster 3, distinguished by the earliest CFI, in addition to higher milk volume and more frequent BF frequency. A trend toward significance indicated that women with higher PPD symptom scores may be more likely to belong to Cluster 3. Taken together, these findings point to a possible relationship between the PPD symptom trajectories and BFP.

Maternal depression is a complex condition with clinical trajectories that vary widely depending on the severity, persistence, and timing of depressive symptoms. Several cutoff points have been used to categorize the presence of PPD symptoms; however, binary categorizations may not capture the transient nature of maternal mental health. Some studies have investigated maternal PPD symptoms over time, employing other methodological approaches, such as group-based modeling, latent profile analysis, and latent growth mixture modeling, to capture these distinct trajectories, elucidating patterns that may not be discernible through conventional analyses.[33] In a recent study using data from the population-based birth cohort Maternal and Child Health and Nutrition in Acre (MINA)-Brazil (n=1,141), conducted in the North region of Brazil, repeated measures of maternal depressive symptoms were collected at 3 and 6-8 months and at 1 and 2 years postpartum, using the EPDS. Four distinct trajectories of maternal PPD symptoms were identified: low (67.1%), increasing (11.5%), decreasing (17.4%), and high-chronic (4.0%).[33]

In another study involving data from 14,170 mothers who participated in the Avon Longitudinal Study of Parents and Children, the EPDS was used to capture maternal depressive symptoms across 10 time points, two prenatal (18 and 32 weeks) and eight postpartum (2, 8, 21, 33, 61, 73, 97, and 134 months). A latent growth model was applied and identified four distinct trajectories of maternal depressive symptoms over time: minimal

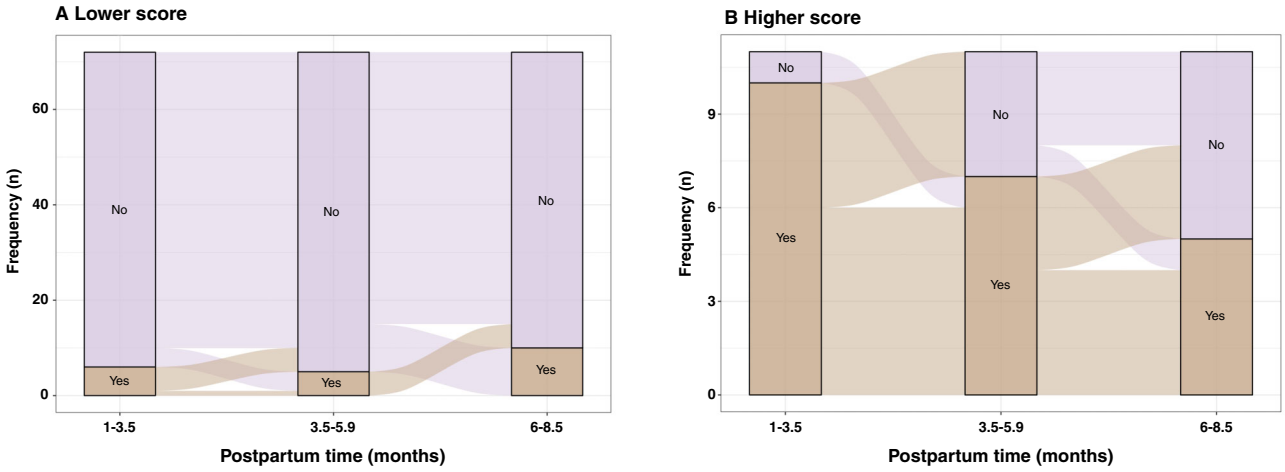


Figure 2 Alluvial plot of postpartum depressive symptoms at follow-up visits, stratified by trajectories of postpartum depression symptom score, among the Mothers, Infants and Lactation Quality-Brazil study. The lines in the plot represent changes in Edinburgh Postnatal Depression Scale status over time, considering postpartum depressive symptoms: yes ($\geqslant$ 11) and no ($<$ 11), classified according to the cutoff score established by Santos et al.[23] A) Lower score class (n=85). B) Higher score class (n=12).

Table 2 Association between trajectories of PPD symptom scores and BFP pattern clusters from MILQ-Brazil study

		Clusters of BFP			
		Cluster 2 (n=34)		Cluster 3 (n=26)	
Trajectory PPD symptoms score	Cluster 1 (n=37)	OR (95%CI)	p-value	OR (95%CI)	p-value
Model 1[†]					
Low score	Ref	Ref	-	Ref	-
High score	Ref	1.95 (0.42-8.88)	0.386	4.17 (0.96-18.50)	0.055
Model 2[‡]					
Low score	Ref	Ref	-	Ref	-
High score	Ref	1.73 (0.33-9.08)	0.512	3.95 (0.84-10.18)	0.081

Multinomial logistic regression was performed. PPD symptom trajectories estimated by latent class analysis: lower score indicates consistently lower PPD symptom levels (n=85), while higher score indicates elevated levels (n=12) throughout the study, according to Edinburgh Postnatal Depression Scale score. BFPs were created using cluster analysis and longitudinal data. The following variables were included: breast milk volume, BF frequency, BF duration per feeding, and age at introduction of solid/semi-solid foods. Key characteristics: Cluster 1, later food introduction with moderate volume and average frequency; Cluster 2, intermediate food introduction with lower volume and lower frequency; Cluster 3, earlier food introduction with higher volume and higher frequency. Cluster 1 was used as the reference category, as it showed a balanced BF profile and the latest introduction of complementary foods.
BFP = breastfeeding pattern; MILQ-Brazil = Mothers, Infants, and Lactation Quality-Brazil; OR = odds ratio; PPD = postpartum depression.
[†] Non-adjusted.
[‡] Adjusted for parity, maternal age, maternal education, and pre-pregnancy body mass index.

symptoms (79%), increasing symptoms (4%), persistent symptoms (11%), and decreasing symptoms (6%).[34] Most studies on perinatal depressive symptoms identify between two and five trajectories.[35] Our data also revealed two trajectories: lower score (87%) and higher score (12%). This distribution reflects the small number of participants grouped in our study and is consistent with the literature, where most women fall into trajectories of low or nonexistent PPD symptomatology, while approximately 5-12% exhibit elevated and persistent depressive symptoms over time.[33,34]

PPD symptoms typically improve over time for most women. However, for a significant proportion, these symptoms become persistent, and if left untreated, approximately 40% of these women may continue to experience symptoms until their children enter preschool.[36,37] Our findings underscore the variability and dynamics of PPD symptoms, as evidenced by the transitions observed in the alluvial plot. Given the potential for far-reaching negative consequences for the mother-infant dyad, particularly regarding BF practices, it is crucial to monitor these symptoms over an extended postpartum period.

To our knowledge, this is the first longitudinal study to perform a cluster analysis to identify BFP. Cluster 3 demonstrated higher mean breast milk volume and BF frequency, which are considerably higher than reported in the literature (919 mL and 20 times/24 hours, respectively).[38,39] However, this cluster also showed shorter BF durations per feeding than in another study by Kent et al.,[39] in which exclusively breastfed infants had median durations of 36 minutes in the first month postpartum and

29 minutes at 3 months postpartum. This paradox can be elucidated by several interrelated factors inherent to this group. The relatively short duration of BF sessions may result in an increased BF frequency, which, in turn, can lead to greater energy expenditure and maternal fatigue.[40] The earlier mean age at introduction of liquids/foods (109 days) may also reflect this set of characteristics, given that factors associated with the early cessation of EBF include high levels of stress and fatigue, as well as parity, dyad separation, maternal educational attainment, maternal BF education, maternal breast and nipple pain, return to work, social influence, and perceived inadequate milk supply.[41,42]

The findings from the unadjusted and adjusted models suggest a possible trend: higher PPD symptom scores are associated with less favorable BFP. Specifically, women with higher symptom scores tended to be classified in Cluster 3, which is characterized mainly by earlier food introduction. Although the association did not reach statistical significance, this pattern likely reflects the modest sample size rather than the absence of an underlying relationship. These results should therefore be interpreted with caution, but they offer relevant indications that deserve further investigation.

Evidence indicates that PPD is associated with early cessation of EBF.[19,43] In a study by Flores-Quijano et al.[44] which followed lactating women from the second to the 12th week postpartum in Mexico (n=163), women with depressive symptoms chose to introduce complementary foods earlier compared to those without depressive symptoms. Similarly, Rahman et al.,[45] in a cohort study conducted from the third trimester of pregnancy to 6 months postpartum in Pakistan, observed that perinatal depression was associated with early BF cessation but not with reduced breast milk volume. However, depression was related to the perception of insufficient breast milk production.

PPD symptoms are often associated with elevated stress levels and the perception of insufficient breast milk volume.[17] A systematic review of 20 studies from both high-income countries and LMICs (n=36.700) concluded that women with PPD may experience more concerns about breast milk insufficiency, leading to an increased BF frequency to ensure adequate intake for the baby.[46] The pattern of frequent, shorter BF sessions observed in Cluster 3 could thus be a compensatory response to perceived low milk supply, despite the higher volume observed in our results. Such compensatory behaviors may exacerbate maternal fatigue, which has been linked to sleep dysregulation, reduced energy availability, and neuroendocrine stress responses.[40] This interplay between fatigue and stress may contribute to higher PPD symptom scores, creating a cycle that undermines the sustainability of EBF.

The absence of statistically significant results in our models may be attributed to some study limitations, including the relatively small sample size. Furthermore, the EPDS warrants consideration, as it is a screening tool for depressive symptoms and does not provide clinical diagnoses, highlighting the need for caution when interpreting these findings. Nevertheless, the EPDS is widely utilized in epidemiological research and has been validated for postpartum women in Brazil. Additionally, depressive symptoms and breast milk volume were not assessed before the 1-month postpartum period, and some variables relied on maternal self-report, which may introduce recall or reporting bias. As with any observational study, residual confounding may persist, particularly from relevant factors not captured in this analysis (e.g., social support, maternal sleep quality, hormonal conditions). The generalizability of these findings is also limited by the single-site design and the specific characteristics of the study population. Key strengths of this study include the use of the deuterium oxide DTM technique, considered the gold standard for estimating breast milk volume,[27] the application of longitudinal data during the postpartum period, and the methodological aspects involved in cluster analysis based on trajectories.

In conclusion, this study highlights the complexity of maternal mental health from 1 to 8.5 months postpartum and its impact on BF behaviors. The relationship between PPD symptoms and BFPs indicates that women with higher PPD symptom scores may be more likely to engage in less favorable BF practices, such as the early introduction of complementary foods. Considering the long-term implications for maternal health and child development, future interventions should focus on the mental health of lactating mothers, ensuring that necessary support is provided to sustain EBF. In this context, the importance of integrating mental health screening into primary-care BF support programs must be emphasized. Furthermore, longitudinal studies with larger samples are needed to better understand these relationships and identify potential intervention points to support mothers experiencing PPD symptoms.

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Disclosure

The authors report no conflicts of interest.

Data availability statement

Data described in the manuscript, code book, and analytic code will be made available upon request, pending application and approval.

Author contributions

GTS: Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing.

ADSC: Writing – review & editing.
DPP: Data curation, Formal analysis, Methodology, Supervision, Writing – review & editing.
ACCF: Conceptualization, Methodology, Supervision, Writing – review & editing.
BCS: Writing – review & editing.
DBM: Writing – review & editing.
AEN: Writing – review & editing.
LHA: Funding acquisition, Project administration, Resources, Writing – review & editing.
GK: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing.
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