Received: 5 April 2021 | Accepted: 5 February 2022

DOI: 10.1111/birt.12625

ORIGINAL ARTICLE

BIRTH ISSUES IN PERINATAL CARE WILEY

Does breastfeeding influence sleep? A longitudinal study across the first two postpartum years

Laura Astbury BPsych (Hons)[1] | **Christie Bennett PhD**[2] | **Donna M. Pinnington BPsych (Hons)**[1,3] | **Bei Bei PhD**[1,3]

[1]Turner Institute for Brain and Mental Health, School of Psychological Sciences, Faculty of Medicine, Nursing and Health Sciences, Monash University, Clayton, Victoria, Australia

[2]Department of Nutrition and Dietetics and Food, Be Active Eat Sleep (BASE) Facility, School of Clinical Sciences, Monash University, Clayton, Victoria, Australia

[3]Centre for Women's Mental Health, Department of Psychiatry, University of Melbourne, Royal Women's Hospital, Melbourne, Victoria, Australia

Correspondence
Bei Bei, Turner Institute for Brain and Mental Health, School of Psychological Sciences, Faculty of Medicine, Nursing and Health Sciences, Monash University, 18 Innovation Walk, Clayton Campus, Vic. 3800, Australia.
Email: bei.bei@monash.edu

Funding information
Data collection was supported by Rob Pierce Grant-in-Aid and Helen Bearpark Scholarship from Australasian Sleep Association, Strategic Grant Scheme from Faculty of Medicine, Nursing and Health Sciences, Monash University, and the Royal Women's Hospital Foundation. Bei (APP1140299) is supported by National Health and Medical Research Council Fellowships, and Pinnington by Australian Postgraduate Awards by Department of Education and Training. The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report

Abstract

Background: The association between breastfeeding and sleep of the gestational parent is poorly understood. This longitudinal study investigated how breastfeeding is associated with total nighttime sleep duration and sleep efficiency (percentage of total sleep time in bed) in nulliparous participants over the first two postpartum years.

Methods: Nulliparous participants ($N = 155$, $M_{age} = 33.45$, $SD_{age} = 3.50$) self-reported patterns of breastfeeding via telephone interviews and sleep via self-report at 1.5, 3, 6, 12 and 24 months postpartum. Data were analyzed using mixed-effects models, with breastfeeding variables as predictors and sleep variables as outcomes, controlling for relevant covariates.

Results: Neither the presence of breastfeeding nor the percentage of human milk in infants' total diets was significantly associated with participants' sleep duration or sleep quality (P-values > 0.08). This finding held after controlling for the number of nighttime feeds (P-values > 0.11). However, greater numbers of nighttime feeds, regardless of feeding content, were strongly associated with shorter sleep duration and poor sleep efficiency (P-values < 0.05). On average, with each additional nighttime feed, nocturnal sleep duration decreased by 6.6-8.4 minutes, and sleep efficiency decreased by 2.88%-3.02%.

Conclusions: Data from this study showed that breastfeeding per se was not associated with shorter or poor nocturnal sleep, but the number of nighttime feeds was. Sharing nighttime infant care amongst different carers in the household could help reduce postpartum sleep disturbance and ameliorate its negative impact on wellbeing.

[correction added on May 13, 2022, after first online publication: CAUL funding statement was added.]

KEYWORDS
breastfeeding, longitudinal, postpartum, sleep

1 | INTRODUCTION

Sleep is a major concern for parents during the postpartum period[1] as decreased sleep duration[2] and poor sleep quality[3] are commonly reported by caregivers of newborn infants. Sleep quality of the gestational parent is shown to be at its lowest during the first postpartum month, followed by a gradual recovery. However, sleep remains fragmented over at least the first four postpartum months,[4] with recent evidence showing that sleep disturbance may continue into the first three postpartum years.[5] Postpartum sleep disturbance is associated with symptoms of depression and anxiety,[6,7] negative impact on the mother-infant relationship,[8] worse daytime functioning,[9,10] and poor quality of life.[11]

Nighttime infant care, nighttime feeding, and infant sleep location may contribute to postpartum sleep disturbance.[12-14] Further, a recent mixed-methods study found that new parents found breastfeeding to be more difficult than anticipated. Furthermore, they found that individuals with more disrupted sleep during pregnancy were less likely to initiate or maintain breastfeeding.[15] This suggests that sleep-related experiences may influence decisions around breastfeeding for some individuals. However, at present, little is known about how breastfeeding itself, independent of the action of awakening to feed, influences gestational parents' sleep.

Prolactin and oxytocin, the two hormones responsible for the synthesis and the ejection of milk respectively,[16] also play a role in sleep. Oxytocin counteracts the effects of the stress hormone cortisol to allow relaxation.[17] Although human research is limited, animal models suggest that oxytocin, under basal, stress-free conditions, may promote sleep.[18] Prolactin may decrease human sleep onset time and increase slow-wave sleep.[19] Moreover, prolactin follows a circadian rhythm, with increased secretion at night, and may assist with relaxation and rest.[20]

To date, just over a dozen studies have investigated how breastfeeding may influence gestational parents' sleep, and the results are inconclusive. Consistent with physiological underpinning, some studies found that breastfeeding was associated with longer sleep duration[21-24] and greater slow-wave sleep.[25] However, other studies did not find a significant association between breastfeeding and sleep.[26,27] For example, an actigraphy-based study found that breastfeeding was not associated with sleep, but higher numbers of individuals (including infants) sharing the same sleep surface was significantly associated with shorter sleep duration and poor sleep quality.[14] Further, a five-month longitudinal study found that higher frequency of nocturnal breastfeeding is associated with a decreased sleep duration.[28] Most studies focused on sleep duration and neglected sleep quality.[22,23,28] There is also a lack of longitudinal studies, as well as studies that explored this relationship past the first four to five months postpartum.[4,27,28]

It is important to investigate this relationship over a longer duration as the World Health Organization (WHO)[29] recommends exclusive breastfeeding for the first six months and then complementary breastfeeding for up to two years and beyond. Furthermore, nulliparous individuals (ie, no older children) experience poor sleep than multiparous individuals (ie, with older children).[30] As individuals are likely to choose the same feeding method for each and their subsequent children,[31] the association between breastfeeding and sleep is particularly important when raising the first child.

The current study aimed to investigate how breastfeeding was associated with sleep duration and quality in nulliparous gestational parents from birth to two years postpartum over five time points (1.5 months, 3 months, 6 months, 12 months, and 24 months). Considering that nighttime feeding and infant sleep location may be relevant to nocturnal sleep, we examined these associations both without and with adjustment for: (a) the number of nighttime feeds; and (b) whether or not participants and their infants were sleeping in the same room.

2 | METHOD

This is a secondary data analysis of a single-blinded randomized controlled trial comparing behaviourally-based sleep and diet interventions (Australian New Zealand Clinical Trial Registry: ACTRN12616001462471). The protocol[32] and primary outcome paper[33] have been published elsewhere. The study was approved by the Royal Women's Hospital (RWH) and the Monash University Human Research Ethics Committees.

2.1 | Participants

Participants were a community sample of expectant nulliparas (N = 155) recruited from the Childbirth Education Program at the RWH in Victoria, Australia. Inclusion criteria were: (a) nulliparity; (b) age 18 or above; (c) singleton pregnancy; (d) English literacy; and (e) regular access to email and internet. Participants utilizing any form of feeding method (eg, exclusively breastfeeding, mixed feeding, formula feeding) were included in the study. Exclusion criteria included: (a) current severe physical or psychiatric conditions as per screening (see protocol for details); (b) the use of sleep altering medications or substances; and (c) physiological, non-insomnia–based sleep disorders. Sleep disorders were screened using *Duke Structured Interview for Sleep Disorders* (*DSISD*)[34] and psychiatric disorders using the *Mini International Neuropsychiatric Interview 7.0*.[35]

2.2 | Procedures

After informed consent and screening, eligible participants in the larger study were randomized 1:1 to either a healthy sleep or a healthy diet condition. The primary outcome paper[33] of the larger study focuses on group differences in sleep outcomes. The sleep intervention aimed to address perinatal sleep disturbance using cognitive behavioral strategies and included components such as sleep hygiene, understanding differences between symptoms of insomnia and sleep deprivation, mindfulness-based strategies, and skills for managing sleepiness/fatigue. The diet condition included information regarding nutrition for the pregnancy and postpartum period, postpartum weight management, introducing solid foods to the infant and family eating. Breastfeeding was not an aspect of either condition.

Breastfeeding data were collected via telephone interviews, and sleep data were collected via online surveys over five time points repeatedly at 1.5 (T1), 3 (T2), 6 (T3), 12 (T4), and 24 (T5) months postpartum. Participants were provided with a 100 Australian Dollars (AUD) voucher at T3, 50 AUD at T4, and 20 AUD at T5 as tokens of appreciation.

2.3 | Measures

2.3.1 | Sleep

Sleep duration is operationalized as self-reported total sleep time (TST); sleep quality is operationalized as sleep efficiency (SE; percentage of TST of time spent in bed, capturing both sleep initiation and sleep maintenance). Participants were asked to complete seven items based on the *Consensus Sleep Diary*[36] to report aspects of their sleep from the past week. In this study, TST and SE were extracted from these items. A 16-item variation of the *Patient Reported Outcomes Measurement Information System* (*PROMIS*)[37] rated on a five-point scale was used to measure sleep disturbance (eight questions) and sleep-related impairment (eight questions) over the past two weeks. Both the PROMIS sleep disturbance and sleep-related impairment are well validated,[38] and form a T-score with a population mean of 50 and a standard deviation of 10.

Breastfeeding information was collected via structured telephone interviews, and the following information was extracted for each of the five time points: (a) time since ceasing breastfeeding (in weeks); (b) the percentage of human milk (in infants' total diet); and (c) the average number of nighttime feeds per night, regardless of feed content.

In addition, self-reported height and weight were used to calculate concurrent body mass index (BMI) at each time point.

2.4 | Statistical analyses

Data analysis was completed using R (version 3.6.2),[39] and statistical significance was set to an alpha value of $P < 0.05$. Missing data are expected in a longitudinal study and are handled using maximum likelihood in mixed-effects models.

Time since ceasing breastfeeding was strongly skewed and was converted to a categorical variable. Analyses using the following three different categorizations were compared using model fit indices Akaike's Information Criteria (AIC) and Bayesian Information Criteria (BIC): (a) currently breastfeeding vs not currently breastfeeding; (b) currently breastfeeding, vs short (≤4 weeks), vs long (>4 weeks) time since ceasing breastfeeding; and (c) currently or short time (≤4 weeks) since ceasing breastfeeding vs long time (>4 weeks) since ceasing breastfeeding. The first categorization emerged as superior to the other two and were used in the final analyses.

The variable percentage of human milk in infants' total diet was calculated for instances when breastfeeding was current. This variable appeared to have a binomial distribution with most participants either breastfeeding at high or low percentages. Therefore, this variable was converted to a two-level categorical variable of high (>50%) or low (≤50%).

First, linear mixed-effects models were conducted in all available data with breastfeeding status (current vs not currently breastfeeding) as the predictor and each sleep variable as the outcome, with and without adjusting for covariates. Time-varying covariates included infant age (ie, weeks since childbirth), infant sleep location (same room as participant: 0, separate room: 1), the number of nighttime feeds, and BMI at each time point. Time-invariant covariates included gestational parent age at enrollment and group condition allocation. Further mixed-effects models used the same configuration, except restricting data to instances of current breastfeeding and included high vs low percentage of human milk as the predictor.

Random effects were included wherever possible and dropped if the models did not converge. Effect sizes were calculated using the marginal and conditional F^2 values for each model. Marginal F^2 denotes the variance explained by the fixed effects divided by residual variance, whereas the conditional F^2 denotes the total variance explained by the fixed and random effects divided by residual variance.[40] A small number of multivariate outliers were identified, but sensitivity analyses showed that all findings held after removing them. Therefore, all values were included to preserve the representation of the sample.

3 | RESULTS

Table 1 shows the sociodemographic characteristics of participants. Participants had a mean age of 33.45 years (SD = 3.50), they were all females, mostly Caucasian (83%) or Asian/Indian (10%), and most (89%) achieved a university level of education. Overall, the rate of missing data is low; among the 155 participants who commenced the study, 73% completed all five time points, and 98% completed three or more time points. Analyses below included all 155 participants.

Ninety-six percent of participants were breastfeeding their infants at T1, and this number decreased at each time point (see Table 2). Over half (57.1%) of the participants were still breastfeeding at 12 months postpartum, and this dropped to 13.5% at 2 years postpartum. Of those who were breastfeeding their infants, 89% started off breastfeeding with a high percentage (>50% in infants' total diet) of human milk, which gradually decreased to a low percentage.

3.1 | Sleep

Table 1 describes TST and SE over time. Mean TST increased from 6.19 hours at 1.5 months postpartum to 7.39 hours at 24 months postpartum, while SE gradually increased from 66.1% to 84.9% during this period. As reported previously,[33] the group differences in TST and SE between intervention conditions were non-significant at T1, T2, T3 and T4 (all P-values > 0.16). At T5 (2 years postpartum), the healthy sleep condition had longer TST (model estimated mean [95% confidence interval]: 7.52 [7.28, 7.76] vs 7.15 [6.89, 7.41] hours, $P = 0.039$) and higher SE (86.45 [83.61, 89.29] vs 82.46 [79.53, 85.39] $P = 0.059$), but effect sizes were small. Group allocation was included as a covariate but was a non-significant predictor of both TST and SE in analyses below (all P-values > 0.36).

Mixed-effects models examining the associations between breastfeeding and sleep with or without adjusting for

TABLE 1 Summary of participant characteristics

			N = 155
Age, M (SD)			33.45 (3.50)
Body mass index (BMI), M (SD)			25.12 (3.79)
Ethnicity			
Asian/Indian, n (%)			15 (10.0)
Caucasian, n (%)			130 (83.0)
Middle Eastern, n (%)			1 (<1.0)
Other, n (%)			9 (7.0)
Level of education			
Less than bachelor's degree, n (%)			17 (11.3)
Bachelor's degree, n (%)			52 (33.3)
Postgraduate degree, n (%)			86 (55.4)
Sleep characteristics	**Sleep efficiency**	**Total sleep time**	**Infant sleeping location: same room (%)**
1.5 months postpartum M (SD)	66.14 (15.31)	6.19 (1.24)	92
3 months postpartum M (SD)	75.27 (12.58)	6.98 (1.10)	83
6 months postpartum M (SD)	75.74 (12.23)	6.95 (1.10)	59
12 months postpartum M (SD)	84.71 (9.76)	7.35 (0.87)	34
24 months postpartum M (SD)	84.94 (11.23)	7.39 (1.03)	25

TABLE 2 Breastfeeding variables at each time point

	Breastfeeding status		Percentage of human milk in infant diet	
Months postpartum	n	Currently breastfeeding, n (%)	n	High percentage, n (%)
1.5 months	155	149 (96.1)	129	115 (89.2)
3 months	152	140 (92.1)	150	128 (85.3)
6 months	152	129 (84.9)	151	118 (78.1)
12 months	119	68 (57.1)	106	8 (7.6)
24 months	111	15 (13.5)	112	0 (0.0)

Note: Percentage of human milk in total infant diet is calculated for currently breastfeeding instances. A low percentage of human milk is operationalized as less than or equal to 50% in total feed; a high percentage of breastfeeding is operationalized as greater than 50% in total infant diet.

covariates are summarized in Tables 3 and 4. In both the adjusted and unadjusted models, currently (vs not currently) breastfeeding was not significantly associated with TST (P-values > 0.48). There was a trend for currently breastfeeding to be associated with lower SE ($P = 0.08$), but this association was absent after adjusting for covariates ($P = 0.95$). Among instances where participants were currently breastfeeding, and in both the adjusted and unadjusted models, percentage of breastfeeding (above or under 50%) was not associated with either TST or SE (P-values > 0.11).

In all adjusted models, the number of nighttime feeds, regardless of the feeding method, was one of the strongest predictors of shorter TST and lower SE; for each additional nighttime feed, TST decreased by 6.6-8.4 minutes (P-values < 0.05), and SE decreased by 2.88%-3.02% (P-values < 0.001). In the models on breastfeeding status predicting sleep, sleeping in a separate (compared to the same) room as the infant was associated with longer TST and higher SE (P-value < 0.05; Table 3). However, infant sleep location was not significantly associated with maternal sleep in the percentage of human milk models (P-values > 0.10; Table 4). Finally, as expected, older infant age was significantly associated with longer TST and higher SE (P-values < 0.05).

4 | DISCUSSION

This study examined the associations between breastfeeding and sleep duration and quality in first-time gestational parents over the first two postpartum years. Neither the presence nor the percentage of breastfeeding per se was significantly associated with sleep duration or quality. However, the higher number of nighttime feeds, regardless of feeding method, emerged as a strong predictor of shorter sleep duration and poor sleep quality.

The majority (78.1%) of participants chose to breastfeed with a high percentage of breastmilk for the first six months of their infant's life, which is higher than in global trends (median: 42.7% across 22 countries),[41] yet consistent with WHO's[29] recommendation for exclusive breastfeeding until the infant is six months old. This finding should be interpreted in the context of the overall high education level for this sample, a known predictor of high breastfeeding compliance.[42] Many participants (42.9%) had ceased breastfeeding by 12 months postpartum, before WHO's recommendation of complementary breastfeeding up to two years and beyond. This significant decline in breastfeeding at around 12 months postpartum coincided with the end of typical Australian maternity leaves[43] when gestational parents are often returning to work.

The findings that breastfeeding may not impact sleep duration or sleep quality in this study is consistent with findings from previous studies.[24,25] It is also possible that different ways of quantifying sleep duration contributed to different findings: a previous study that found breastfeeding to be associated with longer sleep duration included naps[22] whilst this study focused on nocturnal sleep. We did find a trend in breastfeeding being associated with worse sleep efficiency, but this association was no longer significant after adjusting for the number of nighttime feeds carried out by the gestational parent and infant sleep location. This suggests that it is likely that the action of getting up and feeding the infant, and not breastfeeding per se, that may disrupt sleep. Infant sleep location as a covariate, shared mixed associations with maternal sleep, highlighting potentially complex relationships amongst breastfeeding, infant room/bedsharing, and maternal sleep[44] that requires further research.

Changes in sleep duration and quality in this study are consistent with the literature.[28,45,46] Sleep during the first six postpartum months is highly disrupted for gestational parents and recovery from this disturbance is taking place through at least two years postpartum.

4.1 | Limitations and strengths

Findings need to be interpreted in light of a number of limitations. Sleep was assessed via self-report and not

TABLE 3 Breastfeeding status predicting sleep duration and quality with and without adjusting for covariates

	Total sleep time		Sleep efficiency	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Intercept	6.62 [6.31, 6.93], <0.001	8.73 [7.32, 10.14], <0.001	73.38 [69.50, 77.27], <0.001	90.70 [74.46, 106.94], <0.001
Group allocation	0.08 [−0.17, 0.33], 0.52	0.11 [−0.14, 0.36], 0.37	−0.89 [−3.66, 1.89], 0.53	−0.08 [−2.92, 2.75], 0.96
Infant age	0.01 [0.01, 0.01], <0.001	0.00 [0.00, 0.01], 0.02	0.14 [0.10, 0.17], <0.001	0.08 [0.03, 0.12], <0.001
Currently breastfeeding	−0.09 [−0.35, 0.16], 0.48	−0.01 [−0.29, 0.28], 0.97	−2.70 [−5.73, 0.32], 0.08	−0.11 [−3.47, 3.25], 0.95
Infant in separate room		0.28 [0.07, 0.49], 0.01		3.21 [0.67, 5.76], 0.01
Participant age		−0.04 [−0.08, −0.01], 0.03		−0.18 [−0.58, 0.22], 0.38
Participant BMI		−0.03 [−0.05, 0.00], 0.08		−0.32 [−0.65, 0.00], 0.05
Nighttime feeds		−0.14 [−0.22, −0.06], <0.001		−3.02 [−3.94, −2.10], <0.001
N	155	153	155	153
Marginal F^2	0.07	0.15	0.19	0.33
Conditional F^2	0.75	0.84	0.60	0.80

Note: Unstandardized coefficients [95% confidence interval] for fixed effects and *P*-values are reported for each predictor.

TABLE 4 Percentage of human milk in infants' total diet predicting sleep duration and quality for currently breastfeeding instances with and without adjusting for covariates

	Total sleep time		Sleep efficiency	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Intercept	6.40 [6.16, 6.65], <0.001	8.24 [6.59, 9.89], <0.001	68.68 [65.89, 71.46], <0.001	87.15 [69.27, 105.04], <0.001
Group allocation	0.02 [−0.27, 0.32], 0.88	0.05 [−0.24, 0.35], 0.72	−1.49 [−4.79, 1.81], 0.38	−0.42 [−3.56, 2.75], 0.80
Infant age	0.02 [0.01, 0.02], <0.001	0.01 [0.01, 0.02], <0.001	0.22 [0.14, 0.30], <0.001	0.21 [0.12, 0.29], <0.001
% of human milk (low)	−0.16 [−0.49, 0.17], 0.35	−0.30 [−0.67, 0.07], 0.11	0.83 [−3.19, 4.84], 0.68	−1.51 [−5.85, 2.84], 0.50
Infant in separate room		0.24 [−0.05, 0.52], 0.10		1.36 [−1.98, 4.70], 0.43
Participant age		−0.03 [−0.07, 0.02], 0.24		−0.04 [−0.49, 0.40], 0.85
Participant BMI		−0.03 [−0.07, 0.00], 0.07		−0.47 [−0.87, −0.08], 0.02
Nighttime feeds		−0.11 [−0.20, −0.02], 0.02		−2.88 [−3.92, −1.83], <0.001
N	148	145	148	145
Marginal F2	0.05	0.12	0.12	0.25
Conditional F2	0.73	0.74	0.62	0.66

Note: Unstandardized coefficients [95% confidence interval] for fixed effects and *P*-values are reported for each predictor.

objective methods. Objective hormone (eg, prolactin and oxytocin) levels were not measured, and it was not possible to ascertain the associations between hormone levels and sleep. In addition, we did not collect data on how much human milk was expressed versus directly fed, which limited our ability to further understand how different breastfeeding approaches affect sleep. There may also be differences in sleep related to different feeding methods (eg, exclusively breastfeeding, solids and breastmilk, solids and formula), which we did not examine. We also did not collect data on weaning foods. Results may not be generalizable to individuals with low levels of education or socio-economic status, those who are multiparous, or to gestational parents in other countries. This study was carried out in the context of a randomized controlled trial, rather than an observation-only study. However, the interventions were unrelated to breastfeeding, and, except small differences in sleep at two years postpartum, the two intervention conditions did not differ significantly in sleep duration or quality over time; we further controlled for group assignment as a covariate.

Nevertheless, this study contributes to the literature by investigating the relationship between breastfeeding and gestational parents' sleep longitudinally over the first two postpartum years. Previous research has investigated this relationship up to five months postpartum,[4,26-28] much shorter than the two-year recommendations from WHO. Further, this study included a large community sample and considered both sleep duration and sleep quality rather than either dimension.

4.2 | Implications

In a community sample of first-time gestational parents, breastfeeding did not appear to be associated with concurrent shorter or worse sleep. This could be reassuring for new parents so that they are not deterred from breastfeeding due to concerns of sleep. However, the act of getting up and feeding the infant, regardless of breastfeeding or formula feeding, was detrimental to parental sleep. Previous studies showed that individuals who breastfed tend to receive less support from their partners with nocturnal infant feeds,[47] potentially further exacerbating the perceived link between breastfeeding and sleep disruption. As shown in mounting evidence, early parenthood is marked by significant sleep disturbance.[2-5] Gestational parents may be able to improve sleep by sharing the responsibility of nighttime feeding with their partner or other support persons. This is particularly relevant for the initial days and weeks after childbirth, when sleep disruption is particularly severe.[48] Perinatal professionals could utilize findings from this study to educate about breastfeeding. For those individuals who have the support, providers may utilize the findings from this study to encourage shared nighttime infant care from the whole household to mitigate negative impact on sleep and well-being on new parents.

ACKNOWLEDGMENTS

The authors would like to thank all participants for generously donating their time to this project. We thank Prof Louise Newman, Kaye Dyson, and Elisabeth Gasparini for supporting recruitment, and (alphabetical) Cassandra Fong, Dr Catherine Fulgoni, Anthony Hand, Ashley Lam, Jin Joo Lee, Sarah Samuel, Lin Shen, Isabelle Smith, Emma Thompson, and Sumedha Verma for assistance in collecting data used in this manuscript. Open access publishing facilitated by Monash University, as part of the Wiley - Monash University agreement via the Council of Australian University Librarians.

DATA AVAILABILITY STATEMENT

De-identified individual patient data can be requested from the corresponding author upon reasonable request. Open access publishing facilitated by Monash University, as part of the Wiley - Monash University agreement via the Council of Australian University Librarians.

ORCID

Laura Astbury https://orcid.org/0000-0001-8822-2895
Christie Bennett https://orcid.org/0000-0001-9507-2661
Bei Bei https://orcid.org/0000-0001-9660-6573

REFERENCES

1. Hunter LP, Rychnovsky JD, Yount SM. A selective review of maternal sleep characteristics in the postpartum period. *J Obstet Gynecol Neonatal Nurs*. 2009;38(1):60-68. doi:10.1111/j.1552-6909.2008.00309.x
2. Signal TL, Gander PH, Sangalli MR, Travier N, Firestone RT, Tuohy JF. Sleep duration and quality in healthy nulliparous and multiparous women across pregnancy and post-partum. *Aust N Z J Obstet Gynaecol*. 2007;47(1):16-22. doi:10.1111/j.1479-828X.2006.00672.x
3. Christian LM, Carroll JE, Porter K, Hall MH. Sleep quality across pregnancy and postpartum: effects of parity and race. *Sleep Health*. 2019;5(4):327-334. doi:10.1016/j.sleh.2019.03.005
4. Montgomery-Downs HE, Insana SP, Clegg-Kraynok MM, Mancini LM. Normative longitudinal maternal sleep: the first 4 postpartum months. *Am J Obstet Gynecol*. 2010;203(5):465.e1-465.e7. doi:10.1016/j.ajog.2010.06.057
5. Wang G, Deng Y, Jiang Y, et al. Corrigendum: Trajectories of sleep quality from late pregnancy to 36 months postpartum and association with maternal mood disturbances: a longitudinal and prospective cohort study. *Sleep*. 2019;42(8):zsz106. doi:10.1093/sleep/zsz106

6. Dørheim SK, Bondevik GT, Eberhard-Gran M, Bjorvatn B. Sleep and depression in postpartum women: a population-based study. *Sleep*. 2009;32(7):847-855. doi:10.1093/sleep/32.7.847
7. Bei B, Coo S, Trinder J. Sleep and mood during pregnancy and the postpartum period. *Sleep Med Clin*. 2015;10(1):25-33. doi:10.1016/j.jsmc.2014.11.011
8. Tikotzky L. Postpartum maternal sleep, maternal depressive symptoms and self-perceived mother–infant emotional relationship. *Behav Sleep Med*. 2016;14(1):5-22. doi:10.1080/15402002.2014.940111
9. Wilson N, Wynter K, Anderson C, Rajaratnam SMW, Fisher J, Bei B. Postpartum fatigue, daytime sleepiness, and psychomotor vigilance are modifiable through a brief residential early parenting program. *Sleep Med*. 2019;59:33-41. doi:10.1016/j.sleep.2019.01.012
10. McBean AL, Montgomery-Downs HE. Timing and variability of postpartum sleep in relation to daytime performance. *Physiol Behav*. 2013;122:134-139. doi:10.1016/j.physbeh.2013.09.003
11. Rychnovsky J, Hunter LP. The relationship between sleep characteristics and fatigue in healthy postpartum women. *Womens Health Issues*. 2009;19(1):38-44. doi:10.1016/j.whi.2008.07.015
12. Hagen EW, Mirer AG, Palta M, Peppard PE. The sleep-time cost of parenting: sleep duration and sleepiness among employed parents in the Wisconsin sleep cohort study. *Am J Epidemiol*. 2013;177(5):394-401. doi:10.1093/aje/kws246
13. Filtness AJ, MacKenzie J, Armstrong K. Longitudinal change in sleep and daytime sleepiness in postpartum women. *PLoS One*. 2014;9(7):e103513. doi:10.1371/journal.pone.0103513
14. Crittenden AN, Samson DR, Herlosky KN, Mabulla IA, Mabulla AZP, McKenna JJ. Infant co-sleeping patterns and maternal sleep quality among Hadza hunter-gatherers. *Sleep Health*. 2018;4(6):527-534. doi:10.1016/j.sleh.2018.10.005
15. Gordon LK, Mason KA, Mepham E, Sharkey KM. A mixed methods study of perinatal sleep and breastfeeding outcomes in women at risk for postpartum depression. *Sleep Health*. 2021;7(3):353-361. doi:10.1016/j.sleh.2021.01.004
16. Sriraman NK. The nuts and bolts of breastfeeding: anatomy and physiology of lactation. *Curr Probl Pediatr Adolesc Health Care*. 2017;47(12):305-310. doi:10.1016/j.cppeds.2017.10.001
17. Uvnäs-Moberg K, Petersson M. Oxytocin, ein Vermittler von Antistress, Wohlbefinden, sozialer Interaktion, Wachstum und Heilung/ Oxytocin, a mediator of anti-stress, well-being, social interaction, growth and healing. *Z Psychosom Med Psychother*. 2005;51(1):57-80. doi:10.13109/zptm.2005.51.1.57
18. Lancel M, Krömer S, Neumann ID. Intracerebral oxytocin modulates sleep–wake behaviour in male rats. *Regul Pept*. 2003;114(2-3):145-152. doi:10.1016/S0167-0115(03)00118-6
19. Avidan AY. Introduction to clinical corners in sleep medicine. *Sleep Med*. 2007;9(1):95. doi:10.1016/j.sleep.2007.09.010
20. World Health Organization. *Infant and Young Child Feeding: Model Chapter for Textbooks for Medical Students and Allied Health Professionals*. World Health Organization; 2009.
21. Doan T, Gay CL, Kennedy HP, Newman J, Lee KA. Nighttime breastfeeding behavior Is associated with more nocturnal sleep among first-time mothers at one month postpartum. *J Clin Sleep Med*. 2014;10(03):313-319. doi:10.5664/jcsm.3538
22. Hughes O, Mohamad MM, Doyle P, Burke G. The significance of breastfeeding on sleep patterns during the first 48 hours postpartum for first time mothers. *J Obstet Gynaecol*. 2018;38(3):316-320. doi:10.1080/01443615.2017.1353594
23. Kendall-Tackett K, Cong Z, Hale TW. The effect of feeding method on sleep duration, maternal well-being, and postpartum depression. *Clin Lact*. 2011;2(2):22-26. doi:10.1891/215805311807011593
24. Kendall-Tackett K, Cong Z, Hale TW. Depression, sleep quality, and maternal well-being in postpartum women with a history of sexual assault: a comparison of breastfeeding, mixed-feeding, and formula-feeding mothers. *Breastfeed Med*. 2013;8(1):16-22. doi:10.1089/bfm.2012.0024
25. Blyton DM, Sullivan CE, Edwards N. Lactation is associated with an increase in slow-wave sleep in women. *J Sleep Res*. 2002;11(4):297-303. doi:10.1046/j.1365-2869.2002.00315.x
26. Montgomery-Downs HE, Clawges HM, Santy EE. Infant feeding methods and maternal sleep and daytime functioning. *Obstet Gynecol Surv*. 2011;66(4):201-202. doi:10.1097/OGX.0b013e318225c5e9
27. Sharkey KM, Iko IN, Machan JT, Thompson-Westra J, Pearlstein TB. Infant sleep and feeding patterns are associated with maternal sleep, stress, and depressed mood in women with a history of major depressive disorder (MDD). *Arch Womens Ment Health*. 2016;19(2):209-218. doi:10.1007/s00737-015-0557-5
28. Vitzthum VJ, Thornburg J, Spielvogel H. Impacts of nocturnal breastfeeding, photoperiod, and access to electricity on maternal sleep behaviors in a non-industrial rural Bolivian population. *Sleep Health*. 2018;4(6):535-542. doi:10.1016/j.sleh.2018.09.011
29. World Health Organization, Nutrition for Health and Development. Guideline. 2017. Accessed March 5, 2021. http://www.ncbi.nlm.nih.gov/books/NBK487819/
30. Lee KA, Zaffke ME, Mcenany G. Parity and sleep patterns during and after pregnancy. *Obstet Gynecol*. 2000;95(1):14-18. doi:10.1097/00006250-200001000-00003
31. Taylor JS, Geller L, Risica PM, Kirtania U, Cabral HJ. Birth order and breastfeeding initiation: results of a national survey. *Breastfeed Med*. 2008;3(1):20-27. doi:10.1089/bfm.2007.0006
32. Bei B, Pinnington DM, Shen L, et al. A scalable cognitive behavioural program to promote healthy sleep during pregnancy and postpartum periods: protocol of a randomised controlled trial (the SEED project). *BMC Pregnancy Childbirth*. 2019;19(1):1-9.
33. Bei B, Pinnington DM, Quin N, et al. Improving perinatal sleep via a scalable cognitive behavioural intervention: findings from a randomised controlled trial from pregnancy to 2 years postpartum. *Psychol Med*. 2021;1-11
34. Edinger J, Wyatt J, Olsen M, et al. Reliability and validity of the Duke Structured Interview for Sleep Disorders for insomnia screening. *Sleep*. 2009;32:A265.
35. Sheehan D, Lecrubier Y, Harnett Sheehan K, et al. The validity of the Mini International Neuropsychiatric Interview (MINI) according to the SCID-P and its reliability. *Eur Psychiatry*. 1997;12(5):232-241. doi:10.1016/S0924-9338(97)83297-X
36. Carney CE, Ulmer C, Edinger JD, Krystal AD, Knauss F. Assessing depression symptoms in those with insomnia: an examination of the beck depression inventory second edition (BDI-II). *J Psychiatr Res*. 2009;43(5):576-582. doi:10.1016/j.jpsychires.2008.09.002

37. Pilkonis PA, Choi SW, Reise SP, et al. Item banks for measuring emotional distress from the Patient-Reported Outcomes Measurement Information System (PROMIS®): depression, anxiety, and anger. *Assessment*. 2011;18(3):263-283. doi:10.1177/1073191111411667
38. Buysse DJ, Yu L, Moul DE, et al. Development and validation of patient-reported outcome measures for sleep disturbance and sleep-related impairments. *Sleep*. 2010;33(6):781-792. doi:10.1093/sleep/33.6.781
39. R. The R Project for Statistical Computing. Published 2013. http://www.R-project.org/
40. Nakagawa S, Schielzeth H. A general and simple method for obtaining R^2 from generalized linear mixed-effects models. *Methods Ecol Evol*. 2013;4(2):133-142. doi:10.1111/j.2041-210x.2012.00261.x
41. Lutter CK, Morrow AL. Protection, promotion, and support and global trends in breastfeeding. *Adv Nutr*. 2013;4(2):213-219. doi:10.3945/an.112.003111
42. Kristiansen AL, Lande B, Øverby NC, Andersen LF. Factors associated with exclusive breast-feeding and breast-feeding in Norway. *Public Health Nutr*. 2010;13(12):2087-2096. doi:10.1017/S1368980010002156
43. Fair Work Ombudsman. Maternity & parental leave. Published 2021. Accessed March 5, 2021. https://www.fairwork.gov.au/leave/maternity-and-parental-leave
44. Bovbjerg ML, Hill JA, Uphoff AE, Rosenberg KD. Women who bedshare more frequently at 14 weeks postpartum subsequently report longer durations of breastfeeding. *J Midwifery Womens Health*. 2018;63(4):418-424. doi:10.1111/jmwh.12753
45. Gay CL, Lee KA, Lee S-Y. Sleep patterns and fatigue in new mothers and fathers. *Biol Res Nurs*. 2004;5(4):311-318. doi:10.1177/1099800403262142
46. Nishihara K, Horiuchi S. Changes in sleep patterns of young women from late pregnancy to postpartum: Relationships to their infants' movements. *Percept Mot Skills*. 1998;87(3):1043-1056. doi:10.2466/pms.1998.87.3.1043
47. Tikotzky L, Sadeh A, Glickman-Gavrieli T. Infant sleep and paternal involvement in infant caregiving during the first 6 months of life. *J Pediatr Psychol*. 2010;36(1):36-46. doi:10.1093/jpepsy/jsq036
48. Bei B, Coo Calcagni S, Milgrom J, Trinder J. Day-to-day alteration of 24-hour sleep pattern immediately before and after giving birth: 24-hour sleep before and after childbirth. *Sleep Biol Rhythms*. 2012;10(3):212-221. doi:10.1111/j.1479-8425.2012.00563.x

How to cite this article: Astbury L, Bennett C, Pinnington DM, Bei B. Does breastfeeding influence sleep? A longitudinal study across the first two postpartum years. *Birth*. 2022;49:540–548. doi:10.1111/birt.12625