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Hawley E. Montgomery-Downs, Heather M. Clawges and Eleanor E. Santy

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Infant Feeding Methods and Maternal Sleep and Daytime Functioning

WHAT’S KNOWN ON THIS SUBJECT: Breastfed infants are reported to awaken more often and to sleep less. Because of its well-established benefits for both infants and mothers, any perceived disadvantage of breastfeeding should be evaluated carefully. Feeding method effects on maternal sleep are relatively unknown.

WHAT THIS STUDY ADDS: We did not find any objective, subjective, or sleepiness/fatigue differences among women who used different feeding methods. The risks of not breastfeeding should be weighed against the cumulative lack of evidence of any benefit of formula feeding on maternal sleep.

abstract

OBJECTIVE: Our purpose was to explore maternal actigraphically measured sleep, subjective sleep reports, and daytime functioning on the basis of current feeding method status during postpartum weeks 2 through 12.

METHODS: Objectively measured total sleep time, sleep efficiency, and fragmentation, subjectively reported numbers of nocturnal awakenings, total nocturnal wake time, and sleep quality, and sleepiness/fatigue measured by using the fatigue visual analog scale, the Stanford Sleepiness Scale, or the Epworth Sleepiness Scale were assessed.

RESULTS: We did not find differences between women who were exclusively breastfeeding, exclusively formula feeding, or using a combination of the 2 methods, with respect to the assessed parameters.

CONCLUSIONS: Efforts to encourage women to breastfeed should include information about sleep. Specifically, women should be told that choosing to formula feed does not equate with improved sleep. The risks of not breastfeeding should be weighed against the cumulative lack of evidence indicating any benefit of formula feeding on maternal sleep. Pediatrics 2010;126:e1562–e1568

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KEY WORDS
infant, breastfeeding, formula, sleep, postpartum, maternal

ABBREVIATIONS
AAP—American Academy of Pediatrics
PDA—personal digital assistant

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The cumulative evidence supporting the benefits of breastfeeding is so significant that the American Academy of Pediatrics (AAP) 2005 policy statement concludes, “the AAP firmly adheres to the position that breastfeeding ensures the best possible health as well as the best developmental and psychosocial outcomes for the infant. Enthusiastic support and involvement of pediatricians in the promotion and practice of breastfeeding is essential to the achievement of optimal infant and child health, growth, and development.”

Because of its well-established benefits for both infants and mothers, any perceived disadvantage of breastfeeding should be evaluated carefully. One obstacle to a woman’s decision to breastfeed may be concern about how breastfeeding will affect her sleep. Panchula recommends that, “We will want to reassure her that she will do fine with less sleep (don’t we all?) and educate her about the important and very real needs of her infant, who is still an immature being not yet ready to be independent.” A growing body of evidence shows that mothers may not, in fact, “do fine with less sleep.” Postpartum affect is related to sleep and fatigue to the extent that that Fisher et al proposed that postpartum affect is on a continuum indistinct from fatigue. Although distinguishing the cause-effect relationship between postpartum sleep and depression has been difficult, fragmented sleep as a cause of negative affect is supported by evidence that improvements in infant sleep lead to improvements in maternal depression. Maternal sleep disturbance also may have a negative impact on infants; maternal depression is predictive of worse infant-parent interactions and infant emotional and cognitive outcomes, failure to thrive, and greater behavioral, emotional, and social problems.

Although the benefits of breastfeeding are undisputed, mothers’ concerns about how feeding methods might affect their sleep are legitimate and should be met with understanding, and mothers should be given the most current evidence to help them make decisions regarding feeding methods. There is some subjective evidence from maternal diaries of infant sleep that, compared with formula-fed infants, breastfed infants have less total sleep time and more nighttime awakenings although others reported no differences for either infant sleep measure. The single objective (actigraphy) study showed more fragmented infant sleep with increased nocturnal breastfeeding. The impact of feeding methods on maternal sleep has been understudied. By using actigraphy, Gay et al reported that breastfeeding mothers spent more time awake during the night but did not differ from formula-feeding mothers with respect to total sleep time. In another study, those authors reported that breastfeeding mothers slept ~40 minutes more per night. Breastfeeding mothers demonstrated no total sleep time difference when home-based polysomnography was used, although they did demonstrate lower sleep efficiency and more nocturnal awakenings.

The objective of our study was to build on this literature by exploring potential differences between mothers who breastfed, mothers who formula-fed, and mothers who used a combination of the 2 methods, with respect to both objective and subjective measures of maternal sleep and daytime functioning, by using data from a longitudinal, field-based study of the first 3 postpartum months.

METHODS

Participants

The study was approved by the West Virginia University Office of Research Compliance. Women were recruited prenatally through childbirth classes, community advertisements, and word of mouth. Telephone screening was conducted before administration of informed consent procedures and Health Information Portability and Accountability Act authorization. Women were excluded from participation and referred for further evaluation and treatment, as appropriate, on the basis of a history of major depressive or anxiety disorder, a score of ≥16 on the Center for Epidemiologic Studies Depression scale, pregnancy with multiple fetuses, premature delivery, or infant admission to the NICU. All other respondents who were pregnant or whose infants were <1 week of age were recruited for participation.

Data were collected from 2 overlapping postpartum phases. The first phase included a convenience sample of primiparous and multiparous women who participated during postpartum weeks 9 through 16. On the basis of the success of the first phase, the second phase was begun earlier in the postpartum period, lasted for a longer time, and included only primiparous women, who participated during postpartum weeks 2 through 13.

After participation, mothers were interviewed by a researcher via telephone and asked to recall their feeding methods during the first week after birth. If they breastfed their child at any time, they were asked if or when they supplemented with formula and if or when they weaned their child off of breast milk, which yielded 3 groups at each postpartum week, that is, mothers who breastfed exclusively, mothers who used formula exclusively, and mothers who used a combination of the 2 methods.

Protocol

A member of the research team visited the homes weekly, to give the mothers a new actigraph and a personal digital
Assistant (PDA), which was used for data collection through the computerized experience sampling method.25

**Objective Sleep Measures**

Sleep measures were recorded objectively by using continuous wrist actigraphy (Actiwatch-64 [MiniMitter, Bend, OR]). Use of the Actiwatch-64 has been validated for recognition of adult sleep.26–28 The highest-resolution setting (15-second epoch) and validated default wake threshold value (40 movement counts per epoch) were used to interpret movement signals. Periods of nocturnal sleep and daytime naps were identified by participants by using PDA-based sleep diaries (Bruner Consulting, Longmont, CO), which were completed in real time at every bedtime and arising time for nocturnal sleep and diurnal nap periods. The software also has a method for retrospective entries, which are annotated as retrospective. By using the sleep diary, nocturnal sleep periods were identified on the actigraphic signal. The following measures were analyzed for identified sleep periods by using Actiware software (MiniMitter): total sleep time, that is, minutes of sleep between initial sleep onset and final awakening; sleep efficiency, that is, proportion of sleep time between initial sleep onset and final awakening; sleep fragmentation index, that is, percent mobile epochs plus the ratio of percent 1-minute immobile bouts to percent mobile.

**Subjective Sleep Measures**

Each morning, participants used the PDA to report the following. “How many times do you think you woke up last night (drop-down menu of 0–99)?” “Please indicate how long you were asleep last night (total) (fill-in hours and minutes).” “Where 100 is fully awake last night (total) (drop-down menu of 0–99)?” “Where 100 is fully rested, please indicate your quality of sleep (Likert scale of 0–100).” “How many times do you think you woke up last night (total) (fill-in hours and minutes).” “Where 100 is fully awake last night (total) (fill-in hours and minutes).” “Where 100 is fully rested, please indicate your quality of sleep (Likert scale of 0–100).”

**Daytime Functioning**

The fatigue visual analog scale, the Stanford Sleepiness Scale, and the Epworth Sleepiness Scale were self-administered by using the PDA. Participants were asked to complete these measures whenever they fed their infants during the day.

The fatigue visual analog scale29 is a 100-point scale that was used previously to measure fatigue among postpartum women,21 rating, “How tired/fatigued do you feel right now?” (from 0 = not at all tired/fatigued to 100 = very tired/fatigued). The Stanford Sleepiness Scale30 measures how sleepy subjects feel in their current state (scale of 1–7, with 1 = feeling active, vital, alert, or wide awake and 7 = no longer fighting sleep, sleep onset soon, or having dream-like thoughts); scores of ≥3 indicate extreme sleepiness. The Epworth Sleepiness Scale31 measures subjects’ likelihood of falling asleep (with a scale of 0–3), in each of 8 different real-life situations. Total scores on this scale can range from 0 to 24, and scores of >10 indicate extreme sleepiness. The Epworth Sleepiness Scale typically is used to reflect trait-like behavior in the past month, but for this study we used this measure to reflect present state.

**Statistical Analyses**

Feeding methods (breastfeeding, formula feeding, or both) were identified for each postpartum week and compared with outcomes during the same week. To reduce the number of analyses and to avoid type 2 errors, we examined only postpartum weeks 2, 4, 6, 8, 10, and 12. In other words, if a mother began formula supplementation at week 4 and then weaned from breast milk entirely at week 7, she was categorized as breastfeeding during week 2, using both methods during weeks 4 and 6, and formula feeding at week 8. Each participant’s objective sleep measures (total sleep time, sleep efficiency, and sleep fragmentation), subjective sleep measures (nocturnal awakenings, total wake time, and sleep quality), and daytime functioning measures (fatigue visual analog scale, Stanford Sleepiness Scale, and Epworth Sleepiness Scale results) were averaged within each postpartum week. At least 4 nights of recording were required for calculation of each participant’s weekly average.

Data were analyzed with SPSS 16.0 (SPSS Inc, Chicago, IL). Descriptive statistics were calculated. One-way analysis of variance was used to determine statistically significant differences between feeding method groups with respect to outcome measures at each week. Results were considered statistically significant at P < .05. Cohen’s d was used to describe effect sizes, with the conventional interpretation of d = 0.2 being considered small, d = 0.5 being considered medium, and d = 0.8 being considered large.32 Data on figures are shown as mean ± SEM. Because this was an exploratory study and the results were negative, we performed a posthoc power analysis. With 80 participants and a 2-tailed α value of <.05, we had power of 0.94 to find a strong effect size (d = 0.8) and power of 0.60 to find a moderate effect size (d = 0.5). Therefore, with our current sample size, we would expect to find a true difference (P < .05) 60% of the time if it was moderate and 94% of the time if it was strong.

**RESULTS**

Twenty-four mothers participated in the first phase of the study (postpartum weeks 8–16) and 70 participated in the second phase (postpartum weeks 2–13). Of those subjects, we were unable to contact 14 (5 from the first phase and 9 from the second phase) for the interview on feeding methods. Mothers whom we could not...
contact were younger \((P = .004)\), had fewer years of education \((P < .001)\), had lower incomes \((P < .001)\), and were less likely to be breastfeeding at the beginning of the study \((contacted, 80\%; unable to be contacted, 54\%; \(P = .035)\). Mothers whom we could not contact were not statistically different with respect to marital status or delivery method. No infant had a birth defect or syndrome (such as trisomy 21) that would be expected to affect feeding.

The analyses presented here are based on data for the remaining 80 subjects. The number of mothers in each of the 3 feeding method groups at each postpartum week and the weekly numbers of sleepiness/fatigue reports they made are presented in Table 1. Participant demographic features are presented in Table 2.

Figure 1 shows the actigraphically recorded total sleep time, sleep efficiency, and sleep fragmentation for the 3 groups at each postpartum week. The only statistically significant difference among these objective sleep measures was on postpartum week 10, when mothers who used both feeding methods had greater sleep efficiency than did those who used formula feeding alone \((F = 5.8; P = .021)\). The effect size was moderate \((d = 0.75)\).

Figure 2 shows the subjective number of nocturnal awakenings, total nocturnal wake time, and sleep quality for the 3 groups at each postpartum week. There were no statistically significant differences between groups at any postpartum week with respect to maternal reports of these subjective sleep measures. Despite the lack of statistically significant differences, it seemed that breastfeeding women had more self-reported nocturnal wake time, compared with formula-feeding women, especially at postpartum weeks 2, 6, and 8 (Fig 2B). To explore this further, we calculated effect sizes for those 2 groups at each week. Cohn’s \(d\) was 0.88 (strong) at week 2, 0.09 (trivial) at week 4, 0.70 (moderate) at week 6, 0.54 (moderate) at week 8, 0.18 (trivial) at week 10, and 0.29 (small) at week 12. We suspect that the large variability (shown in the error bars in Fig 2B) accounts for the lack of statistical significance at week 2.

Figure 3 shows the subjective fatigue visual analog scale, Stanford Sleepiness Scale, and Epworth Sleepiness Scale results for the 3 groups at each postpartum week. Scores on the Stanford Sleepiness Scale among all groups across weeks clustered

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### Table 1: Numbers of Mothers Who Fed Their Infants Exclusively Breast Milk, Exclusively Formula, or Both Breast Milk and Formula and Numbers of Sleep and Sleepiness Reports at Each Postpartum Week

<table>
<thead>
<tr>
<th>Postpartum Week</th>
<th>(n)</th>
<th>Average No. of Subjective Sleep Reports</th>
<th>Average No. of Sleepiness/Fatigue Reports</th>
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<tr>
<td>Exclusive Breastfeeding</td>
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<tr>
<td>Exclusive Formula Feeding</td>
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<td>Both Breastfeeding and Formula Feeding</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>12</td>
<td>27</td>
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### Table 2: Participant Demographic Features

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<th>Feature</th>
<th>Age, mean ± SD (range), y</th>
<th>Education, mean ± SD (range), y</th>
<th>Income, mean ± SD (range), $</th>
<th>Married, %</th>
<th>White, %</th>
<th>Vaginal delivery, %</th>
<th>Primiparous, %</th>
<th>Term, %</th>
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<td></td>
<td>27.9 ± 4.8 (18.4–40.1)</td>
<td>16.5 ± 2.7 (10–22)</td>
<td>68 352 ± 35 383 (6904–180 000)</td>
<td>88.6</td>
<td>92%</td>
<td>75%</td>
<td>87%</td>
<td>100</td>
</tr>
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* American Indian, 1%; black, 1%; Hispanic, 1%; unreported, 1%; biracial, 4%.

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**Figure 1**
Objective measures of total sleep time (A), sleep efficiency (B), and sleep fragmentation (C) among mothers who fed their infants breast milk, formula, or both at each postpartum week. \(a \leq .01\).
around 3, which indicates “awake, but relaxed; responsive but not fully alert” and represents the generally accepted cutoff point indicating extreme sleepiness. Scores on the Epworth Sleepiness Scale were generally below the cutoff value of 10. There were no statistically significant differences between groups at any postpartum week with respect to maternal reports of these subjective measures of sleepiness or fatigue.

**DISCUSSION**

We found no differences in measures of objective sleep, subjective sleep, or sleepiness/fatigue between mothers who were breastfeeding, mothers who were formula feeding, and mothers who were using a combination of the 2 methods. Negative findings such as ours must have acceptable statistical power to ensure that they are not spurious; if we did not have sufficient power, then it would be tempting to make deductions from visual inspection of our graphs. However, our posthoc power analyses bolster our confidence that, if a moderate to large effect existed, we would have found it within our sample.

Our use of actigraphy makes our objective results most directly comparable to those of 2 other studies that used similar methods. One found that breastfeeding mothers spent more time awake during the night but demonstrated no total sleep time differences. The other reported that breastfeeding mothers slept an average of 40 minutes more per night. Similar to the study by Gay et al, a report based on home polysomnography found that breastfeeding mothers had lower sleep efficiency and more nocturnal awakenings but no total sleep time difference.

To our knowledge, we have replicated the only other study to include subjective sleep disturbance and fatigue reports, which also showed no significant differences between mothers who breastfed and mothers who both breastfed and formula fed their infants. The contrast between our negative subjective maternal sleep findings and previous studies that showed that mothers reported that their breastfed infants awakened more often at night are intriguing. Without our and others’ evidence, it would stand to reason that, if the infants awakened more often, their mothers would too. It is possible that, despite their self-reports, breastfeeding mothers are awakening more often during the night to feed their infants but they return to sleep more quickly or sleep during feedings and consequently do not remember those awakenings. Objective actigraphy cannot be used to determine whether this is true, because actigraphy is not validated for identification of discrete awakenings.

We suggest that, if breastfeeding mothers are awakening more often at

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**FIGURE 2**
Subjective nocturnal awakenings (A), total wake time (B), and sleep quality (C) among mothers who fed their infants breast milk, formula, or both at each postpartum week.

**FIGURE 3**
Fatigue visual analog scale (A), Stanford Sleepiness Scale (B), and Epworth Sleepiness Scale (C) results for mothers who fed their infants breast milk, formula, or both at each postpartum week.
night, then breastfeeding itself may have a compensatory effect. In other words, breastfeeding mothers awakening more often at night may return to sleep more quickly and not remember these awakenings. Possible reasons for this may include the fact that they are not exposed to as much ambient light or physical activity, compared with preparing formula. It also is possible that breastfeeding mothers sleep during feedings; Quillin and Glenn\textsuperscript{33} reported that breastfeeding mothers who coslept slept more than did breastfeeding mothers who did not cosleep or formula-feeding mothers.

The notion that breastfeeding may have a soporific effect has some support. Sánchez et al\textsuperscript{34} showed that 4 nucleotides present in breast milk have strong maternal circadian rhythms and seem to facilitate a “hypnotic action” in infants. In addition, differences in circulating prolactin levels are suspected to have a primary role in sleep architecture differences among breastfeeding and formula-feeding mothers. Prolactin shows a nocturnal peak, which is vital for milk production, and usually is associated with facilitation of sleep onset and \( \delta \) wave activity important for restorative sleep.\textsuperscript{35}

There are some limitations to our results. Because we excluded from participation women with Center for Epidemiologic Studies Depression scale scores of \( \geq 16 \) and those with a history of depression or anxiety, our results may not be generalizable to depressed or anxious women. This is important, because women who are depressed are less likely to continue breastfeeding.\textsuperscript{36} In addition, the 15% of the original study participants whom we were unable to contact for the breastfeeding interviews were younger, had less education, had lower incomes, and were less likely to breastfeed at the beginning of the study, compared with the subjects whom we were able to contact for follow-up interviews. This loss might have caused a bias in our data, with the average annual household income of our participants being 23% higher than the national average for the United States in 2007.\textsuperscript{57} However, our participants resided in an Appalachian region known for social risk, and they demonstrated a high level of demographic socioeconomic variance. Finally, although the Epworth Sleepiness Scale has been validated for use with several sleepy populations, it has not been validated specifically for use with postpartum women, and it has not been validated for use as a measure of state, as we used it here; rather, it has been validated and generally is used as a trait measure of general recent experience.

CONCLUSIONS

To date, there is little evidence to support the notion that breastfeeding has a negative impact on maternal sleep. Efforts to encourage women to breastfeed, as currently endorsed enthusiastically by the American Academy of Pediatrics,\textsuperscript{1} should include information about sleep. Specifically, women should be told that a choice to formula feed does not necessarily equate with improved sleep. The risks of not breastfeeding should be weighed against the cumulative lack of evidence showing any benefit of formula feeding on maternal sleep.

ACKNOWLEDGMENTS

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