

Maternal Sleep and Arousals During Bedsharing With Infants

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Summary: Contrary to popular perception, studies show that parent-infant bedsharing is not uncommon in American society. A belief that bedsharing with infants negatively impacts the quality of adult sleep also appears widespread. This has not been substantiated, however, because the few studies that have measured the impact of bedsharing on adult sleep examined only bedsharing with another adult. In the present study, laboratory polysomnography was performed in 20 routinely bedsharing and 15 routinely solitary-sleeping, breastfeeding, Latino mother-infant pairs comparing the mothers' sleep when bedsharing to solitary-sleeping nights. Infants were 11-15 weeks old at the time.

Irrespective of routine sleeping arrangement, mothers' total sleep time was not decreased on the bedsharing night compared to the solitary night. Across the two groups, percent Stage 3-4 sleep (of total sleep time) was significantly reduced on the bedsharing night but only by 3.9%, while Stage 1-2 sleep was increased 3.7%. Episodes of both Stages 3-4 and 1-2 were significantly shorter. The amount of rapid eye movement (REM) sleep was unaffected. Overall, arousal frequency was significantly increased by 3.6 hour⁻¹. As the increase in arousal frequency was stage specific, it could account for the pattern of stage changes. Nocturnal wakefulness was not increased, however, because awakenings were of shorter duration. These effects of bedsharing did not habituate with routine bedsharing because they were not diminished in the routinely bedsharing mothers compared to the routinely solitary-sleeping mothers.

We find that the impact of bedsharing on maternal sleep is modest and somewhat different from the reported impact of sleeping with another adult. From the infant's standpoint, the effects on maternal sleep are adaptive to the extent that opportunities to monitor the infant's status are enhanced. The mother's caregiver role is likely germane to differential effects on sleep of bedsharing with an infant versus another adult. **Key Words:** Bedsharing—Co-sleeping—Maternal sleep—Adult sleep.

There is wide cultural diversity in where infants are routinely placed for sleep. Industrialized societies have largely adopted the practice of solitary, separate-room sleeping for infants, with exceptions such as in Japan where co-sleeping (room sharing or sharing the same bedding) is commonplace (1). Yet, for the majority of the world's cultures, some form of co-sleeping is still the customary arrangement. In a survey of 127 cultures worldwide from which reliable data on sleeping arrangement were obtained, Barry and Paxson (2) reported that for 79% of the cultures, infants slept in the parents' room; this involved sharing the same bed or sleeping surface for at least 44% of the cultures.

That few studies have addressed the prevalence of parent-infant bedsharing in the United States probably reflects a societal bias favoring solitary sleeping. However, available data indicate that bedsharing with infants is not uncommon among Americans. For exam-

ple, frequent all-night or part-night bedsharing with infants or toddlers was reported in 19% of whites, 59% of blacks, and 26% of Hispanic families sampled from New York City and Cleveland (3,4). In Appalachian white families of eastern Kentucky, the incidence of routine bedsharing in infancy was found to be 36.4% (5). Parental perceptions that bedsharing is outside the societal norm probably lead to under-reporting (6-8), suggesting that the actual rates may be even higher than indicated in some investigations.

The only studies of the effects of bedsharing on human sleep have been with adults. Monroe's laboratory study of married good sleepers using all-night recordings of electroencephalogram (EEG) and electrooculogram (EOG) is well known (9). He found that couples who routinely bedshared had less Stage 3-4 sleep and more Stage rapid eye movement (REM) when they bedshared than when they slept alone. Reported sleep quality did not differ between sleeping arrangements. Aaronson et al. (10) monitored one couple's sleep at home for a week using time-lapse photography. They reported that 60% of the man's movements were matched by the woman's and 70% of the woman's

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were matched by the man's. In a more recent home study, Pankhurst and Horne (11) used wrist actigraphy to assess the temporal relationship of body movements between routine bedsharers. About one-third of body movements had an onset within the same 30 second epoch in both partners. Furthermore, the frequency of discrete movements was higher in bedsharers than in subjects who slept alone, yet couples typically reported that they slept better with the bed partner.

The present study is the first to measure the effects on adult sleep of bedsharing with infants. Given the uniqueness of the caretaker role and differences between sleep and arousal patterns in infants and adults (12,13), adult sleep might be affected differently by bedsharing with an infant versus another adult. Sleep architecture and arousals were assessed by laboratory polysomnography in both routinely bedsharing (RB) and routinely solitary (RS) sleeping mother-infant pairs under both bedsharing and solitary-sleeping conditions. Bedsharing effects on infant sleep have been reported separately (14,15).

METHODS

Thirty-five mother-infant pairs were recruited from the Birthing Center at the University of California Irvine Medical Center, Orange, CA. Twenty had been RB since birth and 15 were RS sleeping. RB was defined as bedsharing with the mother for at least 4 hours/night, 5 days/week; RS was defined as bedsharing no more than 1 night/week for any part of the night. Two week daily sleep logs were completed at home just prior to the sleep recordings to confirm maternal reports of the infants' usual sleep environment. For the 33 pairs who completed all 14 nights of the log, the mean number (\pm standard deviation) of bedsharing nights was 13.7 ± 0.5 for the RB group versus 0.6 ± 0.9 for the RS group.

To control for potential cultural differences in attitudes toward or implementation of bedsharing, all mothers were Latino because bedsharing is an accepted practice in this ethnic group (16). Other inclusion criteria for mothers were: age <38 years old, exclusively or predominantly breastfeeding (no more than two 4 ounce bottles of formula per day and none after 3:00 p.m.), prenatal care, no present or past history of drug or alcohol abuse, no history of smoking, alcohol, or illicit drug use during pregnancy, uncomplicated pregnancies, good health and freedom from sleep disorders, no medications known to affect sleep pattern, and choice of sleeping practice for reasons other than infant temperament. The latter criterion was included to eliminate infant temperament (e.g. response to a "fussy" infant) as a possible factor in choice of sleeping practice. A physician trained in sleep disorders

medicine performed the sleep histories. RB mothers were 27.0 ± 5.9 years of age, and RS mothers were aged 24.3 ± 8.5 years, a non-significant difference.

Inclusion criteria for infants have been previously described (15). In brief, infants were healthy and 11–15 weeks old at the time of testing and developmentally normal. They had no personal or family history of prolonged apnea or an apparent life-threatening event. RB infants were comprised of 11 males and nine females (aged 13.0 ± 1.3 weeks), and RS infants were comprised of four males and 11 females (aged 12.9 ± 1.3 weeks).

Each pair underwent three consecutive nights of polysomnography: an initial adaptation night (matching the routine home-sleeping arrangement) followed by a bedsharing night (BN) and a solitary-sleeping night (SN) in randomly assigned order. On BNs, mother-infant pairs shared the same twin-size bed used by the mothers for solitary sleeping. For solitary sleeping, infants were placed in a standard crib in a room adjacent to the mothers' with the doors between them open. Infants were maintained on their usual feeding and sleeping schedules, with mothers performing all caretaker interventions ad libitum. Mothers were blind to all experimental hypotheses and instructed only to prepare their infants for sleep as they would at home. Mothers also retired at their self-reported usual times, and monitoring was terminated after mother and infant had awakened the next morning at their usual times. Mothers completed short questionnaires each morning that addressed how their laboratory sleep compared to their usual sleep at home.

Monitoring in mothers and infants included standard non-invasive polysomnographic measures (C3/A2 and O1/A2, left and right EOGs, chin electromyogram (EMG), airflow via an oro-nasal thermister (mothers) or thermocouple (infants), respiratory effort at the chest and abdomen via piezo crystal belts, electrocardiogram (EKG), and infra-red audio-videocamera recording. All signals from a given pair were recorded simultaneously each night on a single 22 channel polygraph (Grass 8 plus, Grass Instruments, Quincy, MA). Sleep stages were scored in 30 second epochs using the Rechtschaffen and Kales (17) system in mothers (modified by collapsing across Stages 1 and 2 and across Stages 3 and 4) and the similar Guilleminault and Souquet (18) system in the infants. Two types of arousals were identified. Both stage-scoring systems identify epochal awakenings (EWs) that reflect a change in stage scoring to wakefulness. More transient arousals (TAs) ≥ 3 seconds were also scored according to established criteria (19), modified only in that arousals meeting criteria for EWs were scored separately as such. In addition, all arousals were categorized according to temporal overlap with arousal of any type

TABLE 1. Sleep architecture^a

	Group	\bar{x} BN	\bar{x} SN	Group	Night	Interaction
Recording Time (minutes)	RB	475.9 ± 9.3	472.8 ± 9.4			
	RS	455.4 ± 14.0	445.5 ± 15.1	0.144	0.136	0.435
Total Sleep Time (minutes)	RB	392.3 ± 10.2	374.2 ± 11.0			
	RS	360.2 ± 17.2	359.6 ± 22.4	0.250	0.188	0.219
Sleep efficiency	RB	0.82 ± 0.01	0.79 ± 0.02			
	RS	0.79 ± 0.02	0.80 ± 0.03	0.604	0.495	0.163
WASO (minutes)	RB	58.6 ± 6.1	70.0 ± 6.6			
	RS	62.7 ± 8.3	61.5 ± 11.9	0.784	0.553	0.461
Stage 1-2 (minutes)	RB	220.2 ± 9.5	195.0 ± 8.5			
	RS	208.3 ± 16.1	196.0 ± 18.4	0.753	0.004*	0.298
Stage 3-4 (minutes)	RB	83.8 ± 5.6	93.2 ± 8.6			
	RS	72.1 ± 7.1	87.3 ± 8.5	0.379	0.009*	0.508
Stage REM (minutes)	RB	88.3 ± 5.0	86.0 ± 4.6			
	RS	79.8 ± 4.9	76.3 ± 4.1	0.170	0.482	0.881
Stage 1-2 (% TST)	RB	56.0 ± 1.8	52.1 ± 1.8			
	RS	57.1 ± 2.9	53.7 ± 2.9	0.659	0.014*	0.833
Stage 3-4 (% TST)	RB	21.4 ± 1.3	24.8 ± 2.2			
	RS	20.7 ± 2.4	25.5 ± 2.8	0.991	0.001*	0.527
Stage REM (% TST)	RB	22.5 ± 1.2	23.1 ± 1.1			
	RS	22.2 ± 1.0	20.7 ± 1.6	0.340	0.680	0.344
REM latency (minutes)	RB	66.8 ± 3.7	77.0 ± 7.0			
	RS	104.0 ± 14.1	87.9 ± 6.2	0.036*	0.455	0.193
No. REM episodes	RB	4.2 ± 0.2	4.1 ± 0.2			
	RS	3.6 ± 0.3	3.4 ± 0.3	0.040*	0.349	0.753

BN, bedsharing night; SN, solitary-sleeping night; WASO, waking after sleep onset; REM, rapid eye movement; RB, routinely bedsharing; RS, routinely solitary; SEM, standard error of the mean; ANOVA, analysis of variance.

* Significant findings.

^a Table entries reflect group means (\pm SEM) and ANOVA results for 20 RB and 15 RS mothers. *p* values are given in the three columns on the right for group, night, and interaction effects.

in the other member of the pair. To prevent experimenter bias in the identification of overlapping arousals, sleep stages and arousals were scored independently in mothers and infants (by covering from view all signals of the other member of the pair) before arousal overlap was determined.

For all derived variables describing sleep architecture and arousal frequency, 2 × 2 analyses of variance (ANOVAs) were used in the analysis: the two levels of between-subjects effects were the routine sleeping arrangements (RB vs. RS) and the two levels of within-subjects effects were the laboratory conditions (BN vs. SN). Inclusion of the order of the laboratory conditions or the sex of the infant as covariates failed to show a significant effect of either of these factors. For the analysis of overlapping arousals, non-parametric tests were used because of non-normal distributions

and unequal variances among the groups; the Wilcoxon Matched-Pairs Signed-Ranks test was used for within-group comparisons of the two laboratory conditions and the Mann-Whitney *U* test was used for comparisons between groups. The Chi-Square test (corrected for continuity) was used for all comparisons of responses on the post-sleep questionnaire. Significance was assigned when *p* < 0.05.

RESULTS

Analysis of variance results for sleep stage and arousal frequency variables are given in Tables 1 and 2, respectively. With two exceptions, all of the significant differences reflected effects of night (BN vs. SN) rather than effects of group (RB vs. RS). No signifi-

TABLE 2. Arousal frequencies

	Group	\bar{x} BN	\bar{x} SN	Group	Night	Interaction
Total arousals hour ⁻¹	RB	17.1 ± 1.5	12.8 ± 1.1			
	RS	13.0 ± 1.4	10.4 ± 1.6	0.097	<0.001*	0.199
EWs hour ⁻¹	RB	4.2 ± 0.3	2.8 ± 0.3			
	RS	4.5 ± 0.3	3.0 ± 0.5	0.560	<0.001*	0.823
TAs hour ⁻¹	RB	12.9 ± 1.5	10.0 ± 1.1			
	RS	8.5 ± 1.2	7.4 ± 1.3	0.058	<0.001*	0.095

EWs, epochal awakenings; TAs, transient arousals.

* Significant findings.

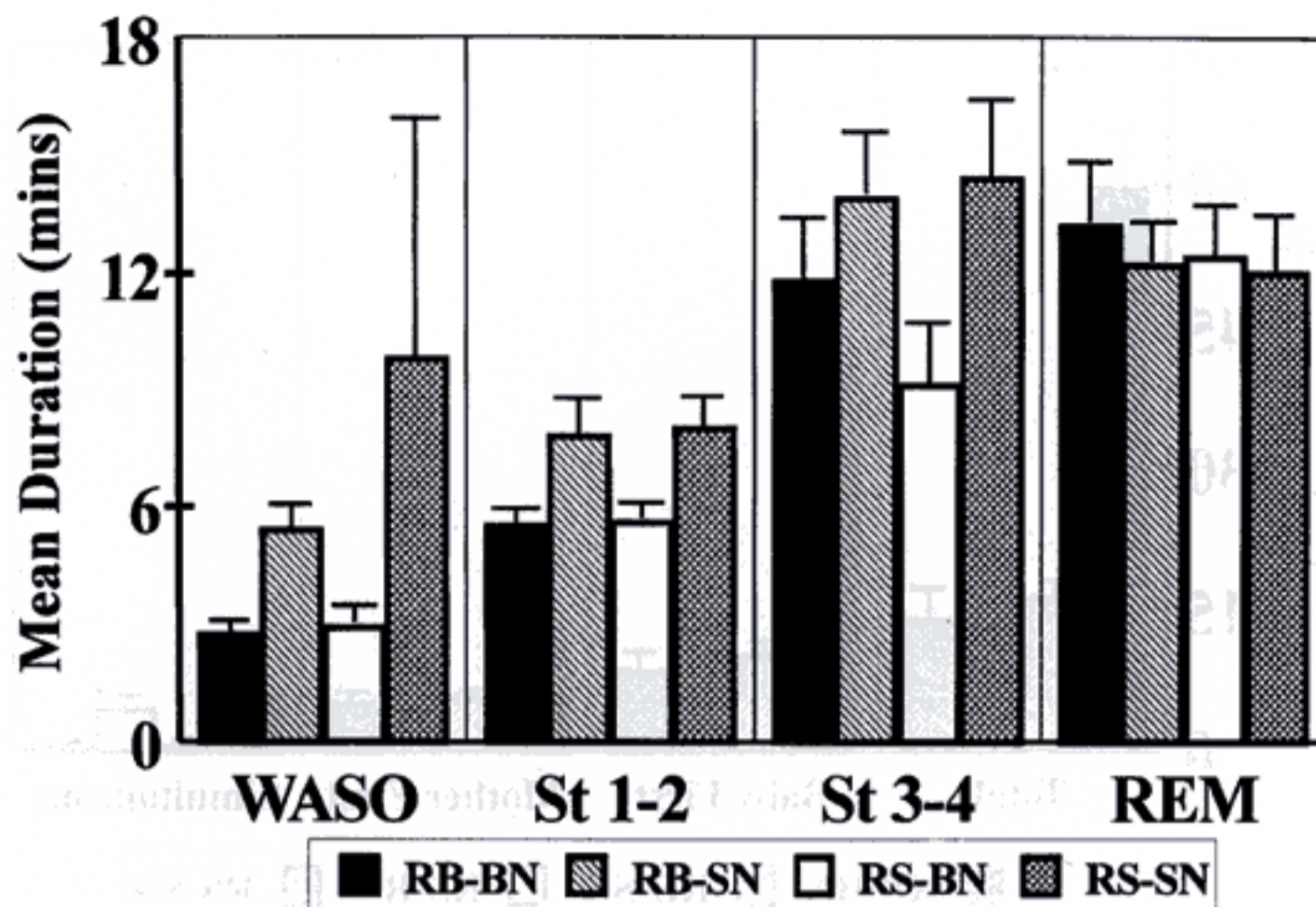


FIG. 1. Mean [\pm standard error of the mean (SEM)] sleep-wake stage durations are graphed by group and by night. All but Stage REM showed significant effects of night with no significant group or interaction effects.

cant interaction effects were found for any variable examined.

Total recording time, total sleep time, and sleep efficiency (ratio of total sleep time to total recording time) did not differ significantly on the two nights (Table 1). However, on the BN, mothers had greater duration and percent Stage 1-2 (of total sleep time) and reciprocally shorter duration and lower percent Stage 3-4 than on the SN, irrespective of routine sleeping arrangement. Although these differences in sleep stages were highly significant, the magnitudes of the differences were small. Combining RB and RS groups, percent Stage 1-2 was on average higher by only 3.7% on the BN, and percent Stage 3-4 was on average just 3.9% lower. No difference in the amount of REM sleep was found. However, there were modestly significant group differences in REM latency and number of REM episodes; REM latency was shorter and the number of REM episodes (15 minute combining rule) was higher in the RB mothers (see Table 1).

The mean duration of uninterrupted episodes of each of the three sleep stages is plotted for both groups in Fig. 1. ANOVA revealed that, independent of routine sleeping arrangement, the BN was associated with shorter duration episodes of both Stages 1-2 ($p < 0.001$) and 3-4 ($p < 0.001$) but not Stage REM ($p = 0.447$). ANOVA failed to reveal any significant effects of laboratory condition or routine sleeping arrangement on the longest duration of any sleep stage. However, for only Stage 1-2, the number of episodes was higher on the BN ($p < 0.001$); across all 35 mothers, the number of Stage 1-2 episodes was increased by an

average of 13.1 (a 45.2% increase) on the BN compared to the SN.

The frequency (per hour of sleep) of total arousals was higher on the BN than on the SN, irrespective of routine sleeping arrangement. This reflected higher frequencies of both EWs and TAs (Table 2). Across all 35 mothers, total arousals were increased by an average of 3.6 hour^{-1} on the BN, with 1.4 hour^{-1} more frequent EWs and 2.2 hour^{-1} more frequent TAs. Despite this, there was no evidence to suggest that the total amount of waking after sleep onset (WASO) (i.e. intra-sleep waking time) was greater on the BN (Table 1). Episodes of WASO are nearly synonymous with EWs with the exception that the former does not include the final EW that occurs at the end of the night. The fact that episodes of WASO were significantly shorter on the BN, regardless of routine sleeping arrangement (Fig. 1), explains why more frequent EWs did not result in increased intra-sleep waking time.

Examination of arousal frequency as a function of sleep stage suggests that the decreased durations of both Stages 1-2 and 3-4 were probably related to arousals. The frequency of total arousals was analyzed separately (ANOVA) for each sleep stage. Compared to the SN, arousal frequency was higher on the BN for both Stage 1-2 ($p < 0.001$) and Stage 3-4 ($p = 0.015$), but not for Stage REM ($p = 0.431$). Consideration of EWs and TAs separately showed that EWs were more frequent in both Stages 1-2 ($p < 0.001$) and 3-4 ($p = 0.002$) on the BN, whereas TAs were also more frequent in Stage 1-2 ($p < 0.001$) but not in Stage 3-4 ($p = 0.171$).

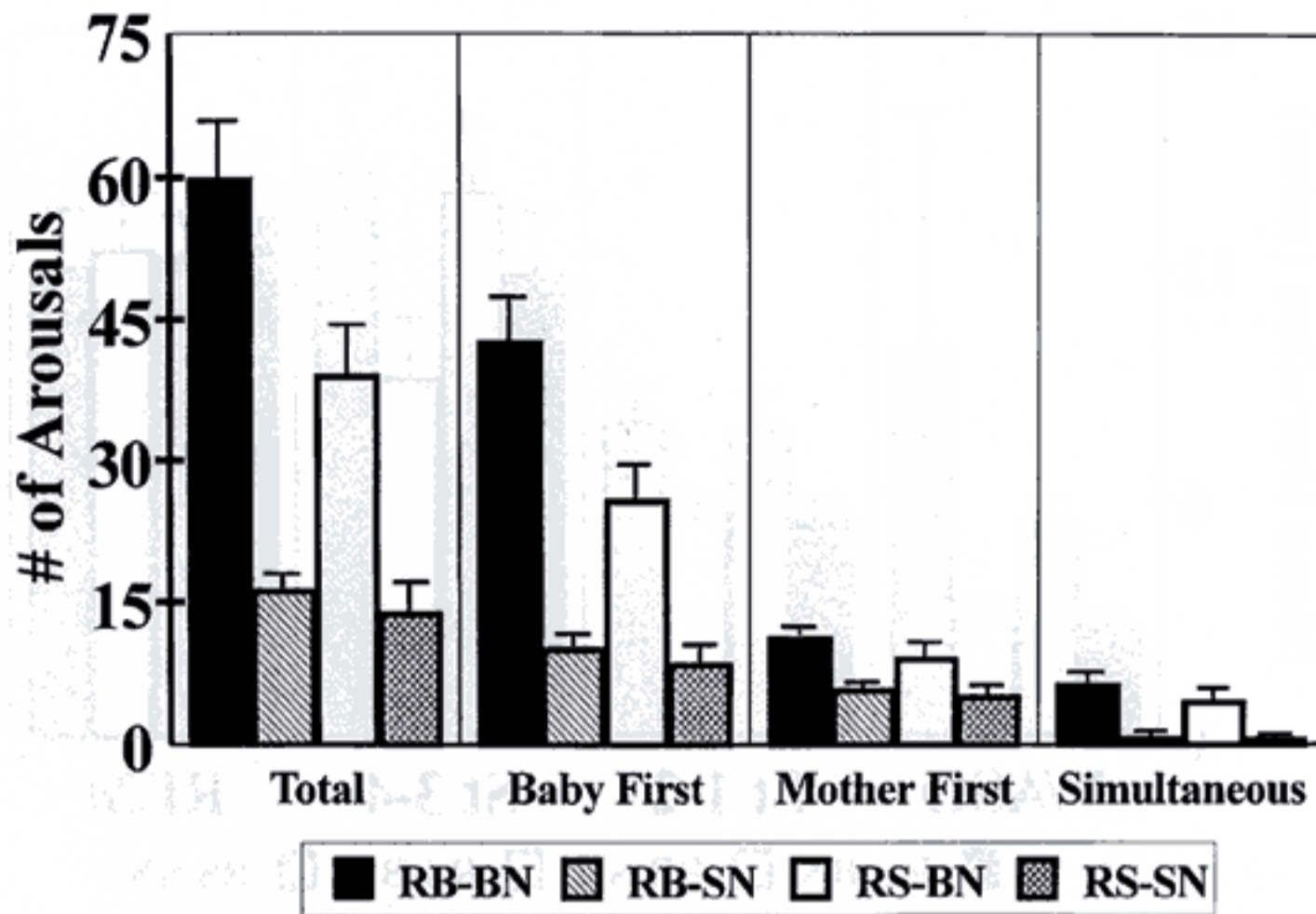


FIG. 2. Mean (\pm SEM) number of maternal arousals overlapping infant arousals is graphed by group and by night. All within-group comparisons of the bedsharing night (BN) and the solitary-sleeping night (SN) were highly significant ($p \leq 0.002$); this was also true for all between-group comparisons of routinely bedsharing (RB) on bedsharing night (BN) versus routinely solitary (RS) on solitary-sleeping night (SN) ($p < 0.001$).

To assess whether rebound of Stage 3–4, as described in sleep deprivation experiments (20), might contribute to the higher percent Stage 3–4 on the SN, Stage 3–4 was compared in two subsets of RS mothers: those whose SN occurred on night 2 preceding the BN ($n = 9$) and those whose SN occurred on night 3 following the BN ($n = 6$). No significant differences were found between the subsets on the SN in the amount of Stage 3–4 (total duration or percent of total sleep time) or in the mean duration of Stage 3–4 episodes (t tests, $p > 0.05$). These same Stage 3–4 variables also failed to show significant differences (t tests, $p > 0.05$) on the BN when the subset of RB mothers whose BN followed the SN ($n = 10$) was compared with the subset of those mothers whose BN preceded the SN ($n = 10$). This argues against a rebound explanation for the effects of bedsharing on Stage 3–4 sleep.

Epochal awakenings and TAs were combined for the analysis of temporal overlap of maternal arousals with arousals in infants. Combining RB and RS mothers, the percent of maternal arousals that overlapped one or more infant arousals averaged 51.5% on the BN compared to 20.7% on the SN. The number of overlapping arousals is graphed in Fig. 2 for each group separately on both the BN and SN. For both RB and RS mothers, the number of overlapping arousals was more than doubled on the BN compared to the SN, a highly significant difference for each group (Wilcoxon Matched-Pairs Signed-Ranks tests, $p < 0.001$). Further within-group comparisons of the BN and SN revealed in both RB and RS groups highly

significant increases on the BN in all three types of overlapping arousals: those where the infant aroused first, where the mother aroused first, and where they appeared to be simultaneous ($p \leq 0.002$). However, by far the largest magnitude increase was in the number where the infant aroused first. On average, there were 32.5 more such arousals on the BN in the RB group and 17.3 more in the RS group. In contrast, the number where the mother aroused first was on average greater by only 5.5 in the RB group and 4.0 in the RS group on the BN. Of note, the largest magnitude differences in overlapping arousals, irrespective of which bedpartner aroused first, were seen consistently in the comparisons of the two groups in their routine sleeping conditions (Fig. 2). These comparisons (RB on BN vs. RS on SN) revealed highly significant differences for all three types of overlapping arousals ($p < 0.001$, Mann-Whitney U tests).

Despite the similar sleep patterns exhibited by RB and RS mothers in each of the two laboratory conditions, RS mothers rated their sleep quality lower on the BN than did RB mothers. Ninety-four percent of RB mothers reported that they had slept enough, whereas only 33% of the RS group said they had ($p < 0.001$, chi-square). Similarly, 80% of RB mothers claimed they slept the same amount or more than usual on the BN in contrast to only 33% of the RS mothers ($p = 0.01$). Eighty percent of RB mothers said that the number of times they awoke was the same or less than usual on the BN in contrast to 47% for the RS group ($p = 0.09$). RS mothers gave the following responses to these same questions after the SN revealed rela-

tively greater satisfaction than after the BN: 80% said they had slept enough ($p = 0.03$), 67% reported they slept the same amount or more than usual ($p = 0.14$), and 87% said they awoke the same number of times or less than usual ($p = 0.05$). In contrast, RB mothers' responses to all three questions were not significantly different after the SN compared to the BN ($p < 0.05$).

DISCUSSION

This study shows that bedsharing with one's infant modestly reduces the amount of Stage 3–4 sleep and increases the amount of Stage 1–2 sleep in breastfeeding women. The amount of Stage REM remains unchanged. Contrary to popular belief, bedsharing did not reduce the total sleep achieved or result in more total WASO. However, the pattern of arousals was affected in that EWs and TAs were both more frequent during bedsharing than when mothers slept alone. The constancy of total WASO in the bedsharing and solitary conditions is reconciled with the more frequent EWs during bedsharing by the significantly shorter duration of EWs on the bedsharing night. That these effects of bedsharing occurred independently of whether or not the infants routinely bedshared with their mothers suggest that the mothers' responses to bedsharing did not habituate when bedsharing was customary. However, despite similar sleep patterns during bedsharing in the two groups, the mothers who routinely slept separately from their infants rated their sleep quality less favorably during bedsharing than did mothers who routinely bedshared.

Previous studies suggest both similarities and differences in the impact of bedsharing with an infant versus with another adult. The design of our study was similar to that used in Monroe's laboratory study (9) on effects of bedsharing with another adult—an adaptation night followed by one bedsharing and one solitary night. The results were similar, too, in that percent Stage 3–4 sleep (of total sleep time) was selectively reduced during bedsharing and by 4.7% when bedsharing with another adult versus 3.9% when bedsharing with one's infant. No differences in total sleep time were detected in either study. Furthermore, both Monroe's subjects (who routinely bedshared at home) and the RB mothers in our study were generally satisfied with their sleep on the bedsharing night. However, Stage REM was higher on the bedsharing night in Monroe's study, whereas Stage 1–2 was higher in ours. Pankhurst and Horne's (11) more recent study of bedsharing adults, using wrist actigraphic recordings in the home, indicates that more frequent arousals is another feature common to bedsharing with adults and infants. Despite this, the RB adults in both their study and ours did not rate their sleep worse during bed-

sharing compared to the night(s) when they slept alone. A complete quantitative comparison of the two studies is precluded, however, by the fact that arousals can be surmised only from body movements in their study in contrast to the EEG arousals measured in ours. Nevertheless, a high rate of overlapping arousals, as measured in our study, also characterizes adults sleeping together and is strongly supported by Pankhurst and Horne (about one-third of body movement onsets occurred within the same 30-second epoch in couples who routinely shared the same bed). Pankhurst and Horne contrasted this with a fraction of only 0.06, explained by chance alone, and with a measured concordance of 0.15 when the woman's true bedpartner's actigram was replaced by one from another male. In our study, the fraction of the mother's EEG arousals that temporally overlapped an arousal in the infant was about one-half during bedsharing compared to one-fifth in the solitary condition.

In light of the common perception that bedsharing with infants negatively impacts parental sleep, it is notable that the pattern of sleep changes occasioned by bedsharing was dissimilar to that which is characteristic of individuals with chronic sleep disturbance. In fact, the mothers in our study exhibited percentages of Stages 3–4 and REM sleep during bedsharing comparable to the normative values for young women sleeping in the laboratory (21–23). This is important since these particular sleep stages are the most vulnerable to disruption [as indicated by the diminished amounts of these stages that characterize a variety of intrinsic or extrinsic sleep disturbances (24)]. Compared with normative values in young women sleeping alone, the major disparities in our mothers were a typically 30–60 minute shorter total sleep time, 30–40 minutes more WASO, and a related 0.10–0.15 decline in sleep efficiency. As this was true for the SN as well as the BN, we infer that these differences were unrelated to bedsharing. The nocturnal demands placed on the mother for feeding and other caretaker interventions, which modestly curtailed her sleep, is the most likely explanation.

Only two studies have provided normative data on arousals in adults suitable for comparison with our findings. Mathur and Douglas (25) evaluated awakenings based on Rechtschaffen and Kales' (17) scoring (which is equivalent to the EWs reported here) as well as EEG arousals ≥ 3 seconds according to the American Sleep Disorders Association Atlas Task Force (19) (equivalent to total arousals in our study). Their subjects averaged 37 years of age, were studied for only one laboratory night, and were not screened for sleep disorders. Also, Mathur and Douglas' scoring was based on 20 second epochs. Although these design differences do not allow a direct comparison of their re-

sults with ours, it is noteworthy that the mothers in our study (including on the BN) exhibited similar arousal frequencies to those in the Mather and Douglas study. The 4-hour⁻¹ EWs they reported is only slightly lower than the average 4.3-hour⁻¹ EWs shown on the BN by our mothers (RB and RS groups combined); and the 16-hour⁻¹ total arousals they reported is slightly *higher* than the 15.3-hour⁻¹ total arousals exhibited by our mothers on the BN. These similarities underscore our finding that bedsharing's gross effects on sleep are of relatively modest magnitude. However, the more appropriate comparison may be with the results of Acebo et al. (23) who studied younger women (mean age 22.4 years) who were screened for sleep disorders. They measured transient EEG arousals (≥ 3 seconds but ≤ 15 seconds) equivalent to the TAs assessed in our study. The 11.0-hour⁻¹ TAs we found in mothers on the BN was about double the 5.3-hour⁻¹ TAs reported for the women in Acebo et al.'s study. However, even on the SN, TAs were 68% more frequent in our mothers than in Acebo et al.'s subjects. This underscores the point made earlier that bedsharing per se contributes less to changes in maternal sleep than does the fact of maternal breastfeeding status.

Notwithstanding, some of the present findings shed light on how specific aspects of maternal sleep are altered by bedsharing. First, the decrease in Stage 3–4 on the BN does not appear to reflect a simple "rebound" effect on the SN, as has been measured during recovery sleep in sleep-deprivation experiments (20). This is shown by the independence of this Stage 3–4 effect of routine sleeping arrangement and, for the RS mothers, absence of a measurable Stage 3–4 difference between the time when the SN followed versus preceded the BN. Furthermore, the effect on Stage 3–4 sleep, though highly significant ($p < 0.01$ for both duration and percentage), was of small magnitude, and the amount achieved on the BN was still well within the normal range for young women (21–23). There was also no evidence that RB mothers were sleep deprived relative to RS mothers since total sleep time was no longer on the SN in either group. We suggest that arousal pattern could be the primary factor distinguishing maternal sleep in the two conditions inasmuch as the BN, compared to the SN, was associated with both more frequent arousals overall and shorter but equally numerous episodes of Stage 3–4. The fact that EWs were more frequent in Stage 3–4 supports this since a change to lighter non-REM (NREM) sleep (Stage 1–2) typically follows EWs from Stage 3–4. Additionally, arousal pattern may account for the changes seen in Stage 1–2 sleep during bedsharing. EWs were also more frequent in Stage 1–2 on the BN. This could explain both the shorter and more numerous Stage 1–2 episodes and the greater total amount

of Stage 1–2 since sleep immediately following arousal from Stage 1–2 would most often be Stage 1–2.

We suggest that the mother's caretaker role is an important factor contributing to the arousal pattern during bedsharing. Beyond its face validity, this notion is supported by several observations. Across the two groups, mothers aroused on average 30% more often when the baby was in the same bed. That a high fraction ($\sim 1/2$) of maternal arousals overlapped the infants' arousals and that about two-thirds of those times the infants clearly aroused first suggests a relatively high level of responsivity on the mothers' parts to the infants. This responsivity did not habituate when bedsharing was routine. A high degree of maternal attentiveness is also indicated by the close proximity and face-to-face orientation generally maintained by these mothers during bedsharing. For example, it was not uncommon for mother and infant to sleep face-to-face for large portions of the night and at distances less than 20 cm when face-to-face (26,27). Obviously, the augmented sensory stimulation from sleeping at such close range could facilitate more arousals in general, as might be expected when any bedpartner is present, as well as other arousals stemming from assuming an active caretaker role. The latter would include nocturnal-nursing episodes that we have found to occur twice as often during routine bedsharing as during routine solitary sleeping (28).

Bedsharing effects on maternal sleep have been considered, at least in western society, to be largely negative. For example, attempts by child-care experts to discourage parents from sharing their bed with infants and toddlers stem partly from concerns about unwanted disruptions of the parents' sleep (29,30). However, from the present study, the alterations in maternal sleep during bedsharing should be adaptive to infants. More frequent arousals would increase mothers' opportunities to monitor infants' changing status. The physical proximity during bedsharing would greatly facilitate detection of less overt perturbations in status (e.g. changes in skin temperature, labored breathing, prolonged apnea, unsafe bedding conditions, or regurgitation) that a mother could not detect when the infant slept separately and alone. Clearly, the recent popularity of auditory infant monitors in American society reveals an attempt to compensate for a perceived increase in infant vulnerability when the caretaker is distant. Furthermore, it can be hypothesized that slightly limiting the length of maternal Stage 3–4 sleep episodes would prove beneficial to infants. Arousal threshold is thought to be high in the EEG delta range (31–33). Shorter Stage 3–4 episodes might facilitate the mother's ability to respond to more subtle stimuli from the infant as well as reduce the intervals between times when the mother spontaneously awakens and

checks the infant. This does not mean, of course, that bedsharing would be universally beneficial to infants. A variety of other factors, such as the parent's attitude toward bedsharing, drug or alcohol intoxication, and cigarette smoking (34–38), should be carefully considered when evaluating the potential benefits or risks of bedsharing to an infant in a given situation.

Limitations

As this is the first study to measure the effects of bedsharing with an infant on the caretaker's sleep, appreciation of its limitations is especially important. For example, in this study design, daytime sleepiness and napping were not measured. Given that even transient EEG arousals, when frequent, have been shown to cause measureable daytime sleepiness (39), an objective measure of daytime sleepiness would be helpful to determine if the more frequent EWs and TAs during bedsharing result in significant daytime sleepiness. Also, daytime napping certainly could affect nocturnal sleep and, potentially, the sensitivity of the mother to stimuli from the bedsharing infant. However, differences in napping between the two study groups seem unlikely given that only two significant differences were detected between them—compared to RB mothers, RS mothers' REM latencies were on average 24.2 minutes longer, and they exhibited 0.7 fewer REM episodes across the two study nights. Although the basis for these differences is not clear, that the two groups did not differ significantly in terms of total duration or percent of either REM or Stage 3–4 sleep does not support the possibility that sizable differences in daytime napping are present. It is also our impression that very few of the mothers studied were employed outside the home (although we did not measure this systematically), which would serve generally to equalize opportunities to nap in the two groups.

Another possible design limitation was the small bed size used for bedsharing. This might have promoted artificially close proximity between mother and infant and augmented the impact of bedsharing on arousals. However, it was observed that infant position was managed by the mothers, especially during periods of breastfeeding, and that mothers enclosed their infants within their arm(s) for large portions of the night (J. McKenna et al., unpublished observations). Breastfeeding inherently places infants and mothers in extremely close proximity and in face-to-face orientation, both of which are often maintained afterward since mother and infant commonly fall back to sleep with the infant still attached to the breast. The overall high degree of close face-to-face proximity that mother–infant pairs maintained during bedsharing (26,27) also suggests an active process in determining

the mother's proximity and orientation to the infant. Furthermore, mother–infant bedsharing in a single bed (or couch of similar size) is probably not an uncommon occurrence in the population we sampled.

Possible limitations on the extent to which the results would generalize to other subject populations also should be noted. 1) All mothers were breastfeeding. Non-breastfeeding mothers might exhibit different sleep patterns related to either the physiology of breastfeeding itself or different levels of sensitivity to cues from the infant, especially those concerning appetitive behaviors. For example, it is known that breastfed infants feed more often during the night (40,41). Infants may, as a consequence, exhibit more or different appetitive/approach behaviors toward the mother (42–44) that could impact the mothers' sleep differently than would bottle-fed infants. 2) Our impression that few mothers in our study were working outside the home could mean that different sleep patterns and attitudes toward bedsharing might occur if opportunities to nap were more curtailed by outside employment. 3) Only Latino subjects were recruited. It remains unclear to what extent the bedsharing effects we measured would generalize to other cultural groups. Type of sleeping surface and parental attitudes toward bedsharing vary across cultures and might modify the effects on maternal sleep. For example, no other studies have characterized mother–infant proximity during bedsharing. This could be an important variable in modulating the effect of the infant. 4) The impact on maternal sleep could be modified by the additional presence of the father in the shared bed. 5) Finally, it is uncertain how the results would generalize to male caretakers who assume primary responsibility for the infant during the night.

CONCLUSIONS

Infant bedsharing modestly decreased the time breastfeeding mothers spent in Stage 3–4 sleep and reciprocally increased time in Stage 1–2. Episodes of both Stages 1–2 and 3–4 were shorter in bedsharing mothers. These architectural changes may be explained by stage-specific increases in arousal frequency not seen in Stage REM. Nonetheless, nocturnal wakefulness was not increased as periods of waking were shorter. These effects of bedsharing appeared independent of whether or not mothers routinely bedshared. That perturbations in sleep stages were minimal and that total sleep time and wakefulness were not affected serve to dispel popular notions about bedsharing with infants. We suggest that the effects of bedsharing on maternal sleep are adaptive for infants insofar as mothers' opportunities to monitor the status of their infants are enhanced.

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