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Can Modifications to the Bedroom Environment Improve the Sleep of New Parents? Two Randomized Controlled Trials

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Abstract

Postpartum sleep disruption is common among new parents. In this randomized controlled trial we evaluated a modified sleep hygiene intervention for new parents (infant proximity, noise masking, and dim lighting) in anticipation of night-time infant care. Two samples of new mothers ($n = 118$ and 122) were randomized to the experimental intervention or attention control, and sleep was assessed in late pregnancy and first 3 months postpartum using actigraphy and the General Sleep Disturbance Scale. The sleep hygiene strategies evaluated did not benefit the more socioeconomically advantaged women or their partners in Sample 1, but did improve postpartum sleep among the less advantaged women of Sample 2. Simple changes to the bedroom environment can improve sleep for new mothers with few resources.

Keywords

sleep; parents; postpartum; intervention studies; actigraphy

One of the major challenges of adapting to parenthood is the sleep disruption that characterizes the early postpartum period (Hunter, Rychnovsky, & Yount, 2009; Kennedy, Gardiner, Gay, & Lee, 2007). Parents are aware that caring for a newborn with random sleep and feeding patterns will likely result in sleep deprivation and fatigue, but few are prepared for the physical and emotional demands of this experience. Most parents eventually find adaptive ways of coping with the stress of postpartum sleep loss, but for some, the sleep disruption is associated with diminished well-being, depressed mood, poor role adjustment, relationship dissatisfaction, and exhaustion (Dorheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009; Goyal, Gay, & Lee, 2007, 2009; Wilkie & Shapiro, 1992). First-time mothers are at particular risk for poor sleep (Lee & Zaffke, 1999; Signal et al., 2007), possibly due to the challenges of learning and adjusting to a new role. Given the burden sleep loss places on new parents, interventions to help them minimize the stress of sleep loss and assist them in coping with night-time infant care would be welcomed. The purpose of this study was to address this need by evaluating an easy-to-use intervention for improving sleep among new parents following the birth of their first infant.

A number of researchers have evaluated interventions for enhancing infant sleep, with the intent that they would have positive effects on parental sleep as well. The interventions are typically behavioral-educational, as hypnotic medications are not recommended for

management of long-term sleep problems (i.e., those lasting more than 2 weeks), are not conducive to night-time infant care, and should be avoided if possible in breastfeeding mothers because of potential risk to the newborn (Wolfson & Lee, 2005). Given the demands of the postpartum period, easily implemented, behavioral-educational interventions are the appropriate approach for improving sleep among new parents.

Results for behavioral-educational interventions promoting maternal well-being by improving infant sleep are promising (Hall, Saunders, Clauson, Carty, & Janssen, 2006; Hiscock, Bayer, Hampton, Ukoumunne, & Wake, 2008; Mindell, Telofski, Wiegand, & Kurtz, 2009), but only one intervention included strategies specifically designed to improve maternal sleep. In a randomized controlled pilot study of 30 new mothers and their infants, Stremler et al. (2006) found that an intervention that combined techniques for enhancing infant sleep with those promoting maternal sleep, including sleep hygiene techniques, not only lengthened infants' longest sleep period, but also increased mothers' total sleep time and decreased the proportion of mothers reporting problematic sleep.

Sleep hygiene principles (Hauri, 1998), such as those included in the Stremler study, have been found to be helpful when combined with other techniques for reducing sleep disturbance in a variety of populations, including children, the elderly, and those with insomnia, chronic illness, or a psychiatric disorder (Berger et al., 2009; Morin et al., 2006). Learning about the effects of noise, light, temperature, exercise, diet, and rhythm on one's sleep can help new parents make the necessary changes to optimize their sleep quality and quantity. Although sleep hygiene practices have shown promise in other populations, they have not been evaluated for promoting sleep in new parents, despite their relevance to night-time infant-care practices and the possibility of their implementation resulting in enhanced sleep for the entire family. Inclusion of sleep hygiene principles in the Stremler study is noteworthy, but because both the intervention and control groups received sleep hygiene information, the efficacy of these strategies for improving sleep in new parents remains unclear.

New fathers are also at risk for poor sleep (Damato&Burant, 2008; Gay, Lee,&Lee, 2004), but few researchers have examined how interventions directed toward mothers could negatively or positively affect fathers, and few have included strategies that might improve fathers' sleep. Hall et al. (2006) included outcomes for both parents in their evaluation of an intervention for infant sleep problems, but the parental sleep and fatigue outcomes were not analyzed by gender, and therefore it is difficult to determine the effect on fathers. One of the benefits of a sleep hygiene intervention is that the basic principles may prove helpful to all members of the family, not only during the postpartum period, but throughout the lifespan.

The behavioral-education intervention evaluated in this study was based on sleep hygiene principles and was designed to minimize parental sleep disruption by making night-time infant care as convenient and minimally arousing as possible. The intervention consisted of three components: (a) mother–infant proximity, (b) noise attenuation, and (c) low lighting. Infant proximity is used in many cultures to decrease the episodes and durations of night-time arousals. Having the infant nearby can arouse the mother more gently with minimal infant vocalization, in contrast to the heightened and lengthy arousals stimulated by progressively louder and more distressing infant vocalizations from another room. Family co-sleeping ranges from bed-sharing to room-sharing in separate beds, and is common practice throughout the world, but not among most families in the United States (Willinger, Ko, Hoffman,Kessler,& Corwin, 2003).

Although infant proximity may be convenient for providing night-time care, infants can also make non-distressful noises while asleep that needlessly awaken an anxious and vigilant

new parent. Intermittent noise can elicit arousals from sleep that never become fully conscious awakenings, but nevertheless disturb sleep (Griefahn & Spreng, 2004). White noise can help mask such intermittent noises and thereby promote more consolidated sleep (López, Bracha, & Bracha, 2002). Light exposure has also been shown to disrupt the circadian rhythms of sleep–wake cycles (Wever, 1989), yet some light is necessary to safely perform infant night-time care, such as feedings and diaper changes. Dim lighting was included in the experimental intervention to address the need for some lighting, while minimizing the disruption of sleep–wake cycles and melatonin secretion.

The primary objective of this study was to evaluate the effectiveness of the Sleep Hygiene Intervention Package for Parents (SHIPP). The intervention was designed to minimize night-time arousals and promote sleep maintenance among mothers following the birth of their first child. The intervention was evaluated in two cohorts with diverse demographic and socioeconomic backgrounds. Although they were not the primary focus of the intervention, the partners of women in the first cohort also were included to evaluate the impact of the intervention on their sleep. Intervention effectiveness was evaluated using both objective and subjective measures, and acceptability ratings also were obtained. It was hypothesized that:

1. Mothers (and their partners in Sample 1) assigned to the experimental intervention would have significantly better sleep outcomes (i.e., longer sleep times and higher sleep efficiency as measured by actigraphy and less sleep disturbance by self-report) compared to mothers (and their partners in Sample 1) assigned to the control intervention.
2. Mothers assigned to the experimental intervention would report high rates of use (>75%) and high rates of satisfaction (>75%) with the intervention components.

METHODS

In this article we report two randomized controlled trials of a sleep hygiene intervention for new parents. The first trial (Sample 1) was conducted with a sample of first-time parents (mothers and their partners) who were predominantly educated, employed, and economically advantaged. To determine whether the intervention was effective for less advantaged women, the study was repeated in a second sample of first-time mothers who generally had less education, lower employment rates, and lower incomes (Sample 2). Both studies were approved by the institution's Committee on Human Research. Informed consent was obtained from each participant, and all were paid for their time and effort.

Participants

Sample 1—Expectant couples were recruited between 2001 and 2003 from fee-based childbirth education classes at a large academic hospital. To be eligible, parents had to be expecting their first child, at least 18 years of age, and able to read and write English. Couples were excluded if they planned to hire a live-in nanny, either parent had a diagnosed sleep disorder, or either parent worked the night shift.

Sample 2—Pregnant women were recruited between 2004 and 2008 from free prenatal classes and clinics serving low-income women. To be eligible, women had to be expecting their first child, at least 18 years of age, and able to read and write English. Women were excluded if they had a diagnosed sleep or mood disorder or worked the night shift. Unlike Sample 1, women without partners were eligible for participation, and partners were not included in Sample 2.

Figure 1 illustrates the flow of participants for each study sample. To be consistent with the eligibility criteria for Sample 2, women in Sample 1 who had a history of mood disorder or were delivering twins were excluded from analyses. Demographic characteristics for the two samples are presented in Table 1. Given that study enrollment occurred at 36 weeks gestation, all infants were born full-term. As intended, the samples differed significantly on demographic variables such as age, education, employment, and income. The partners of women in Sample 1 had a mean age of 34.1 ± 5.7 , and the partner sample was 73% White, 12% Asian, 9% Latino, 4% African-American, and 3% mixed or other race. All but one of the partners in Sample 1 were male.

Procedures

Participants in both samples were assessed four times in their homes or another location of their choice. The first assessment occurred during the last month of pregnancy, and subsequent assessments were conducted during the first, second, and third months after delivery. We are not reporting the data collected at 2 months postpartum because in Sample 2 this assessment was intentionally coordinated with the infants' first immunization, which was expected to influence the sleep of the mother as well as the infant during that assessment.

Measures

The measures listed below were obtained in both samples and were conducted at each assessment.

Wrist Actigraphy—To objectively estimate sleep quality and quantity, each participant was asked to wear a wrist actigraph (Ambulatory Monitoring, Inc., Ardsley, NY) for 48 hours as part of each assessment. The actigraph is a wrist-worn device that provides continuous data using a microprocessor that senses motion with a piezoelectric linear accelerometer. To minimize the variability due to potential differences in weekday and weekend sleep patterns, data were collected only on weekdays.

Trained research assistants blinded to intervention group analyzed the actigraph data using the autoscoring Cole–Kripke algorithm program available in Action4 software (Ambulatory Monitoring, Inc.). Four sleep-related outcomes variables were used in this study: (a) nocturnal sleep time in hours, (b) nocturnal sleep efficiency, (c) wake after sleep onset (WASO), and (d) total daytime sleep between 09:00 and 20:59. As estimates of sleep disruption, sleep efficiency is computed as the percentage of sleep time relative to the time spent in bed, and WASO is computed as the percentage of time spent awake relative to the time spent in bed after initially falling asleep. For typical adults with a 7- to 8-hour sleep period, WASO of 15% represents more than an hour of wake time after falling asleep. AWASO percentage of 5–10% is typical in healthy, non-pregnant women and greater than 15% indicates severe sleep disruption (Lee, Zaffke, & McEnany, 2000). These outcomes represent standard sleep measures of sleep quantity and quality (Ancoli-Israel et al., 2003; Berger, Farr, Kuhn, Fischer, & Agrawal, 2007; Berger et al., 2008).

Congruence between single-night polysomnographic measures and actigraphy measures indicate adequate validity and reliability when sleep is assessed in healthy young adults, including women of childbearing age (Ancoli-Israel et al., 2003; Jean-Louis et al., 1996; Walsh et al., 1991), with strong agreement between the two methods (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992; De Souza et al., 2003). In this study, participants wore the actigraph for a period of 48 hours to avoid varying weekday and weekend sleep patterns and to minimize participant burden in these samples of new parents. To facilitate interpretation of actigraphy data, participants also used 48-hour sleep logs to record their bed times, wake

times, and times when the actigraph was removed. Paired *t*-tests revealed no statistically significant difference between night 1 and night 2 data, and the two nights were significantly correlated for total sleep time ($r > .5$). Therefore, daily actigraphy measures were averaged to obtain mean values for each 48-hour assessment.

General Sleep Disturbance Scale—Participants completed the General Sleep Disturbance Scale (GSDS; Lee, 1992) as a subjective measure of their sleep. The GSDS consists of 21 items rating the frequency of specific sleep problems during the past week from 0 (*not at all*) to 7 (*every day*). The total score ranges between 0 and 147, and subscale scores range between 0 and 7, with higher scores indicating greater frequency of sleep disturbance. Total scores of 43 or higher indicate poor sleep. A subscale score of 3 or higher indicates that sleep was perceived as disturbed on three or more nights during the past week, corresponding to DSM-IV criteria for primary insomnia (American Psychiatric Association, 1994). The GSDS subscales address sleep quality, sleep latency, sleep quantity, sleep maintenance, early awakening, use of medication to promote sleep, and excessive daytime sleepiness. Only the GSDS total score and 7-item daytime sleepiness subscale score were included in this study. The GSDS has well-established discriminant and concurrent validity as well as reliability in pregnant and postpartum women (Gay et al., 2004; Lee & DeJoseph, 1992). In the current samples, the Cronbach alpha coefficient was .81 for the total scale and .74 for the daytime sleepiness subscale.

Demographic and Birth Information—Participants were asked for demographic information, including age, race/ethnicity, partner and marital status, education, employment, and income. Following childbirth, mothers were asked about delivery type (vaginal or cesarean), sleeping arrangements, and infant feeding type. Sleep results for outcomes related to type of delivery and feeding type are reported elsewhere for Sample 1 (Doan, Gardiner, Gay, & Lee, 2007; Lee & Gay, 2004).

Intervention Use and Satisfaction—As part of each postpartum assessment, participants in both the experimental intervention and control groups completed a short questionnaire about their use of and satisfaction with their assigned intervention (either sleep hygiene strategies or dietary recommendations) during the prior month. In addition, spontaneous use of the three sleep hygiene strategies was assessed among mothers in the Sample 1 control group at the end of their study participation to avoid inadvertently suggesting their use and thereby contaminating the control group. The Sample 2 control group was asked where their infant slept at each monthly assessment, but was not asked about noise attenuation or low lighting.

Experimental Intervention

The experimental intervention was introduced during the third trimester, before the birth of the infant, when components of the intervention could be tried and some adaptation could occur. It was administered upon completion of the sleep assessment in the last month of pregnancy and was presented to both parents in Sample 1 and only to the mother in Sample 2. Participants were provided with a laminated information card summarizing the following components of the intervention.

Infant Proximity—Participants were provided with a bassinet so that the infant could sleep beside the mother's bed. Participants were encouraged to keep baby care supplies (e.g., diapers, wipes) in the bottom of the bassinet to make night-time care as efficient and convenient as possible. The bassinet was safe for infants up to 15 pounds; once infants exceeded that weight or were able to push themselves up, parents were instructed to stop using the bassinet.

Noise Attenuation—Sleep-disturbing noises (e.g., intermittent infant vocalizations, snoring bed-partner, neighbors, and street noise) were attenuated by providing participants with a white noise machine (Tranquil Moments Alarm Clock, Brookstone, Inc., Merrimack, NH). The white noise volume was loud enough (30 dBA) to mask non-essential sounds, but did not prevent the mother from hearing the infant. Whenever possible, the sound machine was placed at the foot of the bed so that both bed partners could hear it. Participants were asked to start using the sound machine during the third trimester so they would be habituated prior to delivery.

Low Lighting—Participants were provided with a night-light (Night Light—4Watt, ACE Hardware Corp., Oak Brook, IL) emitting 40 lux at a distance of 18 in. to use for night-time infant care instead of brighter bedroom lighting. A power strip was provided so that the nightlight could be placed on the mother's side of the bed and switched on as needed.

Control Intervention

Participants randomly assigned to the attention-control group were provided with a pamphlet containing information about how diet can influence sleep and recommendations for healthy eating. The research assistant discussed with the participants their current eating habits and referred to the pamphlet for suggested dietary changes, if needed. If questions were raised about managing sleep or other parenting issues, participants were encouraged to talk with their healthcare provider. Like the experimental intervention, the control intervention session was administered upon completion of the sleep assessment in the last month of pregnancy and was presented to both parents in Sample 1 and only to the mother in Sample 2. The length of both the experimental and control intervention sessions was approximately 30 minutes.

Intervention Fidelity

The experimental and control interventions were administered by research assistants trained to deliver the protocols. The intervention components were summarized on a laminated card, and the dietary recommendations were outlined in a pamphlet. The card or pamphlet was provided to participants as a reminder of the intervention components or dietary recommendations. Participants were asked to use the assigned intervention strategies until their infant was 3 months old. In addition, participants were asked about their experience with the assigned intervention strategies at each postpartum assessment. Although continued use of each intervention component was encouraged, it was not required for continuing study participation. Given the challenges of the postpartum period, parents would be unlikely to continue using strategies that were ineffective, and therefore participants reported their use of each intervention component even if they stopped using one or more of the strategies. This approach was sensitive to the needs of new parents and facilitated valid intention-to-treat analyses.

Randomization

Following 48 hours of initial data collection during the last month of pregnancy, participants were randomized in blocks of six to either the control or experimental group. Participants recruited from childbirth education classes were randomized as a cluster to minimize the risk of contamination among class participants. Block randomization was used to balance group assignments over the course of the study, but perfect balance could not be ensured given the unpredictable number of parents recruited from each childbirth class. Sample 1 couples were randomized at a ratio of 1:1, and Sample 2 participants were randomized at a ratio of 2:1 (experimental/control). The larger number of women assigned to the experimental group in Sample 2 allowed for a second randomization at 2 months postpartum, which randomly

assigned half of the experimental group to an acetaminophen intervention designed to improve infant sleep following immunization. This second randomization at 2 months postpartum was evaluated through group comparisons to determine its effect on the 1 and 3-month data prior to proceeding with the main analysis.

Analysis

Sample size was determined by a priori power estimates reflecting 80% power to detect a significant improvement in postpartum sleep maintenance, using a cluster randomization design and an alpha level of .01 (to allow for multiple comparisons). Square root transformation was used to normalize the skewed distributions of WASO and daytime sleep values. Descriptive statistics were used to describe the characteristics of the samples. To identify baseline differences between the two samples, chi-square tests were used for categorical variables, and independent-sample *t*-tests were used for continuous variables. Parametric comparisons were confirmed with Mann–Whitney *U*-tests to ensure that non-normal distributions were not unduly influencing the results. The experimental and control groups for each sample were compared on postpartum objective and subjective sleep measures using a repeated measures analysis of variance, with time (1 and 3 months) as the within-subjects factor and group (experimental or control) as the between-subjects factor. All maternal and birth characteristics listed in Table 1 were evaluated as potential covariates. The effect of the infant intervention in Sample 2 was evaluated using independent-sample *t*-tests comparing the maternal postpartum sleep of those assigned to the infant intervention with the sleep of those who were not. Data were analyzed using SPSS for Windows version 16.0. A two-tailed alpha level of .05 was used for all statistical tests.

RESULTS

The two samples differed on baseline actigraphy measures, with women in Sample 2 generally having poorer sleep by objective, but not subjective measures (see Table 2). Within each study sample, there were no parental sleep differences between the intervention and control participants at baseline, nor were there any significant differences between the groups on any of the maternal or birth characteristics listed in Table 1. Therefore, no covariates were included in subsequent analyses of the intervention effects. Among the women assigned to the experimental intervention in Sample 2, the half whose infants were assigned to the acetaminophen intervention at 2 months postpartum did not differ on any of the sleep outcomes at 1 or 3 months postpartum compared to women whose infants were not assigned to the acetaminophen intervention. Because the acetaminophen intervention had no effect on maternal sleep at 1 or 3 months postpartum, all participants were included in subsequent analyses.

Intervention Effects

In Sample 1, the experimental intervention had no effect on the postpartum sleep of mothers or their partners (see Table 3). In Sample 2, the mothers in the intervention group had better postpartum sleep; they obtained more nocturnal sleep, had better sleep efficiency, and had less WASO than mothers in the control group. In post hoc analyses, the differences in maternal sleep were statistically significant ($p < .05$) only at 3 months postpartum. Figure 2 illustrates WASO patterns by group, time, and sample.

Sample 1 also included data on the mothers' partners. As with the mothers themselves, the intervention had no effect on the sleep–wake patterns of partners in Sample 1. Baseline and 1-month postpartum data for partners in the control group are presented elsewhere (Gay et al., 2004).

Intervention Use and Satisfaction

The results reported above were based on intention-to-treat analyses. However, as with any behavioral intervention, actual use of the intervention components varied over time, by sample and by group. Table 4 reports intervention use and satisfaction ratings of mothers assigned to the intervention group, as well as available data on spontaneous intervention use among mothers in the control group. The rates of use in the intervention group are not directly comparable to the rates of spontaneous use in the control group given the different types of assessment (i.e., monthly use of the specific component in the intervention group vs. any use of the sleep hygiene principle during the first 3 postpartum months in the control group), but the data are reported in Table 4 for the purpose of general comparison.

The bedside bassinet was a popular component of the intervention; 78% of mothers in the experimental group reported using it in the first month, dropping to 69% by 3 months postpartum (see Table 4). However, bassinet use was also common in the control group. Use of a bassinet or crib in the parents' room at some point during the first 3 postpartum months was reported by 62% of the mothers in the Sample 1 control group and 72% of those in the Sample 2 control group. Reports of parent–infant bed-sharing were common in both samples (see Table 1), and the rates were similar in both the intervention and control groups. Many parents reported preferring the closeness and convenience of bed-sharing, even compared to the bedside bassinet. In addition, some parents reported that their infant did not sleep as well in the bassinet, and others reported that their infant outgrew it prior to the 3-month assessment. Few parents in either sample reported that their infant slept in a separate room, making it difficult to demonstrate that infant proximity was beneficial.

The white noise machine was the least acceptable part of the intervention, with less than half of the intervention participants reporting that they consistently used it. In contrast to the other intervention components, sound machines were rarely used by parents in the control group (see Table 4), although 14% of control group families in Sample 1 did report using fans or other noise-masking strategies (Sample 2 data not available). Among parents who chose not to use the sound machine, some reported that they needed silence in order to sleep, and others stopped using the sound machine because their partner did not like it. Those who liked the sound machine often reported that it was helpful for the infant as well and that they moved it to the infant's room once the infant was sleeping in another room.

The night light was the most consistently used intervention component, with about 75% of intervention group mothers in both samples reporting that they used it at both the 1- and 3-month postpartum assessments. However, the data on spontaneous use indicated that 36% of the mothers in the Sample 1 control group also reported use of low lighting (of unknown brightness and location) while providing infant care at night, thereby reducing the likelihood of detecting group differences. Information on use of low lighting was not available for the Sample 2 control group.

DISCUSSION

The sleep hygiene intervention evaluated in this study provided little benefit to mothers or their partners from socioeconomically advantaged backgrounds, but provided some benefit to younger new mothers with fewer resources. As such, the study findings partially support the first hypothesis, and the answer to the question of whether modifications to the bedroom environment can improve the sleep of new parents seems to be “maybe a little.” However, the relatively weak findings of this study compared to the stronger findings of prior studies focused on infant sleep interventions (Hall et al., 2006; Stremler et al., 2006) suggest that bedroom modifications based on sleep hygiene principles are insufficient on their own, and would be more effective in fostering parent sleep if supplemented by specific strategies for

promoting infant sleep. These infant strategies might include those that facilitate infant self-soothing behaviors and circadian entrainment and avoid negative sleep associations (Mindell et al., 2009; Sadeh, Mindell, Luedtke, & Wiegand, 2009; Stremler et al., 2006).

The second hypothesis regarding the acceptability of the intervention components also was partially supported. The nightlight was highly acceptable to new parents, the bedside bassinet was acceptable in the first month with a slight decrease by the third month, and the sound machine did not meet the acceptability threshold hypothesized in this study. Further research is needed to identify ways in which the sound machine could be more appealing for parents to consider as a way to mask environmental noises. Identifying which types of parents or environments are most in need of masking noise to minimize arousals from sleep would also be an area for further research consideration.

One of the challenges of this study was that the intervention components were widely available and seemed to be gaining in popularity, thereby making it difficult to find an adequate control group of parents not using some or all three components of the sleep hygiene intervention. Spontaneous use of the intervention components was of particular concern in Sample 1, which may help to explain the lack of group differences in this sample of socially and economically advantaged women. Sample 1 was recruited exclusively from childbirth classes, and it is possible that the class included information for promoting sleep that increased spontaneous use of the intervention strategies. Spontaneous use of the intervention components was not systematically assessed in the Sample 2 control group, but given their more limited educational, social, and material resources, it is less likely that they would adopt healthy sleep hygiene practices on their own. A greater difference in the use of the sleep hygiene strategies between the intervention and control group in Sample 2 would have resulted in more power to detect group differences in this sample. Furthermore, the home environments of participants in Sample 2 may have been less conducive to good sleep, thereby enhancing the usefulness of the sleep hygiene techniques. For instance, a white noise machine may be more beneficial for women living in larger households and in more crowded conditions.

In addition to spontaneous use of the intervention components in the control group of this study, there was also low fidelity in the intervention group, thereby limiting the ability to detect group differences. Parents were often struggling with the demands of newborn care, and if an intervention strategy was not immediately helpful, they were sometimes quick to abandon it and try something else. As a result, parents frequently reported using multiple strategies for managing sleep, and it was often unclear which approaches were most helpful.

With any behavioral intervention, there is the possibility of spontaneous use and individual customization of the intervention components. Therefore, it is essential to assess intervention use in both control and intervention groups. This can be challenging when trying to avoid contamination because asking about use could inadvertently suggest the intervention components to those in the control group. To avoid introducing the intervention to the control group, assessment should only be done at the conclusion of the study. However, recall bias, particularly in longer studies, can be a threat to validity. These challenges highlight the importance of conducting intention-to-treat analysis, which takes into consideration spontaneous use in the control group, as well as adaptation and non-use of the components in the intervention group.

Because the intervention components were administered as a package, the benefit of individual components could not be determined by this study. For example, infant proximity without a countermeasure, like white noise, to mask the infant's noisy sleep could unnecessarily awaken a highly vigilant new mother. However, the practice of maintaining

infant proximity was a popular night-time care strategy in both the intervention and control groups of this study. Although some parents reported concerns that their infant would have difficulty later transitioning to his or her own room, the vast majority clearly understood the advantages of infant proximity during the first few postpartum months. Parent–infant bed-sharing was surprisingly common across both samples, and the rates were markedly higher than the 12% reported nationally (Willinger et al., 2003). These findings may reflect regional differences in bed-sharing popularity or provide additional evidence that the practice of bed-sharing is becoming more common across all socioeconomic groups.

Noise attenuation was not an issue many parents considered, although reactions to the white noise machine were mixed. Some parents found it very effective, particularly for the infant; others reported that the background noise disturbed their own sleep or the sleep of the other adult bed partner. It was unclear whether this was due to inadequate adaptation to the white noise or if no amount of adaptation would have helped. Dim lighting was the most popular component of the intervention, and yet, some parents felt additional light was necessary to properly conduct infant care.

There are other sleep hygiene principles that were not included as part of this intervention, but might be considered in future studies. Exposure to daylight, in particular, plays an important role in circadian entrainment and the regulation of sleep–wake patterns for infants and adults (Czeisler & Gooley, 2007; Harrison, 2004), and increasing daytime exposure to sunlight might have beneficial effects on the sleep of parents and their infant (Tsai, Barnard, Lentz, & Thomas, 2009).

Obtaining stable measures of sleep patterns among new parents can be challenging. In this study, both objective and subjective measures of parental sleep were used. To minimize the burden on participants, reduce potential for missing data, and maximize compliance with monitoring, a 48-hour monitoring period was used rather than other recommended time frames (Morgenthaler et al., 2007). Given weekend versus weekday variability, the focus was limited to weekday sleep patterns. Postpartum sleep can be highly variable and can change significantly over a relatively short period of time. Therefore, future researchers should address appropriate time frames for monitoring sleep in this specific clinical population.

In conclusion, the results of this study suggest that simple bedroom modifications based on sleep hygiene principles have different beneficial outcomes depending on the family's socioeconomic resources. Some parents reported that the bedside bassinet was the perfect solution; others reported that their sleep and well-being improved immensely once they began bed-sharing or once their infant was moved to a separate room. There was similar diversity in the responses to the white noise machine and the dim lighting.

In light of these findings, the most helpful intervention may be to provide new parents with accurate information regarding sleep during the postpartum period. Before the birth occurs, new parents should have information about principles for promoting both parental and infant sleep. Nurses can acknowledge a variety of suitable parenting practice strategies as part of the educational session, giving parents the opportunity to think through and discuss which strategies might work best in light of their personal preferences and family circumstances. Such an approach is likely to promote parent competence while also improving sleep and reducing the stress of new parenthood.

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FIGURE 1.
CONSORT diagram of participant flow.

FIGURE 2.

Comparison of wake after sleep onset ($M \pm SEM$) over time by group (control vs. intervention) and study sample (1 vs. 2). Both samples improved over time, but only among the less advantaged mothers of Sample 2 did the intervention group have less wake after sleep onset than the control group.

Table 1Demographics, Birth Characteristics, and Infant Care Practices by Sample (M $\pm$ SD or%)

	Sample 1 (<i>n</i> = 118)	Sample 2 (<i>n</i> = 122)	Statistics
Maternal characteristics			
Age in years	32.1 $\pm$ 4.5	26.7 $\pm$ 6.4	$t(217) = 7.6, p < .001^b$
Race/ethnicity			$\chi^2(4, N = 240) = 41.3, p < .001$
Asian	19%	31%	$\chi^2(1, N = 240) = 5.0, p = .025$
Black/African American	3%	12%	$\chi^2(1, N = 240) = 9.0, p = .004$
Hispanic/Latina	8%	22%	$\chi^2(1, N = 240) = 9.1, p = .003$
White/Caucasian	64%	25%	$\chi^2(1, N = 240) = 38.6, p < .001$
Mixed/Other	6%	10%	ns
Education			$\chi^2(3, N = 240) = 62.6, p < .001$
High school degree or less	3%	33%	
Trade school/some college	14%	31%	
College degree	42%	26%	
>College degree	41%	10%	
Employed at enrollment	75%	38%	$\chi^2(1, N = 240) = 33.1, p < .001$
Annual household income			$\chi^2(1, N = 231) = 139.6, p < .001$
<\$36,000/year	7%	84%	
$\geq$ \$36,000/year	93%	16%	
Household size			
Mean	2.2 $\pm$ 1.0	3.7 $\pm$ 2.4	$t(155) = 6.2, p < .001^b$
% > 2	11%	60%	$\chi^2(1, N = 240) = 62.2, p < .001$
In a relationship ^a	100%	84%	$\chi^2(1, N = 240) = 20.0, p < .001$
Married	86%	30%	$\chi^2(1, N = 240) = 75.0, p < .001$
Birth characteristics			
Cesarean birth (%)	24%	33%	ns
Infant birth weight (kg)	3.5 $\pm$.52	3.4 $\pm$.51	$t(233) = 2.0, p = .046$
Infant care practices at 3 months			
Feeding type			$\chi^2(2, N = 232) = 17.7, p < .001$
Exclusively breastmilk	67%	47%	
Breastmilk and formula	23%	20%	
Exclusively formula	10%	33%	
Usual sleeping arrangement			$\chi^2(2, N = 230) = 14.4, p = .001$
Separate room	23%	6%	
Room-sharing	48%	54%	
Bed-sharing	29%	40%	

Note. For both samples, the intervention and control groups did not differ significantly on any maternal or birth characteristics.

^a Partners were required for inclusion in Sample 1, but not Sample 2.

^b Separate variance *t*-test due to unequal variances, adjusted degrees of freedom.

Table 2Maternal Sleep Measures at Initial Assessment for Each Study Sample (M $\pm$ SD)

	Sample 1	Sample 2	Statistic
Actigraphy	<i>n</i> = 102	<i>n</i> = 109	
Nocturnal sleep time (hours)	7.0 $\pm$ 1.2	7.1 $\pm$ 1.4	ns
Nocturnal sleep efficiency (%)	84 $\pm$ 9.0	78 $\pm$ 13.8	<i>t</i> (187) = 3.7, <i>p</i> < .001 ^a
Nocturnal WASO (%)	13 $\pm$ 8.1	20 $\pm$ 13.4	<i>t</i> (179) = 4.5, <i>p</i> < .001 ^a
Daytime sleep (minutes)	39 $\pm$ 53	80 $\pm$ 63	<i>t</i> (204) = 5.1, <i>p</i> < .001
Self-report	<i>n</i> = 118	<i>n</i> = 122	
Total Sleep Disturbance Score	45 $\pm$ 15	45 $\pm$ 17	ns
Daytime Sleepiness Score	2.7 $\pm$ 1.2	2.8 $\pm$ 1.3	ns

Note. There were no significant baseline sleep differences between the intervention and control groups in either sample.

^aSeparate variance *t*-test due to unequal variances, adjusted degrees of freedom.

Table 3Repeated Measures Analysis of Parental Postpartum Sleep by Group and Sample (M $\pm$ SD)

	1 Month		3 Months		Between-Group, <i>F</i> Statistic
	Control	Intervention	Control	Intervention	
Mothers in Sample 1					
Actigraphy	<i>n</i> = 56	<i>n</i> = 46	<i>n</i> = 56	<i>n</i> = 46	
Nocturnal sleep time (hours)	6.3 ± 1.5	6.0 ± 1.2	7.1 ± 1.1	6.7 ± 1.3	ns
Nocturnal sleep efficiency (%)	68 ± 9.8	69 ± 9.7	81 ± 6.6	80 ± 8.1	ns
Nocturnal WASO (%)	29 ± 8.9	29 ± 9.4	18 ± 8.0	17 ± 8.2	ns
Daytime sleep (minutes)	69 ± 62	79 ± 55	28 ± 37	41 ± 54	ns
Self-report	<i>n</i> = 62	<i>n</i> = 56	<i>n</i> = 62	<i>n</i> = 56	
Total Sleep Disturbance Score	57 ± 15	56 ± 15	38 ± 16	41 ± 17	ns
Daytime Sleepiness Score	3.4 ± 1.1	3.4 ± 1.3	2.0 ± 1.2	2.1 ± 1.2	ns
Mothers in Sample 2					
Actigraphy	<i>n</i> = 32	<i>n</i> = 77	<i>n</i> = 32	<i>n</i> = 77	
Nocturnal sleep time (hours)	6.1 ± 1.4	6.6 ± 1.3	6.5 ± 1.4	7.1 ± 1.4	<i>F</i> (1,107) = 5.6, <i>p</i> =.016
Nocturnal sleep efficiency (%)	68 ± 11	71 ± 10	75 ± 12	80 ± 10	<i>F</i> (1,107) = 5.3, <i>p</i> =.024
Nocturnal WASO (%)	30 ± 11	27 ± 10	23 ± 12	19 ± 10	<i>F</i> (1,107) = 4.9, <i>p</i> =.029
Daytime sleep (minutes)	92 ± 76	90 ± 64	72 ± 88	63 ± 56	ns
Self-report	<i>n</i> = 36	<i>n</i> = 86	<i>n</i> = 36	<i>n</i> = 86	
Total Sleep Disturbance Score	50 ± 19	50 ± 15	36 ± 20	38 ± 16	ns
Daytime Sleepiness Score	3.0 ± 1.4	2.8 ± 1.1	2.0 ± 1.3	2.2 ± 1.2	ns
Fathers in Sample 1					
Actigraphy	<i>n</i> = 55	<i>n</i> = 51	<i>n</i> = 55	<i>n</i> = 51	
Nocturnal sleep time (hours)	6.5 ± 1.5	6.4 ± 1.3	6.7 ± 1.0	6.8 ± 1.2	ns
Nocturnal sleep efficiency (%)	78 ± 12	82 ± 10	83 ± 9	86 ± 9	ns
Nocturnal WASO (%)	18 ± 10	15 ± 10	14 ± 9	12 ± 9	ns
Daytime sleep (minutes)	17 ± 33	32 ± 60	12 ± 18	29 ± 61	ns
Self-report	<i>n</i> = 58	<i>n</i> = 53	<i>n</i> = 58	<i>n</i> = 53	
Total Sleep Disturbance Score	43 ± 15	43 ± 16	32 ± 13	33 ± 12	ns
Daytime Sleepiness Score	2.2 ± 1.1	2.4 ± 1.2	1.6 ± .9	1.7 ± .9	ns

Note. WASO = wake after sleep onset, a measure of sleep disruption.

Table 4**Intervention Use and Satisfaction**

Intervention Group	Sample 1		Sample 2	
	1 Month (n = 68)	3 Months (n = 69)	1 Month (n = 27)	3 Months (n = 27)
Used all or most of the time				
Bassinet near mother's bed	78%	72%	78%	63%
Sound machine	62%	58%	40%	56%
Night light	87%	81%	74%	76%
Somewhat or very satisfied with				
Bassinet near mother's bed	71%	62%	92%	69%
Sound machine	74%	53%	58%	46%
Night light	89%	88%	85%	76%
Any Use in First 3 Postpartum Months				
Control Group	(n = 75)		(n = 46)	
Spontaneous use				
Bassinet/crib in parent's room	62%		72%	
Noise-masking device	14%		a	
Low lighting	36%		a	

^aData for Sample 2 control group not obtained.