Biological Research for Nursing
11(4) 363-370

DOI: 10.1177/1099800409356320
http://brn.sagepub.com

# Effects of Mindful Yoga on Sleep in Pregnant Women: A Pilot Study

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## Abstract

**Purpose:** The purpose of this experimental pilot study was to measure the effects of a mindfulness-based yoga intervention on sleep in pregnant women. **Methods:** Fifteen healthy, nulliparous women in their second or third trimesters with singleton pregnancies attended weekly mindfulness meditation and prenatal Hatha yoga classes in the community for 7 weeks. Sleep variables, as estimated by 72 hr of continuous wrist actigraphy and the General Sleep Disturbance Scale (GSDS), were recorded at baseline (Time 1) and postintervention (Time 2). Control data were obtained by evaluating sleep in the third-trimester group at Time 1. Due to small sample size, data were analyzed using parametric and nonparametric statistics. **Results:** Women who began the intervention in the second trimester had significantly fewer awakenings, less wake time during the night, and less perceived sleep disturbance at Time 2 than at baseline. Those who began during the third trimester had poorer sleep over time in spite of the intervention. Women who began the intervention in their second trimester had less awake time at Time 2 compared to third-trimester controls at Time 1. **Conclusions:** Mindful yoga shows promise for women in their second trimester of pregnancy to diminish total number of awakenings at night and improve sleep efficiency and merits further exploration. Results from this pilot study provide the data to estimate sample size and design and implement powered and more controlled studies in the future.



## Keywords

sleep, actigraphy, pregnancy, yoga, mindfulness


Pregnancy is a time of profound physiologic change coupled with emotional adjustments in anticipation of childbirth and parenthood. Many women experience a cluster of symptoms that includes sleep disturbance during pregnancy. Investigators have suggested that sleep changes in pregnancy contribute to perinatal mood disturbance and somatic complaints (Andersson et al., 2003; Kelly, Russo, & Katon, 2001). Somatic symptoms such as sleep disturbance occur in a majority of pregnant women (Lee, 1998; National Sleep Foundation, 1998; Ostgaard, Zetherstrom, & Roos-Hansson, 1997; Schweiger, 1972; To & Wong, 2003), and adequate interventions do not exist for these symptoms.

The length and quality of sleep during pregnancy is an important and often overlooked component in research. Lee (1998) and Lee, Zaffke, and McEnany (2000) found that pregnant women often have more subjective sleep complaints than nonpregnant women and that alterations of sleep architecture begin in early pregnancy and include delayed sleep onset, night wakings, frequent arousals, and early morning wakings. Worsening sleep as pregnancy progresses has been reported (Greenwood & Hazendonk, 2004), and, in general, women experience less slow-wave sleep, longer wake time, and reduced sleep efficiency as pregnancy advances (Lee, 1998). These problems may result in insufficient sleep and daytime somnolence (Hertz et al., 1992; Lee, 1998). In healthy adults, short-term sleep restriction is associated with cardiac risk factors such as hypertension, high levels of blood glucose, increased systemic inflammation, and hypothalamic-pituitary-adrenal activation (Alvarez & Ayas, 2004; Hall et al., 1998; McEwen, 2006; Meerlo, Sgoifo, & Suchecki, 2008; Mullington, Haack, Toth, Serrador, & Meier-Ewert, 2009).

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To date, controlled studies have not clearly demonstrated the positive effects of mindfulness-based interventions on sleep quality and duration. However, there is some evidence suggesting that practice of mindfulness techniques is associated with improved sleep. Published intervention studies that evaluate yoga and insomnia have used only subjective sleep data and nonpregnant groups. Because sleep state misperception is common in insomnia, objective measures of sleep are important, especially during pregnancy when sleep architecture is changing.

Yoga intervention studies that collected subjective sleep data include Khalsa's (2004) evaluation of the effects of yogic breathing on chronic insomnia subjects who reported significantly less awake time, longer sleep, and improved sleep efficiency. Manjunath and Telles (2005) conducted a controlled trial that evaluated yoga postures in a sample of elders who reported falling asleep faster, sleeping for a longer length of time, and feeling more rested in the morning. Booth-LaForce, Thurston, and Taylor (2007) evaluated the effects of yoga postures on self-reported sleep in menopausal women who reported improved quality of sleep and sleep efficacy. Yoga postures are a component of mindfulness-based interventions and their practice has been linked to improved sleep in cancer patients (Carlson & Garland, 2005; Shapiro, Bootzin, Figueredo, Lopez, & Schwartz, 2003; Winbush, Gross, & Kreitzer, 2007). Results from these studies suggest that yoga may be efficacious to sleep.

Published studies on yoga during pregnancy have not evaluated sleep. Narendran, Nagarathna, Gunasheela, and Nagendra (2005) and Narendran, Nagarathna, Narendran, Gunasheela, and Nagendra (2005) implemented a prenatal yoga intervention (i.e., yoga postures, breathing practices, and meditation) and demonstrated significantly lower incidences of adverse perinatal outcomes in the treatment group compared to controls. Bastani, Hidarnia, Kazemnejad, Vafaei, and Kashanian (2005) and Bastani, Hidarnia, Montgomery, Aguilar-Vafaei, and Kazemnejad (2006) implemented a progressive relaxation program in a randomized clinical trial of 110 pregnant women and found similar results. Vieten and Astin (2008) evaluated a mindfulness-based intervention that included yoga postures and targeted depression-prone pregnant women; they found significant attenuation of anxiety and depression as a result of the intervention. Field, Diego, Hernandez-Reif, Schanberg, and Kuhn (2004) and Field et al. (1999) evaluated massage therapy in depressed pregnant women in their second trimester and found that those who received massage therapy had significantly less sleep disturbance than controls by the end of the treatment period.

Although recent studies have established relationships between interventions that cultivate relaxation and improved sleep, no studies have described objective sleep variables in healthy pregnant women undergoing a mind-body intervention. We propose prenatal mindful yoga as an approach to alter stress appraisal and thereby attenuate the stress response. Mindful yoga is a participatory intervention based on mindfulness-based stress reduction (MBSR) and teaches Iyengar style Hatha yoga tailored to pregnancy as the mode for learning mindfulness skills. The purpose of this pilot study was to investigate whether a 7-week mindful-yoga group intervention during pregnancy could influence sleep disturbance, measured by 72 hr of continuous actigraphy and self-report. We explored three research questions:

1. Comparing postintervention to baseline, do participants have significantly more total sleep time (TST) and less wake time during the night estimated by wrist actigraphy data?
2. Will the group report significantly improved sleep at 7 weeks postintervention, compared to baseline scores?
3. Do pregnant women beginning the intervention in the third trimester respond differently than women beginning the intervention in the second trimester?

## Method

### Sample

A sample in California was recruited via approved recruitment flyers posted throughout the community. E-mailed notices alerted doulas, midwives, and childbirth educators of the program; childbirth education programs hand-delivered or mailed flyers; and 5-min presentations about the study were made to selected childbirth classes. The presentations and flyers explained the purpose of the study and that women would be paid up to US$100 to participate. Pregnant women who met eligibility were at least 18 years old, able to read and write English, expecting a first baby, carrying a singleton pregnancy, planning a hospital birth, and between gestational Weeks 12 and 32 at the start of the intervention. Women were excluded if they reported a history of psychiatric illness or insomnia; currently used medications; worked nightshift; or had diabetes, hypertension, HIV infection, or history of back surgery. We screened 42 pregnant women for eligibility and enrolled 23; 19 were able to meet on the day and time of the mindful-yoga group, but 2 of these left the study due to pregnancy complications (1 was placed on bedrest for preterm labor without preterm birth, and the other for preterm birth). Actigraph monitors failed to record data for 2 additional subjects at the postintervention assessment. The final sample consisted of 15 women with complete actigraphy data, 7 of whom started the intervention in the second trimester and 8 who started in the third.

### Procedure

The Committee on Human Research at the University of California, San Francisco, approved this study. Participation was voluntary. As part of informed consent procedures, each participant was assured of confidentiality and freedom to withdraw from the study at any time. Each participant wore a wrist actigraph to monitor sleep and activity for a 3-day period at both baseline and postintervention. A member of the research team visited each participant at home when she joined the study to instruct her in the wearing of a wrist actigraph and to collect data regarding her subjective sleep disturbance.

## Intervention

The 7-week, mindfulness-based yoga intervention used yoga methods of Iyengar (1979) and a curriculum of MBSR, a program developed by Kabat-Zinn (1990). Mindfulness meditation is defined as a universal capacity to pay purposive attention to the present moment (Hanh, 1976; Kabat-Zinn, 1990). Aspects of mindfulness practice include self-reflection, acceptance, opening to difficulties without avoidance, and learning to be less judgmental and reactive (Kabat-Zinn, 1990; Kornfield, 1993). Mindfulness meditation can be practiced in several ways including sitting meditation, the body scan, Hatha yoga, and walking meditation. Informal aspects include purposeful attention on activities of daily living. Each weekly class was 2 hr in length. Although the total intervention was only 14 hr in length, its aim was to maintain fidelity with MBSR's emphasis on mindfulness.

*Asana* is a Sanskrit word that refers to pose. The yoga *asanas* used in this study were designed for women late in pregnancy. Each weekly yoga session lasted approximately 75 min with guided instruction throughout each pose. The asana practice began with standing poses. The class moved onto seated poses and supported reclining poses. Each class included standing positions; seated leg, groin, and hip stretching; supported squatting; and a movement called the cat-cow. The only backbends done were *supta virasana* (reclining hero pose) supported with the torso on a bolster and a modified *ustrasana* (camel pose) using the chair. *Adho mukha svanasana* (downward dog) was the only inversion practiced. Emphasis was placed on building length along the spine while maintaining a neutrality of spinal position, keeping awareness of the breath, and using the breath and sensations within the body to anchor attention to the present moment. A more detailed description of the mindful-yoga intervention can be found in Beddoe, Yang, Kennedy, Weiss, and Lee (in press), where data for the subjects' psychological and physical distress variable are presented.

## Instruments

*Subjective sleep disturbance.* Subjective sleep disturbance was measured with the General Sleep Disturbance Scale (GSDS; Lee, 1992). The GSDS asks about frequency in the past week of various poor sleep experiences (such as difficulty getting to sleep, waking during sleep, and sleeping poorly) on a numerical rating frequency scale of 0 (*never*) to 7 (*every day*). It has shown good internal consistency with women in previous studies ($\alpha = .88$). The Cronbach $\alpha$ in this sample of pregnant women was .81. The scale yields a mean score ranging between 0 and 7, with higher scores indicating greater frequency of sleep disturbance during the past week. A mean score of 3 or higher distinguishes poor sleep from good sleep.

*Actigraphy.* To objectively estimate sleep and wake time, each participant was asked to wear a wrist actigraph (Ambulatory Monitoring, Inc., Ardsley, NY) for 72 consecutive hours both at baseline and after completing the 7-week intervention. Actigraphy monitoring is a method commonly used to characterize sleep–wake and circadian rhythm patterns. The monitor is a battery-operated wristwatch-size microprocessor that detects wrist movement by sensing motion in all three axes with a piezoelectric linear accelerometer (Lee & Gay, 2004). Actigraphy is reliable and valid for detecting sleep in healthy populations (Littner et al., 2003). Actigraph sleep and wake time has a high degree of agreement with polysomnography recordings in laboratory settings (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992).

Actigraphy data were analyzed using Action4 software (Ambulatory Monitoring, Inc) by the second author who remained blinded to participant characteristics. The autoscoring algorithm yielded five sleep variables: (a) total time in bed at night (TTB); (b) TST during the night between falling asleep and final awakening; (c) sleep onset latency (SOL), or the length of time it took to fall asleep after pressing the event marker on the monitor, which indicated the participant was ready to go to sleep (>30 min indicated difficulty falling asleep); (d) number of awakenings during the night, using criteria of Cole et al. (1992) and Webster, Kripke, Messin, Mullaney, and Wyborney. (1982) to score a wake episode as follows: after 4 min scored as wake, the next 1 min of sleep is scored as wake; and 6 or fewer min of sleep surrounded by 10 min of wake before and after is scored as wake; and (e) wake after sleep onset (WASO) reported as the percentage of min awake divided by min in bed after falling asleep. WASO is an estimate of sleep disruption, with 5% to 10% typical for healthy, nonpregnant women (Lee et al., 2000). A WASO greater than 15% represents more than 1 hr of wake time after falling asleep during a typical 7–8 hr sleep and was considered severe sleep disruption for this study of healthy pregnant women.

## Statistical Methods

Data from both instruments were evaluated for completeness. Frequency distributions were checked for extreme or inconsistent values. Descriptive statistics were used to characterize the sample. Actigraph and GSDS variables were analyzed to obtain descriptive means and standard deviations. Actigraphy data were tested for reliability over 3 days with intraclass correlation coefficients (ICC) and were stable. Actigraph values were then derived by averaging over 3 days at each assessment point.

Due to small sample size, data were analyzed using nonparametric Wilcoxon signed ranks test for paired comparisons between Time 1 (baseline) and Time 2 (postintervention) for each trimester group. Mann-Whitney *U* tests were used for this comparison. To create a control group, we also analyzed the third trimester group's baseline data, used it as a control, and compared it to the second trimester group's data after the intervention. Effect sizes and 95% confidence intervals (CI) were also calculated. Analyses were done with Statistical Package

**Table 1.** Baseline Demographic Characteristics ($N = 15$)

| Characteristic | *N* | % |
|---|---|---|
| Age[a] (years) | | |
| 25–29 | 4 | 27 |
| 30–37 | 11 | 73 |
| Work status | | |
| Full-time | 8 | 53 |
| Part-time | 5 | 34 |
| Not working | 2 | 13 |
| Student status | | |
| Full-time | 3 | 20 |
| Nonstudent | 12 | 80 |
| Weeks' gestation | | |
| 12–24 weeks | 7 | 47 |
| 25–32 weeks | 8 | 53 |
| Prenatal care | | |
| Obstetrician | 8 | 53 |
| Midwife | 7 | 47 |

for the Social Sciences (SPSS) version 15 for Windows. Level of significance was set at $p \leq .10$ for this pilot study to reduce the potential for type 2 error.

## Results

The characteristics of the sample are shown in Table 1. Participating women were middle class, married, and college educated, with 53% of them working full-time. None reported currently smoking cigarettes, taking prescription or illicit drugs, or having medical problems. None of the subjects was obese. All women were having their first baby, planned on attending childbirth classes, intended to breastfeed, and wanted a vaginal birth. All of the working women were planning to return to work after the babies were born. Although none of the women had current mental or physical health problems, 20% reported a history of depression or anxiety in the past.

As shown in Table 2, on the first day of the intervention, women in the third-trimester group averaged 26.5 weeks' gestation. Women who were in the second trimester of pregnancy on the first day of the intervention were, on average, at 21.0 weeks' gestation. For the third-trimester group, baseline data were collected, on average, 2.7 weeks prior to the first day of the intervention when the mean gestation was 26.4 weeks. Baseline data for women in the second-trimester group were collected, on average, at 19.8 weeks' gestation, which was 1.2 weeks prior to the start of the intervention. Postintervention data collection took place uniformly for all participants and immediately following Week 7 of the intervention. On Day 1 of the 3-day postintervention collection cycle, the third-trimester group averaged 36.1 weeks' gestation and the second-trimester group, many of whom were now in their third trimester, averaged 27.1 week's gestation.

Pregnant women attended the 7-week mindful-yoga group program and were instructed to practice at home at least five times during the week between the group sessions. They reported doing mindfulness-based formal practice an average of two times per week, with a range of 0–6 times. Although participants reported that they would readily recommend the program to other pregnant women, they also reported difficulty practicing at home alone.

**Table 2.** Gestational Ages of Participants in Weeks by Group at Baseline (T1), Day 1 of the Intervention, and Postintervention (T2)

| Group | *N* | Mean ± *SD* | Minimum | Maximum |
|---|---|---|---|---|
| T1 | | | | |
| Whole group | 17 | 23.3 ± 4.6 | 12.0 | 29.4 |
| Third trimester | 9 | 26.5 ± 2.3 | 23.7 | 29.4 |
| Second trimester | 8 | 19.8 ± 4.0 | 12.0 | 23.3 |
| Intervention Day 1 | | | | |
| Whole group | 17 | 25.3 ± 5.2 | 13.0 | 31.1 |
| Third trimester | 9 | 29.1 ± 2.0 | 27.1 | 32.1 |
| Second trimester | 8 | 21.0 ± 4.1 | 13.0 | 25.3 |
| T2 | | | | |
| Whole group | 17 | 32.3 ± 5.2 | 20.0 | 39.1 |
| Third trimester | 9 | 36.1 ± 2.0 | 34.1 | 39.1 |
| Second trimester | 8 | 27.1 ± 4.1 | 20.0 | 32.3 |

### *GSDS*

At baseline, women in the second-trimester group had a mean sleep disturbance (GSDS) score of 2.9 ± 1.0, while those in the third-trimester group had a mean score of 1.8 ± 0.5. These scores reveal differences between groups at baseline ($Z = 1.93$, $p = .06$). The number of nights of poor sleep reported at baseline by women in their second trimester was also greater than the number reported by those in their third ($Z = .66$, $p < .05$). At postintervention, mean GSDS scores were 2.4 ± 1.0 for both second- and third-trimester groups. There was a group-by-time interaction ($p = .09$), with women in the second-trimester group reporting fewer nights of poor sleep at Time 2 as compared to baseline, while those in the third-trimester group reporting more nights of poor sleep (Table 3). Post hoc nonparametric analyses indicated that women in the second-trimester group demonstrated significantly improved sleep by total GSDS scores ($Z = –2.03$, $p = .04$) and fewer nights with poor sleep ($Z = –2.1$, $p = .03$). In contrast, participants in the third-trimester group reported worse sleep ($Z = 1.6$, $p = .10$) and more nights with poor sleep ($Z = 1.6$, $p = .10$). After 7 weeks of the mindful-yoga intervention, the women in the second-trimester group still reported worse sleep disturbance at T2 than those in the third-trimester group reported at baseline ($Z = 1.86$, $p = .06$), which served as the control group.

### *Actigraphy*

Reliabilities among three consecutive 24-hr periods for actigraphy data were estimated by ICC. An ICC of at least .60 reflects acceptable stability and reliability of the measure at each timepoint, indicating that the variation achieved between baseline and postintervention was due to the change in subject sleep scores rather than error variance associated with the measure.

**Table 3.** Actigraph Data and General Sleep Disturbance Scale (GSDS) Scores by Group: Baseline (T1) and Postintervention (T2) Means (SD)

| Measure | Second Trimester Group ($n$ = 7) T1 | T2 | Wilcoxon $Z$; 2-Tailed $p$ Value | Third Trimester Group ($n$ = 8) T1 | T2 | Wilcoxon $Z$; 2-Tailed $p$ Value |
|---|---|---|---|---|---|---|
| TTB (min) | 583 (35.9) | 545 (36.6) | −1.69; $p$ = .05 | 575 (43.1) | 547 (53.7) | −1.40; $p$ = .16 |
| TST (min) | 507 (63.5) | 500 (26.2) | −.34; $p$ = .72 | 499 (71.2) | 437 (105.3) | −2.24; $p$ = .01 |
| SEI (%TST/TTB) | 87.5 (9.3) | 92.0 (2.9) | .68; $p$ = .50 | 86.8 (9.4) | 79.2 (16.1) | −1.96; $p$ = .02 |
| Sleep onset latency (min) | 15.5 (14.5) | 8.1 (2.9) | −.68; $p$ = .50 | 5.7 (3.1) | 9.7 (6.0) | 1.61; $p$ = .05 |
| Awakenings (#) | 11.9 (5.7) | 9.2 (4.6) | −1.86; $p$ = .03 | 15.0 (8.5) | 18.0 (8.2) | .98; $p$ = .32 |
| WASO (% of TTB) | 8.9 (7.0) | 5.6 (2.7) | −.68; $p$ = .50 | 11.4 (9.3) | 18.7 (15.8) | 1.82; $p$ = .04 |
| GSDS score | 2.9 (1.0) | 2.4 (1.0) | −2.03; $p$ = .04 | 1.8 (.5) | 2.4 (1.0) | 1.6; $p$ = .10 |
| Slept poorly (GSDS item) | 3.7 (1.6) | 2.0 (1.2) | −2.14; $p$ = .03 | 1.6 (1.8) | 3.3 (2.8) | 1.6; $p$ = .10 |

NOTE: SEI = sleep efficiency; TTB = total time in bed at night; TST = total sleep time; WASO = wake after sleep onset.

**Table 4.** Mean (*SD*) Actigraph Data and General Sleep Disturbance Scale (GSDS) Scores at Baseline (T1) for Women Who Began the Intervention in Their Third Trimester and at Postintervention (T2) for Women Who Began the Intervention in Their Second Trimester

| | Third-Trimester Group at T1 ($n$ = 8) | Second-Trimester Group at T2 ($n$ = 7) | Mann-Whitney $U$; 2-Tailed $p$ Value |
|---|---|---|---|
| Gestational age (weeks) | 26.45 (2.26) | 27.08 (4.12) | 0.42; $p$ = .82 |
| TTB (min) | 575.3 (43.1) | 544.8 (36.6) | −1.27; $p$ = .24 |
| TST (min) | 498.5 (71.2) | 500.0 (26.2) | 0.70; $p$ = .54 |
| SEI (% TST/TTB) | 86.8 (9.4) | 92.0 (2.9) | 1.28; $p$ = .24 |
| Sleep onset latency (min) | 5.7 (3.1) | 8.1 (2.9) | 1.28; $p$ = .24 |
| Awakenings (#) | 15.0 (8.5) | 9.2 (4.6) | −1.39; $p$ = .18 |
| WASO (% of TTB) | 11.4 (9.3) | 5.6 (2.7) | −1.62; $p$ = .12 |
| GSDS score | 1.8 (.5) | 2.4 (1.0) | 1.86; $p$ = .06 |
| Slept poorly (GSDS item) | 1.6 (1.8) | 2.0 (1.2) | 1.00; $p$ = .32 |

NOTE: SEI = sleep efficiency; TTB = total time in bed at night; TST = total sleep time; WASO = wake after sleep onset.

The majority of the sleep variables demonstrated a high degree of stability and reliability across the three nights of data collection, and these variables became more stable over time (sleep efficiency ICC: T1 = .82, T2 = .96; total sleep time ICC: T1 = .75, T2 = .88; awakenings ICC: T1 = .74, T2 = .89; and WASO ICC: T1 = .81, T2 = .97). TTB did not demonstrate a high degree of stability (T1 = .59, T2 = .52).

At baseline, there were no significant differences by trimester group for TTB, SEI (sleep efficiency), TST, number of awakenings, or WASO. The TTB for the entire sample averaged 9.7 hr ($\pm$.65) at baseline and 9.1 hr ($\pm$.75) at postintervention, which was a significant reduction ($Z$ = –2.39, $p$ = .02). The sample's TST also decreased from baseline (8.3 hr $\pm$ 1.1) to posttreatment (7.8 hr $\pm$ 1.4; $Z$ = –1.99; $p$ = .02) by 30 min.

As shown in Table 3, there were important differences in sleep over time by trimester group. Although women who began the mindful-yoga intervention in their second trimester spent nearly 38 min less in bed at Time 2 than at Time 1 (ES –.97; 95% CI –1.75, –.19; $Z$ = –1.69; $p$ = .05), their TST only decreased by 7 min. Women in this group improved their SEI by nearly 5%, had significantly fewer awakenings ($Z$ = −1.86, $p$ = .03), and experienced a lower WASO percentage. By contrast, women who began mindful yoga in their third trimester experienced significant deterioration in SEI ($Z$ = –1.96, $p$ = .02) and TST ($Z$ = –2.24, $p$ = .01), significantly longer SOL ($Z$ = 1.61; $p$ = .05; ES .83, 95% CI .11, 1.55) and greater WASO ($Z$ = 1.82, $p$ = .04). In fact, the mean WASO of women in the third-trimester group indicated severe sleep disruption following the intervention.

To examine whether these trimester differences in outcomes were influenced by advancing pregnancy, we compared Time 2 data for women starting mindful yoga in their second trimester to Time 1 data for women who were about to start the mindful-yoga intervention in their third trimester. This analysis compared women who had completed the intervention by a point in their third trimester to those who were at nearly the same point in their pregnancy but had not yet experienced the mindful-yoga intervention. No significant differences were found between the actigraph data of the two groups. However, the women who began the intervention in their second trimester had fewer awakenings and less wake time during the night compared to women in their third trimester who had not yet begun the intervention, though these differences did not reach the level of statistical significance. There was also a significant difference in the GSDS scores (Table 4).

## Discussion

This is the first study we are aware of that tested a mindfulness-based yoga intervention for pregnant women. Additionally, no other published studies have documented the effects of a mind-body intervention on sleep in healthy pregnancy. The findings from this study are the first to suggest that a mindful-yoga intervention for pregnant women in their second trimester can improve sleep as their pregnancy progresses (Greenwood & Hazendonk, 2004). Previous research has shown that MBSR improves sleep in cancer patients (Carlson & Garland, 2005; Shapiro et al., 2003; Winbush et al., 2007).

Subjective and objective data indicate that healthy women in their second trimester experienced better sleep efficiency with fewer awakenings and less wake time after sleep onset postintervention. These results are significant because clinicians expect that sleep efficiency is reduced as pregnancy advances, and the majority of subjects in the second-trimester group were well into their third trimester at postintervention. By contrast, at postintervention, sleep had deteriorated for women who began the mindful-yoga intervention in their third trimester. Additionally, the fact that actigraph data showed improved day-to-day stability at postintervention suggests stronger circadian rhythmicity among participants in both trimesters as a result of the intervention.

Women in the second-trimester group reported worse subjective sleep at baseline than did women in the third-trimester group. This finding is counter to previous research that documented worsening sleep as pregnancy progresses (Schweiger, 1972). In support of these subjective data, actigraph data showed greater SOL (15.5 min $\pm$ 14.5) for women in the second-trimester group at baseline compared with women in the third-trimester group at baseline (5.75 min $\pm$ 3.1).

The mindful-yoga intervention appears to have been less effective for women in the third trimester of pregnancy. Future studies should examine pregnancy-related factors that may moderate the effects of the intervention for this group. The wide variation in postintervention data for the third-trimester group also suggests that women in this group may have responded differently to the intervention because of pregnancy-related factors.

Our results suggest that mindful yoga, if initiated in the second trimester, may improve sleep in women with healthy pregnancies. Because group differences for GSDS baseline data were detected, however, improvements by postintervention should be interpreted cautiously. Additionally, the mechanism of improved sleep is unclear. Although Iyengar (1979) has indicated specific yoga *asanas* (such as inversions) for insomnia, most of these were not included in the intervention, and they seemed unnecessary for the overall positive effect. Physical activity has been shown to improve sleep (Youngstedt, 2005; Youngstedt, O'Connor, & Dishman, 1997), and one study found that mindful yoga may also be an effective preventive and treatment strategy for back pain in pregnancy (Morkved, Salvesen, Schei, Lydersen, & Bo, 2007).

Sleep during pregnancy is important as it may indirectly contribute to labor outcomes. Reduced time in bed and increased wake time during the night have been associated with longer labor and increased risk of cesarean birth in primiparous women (Lee & Gay, 2004). Moreover, the amount of sleep a woman has the night before labor begins has been associated with pain perception (Beebe & Lee, 2007). Improving sleep in pregnancy may also have positive effects on mental health. Lee, McEnany, and Zaffke (2000) found that negative affect in pregnancy was associated with more time awake at night. An intervention that improves sleep might also improve affect. The relationships among sleep, pain, and affect may be the function of neurotransmitter systems that are involved in multiple regulatory systems for sleep, mood, stress, and labor progression.

## Limitations

It is important to note several limitations of this pilot study. Without an adequate control group matched on weeks of gestation at the time of enrollment, the changes observed over time cannot be attributed solely to mindful yoga. We attempted to control for this limitation by analyzing the data by trimester and by using baseline data of women who began mindful yoga in their third trimester as the control for posttreatment data of women who began the intervention in their second trimester. In addition, due to the small sample, results may have lacked the power to reach statistical significance. Because participants in this sample were predominantly White, middle class, employed, well educated, and married, results cannot be generalized to other ethnicities or socioeconomic groups; nor should results be generalized to women with pregnancy complications. This was a self-selected convenience sample of women who may have been more responsive to the intervention than the general population of pregnant women.

## Conclusion

Our results suggest that mindful yoga may have attributes that moderate sleep disturbance and thereby improve perinatal health. Women who began mindful yoga in the second trimester experienced improved sleep efficiency from pre- to postintervention, while women who began the intervention in the third trimester did not. Based on these findings, we propose mindful yoga as a promising treatment to promote maternal sleep and diminish the potential negative impact of sleep disturbance in pregnancy.

Short-term restriction of sleep, even in healthy people, results in a variety of adverse physiologic effects including elevated blood pressure, activation of the sympathetic nervous system, impaired glucose control, and increased inflammation (Alvarez & Ayas, 2004). During pregnancy, it is particularly important for a person to have optimum functioning of her cardiovascular system and well-modulated glucose control.

To our knowledge, no other mindfulness-based intervention study has addressed a pregnant woman's sleep, an integral part of the physiological response to stress. Results from this pilot study provide the necessary data to estimate sample size and design and implement powered and more controlled studies in the future. Future studies could extend our findings by recruiting a larger sample size, including an attention control group, and following women from early pregnancy until delivery to compare the effects of mindful yoga on women in all three trimesters.

## Declaration of Conflicting Interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

## Funding

The authors disclosed receipt of the following financial support for the research and/or authorship of this article: NIH grant F31 NR009328 and the Yoga Research Education Foundation; and the Graduate Student Research Award, University of California, San Francisco.

## References

Alvarez, G. G., & Ayas, N. T. (2004). The impact of daily sleep duration on health: A review of the literature. *Progress in Cardiovascular Nursing*, *19*, 56-59.

Andersson, L., Sundstrom-Poromaa, I., Bixo, M., Wulff, M., Bondestam, K., & aStrom, M. (2003). Point prevalence of psychiatric disorders during the second trimester of pregnancy: A population-based study. *American Journal of Obstetrics and Gynecology*, *189*, 148-154.

Bastani, F., Hidarnia, A., Kazemnejad, A., Vafaei, M., & Kashanian, M. (2005). A randomized controlled trial of the effects of applied relaxation training on reducing anxiety and perceived stress in pregnant women. *Journal of Midwifery and Women's Health*, *50*, e36-40.

Bastani, F., Hidarnia, A., Montgomery, K. S., Aguilar-Vafaei, M. E., & Kazemnejad, A. (2006). Does relaxation education in anxious primigravid Iranian women influence adverse pregnancy outcomes? A randomized controlled trial. *Journal of Perinatal and Neonatal Nursing*, *20*, 138-146.

Beddoe, A. E., Yang, C. P., Kennedy, H. P., Weiss, S. J., & Lee, K. L. (in press). The effects of mindfulness-based yoga during pregnancy on maternal psychological and physical distress. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*.

Beebe, K. R., & Lee, K. A. (2007). Sleep disturbance in late pregnancy and early labor. *Journal of Perinatal and Neonatal Nursing*, *21*, 103-108.

Booth-LaForce, C., Thurston, R. C., & Taylor, M. R. (2007). A pilot study of a Hatha yoga treatment for menopausal symptoms. *Maturitas*, *57*, 286-295.

Carlson, L. E., & Garland, S. N. (2005). Impact of mindfulness-based stress reduction (MBSR) on sleep, mood, stress and fatigue symptoms in cancer outpatients. *International Journal of Behavioral Medicine*, *12*, 278-285.

Cole, R. J., Kripke, D. F., Gruen, W., Mullaney, D. J., & Gillin, J. C. (1992). Automatic sleep/wake identification from wrist activity. *Sleep*, *15*, 461-469.

Field, T., Diego, M. A., Hernandez-Reif, M., Schanberg, S., & Kuhn, C. (2004). Massage therapy effects on depressed pregnant women. *Journal of Psychosomatic Obstetrics and Gynaecology*, *25*, 115-122.

Field, T., Hernandez-Reif, M., Hart, S., Theakston, H., Schanberg, S., & Kuhn, C. (1999). Pregnant women benefit from massage therapy. *Journal of Psychosomatic Obstetrics and Gynaecology*, *20*, 31-38.

Greenwood, K. M., & Hazendonk, K. M. (2004). Self-reported sleep during the third trimester of pregnancy. *Behavioral Sleep Medicine*, *2*, 191-204.

Hall, M., Baum, A., Buysse, D. J., Prigerson, H. G., Kupfer, D. J., & Reynolds, C. F., 3rd. (1998). Sleep as a mediator of the stress-immune relationship. *Psychosomatic Medicine*, *60*, 48-51.

Hanh, T. N. (1976). *The miracle of mindfulness: A manual for meditation.* Boston: Beacon.

Hertz, G., Fast, A., Feinsilver, S. H., Albertario, C. L., Schulman, H., & Fein, A. M. (1992). Sleep in normal late pregnancy. *Sleep*, *15*, 246-251.

Iyengar, B. K. S. (1979). *Light on Yoga* (2nd ed.). New York: Schocken Books.

Kabat-Zinn, J. (1990). *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness.* New York: Dell Publishing.

Kelly, R. H., Russo, J., & Katon, W. (2001). Somatic complaints among pregnant women cared for in obstetrics: Normal pregnancy or depressive and anxiety symptom amplification revisited? *General Hospital Psychiatry*, *23*, 107-113.

Khalsa, S. B. (2004). Treatment of chronic insomnia with yoga: A preliminary study with sleep-wake diaries. *Applied Psychophysiology and Biofeedback*, *29*, 269-278.

Kornfield, J. (1993). *A path with heart: A guide through the perils and promises of spiritual life.* New York: Bantam Doubleday Dell.

Lee, K. A. (1992). Self-reported sleep disturbances in employed women. *Sleep*, *15*, 493-498.

Lee, K. A. (1998). Alterations in sleep during pregnancy and postpartum: A review of 30 years of research. *Sleep Medicine Reviews*, *2*, 231-242.

Lee, K. A., & Gay, C. L. (2004). Sleep in late pregnancy predicts length of labor and type of delivery. *American Journal of Obstetrics and Gynecology*, *191*, 2041-2046.

Lee, K. A., McEnany, G., & Zaffke, M. E. (2000). REM sleep and mood state in childbearing women: Sleepy or weepy? *Sleep*, *23*, 877-885.

Lee, K. A., Zaffke, M. E., & McEnany, G. (2000). Parity and sleep patterns during and after pregnancy. *Obstetrics and Gynecology*, *95*, 14-18.

Littner, M., Kushida, C. A., Anderson, W. M., Bailey, D., Berry, R. B., Davila, D. G., et al. (2003). Practice parameters for the role of actigraphy in the study of sleep and circadian rhythms: An update for 2002. *Sleep*, *26*, 337-341.

Manjunath, N. K., & Telles, S. (2005). Influence of Yoga and Ayurveda on self-rated sleep in a geriatric population. *Indian Journal of Medical Research*, *121*, 683-690.

McEwen, B. S. (2006). Sleep deprivation as a neurobiologic and physiologic stressor: Allostasis and allostatic load. *Metabolism*, *55*, S20-23.

Meerlo, P., Sgoifo, A., & Suchecki, D. (2008). Restricted and disrupted sleep: Effects on autonomic function, neuroendocrine stress systems and stress responsivity. *Sleep Medicine Reviews*, *12*, 197-210.

Morkved, S., Salvesen, K. A., Schei, B., Lydersen, S., & Bo, K. (2007). Does group training during pregnancy prevent lumbopelvic pain? A randomized clinical trial. *Acta Obstetricia et Gynecologica Scandinavica*, *86*, 276-282.

Mullington, J. M., Haack, M., Toth, M., Serrador, J. M., & Meier-Ewert, H. K. (2009). Cardiovascular, inflammatory, and metabolic consequences of sleep deprivation. *Progress in Cardiovascular Diseases*, *51*, 294-302.

Narendran, S., Nagarathna, R., Gunasheela, S., & Nagendra, H. R. (2005). Efficacy of yoga in pregnant women with abnormal Doppler study of umbilical and uterine arteries. *Journal of the Indian Medical Association*, *103*, 12-14, 16-17.

Narendran, S., Nagarathna, R., Narendran, V., Gunasheela, S., & Nagendra, H. R. (2005). Efficacy of yoga on pregnancy outcome. *Journal of Alternative and Complementary Medicine*, *11*, 237-244.

National Sleep Foundation. (1998). Women and Sleep Poll. Retrieved October 4, 2005, from http://www.sleepfoundation.org/sleeplibrary/index.php?secid=&id=54

Ostgaard, H. C., Zetherstrom, G., & Roos-Hansson, E. (1997). Back pain in relation to pregnancy: A 6-year follow-up. *Spine, 22,* 2945-2950.

Schweiger, M. S. (1972). Sleep disturbance in pregnancy. A subjective survey. *American Journal of Obstetrics and Gynecology*, *114*, 879-882.

Shapiro, S. L., Bootzin, R. R., Figueredo, A. J., Lopez, A. M., & Schwartz, G. E. (2003). The efficacy of mindfulness-based stress reduction in the treatment of sleep disturbance in women with breast cancer: An exploratory study. *Journal of Psychosomatic Research*, *54*, 85-91.

To, W. W., & Wong, M. W. (2003). Factors associated with back pain symptoms in pregnancy and the persistence of pain 2 years after pregnancy. *Acta Obstetricia et Gynecologica Scandinavica, 82,* 1086-1091.

Vieten, C., & Astin, J. (2008). Effects of a mindfulness-based intervention during pregnancy on prenatal stress and mood: Results of a pilot study. *Archives of Women's Mental Health*, *11*, 67-74.

Webster, J. B., Kripke, D. F., Messin, S., Mullaney, D. J., & Wyborney, G. (1982). An activity-based sleep monitor system for ambulatory use. *Sleep*, *5*, 389-399.

Winbush, N. Y., Gross, C. R., & Kreitzer, M. J. (2007). The effects of mindfulness-based stress reduction on sleep disturbance: A systematic review. *Explore (NY)*, *3*, 585-591.

Youngstedt, S. D. (2005). Effects of exercise on sleep. *Clinics in Sports Medicine*, *24*, 355-365.

Youngstedt, S. D., O'Connor, P. J., & Dishman, R. K. (1997). The effects of acute exercise on sleep: A quantitative synthesis. *Sleep*, *20*, 203-214.