Daily Sleep and Fatigue Characteristics in Nulliparous Women during the Third Trimester of Pregnancy

Shao-Yu Tsai, PhD, RN¹; Jou-Wei Lin, PhD, MD²; Lu-Ting Kuo, PhD, MD³; Karen A. Thomas, PhD, RN⁴

¹Department of Nursing, ²Department of Medicine, ³Department of Surgery, College of Medicine, National Taiwan University, Taipei, Taiwan;

⁴Department of Family & Child Nursing, University of Washington, Seattle, WA

Objectives: To examine the association among nighttime sleep and daytime napping behaviors, depressive symptoms, and perception of fatigue in pregnant women.

Design: A prospective descriptive study with within-subject design.

Setting: A university-affiliated hospital and participants' home environments.

Participants: Thirty-eight third trimester nulliparous women completed sleep and depressive symptom questionnaires, wore a wrist actigraphy monitor for 7 consecutive days, and kept a concurrent diary reporting naps and rating their level of fatigue using a 0-10 visual analogue scale each morning, midday, afternoon, and evening. A generalized estimating equation regression model was applied to evaluate the time-dependent association.

Interventions: N/A.

Measurements and Results: Mean duration of total nighttime sleep by actigraphy was 386.3 ± 60.7 min, with 11 (28.9%) women having an average total nighttime sleep < 6 h. Nineteen women (50%) napped > 3 days, and only 2 women did not nap over the entire week. Antecedent night sleep duration had a significant inverse association with morning ($P = 0.022$) and afternoon fatigue ($P = 0.009$) of the subsequent day. Self-reported naps were significantly associated with midday fatigue ($P = 0.003$). More depressive symptoms predicted more severe fatigue throughout the day.

Conclusions: Results suggest that interventions designed to increase sleep duration and decrease depressive symptoms have the potential to prevent, ameliorate, or reduce fatigue in pregnant women. Depressive symptoms during pregnancy likely share some psychological and behavioral tendencies with fatigue and/or sleep disturbance which may complicate the evaluation of intervention effect.

Keywords: Fatigue, pregnancy, sleep, women

Citation: Tsai SY; Lin JW; Kuo LT; Thomas KA. Daily sleep and fatigue characteristics in nulliparous women during the third trimester of pregnancy. *SLEEP* 2012;35(2):257-262.

INTRODUCTION

Sleep disturbance and fatigue are among the most frequent and persistent complaints reported by pregnant women.¹⁻³ Approximately 60% of pregnant women during the last trimester report being fatigued,⁴ and more than 75% complained of disturbed sleep, decreased vigilance, and a need to nap during the day.⁵ Prenatal sleep disturbance and fatigue have separately predicted prolonged labor and cesarean delivery.⁶⁻⁹ These complications may affect both the mother and the infant both in short and long term. Adverse clinical outcomes include increased risk of gestational hypertensive disorders, glucose intolerance, preterm delivery, and postpartum depression.¹⁰⁻¹² Evidence-based recommendations do not exist for prenatal sleep disturbances and fatigue, with only one report on mindful yoga intervention showing a limited effect on improving nighttime sleep quality during the third trimester of pregnancy.¹³ Napping is widely recognized in pregnant women^{1,5,14}; however, such daytime sleep behavior has never been examined in prenatal fatigue studies. Understanding factors that contribute to maternal fatigue and whether napping

may play a role in alleviating fatigue is important to provide the basis for intervention and reduce associated negative pregnancy complications.

Fatigue in pregnancy is the result of multiple nocturnal awakenings that interrupt deep, restorative sleep which occurs least in nulliparas in the third trimester when compared to multiparas across pregnancy.^{7,15} Limited studies have reported contradictory results on prenatal sleep and fatigue. Elek et al. conducted a prospective study of pregnant women and found neither self-reported sleep quantity nor sleep quality obtained the previous night were associated with reported level of fatigue.³ Gay et al. reported increased fatigue associated with self-reported sleep disturbances and subsequently Hall et al. reported an inverse association between fatigue and self-reported nocturnal sleep duration during the third trimester of pregnancy.^{16,17} Lee and Zaffke reported third-trimester fatigue related to less total sleep time as measured by two consecutive nights of home polysomnographic monitoring.¹⁸ One study found that fatigue in early labor was moderately correlated with total nocturnal sleep duration ($r = -0.39$) and wake after sleep onset ($r = 0.36$) as measured by actigraphy the night before delivery, but the correlations did not reach statistical significance due to insufficient power.⁷ These inconsistent findings may result from varying conceptualizations, definitions, and estimates of sleep and fatigue; in any case, clinical recommendations for prenatal fatigue prevention and treatment remain inconclusive.

Daytime sleep or napping is repeatedly reported as a common sleep behavior in pregnant women.^{1,5,14} In healthy nonpregnant individuals, napping not only improves waking performance

Submitted for publication April, 2011

Submitted in final revised form September, 2011

Accepted for publication September, 2011

Address correspondence to: Shao-Yu Tsai, PhD, RN, Assistant Professor, Department of Nursing, College of Medicine, National Taiwan University, No1, Sec 1, Jen-Ai Rd, Taipei Taiwan 10051; Tel: +886-2-2351-7770; Fax: +886-2-2351-0774; E-mail: stsai@ntu.edu.tw

during sleep loss, but also reduces fatigue and enhances mood and vigor.¹⁹ Although daytime napping was suggested to be potentially beneficial for alleviating prenatal fatigue,²⁰ no studies have explored whether such restorative effects may exist in pregnant women. The association between sleep and fatigue may be further complicated when sociodemographic and psychological factors are considered. Women working in the last month of pregnancy were found to experience less nighttime sleep, less daytime sleep, and higher levels of fatigue than nonworking women.¹⁷ Depressive symptomatology, sleep disturbances, or both can potentially influence fatigue. Reeves et al. reported that 90% of women at gestation week ≤ 20 had fatigue which was correlated with unrefreshed sleep and depressive symptoms.²¹ Although research in this area contributes to an understanding of the multifactorial nature of prenatal fatigue, most studies rely on subjective measures of sleep, with none modeling nighttime sleep, daytime napping, and depressive symptoms simultaneously. The purpose of this prospective study was to examine the association among nighttime sleep and daytime napping behaviors, depressive symptoms, and perception of fatigue in nulliparous women during the last trimester of pregnancy using both objective and subjective sleep measurements.

METHODS

Design and Sample

The current study was a prospective, descriptive study with within-subject design conducted in Taipei, Taiwan. Pregnant women during the third trimester were recruited from prenatal clinics in a university-affiliated hospital in Taipei between January and August, 2010. Participants were derived from an ongoing longitudinal sleep study assessing women's sleep from pregnancy to postpartum. The current study represents a cross-sectional analysis of these data. Inclusion criteria included: healthy pregnant women aged > 18 years of age, pregnant with first child during the third trimester, and experiencing no health complications. Gestational age was determined from the last menstrual cycle and was verified with ultrasound scan measurements; alternatively, gestational age was determined by ultrasound scan measurements alone when appropriate. According to medical records diagnosis and self-reported data, women who had multiple gestations, worked night shifts, had diagnosed depression, major longstanding sleep issues, a diagnosed sleep disorder, or took medications known to affect sleep patterns were excluded.

Procedures

The study was approved by the Institutional Review Board of National Taiwan University Hospital. Study purpose and procedures were explained to interested women who attended routine prenatal care at a university prenatal clinic. Women who agreed to participate in the study completed an initial screening interview and if eligible completed a consent form and provided demographic and health information. Women wore an actigraphy monitor for the next 7 continuous days and recorded a daily fatigue-sleep diary. The research assistant from the team called the women twice during the 7-day study to answer questions and enhance participant compliance. After 7 days of recordings, the research assistant met with the women to collect the ac-

tigraphy device and diaries. Women completed the Pittsburgh Sleep Quality Index (PSQI)²² and the Center for Epidemiologic Studies-Depression Scale (CES-D)²³ to finish the study.

Instruments

Actigraphy

To objectively assess nighttime sleep quality and quantity, women wore an actigraphy monitor (Actiwatch2, Phillips-Respironics Co., Inc., Bend, OR) on their non-dominant wrist for 7 consecutive days. The actigraphy monitor is a small, wireless ambulatory device that has an accelerometer sensitive to body movements.²⁴ Detected physical motion was stored as activity counts every 30 sec, and converted to sleep parameters using the recommended medium sensitivity threshold and a validated weighted moving average algorithm included in the Actiware version 5.0 analysis software (Phillips-Respironics Co., Inc., Bend, OR).^{25,26} The actigraphy monitor used for this study has been widely used in research and clinical sleep studies. Actigraphy provides reliable and valid objective assessments of sleep when compared to polysomnography, with an 88% agreement rate between the 2 methods.²⁷ The sleep parameters derived from the actigraphy included: (1) sleep quantity as measured by total sleep time at night (TST), and (2) sleep quality as measured by wake time after sleep onset at night (WASO). Nighttime was defined as the time from bedtime to rising in the morning. WASO was defined as the amount of time awake after first falling asleep.

Daily diary

While wearing the actigraphy monitor, women kept a sleep-fatigue diary documenting their bedtimes, rise times, naps, fatigue rating, and actigraphy monitor removal times. Women rated their levels of fatigue in the morning right after they arose, midday right before lunch, afternoon right before dinner, and evening before they went to bed for 7 consecutive days using a 7-item short version of the 0-10 numerical rating fatigue scale.^{6,28} The fatigue scale requests a response to statements such as "I am feeling tired," "I am feeling drowsy," and "I am feeling fatigued." Each item was rated from 0 (not at all) to 10 (extremely). The 7 items were summed and averaged to provide a mean fatigue score, with higher scores indicating higher levels of fatigue. The instrument has adequate concurrent validity when compared with Stanford Sleepiness Scale and the Profile of Mood States.²⁸ It has excellent internal consistency reliability when used in childbearing women.^{6,7} Psychometric properties for the 7-item Chinese version were shown satisfactory in a sample of Chinese American mothers.²⁹ The Cronbach α coefficients for the 7-item Chinese version used in the current study were 0.98, 0.98, 0.97, and 0.98 for morning, midday, afternoon, and evening fatigue, respectively.

Pittsburgh Sleep Quality Index (PSQI)

Women completed the PSQI,²² a 19-item self-administered questionnaire to assess subjective sleep from 7 components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. A global PSQI score is summed from each component ranging from 0 to 21 with higher scores

indicating lower sleep quality and a more severe sleep disturbance. A global PSQI score > 5 discriminates “good” and “poor” sleepers with a diagnostic sensitivity and specificity of 89.6% and 86.5%, respectively.²² The PSQI is a well-validated instrument with adequate psychometric properties for assessing subjective sleep quality and sleep disturbances over a one-month period.^{22,30} Previous research has also demonstrated internal consistency reliability and test-retest reliability of the PSQI Chinese version in Taiwan’s populations.³¹ Cronbach α coefficient for the Chinese version of the PSQI was 0.73 in the current study.

Center for Epidemiologic Studies-Depression Scale (CES-D)

Women completed the 20-item CES-D²³ at the end of the study to assess maternal depressive symptomatology during the previous week. Responses were based on the occurrence of symptoms on a 4-point scale ranging from zero (rarely or none of the time) to 3 (most or all of the time). The range of the summary score is from zero to 60, with higher scores indicating greater severity of depressive symptoms. A total score ≥ 16 suggests clinically significant depressive symptoms. The CES-D has been used in childbearing women, and demonstrated good reliability and excellent construct validity.^{23,32,33} The Chinese version of the CES-D is widely used in clinical and research settings, and demonstrates good psychometric properties.^{34,35} The Chinese version of the CES-D yielded an α coefficient of 0.88 in the current study.

Data Analysis

Continuous variables were summarized using means and standard deviations. Categorical variables were summarized using frequency and percentages. For descriptive purposes, actigraphic sleep, self-reported naps, and morning, midday, afternoon, and evening fatigue ratings were averaged within each subject and then averaged across subjects to obtain mean values. Due to the correlated nature of the sleep and fatigue data across 7 days within each individual, we conducted a series of multiple linear regression analyses using the generalized estimating equations (GEE) method³⁶ to assess whether perceived morning, midday, afternoon, and evening fatigue severity was associated with objective actigraphic sleep quantity and quality measurements of the previous night, subjective overall sleep quality as measured by the PSQI global scores, self-reported number of naps during the same day, and depressive symptoms as measured by the CES-D total scores when controlling for age, gestational week, body mass index (BMI), and average working hours per week. Possible predictors were selected on the basis of univariate analyses and variables that have been reported in previous studies.^{3,6,9,21} Statistical analyses were performed using the statistical software package SPSS 17.0 (SPSS Inc., Chicago, IL). For all analysis testing, a P-value < 0.05 was considered statistically significant.

RESULTS

Of the 43 women recruited, one withdrew before actigraphy sleep recordings were initiated and one did not provide any actigraphic data due to equipment failure. Three women who reported “cough or snore loudly 3 times per week” on the PSQI suggesting possible sleep disordered breathing were excluded

Table 1—Characteristics of the participants (N = 38)

Characteristic	Value
Age, years	32.08 $\pm$ 5.13
Gestation, weeks	32.58 $\pm$ 2.76
Current BMI, kg/m ²	25.46 $\pm$ 3.28
Education level	
High school	3 (7.9)
College	21 (55.3)
Graduate school	14 (36.8)
Average working hours per week	
> 40 hours	13 (34.2)
30-40 hours	12 (31.6)
< 30	3 (7.9)
Not working	10 (26.3)
CES-D total scores (0-60)	11.07 $\pm$ 7.81
Clinically significant depression (CES-D ≥ 16)	9 (23.6)

Data are presented as mean $\pm$ standard deviation or n (%). BMI, body mass index; CES-D, Center for Epidemiologic Studies-Depression Scale.

from the analyses. The final analyses were thus based on the results of 38 women. All women were married and well-educated, with 92.1% having a college education (Table 1). The mean age of the women was 32.08 $\pm$ 5.13 years and mean gestational week was 32.58 $\pm$ 2.76. Twenty-eight women (73.7%) were employed and maintained their work schedule throughout the study. Nine women (23.6%) experienced clinically significant depression as measured by the CES-D. There were no statistically significant demographic differences between the women with clinically significant CES-D scores and the rest of the sample.

Actigraphic devices were worn for a mean of 5.95 nights, resulting in partially missing data for 40 (15.0%) of 266 nights. Eleven women did not wear the monitor while sleeping for 1 to 3 nights because of forgetting to put the monitor back on after taking it off to shower. Two women reported discomfort wearing the monitor and only wore the monitor for the first night. Days with missing actigraphic data were treated as invalid data and excluded from the analysis. No significant differences existed between women who contributed data for 7 (n = 25) versus < 7 days (n = 13).

Mean duration of total nighttime sleep as measured by actigraphy was 386.3 $\pm$ 60.7 minutes (Table 2), with 11 (28.9%) women having an average total nighttime sleep < 6 h. Mean actigraphic WASO was 54.3 $\pm$ 26.6 min, with 31 (81.6%) women waking an average > 30 min at night. Twenty-five (65.8%) women had poor perceived sleep quality as measured by PSQI (mean = 6.94 $\pm$ 3.53). The usual bedtimes, rise times, sleep latency, and TST reported on the PSQI were 00:24, 07:46, 24 minutes, and 408 minutes, respectively. Across subjects and recording days, 141 of 266 days with naps were reported in the sleep-fatigue diaries: there were 119 days with one nap reported and 22 days with more than one nap reported on a given day, suggesting that some women napped more than once per day. Nineteen women (50%) napped more than 3 days, and only 2 women did not nap over the entire week. Morning, midday, afternoon, and evening fatigue ratings were 3.40 $\pm$ 1.63, 3.59 $\pm$ 1.59, 4.38 $\pm$ 1.24, and

Table 2—Sleep and fatigue characteristics in 38 nulliparous women

Variables	Value
Actigraphic TST at night, minutes	386.3 ± 60.7
Actigraphic WASO at night, minutes	54.3 ± 26.6
PSQI global score (0-21)	6.94 ± 3.53
PSQI poor sleeper (PSQI global score > 5)	25 (65.8)
PSQI usual bedtime, clock time	00:24 ± 2:49
PSQI usual rise time, clock time	7:46 ± 1:25
PSQI usual sleep latency, minutes	24.2 ± 20.4
PSQI usual total sleep time, minutes	408.1 ± 88.3
Self-reported number of days napped	
0 day napped	2 (5.2)
1 day napped	5 (13.2)
2-3 days napped	12 (31.6)
4-5 days napped	8 (21.1)
6-7 days napped	11 (28.9)
Self-reported number of naps on a given day	
0 nap, number of days (% of day)	125 (47.0)
1 nap, number of days (% of day)	119 (44.7)
≥ 2 naps, number of days (% of day)	22 (8.3)
Morning fatigue (0-10)	3.40 ± 1.63
Midday fatigue (0-10)	3.59 ± 1.59
Afternoon fatigue (0-10)	4.38 ± 1.24
Evening fatigue (0-10)	5.81 ± 1.78

Data are presented as mean ± standard deviation or n (%). TST, total sleep time; WASO, wake after sleep onset; PSQI, Pittsburgh Sleep Quality Index.

Table 3—Summary of regression coefficient estimates in fatigue by factors that may be associated with perceived fatigue severity

Fatigue	Predictors	β	P-value
Morning	Actigraphic previous night total sleep	-0.006	0.022
	Depressive symptoms	0.083	0.029
Midday	Nap number of the same day	0.610	0.003
	Depressive symptoms	0.092	0.004
Afternoon	Actigraphic previous night total sleep	-0.005	0.009
	Depressive symptoms	0.067	0.022
Evening	Depressive symptoms	0.119	0.002

Fully adjusted GEE models included actigraphic previous night total sleep and WASO, self-reported number of naps during the same day, subjective overall sleep quality as measured by the PSQI global scores, depressive symptoms as measured by the CES-D total scores, age, gestational weeks, BMI, and average working hours per week. All predictors were included as a linear variable and were modeled simultaneously. Predictors with a significance level of $P < 0.05$ in GEE model analyses are shown here.

5.81 ± 1.78 , respectively. Additional GEE models revealed no significant within-subject differences for fatigue measures across the day in the morning ($P = 0.056$), midday ($P = 0.100$), afternoon ($P = 0.792$), or evening ($P = 0.107$). Fatigue ratings changed with time of day and the daily changes in fatigue ratings were consistent over the 7 days (Figure 1).

Figure 1—Daily changes in fatigue ratings (mean ± standard error) over the seven days. 1 = morning fatigue rating; 2 = midday fatigue rating; 3 = afternoon fatigue rating; 4 = evening fatigue rating.

Examination of factors related to fatigue was conducted with GEE linear regression models (Table 3). In the adjusted model, antecedent night sleep duration was significantly and negatively associated with the morning and afternoon fatigue of the subsequent day. Although self-reported naps were only significantly associated with midday fatigue level ($\beta = 0.610$; $P = 0.003$), the coefficient was moderate for the morning fatigue levels ($\beta = 0.404$; $P = 0.116$). Depressive symptoms were significantly and positively associated with perceived fatigue levels throughout the day. None of the fatigue variables were significantly associated with actigraphic previous night WASO or subjective overall sleep quality.

DISCUSSION

Our prospective investigation of prenatal sleep behavior, depressive symptoms, and fatigue in the third trimester of pregnancy demonstrated that daily perceived fatigue severity was not only associated with previous nighttime sleep duration, but also daytime naps and depressive symptoms. Our data expand on existing literature by limiting the analyses to nulliparous women without diagnosed sleep and depressive disorders. We examined the time-dependent association by controlling for confounding variables (age, gestational weeks, BMI, and average working hours per week). We found no association between fatigue and sleep quality as measured either objectively by actigraphic WASO or subjectively by the PSQI. Our data provide both objective and subjective evidence and further support previous research on sleep disturbance in women during the last trimester of pregnancy.^{2,5}

To our knowledge, no literature exists on fatigue, daytime and nighttime sleep behavior, and depressive symptoms during the last three months of pregnancy. It is interesting to note that, unlike other studies,¹⁷ objective and subjective sleep quality was not significantly associated with fatigue. Rather, the total amount of sleep obtained the previous night was a significant predictor, suggesting the importance of nighttime sleep duration, and that daytime napping does not fully compensate for insufficient nighttime sleep. Our findings of an inverse association between fatigue and sleep duration obtained the previous

night are consistent with previous research documenting a negative correlation between fatigue and self-reported as well as nighttime sleep duration recorded with home polysomnography.^{16,18} The time-dependent association further suggests that fatigue the following day could be relieved by a longer sleep the previous night. The average women's habitual bedtime as reported from the PSQI in this study was past midnight but their rise time was confined due to work schedules. To dissipate daily accumulated fatigue, an earlier bedtime should be encouraged for pregnant women, especially employed pregnant women, to increase the possibility of obtaining sufficient nocturnal sleep.

Although the inconsistent associations between fatigue and nighttime sleep among studies may be explained by different methodologies and statistical approaches, it is worth noting that the average nighttime sleep duration in this study (6.5 h) was shorter than that of prior reports in pregnant women (7.1-7.8 h).^{6,17,37} The 6.5 hours of sleep found in our study was much lower than the 7.5-8 hours of sleep needed by the typical adult. The proportion of women sleeping less than 6 hours (28.9%) was also higher in this study than 15% reported by Lee and Gay using actigraphy in a sample of pregnant women with similar age and educational level. Mean WASO of 56.3 minutes found in our study was comparable to Lee and Gay's study, suggesting that women in our study had even poorer sleep quality.

That women's total nighttime sleep was constrained in our study may be explained by their late bedtime and the need to work in the morning. The average bedtime from the PSQI in this study was much later than a previous report of 10-11 pm in pregnant women.¹ The night-time sleep duration might have been even shorter than the value estimated by actigraphy, given that actigraphy has been shown to overestimate the total sleep time as compared with polysomnography.³⁸ Other researchers have also noted that sleep deprivation, defined as sleeping less than 6 hours per night, is a major concern, occurring in 21% of pregnant women during the third trimester of pregnancy.¹⁶ Our data suggest that sleep loss is a problem for a significant proportion of employed nulliparous women. The short sleep duration found in our study has important clinical implications because < 7 hours of sleep per night has been associated with gestational diabetes mellitus and < 6 hours of sleep per night has been associated with longer labors and cesarean deliveries.^{6,11} It will be imperative to investigate whether short sleep duration is a common pathway to both prenatal fatigue and these medical complications of pregnancy.

Ninety-five percent of the women in our study napped at least one day during the study week. This percentage was even higher than a recent survey that found that 80% of pregnant women across all trimesters nap.⁵ The frequency of daily and weekly napping recorded varied considerably in our study. The prevalence of napping in pregnant women was reported as increasing as pregnancy progressed.^{1,5} More naps were one of the strongest predictors of higher midday fatigue scores in our GEE models. Our study was not designed to determine a causal pathway. Whether midday fatigue contributes to napping or vice versa is still uncertain. Neau et al. reported that 95% of the daytime sleep reported by the pregnant women in their study was essentially a post-lunch nap, with 6% reporting a morning and a post-lunch nap, and 2% reporting only a morning nap. In their study, daytime sleep was reported refreshing for all women

regardless of napping frequency and trimester. Our speculation that fatigue at midday results in daytime naps awaits further research. Morning and evening fatigue levels reported by women in this study were comparable to the fatigue prospective findings of others.¹⁷ The pattern of increased perception of fatigue from dawn to dusk in our study was consistent across the seven days. These results further suggest that if daily fatigue is not ameliorated, there may be accumulated effect of fatigue on pregnant women. If napping can alleviate maternal fatigue, napping may be suggested by perinatal healthcare providers to attenuate fatigue during pregnancy.

Our results indicate that depressive symptoms are associated with fatigue scores reported across 24 hours, suggesting that depressive symptoms are important considerations when treating nulliparous women with fatigue. These results are consistent with Reeves et al., who reported a significant correlation between prenatal fatigue and depression. Using Records and Rice's depressive symptom prevalence rate of 38% during the third trimester of pregnancy,³⁹ CES-D scores ≥ 16 represent 23.6% of the sample in the current study. In Lindgren's study, the proportion of pregnant women scoring ≥ 16 on the CES-D was 44.4% for the total sample.⁴⁰ Our findings, along with prior reports, suggest that it is not uncommon for women to experience clinically significant depression symptoms during pregnancy. Fatigue has been identified as a multidimensional phenomenon.^{3,20,41} We are the first to provide empirical evidence suggesting that, in addition to focusing on increasing nighttime sleep duration, future interventions should aim to screen and reduce depressive symptoms to effectively alleviate fatigue in nulliparous women during the third trimester of pregnancy. Depressive symptoms during pregnancy likely share some psychological, physiological, and behavioral tendencies with fatigue and/or sleep disturbance, which may complicate the design and evaluation of intervention effect, as the association between depressive symptoms and fatigue and/or sleep disturbances may be bidirectional and thus affected by simultaneous causation and reverse causation.

This study has some limitations worth noting. First, our participants were a convenience sample and the majority of them were healthy, married, educated, employed nulliparous women, which restricts generalization of our results to a more diverse population. Second, our data on daytime napping were obtained from women's daily diaries rather than from objective recordings. We did not quantify naps using actigraphic records because many women napped during their daily commute. Third, despite the significant associations between midday fatigue and daytime naps, the direction of the causal relations cannot be determined. Neither did we know the duration, timing, and quality of the naps, nor did we know why the women napped such as napping to compensate for fatigue, napping to prepare for fatigue or simply because the women were habitual nappers prior to entering the study. Fourth, we excluded women who were diagnosed with sleep disorders such as sleep disordered breathing. These women may have worse sleep and more pronounced fatigue than other pregnant women.

In conclusion, our study provides empirical data about common symptoms from pregnant women including sleep disturbances and fatigue. Findings from this study suggest that interventions designed to increase sleep duration and decrease

depressive symptoms have the potential to prevent, ameliorate, or reduce fatigue in pregnant women. Perinatal health care professionals should stress the importance of an earlier bedtime and adequate amount of nighttime sleep to pregnant women to reduce fatigue and negative pregnancy outcomes. The benefit gained from a nap has been shown to be dependent on the sleep architecture of the nap.^{42,43} Future studies in pregnant women with polysomnography are needed to examine the influence of different timing, duration, and architecture of daytime naps on perceived fatigue severity throughout the day. More refined experimental strategies are required to clarify the possible interactive effect of sleep and depression on fatigue, and to develop explanatory and treatment models of fatigue during pregnancy.

ACKNOWLEDGMENTS

The authors thank research assistants, Shan-Shan Yang, Wen-Hsun Chang, and Jin-Hui Yang who assisted in data collection and the women who participated in this study. Performance site: National Taiwan University and National Taiwan University Hospital. This work was supported by National Science Council, Taiwan, NSC 99-2314-B-002-002.

DISCLOSURE STATEMENT

This was not an industry supported study. The authors have indicated no financial conflicts of interest.

REFERENCES

- Mindell JA, Jacobson BJ. Sleep disturbances during pregnancy. *J Obstet Gynecol Neonatal Nurs* 2000;29:590-7.
- Naud K, Ouellet A, Brown C, Pasquier JC, Moutquin JM. Is sleep disturbed in pregnancy? *J Obstet Gynaecol Can* 2010;32:28-34.
- Elek SM, Hudson DB, Fleck MO. Expectant parents' experience with fatigue and sleep during pregnancy. *Birth* 1997;24:49-54.
- Rodriguez A, Bohlin G, Lindmark G. Symptoms across pregnancy in relation to psychosocial and biomedical factors. *Acta Obstet Gynecol Scand* 2001;80:213-23.
- Neau JP, Texier B, Ingrand P. Sleep and vigilance disorders in pregnancy. *Eur Neurol* 2009;62:23-9.
- Lee KA, Gay CL. Sleep in late pregnancy predicts length of labor and type of delivery. *Am J Obstet Gynecol* 2004;191:2041-6.
- Beebe KR, Lee KA. Sleep disturbance in late pregnancy and early labor. *J Perinat Neonatal Nurs* 2007;21:103-8.
- Wilkie G, Shapiro CM. Sleep deprivation and the postnatal blues. *J Psychosom Res* 1992;36:309-16.
- Chien LY, Ko YL. Fatigue during pregnancy predicts caesarean deliveries. *J Adv Nurs* 2004;45:487-94.
- Williams MA, Miller RS, Qiu C, Cripe SM, Gelaye B, Enquobahrie D. Associations of early pregnancy sleep duration with trimester-specific blood pressures and hypertensive disorders in pregnancy. *Sleep* 2010;33:1363-71.
- Facco FL, Grobman WA, Kramer J, Ho KH, Zee PC. Self-reported short sleep duration and frequent snoring in pregnancy: impact on glucose metabolism. *Am J Obstet Gynecol* 2010;203:142 e1-5.
- Chang JJ, Pien GW, Duntley SP, Macones GA. Sleep deprivation during pregnancy and maternal and fetal outcomes: is there a relationship? *Sleep Med Rev* 2010;14:107-14.
- Beddoe AE, Lee KA, Weiss SJ, Kennedy HP, Yang CP. Effects of mindful yoga on sleep in pregnant women: a pilot study. *Biol Res Nurs* 2010;11:363-70.
- Signal TL, Gander PH, Sangalli MR, Travier N, Firestone RT, Tuohy JF. Sleep duration and quality in healthy nulliparous and multiparous women across pregnancy and post-partum. *Aust N Z J Obstet Gynaecol* 2007;47:16-22.
- Lee KA, Zaffke ME, McEnany G. Parity and sleep patterns during and after pregnancy. *Obstet Gynecol* 2000;95:14-8.
- Hall WA, Hauck YL, Carty EM, Hutton EK, Fenwick J, Stoll K. Child-birth fear, anxiety, fatigue, and sleep deprivation in pregnant women. *J Obstet Gynecol Neonatal Nurs* 2009;38:567-76.
- Gay CL, Lee KA, Lee SY. Sleep patterns and fatigue in new mothers and fathers. *Biol Res Nurs* 2004;5:311-8.
- Lee KA, Zaffke ME. Longitudinal changes in fatigue and energy during pregnancy and the postpartum period. *J Obstet Gynecol Neonatal Nurs* 1999;28:183-91.
- Milner CE, Cote KA. Benefits of napping in healthy adults: impact of nap length, time of day, age, and experience with napping. *J Sleep Res* 2009;18:272-81.
- Lee KA. Sleep and fatigue. *Annu Rev Nurs Res* 2001;19:249-73.
- Reeves N, Potempa K, Gallo A. Fatigue in early pregnancy. An exploratory study. *J Nurse Midwifery* 1991;36:303-9.
- Buyssse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Res* 1989;28:193-213.
- Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. *Appl Psychol Meas* 1977;1:385-401.
- Morgenthaler T, Alessi C, Friedman L, et al. Practice parameters for the use of actigraphy in the assessment of sleep and sleep disorders: an update for 2007. *Sleep* 2007;30:519-29.
- Oakley NR. Validation with polysomnography of the Sleepwatch sleep/wake scoring algorithm used by the Actiwatch activity monitoring system. Bend, OR: Mini Mitter Co. Inc.; 1997.
- Kushida CA, Chang A, Gadkary C, Guilleminault C, Carrillo O, Dement WC. Comparison of actigraphic, polysomnographic, and subjective assessment of sleep parameters in sleep-disordered patients. *Sleep Med* 2001;2:389-96.
- Cole RJ, Kripke DF, Gruen W, Mullaney DJ, Gillin JC. Automatic sleep/wake identification from wrist activity. *Sleep* 1992;15:461-9.
- Lee KA, Hicks G, Nino-Murcia G. Validity and reliability of a scale to assess fatigue. *Psychiatry Res* 1991;36:291-8.
- Lee SY, Lee KA. Early postpartum sleep and fatigue for mothers after cesarean delivery compared with vaginal delivery: an exploratory study. *J Perinat Neonatal Nurs* 2007;21:109-13.
- Buyssse DJ, Reynolds CF 3rd, Monk TH, Hoch CC, Yeager AL, Kupfer DJ. Quantification of subjective sleep quality in healthy elderly men and women using the Pittsburgh Sleep Quality Index (PSQI). *Sleep* 1991;14:331-8.
- Tsai PS, Wang SY, Wang MY, et al. Psychometric evaluation of the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI) in primary insomnia and control subjects. *Qual Life Res* 2005;14:1943-52.
- Lee KA, McEnany G, Zaffke ME. REM sleep and mood state in child-bearing women: sleepy or weepy? *Sleep* 2000;23:877-85.
- Goyal D, Gay C, Lee K. Fragmented maternal sleep is more strongly correlated with depressive symptoms than infant temperament at three months postpartum. *Arch Womens Ment Health* 2009;12:229-37.
- Chien CP, Cheng TA. Depression in Taiwan: epidemiological survey utilizing CES-D. *Seishin Shinkeigaku Zasshi* 1985;87:335-8.
- Tang ST, Li CY, Liao YC. Factors associated with depressive distress among Taiwanese family caregivers of cancer patients at the end of life. *Palliat Med* 2007;21:249-57.
- Zeger SL, Liang KY. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 1986;42:121-30.
- Hedman C, Pohjasvaara T, Tolonen U, Suhonen-Malm AS, Myllyla VV. Effects of pregnancy on mothers' sleep. *Sleep Med* 2002;3:37-42.
- de Souza L, Benedito-Silva AA, Pires ML, Poyares D, Tufik S, Calil HM. Further validation of actigraphy for sleep studies. *Sleep* 2003;26:81-5.
- Records K, Rice M. Psychosocial correlates of depression symptoms during the third trimester of pregnancy. *J Obstet Gynecol Neonatal Nurs* 2007;36:231-42.
- Lindgren K. Relationships among maternal-fetal attachment, prenatal depression, and health practices in pregnancy. *Res Nurs Health* 2001;24:203-17.
- Pugh LC, Milligan R. A framework for the study of childbearing fatigue. *ANS Adv Nurs Sci* 1993;15:60-70.
- Tucker MA, Hirota Y, Wamsley EJ, Lau H, Chaklader A, Fishbein W. A daytime nap containing solely non-REM sleep enhances declarative but not procedural memory. *Neurobiol Learn Mem* 2006;86:241-7.
- Hayashi M, Motoyoshi N, Hori T. Recuperative power of a short daytime nap with or without stage 2 sleep. *Sleep* 2005;28:829-36.