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Sleep Quality in Women with and without Postpartum Depression

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Abstract

Objective—To compare and measure the effects of sleep quality on women with and without postpartum depression (PPD).

Design—A case-control repeated measures matched pairs design.

Setting—Home and obstetric office.

Participants—Forty-six women who were 6 to 26 weeks postpartum. Two participants were dropped from the final analysis because they were outliers.

Methods—Participants underwent wrist actigraphy at home for 7 consecutive days to measure sleep quality (sleep latency, wake after sleep onset, sleep efficiency, wake episodes). The Postpartum Depression Screening Scale measured depression severity. Psychosocial variables were collected during a screening interview. A structured clinical interview was used to diagnose PPD. Correlations, t-tests, and hierarchical multiple regressions were run to analyze data.

Results—With the exception of wake episodes, sleep latency ($B = 1.80$, S.E. = 0.73, $P<0.05$), wake after sleep onset ($B = 6.85$, S.E. = 2.85, $P<0.05$), and thus sleep efficiency ($B = -6.31$, S.E. = 3.13, $P<0.05$) predicted PPD symptom severity.

Conclusions—Women with PPD experienced poorer sleep quality than women without PPD, and sleep quality worsened with increasing PPD symptom severity. Clinicians need to address measures to improve sleep quality in depressed mothers to decrease symptom severity, and researchers need to develop interventions to facilitate better sleep quality in women with PPD.

Keywords

Sleep quality; postpartum depression; wrist actigraphy

Callouts:

1. In women with postpartum depression, nighttime breastfeeding demands, high-needs infants, and little nighttime support may negatively impact on sleep quality and further exacerbate depressive symptoms.
2. Women with PPD experienced poorer sleep quality than women without PPD, and sleep quality worsened with increasing PPD symptom severity.
3. Because poor sleep quality may negatively impact on PPD symptom severity, clinicians need to address measures to improve sleep quality and minimize nighttime sleep interruptions.

Women are vulnerable to poor sleep quality in part because of dramatic hormonal fluctuations occurring during the reproductive cycle (Soares & Murray, 2006). Reproductive hormones,

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especially estrogen and progesterone mediate neurotransmitter levels in the brain responsible for maintaining the quality of sleep. Immediately after childbirth, precipitous decreases in estrogen and progesterone precipitate sleep disturbances in most women including difficulty initiating and maintaining sleep even in the absence of infant care (Lee, McEnany, & Zaffke, 2000). Postpartum women experience less total sleep time, less sleep efficiency (time asleep vs. time in bed), and decreased time to rapid eye movement (REM) compared to non-postpartum women. In spite of being biologically programmed to be awake during the day and sleepy at night, new mothers normally experience less sleep and a 20% increase in wake time during the first 6 weeks postpartum (Goyal, Gay, & Lee, 2007). Because the same neurotransmitters that mediate sleep quality also mediate mood, poor sleep quality with accompanying neurotransmitter imbalance has also been linked to an increased prevalence of psychiatric disorders during the postpartum period including postpartum depression (PPD) (Ross, Murray, & Steiner, 2005).

In women with PPD, nighttime breastfeeding demands, high-needs infants, and little nighttime support may negatively impact on sleep quality and further exacerbate depressive symptoms (Huang, Carter, & Guo, 2004; Wolfson, Crowley, Anwer, & Bassett, 2003). Poor sleep quality among women with PPD may compromise performance of critical maternal activities to insure infant safety such as concentration, reaction time, and decision-making (Bernstein et al., 2006). Because infants generally entrain to maternal circadian rhythms, infants of depressed mothers may also experience poor sleep quality, which may further exacerbate maternal depressive symptoms (Hiscock & Wake, 2001). Few studies, however, have examined sleep quality with objective sleep measures in women diagnosed with PPD.

CALLOUT 1

Sleep Quality

Poor sleep quality and major depression have a bi-directional relationship: poor sleep quality is a major risk factor for the onset of depression, and depression is a major risk factor for the onset of poor sleep quality (Lustberg & Reynolds, 2000). Several postpartum studies suggest that women with depressive symptoms experience poorer sleep quality, less total sleep time, longer sleep latency (take more time to fall asleep), and experience more sleep disturbance, while women without depressive symptoms sleep more efficiently and adjust to postpartum sleep disturbance (Da Costa, Dritsa, Rippen, Lowensteyn, & Khalife, 2006; Dennis & Ross, 2005; Goyal, Gay, & Lee, 2007; Hiscock & Wake, 2001; Huang et al., 2004; Wulff & Siegmund, 2000).

A few studies have measured sleep quality in the general postpartum population with objective measures such as actigraphy and polysomnography. In a longitudinal descriptive study of 28 postpartum women using ambulatory polysomnography and self-report measures, Lee, McEnany, and Zaffke (2000) found that participants who experienced depressive symptoms also experienced 80 minutes less total sleep time, shorter REM latency, and less time spent in REM sleep compared to the women who did not experience depressive symptoms. In another sleep study of 124 women using self-report measures, participants who reported symptoms of depression also had difficulty falling asleep, woke earlier, and reported more daytime sleepiness (Goyal, Gay, & Lee, 2007). Although these studies provide a rich knowledge base on the relationship of sleep quality and postpartum mood, none of the studies used structured clinical interviews to diagnose PPD, few used objective measures of sleep quality, and most of the studies were conducted with non-depressed postpartum women. The relationships between poor sleep quality and PPD remain unknown. The findings of these studies draw attention to the need to evaluate sleep quality in women diagnosed with PPD using objective measures and a structured clinical interview for depression.

Postpartum depression

Postpartum depression (PPD) affects 6.5% to 12.9% of all childbearing women (Gaynes et al., 2005) and up to 49.9% of indigent women (Mayberry, Horowitz, & Declercq, 2007). Diagnosis of PPD depends on the persistent presence of a sad mood or decreased interest plus 5 or more symptoms including changes in weight or appetite, sleep disturbance, feelings of anxiety, irritability, altered psychomotor activity, decreased energy, poor concentration, poor self-worth, or suicidal or homicidal ideation (including recurrent thoughts about harming themselves or their infants) (American Psychiatric Association, 2000). Postpartum depression may also affect family planning decisions and negatively impact on mother-infant relationships. Symptoms may start as early as 2 weeks and as late as one year, but usually peak between 6 and 12 weeks postpartum. Depressive symptoms have been reported to last up to 2 years postpartum (Mayberry, Horowitz, & Declercq, 2007).

The most prevalent risk factors for PPD include antepartum depression, personal psychiatric history, family psychiatric history, poor social support, and poverty (Forty et al., 2006; Logsdon & Usui, 2001). Up to 45% of women with antepartum depression develop PPD (Josefsson, Berg, Nordin, & Sydsjo, 2001). The effects of PPD may have serious consequences including cognitive, emotional, and behavioral deficits in children through adulthood; increased risks for chronic, recurrent and treatment-resistant depression; suicide; infanticide; and poor maternal performance of preventive health-care and safety practices for children (Austin, Kildea, & Sullivan, 2007; Chung, McCollum, Elo, Lee, & Culhane, 2004; Horwitz, Briggs-Gowan, Storfer-Isser, & Carter, 2007; Minkovitz et al., 2005; Spinelli, 2005).

Specific Aims

Given the seriousness of the long-term consequences and these gaps in knowledge, the aims of this study were to (1) determine the differences in sleep quality, using wrist actigraphy, between women diagnosed with PPD and women without PPD, using a structured clinical interview for depression, and (2) measure the effects of sleep quality using actigraphy on PPD symptom severity. The research questions guiding the study were: (1) What are the differences in sleep quality measures between women with and without PPD? (2) What is the effect of sleep quality (wake after sleep onset, sleep latency, sleep efficiency, and wake time), as measured by actigraphy, on PPD symptom severity as measured by the Postpartum Depression Screening Scale?

Methods

Design—Data from a convenience sample of 46 women (23 with and 23 without PPD) who were 6 to 26 weeks postpartum were collected and analyzed using a case-control repeated measures matched pairs design. Participants were matched on variables that could affect sleep quality including type of delivery, weeks postpartum, and parity, because lower sleep quality levels have been reported in women who had a cesarean section vs. vaginal delivery, were early postpartum (one week) vs. late postpartum (15 weeks), and were primigravidas vs. multiparas (Kang et al., 2002; Lee et al., 2000; Lee & Lee, 2007). This design method was chosen because case-control matches depressed with non-depressed women, repeated measures helps to assure more consistent comparison of results over the time that data is being collected, and matched pairs eliminates group differences that could affect sleep quality.

Sample and Recruitment—The participants were recruited from one suburban midwifery practice, and two obstetric practices in the northeastern United States from 2004 to 2005 via brochures and posters placed in office waiting rooms. Institutional review board (IRB) approval was obtained prior to initiation of the study. Once potential participants informed their healthcare providers of their interest in the study, healthcare providers gave potential participant contact information to the primary investigator (PI). The PI then called potential

participants to explain the details and invite participation. Recruitment was designed so that an equal number of depressed and non-depressed women would be chosen to participate in the study. Although potential participants informed their healthcare providers of their interest in the study, it is unknown how many women actually saw the brochures and posters and decided not to participate.

A screening tool designed for this study was used to determine eligibility for participation. Eligible participants were 6 to 26 weeks postpartum, were 18 to 44 years old, had a singleton birth vaginally or operatively, were English-speaking, and had access to a telephone. The range of 6 to 26 weeks was chosen because many women are diagnosed with PPD after the 6-week check-up (Stowe, 2005). The PI conservatively chose 26 weeks as a cut-off to avoid confusion of PPD with non-postpartum related major depression. An informal survey of providers in the practices found that women beyond 6 weeks postpartum may come to the obstetric office for a variety of reasons such as late postpartum follow-up, pap smears, and breast or vaginal infections, and would therefore have the opportunity to see the brochures and posters advertising the PPD study. Exclusion criteria included any disabling medical illnesses, long-term infant complications (beyond 6 weeks postpartum), ongoing physical or sexual abuse, ongoing substance abuse or dependence, and traumatic life experiences (e.g. death of spouse, loss of home, victim of violence) occurring within one year of childbirth.

The sample size for the original study, which measured the differences in sleep quality and functional status between women with and without PPD, was determined by power analysis on the functional status portion using SamplePower 2.0 (SPSS, Inc., Chicago, Ill.). Based on the current findings of sleep quality in this study, a post hoc power analysis was performed with Power and Precision™ 2.0 (Biostat, Inc., Englewood, NJ). Using an alpha of 0.05, a power of 0.80 for hierarchical multiple regression analysis with 3 covariates in the first step, 4 primary variables in the second step, the change in R^2 of 0.32 found in the first step, and the change in R^2 of 0.20 found in the second step, a total sample size of 40 was required. Thus the current study was sufficiently powered by using a total final sample size of 44.

Instruments—In the general population, most studies use a structured clinical interview as well as a depression severity scale in order to provide a comprehensive measure of depression. (Lee et al., 2003; Strik, Honig, Lousberg, & Denollet, 2001). Structured clinical interviews determine whether or not participants meet criteria for depression, and the severity scales measure the degree of depression.

The structured clinical interview used in this study was the MINI Neuropsychiatric Interview (MINI) (Sheehan et al., 1998), a 15-minute version of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) (American Psychiatric Association, 2000). The results of the MINI determine if participants meet criteria for major depression, dysthymia, bipolar I and II disorder, panic disorder, agoraphobia, social phobia, generalized anxiety, obsessive-compulsive disorder, psychosis, alcohol dependence, drug dependence, anorexia, bulimia, and posttraumatic stress disorder. Test-retest Kappa statistics for the MINI have been reported as > 0.60 (Sheehan et al., 1998). Comparing general practitioners to expert psychiatrists, inter-rater reliability was 0.85. The MINI has been used in several studies of women with PPD (Adewuya, Ola, Dada, & Fasoto, 2006; Agoub, Moussaoui, & Battas, 2005). The primary investigator (PI), an advanced practice psychiatric nurse with more than 20 years experience in administering structured clinical interviews, administered the MINI to all participants to determine if they met diagnostic criteria for PPD. Based on the results of the MINI, the PI assigned participants to depressed or non-depressed groups.

The severity scale used in this study was the Postpartum Depression Screening Scale (PDSS) (Beck & Gable, 2002), a 35-item self-rated scale with scores ranging from 35 to 175. Higher

scores indicate greater PPD severity. Scores of 35 to 39 are considered normal adjustment, 60 to 79 indicate mild to moderate symptoms of postpartum depression, and scores of 80 to 175 indicate a positive screen for major postpartum depression. The alpha reliability for the entire scale in prior studies ranged from 0.93 to 0.98. (Rychnovsky & Beck, 2006).The alpha reliabilities for the 7 subscales of the PDSS were reported as 0.76 for Sleeping and Eating Disturbance (SLP); 0.86 for Anxiety and Insecurity (ANX); 0.91 for Emotional Lability (ELB); 0.94 for Mental Confusion (MNT); 0.95 for Loss of Self (LOS); 0.92 for Guilt and Shame (GLT); and 0.94 for Suicidal Thoughts (SUI) (Beck & Gable, 2002).

Sleep quality was measured using the Basic Octagonal Motionlogger® wrist actigraph (Ambulatory Monitoring, Inc., Ardsley NY). Wrist actigraphy measured maternal motor activity levels by an internal accelerometer (Korte, Wulff, Oppe, & Siegmund, 2001). Actigraphy has been used to measure sleep wake activity in several studies of postpartum women (Doan, Gardiner, Gay, & Lee, 2007; Gay, Lee, & Lee, 2004; Kang, Matsumoto, Shinkoda, Mishima, & Seo, 2002; Lee & Lee, 2007; Matsumoto, Shinkoda, Kang, & Seo, 2003; Shinkoda, Matsumoto, & Park, 1999; Signal et al., 2007; Stremler et al., 2006). One of these studies reported that concordance between wrist actigraphy and polysomnography, the gold standard for sleep/wake brain activity was 96.3% (Kang, Matsumoto, Shinkoda, Mishima, & Seo, 2002). Actigraphy has also been used in patients with major depression, and has been used to discriminate motor activity and sleep quality between depressed and non-depressed participants in the general population (Caligiuri & Ellwanger, 2000; Jean-Louis et al., 2000; Sadeh & Acebo, 2002; Teicher, 1995; Volkers, 2003).

Action-W Version 2 software® (Ambulatory Monitoring, Inc., Ardsley NY) was used to calculate sleep quality measures including sleep latency, wake after sleep onset, wake episodes, and overall sleep efficiency. Sleep latency measures the time in minutes it takes to fall asleep, and wake after sleep onset (WASO) is defined as the number of minutes spent awake divided by the number of minutes asleep (excluding sleep latency) multiplied by 100. Sleep efficiency is defined as sleep latency plus wake after sleep onset, and is calculated as the number of sleep minutes divided by the number of minutes in bed multiplied by 100. Wake episodes consist of the number of contiguous blocks of one-minute wake epochs. Estimation of sleep minutes, time in bed, sleep onset, sleep offset, wake minutes, and wake epochs was accomplished by the Cole-Kripke algorithm within the Action-W Version 2 software® When a participant removes the wrist actigraphy, for example, for bathing, no data is collected and there is no actigraphy tracing for that interval of time. This period of time where no data tracing occurs was entered as “bad” data in the Action-W Version 2 software® and was subsequently deleted from motor activity calculations. Because previous empirical studies found that participants often underestimate sleep disturbance and overestimate sleep time in activity logs, manual scoring of sleep time was performed as recommended by Mullaney, Kripke, and Messin (1980). Manual scoring involves visual comparison of onset and offset of sleep times as recorded by participants in activity logs compared to actigraphy graph printouts.

Participants were asked to fill out an activity log on a daily basis during the data collection week. The activity log was adapted from the activity log developed by researchers at the Clinical Research Center for Sleep at the University of Pennsylvania. Information elicited in the log included the time of getting into bed, falling asleep, awakenings by the infant, morning awakenings, getting out of bed in the morning, caffeine intake, medication intake, and illness occurrence. Participants were instructed to try to distinguish the time of getting into bed from the time they actually fell asleep to the best of their abilities, and to record both times in their activity logs.

Sample demographics collected included age, race, income, employment (yes, no), educational level, living with partner (yes, no), parity (primiparous, multiparous), type of birth (vaginal,

cesarean), number of weeks postpartum, 6-week maternity leave (yes, no), current activity restrictions (yes, no), infant gender, number of nighttime infant awakenings, infant sleeping > 4 hours per night (yes, no), type of feeding (breast, bottle), experience caring for infants (yes, no), practical help in general and from mother and partner(yes, no), and type of help (children, housework, cooking errands – yes, no).

Data Collection Procedure—Interview data were collected in two 30-minute sessions one week apart. The PI obtained informed consents, administered the screening and demographic questionnaires, and established the PPD/non-PPD diagnosis with the MINI during the first interview. Depression severity was assessed during the second 30-minute interview session using the Postpartum Depression Screening Scale (PDSS) (Beck & Gable, 2002). The PI filled out the questionnaires in order to minimize the occurrence of missing data. All participants who met diagnostic criteria for depression were provided with referrals to local hospital services and psychotherapists for counseling after the MINI was administered and scored. Once the diagnosis of depression was established, participants were assigned to the PPD group while those participants without depression were assigned to the non-depressed group.

The Basic Octagonal Motionlogger® wrist actigraph was placed on the non-dominant wrist of the participant during the first 30-minute interview. Participants wore the wrist actigraph continuously for 7 days except for bathing, and filled out their activity logs everyday during the data collection week. In order to minimize missing data, the research staff also telephoned the participants on a daily basis to remind them to fill out the activity logs and to answer any technical questions. Participants were paid $10 for their participation in the study.

Data Analysis—Data were coded, verified, cleaned, and assessed for outliers and shape of distribution. Descriptive statistics and t-tests were run, and correlation matrixes were constructed for all variables. The research questions were tested using hierarchical multiple regressions for PPD, controlling for infant gender, income, and number of nighttime infant awakenings, with covariates entered simultaneously at the first step followed by individual sleep quality measures (sleep latency, wake after sleep onset, sleep efficiency, and wake episodes) at the second step. The covariates were chosen because previous research findings have emphasized that having a male infant, lower income level and nighttime sleep disturbance could affect depression or sleep quality (Hay, 1997; Howell, Mora, Horowitz, & Leventhal, 2005; Krystal, 2007; Tronick & Weinberg, 1997).

In order to obtain participant response accuracy, an *inconsistent responding index* (INC) is recommended by the authors of the PDSS (Beck & Gable, 2002). The INC is calculated by pairing 10 sets of similar questions. If 4 or more response pairs differ by two or more points, the INC is considered elevated, and thus may not reflect an accurate emotional state. Reasons given for an elevated INC score are a lack of proficiency in English, poor concentration related to depression, or difficulty following directions.

Additional analyses compared sleep quality among the subgroup of women with PPD who did and did not take antidepressants, and who did and did not participate in psychotherapy to determine whether or not they had any effect on sleep quality. A χ^2 test was also run to assess for differences in proportions of maternal characteristics by PPD severity (PDSS score). This additional information was obtained because it could potentially impact on sleep quality results.

Results

Demographics—Among the 71 women who initially responded to the brochures and posters in the waiting rooms, 23.9% (n = 17) declined participation once they were informed of the study details. Out of the remaining 54 women, 46 completed the study. Those who declined participation did not complete a screening questionnaire, demographic questionnaire, or a

structured interview for depression, so it is unknown whether they met inclusion criteria, their demographic makeup, or their PPD status. Among women who consented for the study, 5 women with PPD withdrew because they did not want a PPD diagnosis or because they felt too burdened by the demands of the study. In addition, 3 women from the non-depressed group had non-functioning actigraphs, leaving a remainder of 46 women who completed the study (14.8% attrition). Those women who completed the study had a mean of 25 days more overall help with infants, children, cooking, and running errands ($p<0.001$) and a mean of 35 days more help from partners ($p<0.001$) than those who did not complete the study. There were no significant differences in the presence of PPD between those who did or did not complete the study.

Because two additional participants were found to be outliers (more than 2 standard deviations from the mean) on sleep quality measures, their data was excluded from the final data analysis, which left a total of 44 participants (22 with PPD, 22 without PPD). The first participant was not depressed, but had higher wake after sleep onset compared to the other non-depressed participants (21.2 vs. 11.1, std. dev. 4.3) that affected her overall sleep efficiency (78.0 vs. 89.7, std. dev. 4.0). Closer examination of her data revealed that she was substantially older (40 yrs vs. mean 31 yrs, std. dev. 4.45) than the other non-depressed participants. The second participant was diagnosed with PPD and had significantly lower waking after sleep onset (2.5 vs. 15.1, std. dev. 5.8) compared to the other depressed participants. In this case, this participant had substantially more nighttime help (168 days vs. mean of 41 days, std. dev. 41.4), and was significantly more weeks postpartum (24 weeks vs. mean 10.4 weeks postpartum, std. dev. 5.8) compared to the other depressed participants.

Most of the participants were highly educated Caucasian women who lived with their partners (Table 1). Most of the women were employed and had taken at least a 6-week maternity leave. The majority of the sample was between 6 and 13 weeks postpartum, multiparous, and had experienced a vaginal birth. Most of the mothers breastfed their infants and had help from their partners and mothers including practical help with the infant, other children, housework, cooking, and errands. None of the participants reported any restrictions on their activities at the time of the interview. Compared to women without PPD, women with PPD had significantly more male infants ($p < 0.001$), significantly more nighttime infant awakenings ($p < 0.05$), and had a non-significant trend of having more help with infant care, cooking, and running errands compared to women without PPD (Table 2).

Psychiatric Variables—Using the MINI neuropsychiatric interview (Sheehan et al., 1998), 23 women were diagnosed with PPD, and 23 women did not have any symptoms of major, minor or subsyndromal depression. Mean PDSS scores were significantly higher for women with PPD compared to women without PPD (95.38 vs. 45.34, $p < 0.001$) out of a maximum score of 175 (Table 3). Participants with PDSS scores ≥ 80 (major postpartum depression) had more personal histories of depression than women who scored < 80 ($\chi^2 = 21.40$, $p < 0.001$) (Table 4). No other differences were found in demographics by PDSS score. Women with PPD had significantly more personal psychiatric histories ($p < 0.001$), family psychiatric histories ($p < 0.001$), more history of psychotherapy ($p < 0.05$), more history of antidepressant use ($p < 0.001$), more anxiety ($p < 0.05$), more life stress ($p < 0.001$), and more suicidal thoughts ($p < 0.05$) compared to women without PPD (Table 3). At the time of the interview, 11 women with PPD were taking antidepressants, and 5 were participating in psychotherapy. Three women with PPD were taking antidepressants concurrently with participation in psychotherapy.

Analysis of Research Questions—Research question 1: Using t-test comparison, women with PPD had poorer sleep quality (more wake after sleep onset, $p < 0.05$, and lower sleep efficiency, $p < 0.05$) than women without PPD (Table 3). Research question 2: In multiple

hierarchical regression analysis, poor sleep quality significantly predicted increased PPD symptom severity (Table 5). Women with PPD had longer sleep latency ($p < 0.05$), more wake after sleep onset ($p < 0.05$), and thus a lower sleep efficiency ($p < 0.05$) than women without PPD (Table 5).

Additional Analyses—Although there were significant differences between women with and without PPD on sleep quality measures, there were no significant differences in sleep quality within the subgroup of women with PPD who did ($n = 12$) or did not ($n = 11$) take antidepressants or who did ($n = 5$) or did not ($n = 17$) participate in psychotherapy. More women in the depressed group than the non-depressed group failed to accurately fill out their activity logs compared to wrist actigraphy measures ($p < 0.05$). Specifically, 43% of women with PPD did not record up to 6 nighttime awakenings, while 35% of non-depressed women did not record logging up to 5 nighttime awakenings compared to actigraphy recordings.

Instrument reliability—The Cronbach's alpha for MINI Neuropsychiatric Interview for this study was 0.78. Alpha reliability for motor activity measured by wrist actigraphy was 0.94. Cronbach's alpha for the entire PDSS was 0.97. In this study PDSS subscale alpha reliabilities were: Sleeping and Eating (0.84), Anxiety and Insecurity (0.80), Emotional Lability (0.88), Mental Confusion (0.93), Loss of Self (0.93), Guilt and Shame (0.93), and Suicidal Thoughts (0.86). Three women with PPD had an INC score of 4 and one woman with PPD had a score of 5. A correlation between the INC score and PPD severity found that INC increased with PPD severity. The results, however, need to be viewed with caution since there was a small subsample that scored ≥ 4 on the INC. Although the PDSS may not have reflected an accurate emotional state in these depressed women, they were retained in the study because they met the criteria of major depression in the structured interview.

Discussion

Women with PPD experienced poorer sleep quality compared to women without PPD. Worsening sleep quality (sleep latency, wake after sleep onset, sleep efficiency) also predicted PPD symptom severity. Thus poor sleep quality may have a significant negative impact on the severity of depressive symptoms in women with PPD. Results are similar to findings in the general population where more depressed patients (90%) experienced poor sleep quality compared to non-depressed patients, and over the long term, poor sleep quality increased risk for recurrence and relapse of depression, and risk of suicide (Holsboer-Trachsler & Seifritz, 2000). In an early classic study using polysomnography, Karacan et al (1969) found non-depressed postpartum women experienced increased stage 4 sleep (deep restorative stage) with a concomitant decrease in total sleep time, indicating that these postpartum women were sleeping more efficiently despite nighttime sleep disturbance related to infant care. The study also suggested that women who experienced poor sleep efficiency would be more likely to develop postpartum depression. Findings also support recent studies in which women with depressive symptoms self-reported longer sleep latency and more wake after sleep onset, resulting in a lower sleep efficiency and overall poor sleep quality compared to women without depressive symptoms (Da Costa et al., 2006; Goyal et al., 2007; Huang et al., 2004). Thus data in this study, based on objective measures of sleep quality (wrist actigraphy), supports previous studies that used subjective measures of sleep quality (self-report) in women diagnosed with PPD.

CALLOUT 2

Women with PPD had significantly higher mean scores on the PDSS than women without PPD ($p < 0.001$). Additional analysis found that women with a score of ≥ 80 on the PDSS had significantly more personal histories of depression than women scoring < 80 on the PDSS

(χ^2= 21.40, p < 0.001). These results support the findings by Mancini, Carlson, and Albers (2007) who also found that women with a score of ≥ 80 on the PDSS have significantly more personal histories of depression than women scoring < 80 on the PDSS. Unlike the Mancini study, however, the current study did not find any significant differences in "non-breastfeeding" and "less than a high school education" variables between women who scored ≥ 80 and those who scored < 80 on the PDSS. The differences may be due to having very few non-breastfeeding mothers (*n* = 8) and very few participants with less than a high school education (*n* = 1) in the current study.

The findings of more family and personal psychiatric histories, and more life stress in women with PPD, supports previous findings in studies of women with postpartum depression (Dennis & Ross, 2006; Forty et al., 2006; Horowitz, Damato, Duffy, & Solon, 2005). In a study of concordance of PPD between 120 pairs of sisters, Forty et al., (2006) found that 42% shared a history of PPD, which highlights the importance of assessing family history. Webster et al., (2000) found in a prospective study of 600 women with risk factors for PPD, and 301 women without risk factors, that personal psychiatric history and previous history of PPD significantly predicted PPD (p < 0.001). Life stress was found to be a significant predictor of PPD in a longitudinal study of 594 women at one, four and eight weeks postpartum (Dennis & Ross, 2006).

The findings that women with PPD had significantly more male infants and more nighttime infant awakenings supports previous studies on mother-infant dyads where this association was found (Tronick & Weinberg, 1997; Hay, 1997). According to this research, male infants have more immature cerebral hemispheres than female infants, which results in more disorganized emotional regulation, and heightened positive and negative affect. Male infants were found to be more emotionally demanding, more mother-focused, and have more nighttime awakenings. Although the results of the current study need to be viewed with caution because of the small sample size, clinicians need to be aware of this possible association in order to help women plan for the increased demands and nighttime sleep interruptions related to having a male infant.

The non-significant findings of having more help with other children, cooking, and running errands, and more help from partners and mothers of women with PPD runs counter to prior research where an inverse relationship was found between social support and PPD (Surkan, Peterson, Hughes, & Gottlieb, 2006). This finding may have reflected measurement error by depressed participants, or the study may not have had sufficient power to detect an accurate relationship between PPD and social support. Repeating the current study with a larger study sample may be warranted to fully explore this relationship.

Women with PPD significantly underestimated nighttime awakenings in their activity logs compared to actigraphy from women without PPD, supporting the research of Horiuchi and Nishihara (1999), and Kang (2002). In addition, four women with PPD had INC scores ≥ 4 on the PDSS. Both of these findings may have resulted from decreased cognition and concentration associated with depression. Decreased maternal concentration may negatively impact on maternal ability to provide a safe environment for the infant or other domains of maternal functioning such as household and social activities, activities of daily living, personal healthcare practices, and occupational functioning, but further research is needed to corroborate these results in women with PPD.

When the effects of antidepressants and psychotherapy on sleep quality measures were examined there were no significant differences. Because the number of women with PPD who took antidepressants (*n* = 11) and participated in psychotherapy (*n* = 5) was small, sufficient

power may have been lacking to detect any differences. Further research with larger samples is warranted in order to inform future sleep quality research on women with PPD.

The outliers in this study call attention to other factors which may affect sleep quality. The first outlier was a non-depressed 40 year old mother who was more than two standard deviations higher in wake after sleep onset than the other non-depressed women. Because sleep quality normally declines with increasing age in the general population (Espiritu, 2008), further research is needed to explore the relationship of sleep quality and PPD in older mothers. The second outlier was a depressed mother who was found to be more than 3 standard deviations higher than the mean on infant care support, more than 2 standard deviations higher than the mean on the number of weeks postpartum, and was more than 2 standard deviations lower on wake after sleep onset than others in the depressed group. Additional research is needed to explore the relationship between PPD, number of weeks postpartum, infant care support, and both lower and higher waking after sleep onset (WASO).

Limitations and strengths

The strengths of this study include use of a structured clinical interview to diagnose PPD, a measure for depression severity, an objective measure to examine sleep quality, and data collection in a natural setting (home). The limitations of a small sample size may fail to detect differences in wake episodes when there may actually be an effect (Type II error). Although women with PPD may have underestimated nighttime awakenings, actigraphy may have overestimated activity due to restless sleep. Actigraphy may also have underestimated activity if the participants were awake but motionless. Low correlation between actigraphy and polysomnography in participants with major depression in the general population suggests that future research should consider using the gold standard polysomnography in the home setting to increase confidence in results. However, women with PPD may be less likely to participate in a study with more equipment burden. In addition, Jean-Louis et al., (2000) stated that wrist actigraphy is preferred in the home setting because it is less stressful and expensive. Women in the depressed group also underestimated nighttime awakenings in activity logs when compared to actigraphy; thus accuracy of these and other items written in the activity logs (caffeine intake, medications, illnesses, times of taking the wrist actigraphy off, etc.) is called into question. Although telephone calls were made on a daily basis to remind participants to fill out their activity logs, it is unknown whether or not this method helped to obtain more complete data. Future research could examine whether telephone reminders are helpful in obtaining more complete data in studies of women with PPD. The results of this study can only be generalized to Caucasian, highly educated, partnered, middle class women.

Clinical Relevance

Prior research found that nighttime sleep disruptions may negatively impact on sleep quality (Brown, Buboltz, & Soper, 2002; Freedman, Gazendam, Levan, Pack, & Schwab, 2001). Because the results of the current study suggest that women with PPD experienced poorer sleep quality, more waking after sleep onset, and had more nighttime demands from male infants, clinicians need to address measures to improve sleep quality and minimize nighttime sleep interruptions. Discussion with depressed mothers and their families could consist of formulating a plan for nighttime infant care assistance to minimize sleep disruption at home, especially when women with PPD have male infants.

Clinicians could also educate women on sleep hygiene measures such as going to sleep only when feeling sleepy; doing something boring if unable to sleep within 20 minutes of lying in bed; avoiding naps; going to bed and getting up the same time everyday; avoiding exercise, nicotine, caffeine and alcohol within 4 hours of bedtime; having a light snack; taking a hot bath before bedtime; and using the bed and bedroom only for sleeping (American Academy of Sleep

Medicine, 2007). Other interventions that have been suggested to improve maternal sleep quality in the postpartum period include progressive relaxation and deep breathing, education on techniques to improve infant sleep, and discussion of ways to maximize opportunities for sleep (Stremler, Hodnett, & Lee et al., 2006). Women with PPD, who continue to have poor sleep quality despite non-pharmacological measures, may also benefit from referrals for pharmacotherapy and/or Cognitive Behavioral Therapy (CBT) (Edinger & Sampson, 2002). In the hospital, nurses could maximize sleep quality of all mothers by timing care-giving measures and diagnostic studies to minimize interruptions in sleep.

CALLOUT 3

Conclusions

The results of this study suggest that women with PPD experience poorer sleep quality than women without PPD, and that poor sleep quality negatively impacts on the severity of PPD symptoms. Further research is needed on larger and more diverse samples; to explore the relationship of sleep quality and PPD in older mothers; and to explore the relationship of sleep quality, PPD, infant care support, waking after sleep onset, and number of weeks postpartum. Finally, there is a critical need for clinicians and researchers to collaborate in developing and testing effective sleep quality interventions for women suffering from PPD to restore maternal functioning; decrease risks for relapse, recurrence, and suicide; and to improve maternal-infant outcomes.

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Table 1

Total Sample Demographics

Variable	n = 44
Age(yrs), M (SD)	31 (4.96)
Caucasian	34 (73.9)
Annual income ≥ $75,000	28 (64)
Employed	25 (57)
> High School Education	42 (95.5)
Live with Partner	42 (95.5)
Multiparous	24 (54.5)
Vaginal Birth	36 (82)
6–13 weeks postpartum	36 (82)
6-week maternity leave	26 (59)
Breastfeeding	36 (82)
Number of days of help	41 (41.4)
Help from partner	39 (85)
Help from own mother	32 (68)
Help with infant	40 (87)
Help with other children	24 (54.5)
Help with cooking	39 (85)
Help with running errands	41 (93)
Current activity restrictions	0 (0)

Note. Results are reported as n (%) unless otherwise noted.

Table 2

Comparison of Demographics Between Women With and Without Postpartum Depression.

Variable	Postpartum Depression With *n* =22	Postpartum Depression Without *n* =22	t	χ^2
Age(yrs) M (SD)	30 (5.57)	31 (4.12)	0.49	
Caucasian	16 (72.7)	18 (81.8)		0.52
Annual income ≥ $75,000	12 (54.5)	16 (72.7)		1.31
Employed	12 (54.5)	13 (59.1)		0.09
>High School Education	20(90.9)	22 (100)		2.10
Live with Partner	20(90.9)	22 (100)		2.10
Female Infant	7 (31.8)	18 (81.8)		11.21**
Number of nighttime infant awakenings M (SD)	2.82 (2.06)	1.68 (1.59)	2.91*	
Baby sleeps > 4 hrs	14 (63.6)	17 (77.2)		0.98
Breastfeeding	18 (81.8)	18 (81.8)		0.00
Experience caring for infants	16 (72.7)	12 (54.5)		1.57
Practical help husband	20 (95.2)	19 (86.4)		1.10
Practical help own mother	17 (77.2)	15 (68.1)		0.46
Practical help infant	22 (100)	22 (100)		0.00
Help with other children	14 (63.6)	10 (45.5)		1.33
Help with housework	21 (95.5)	21 (95.5)		0.00
Help with cooking	20 (95.2)	19 (86.4)		0.23
Help with errands	22 (100)	19 (86.4)		3.22

Note. Data are reported as n (%) unless otherwise noted.

* $p<0.05$

** $p<0.001$

Table 3

Differences in Psychiatric and Sleep Quality Variables Between Women With and Without PPD.

Variable	Postpartum Depression With (*n*=22)	Postpartum Depression Without (*n*=22)	t	χ^2
PPD Severity, M (SD)	95.38 (27.08)	45.05 (10.87)	−8.06**	
Lifetime personal psychiatric	16 (72.7)	5 (22.7)		11.02**
Family psychiatric History	17 (81)	11 (47.8)		5.21**
Psychotherapy	5 (22.7)	0 (0)		6.18*
Antidepressants	11 (50.0)	0 (0)		16.5**
Life stress	12 (52.1)	4 (17.3)		8.00**
Suicidal thoughts	5 (21)	0 (0)		6.18*
Generalized anxiety	5 (21)	0 (0)		6.18*
Wake after sleep onset M (SD)	13.36 (5.61)	11.55(4.73)	−2.35*	
Sleep latency M (SD)	12.98 (6.07)	11.83 (5.75)	1.41	
Sleep efficiency M (SD)	87.64 (5.36)	89.17 (4.58)	2.06*	
Wake episodes, M (SD)	10.29 (2.59)	9.63 (2.53)	1.86	

Note. Results are reported as n (%) unless otherwise noted.

* p<0.05

** p<0.001

Table 4

Maternal Demographics by PDSS Score

Variable	Negative ≤ 59	Minor PPD 60–79	Major PPD ≥80	χ^2
Age				2.68
≤ 19	0 (0)	0 (0)	1 (2.2)	
20–29 yrs	10 (22.7)	4 (9.1)	6 (13.6)	
≥ 30 yrs.	11 (25.0)	6 (13.6)	6 (13.6)	
Parity				2.02
Primiparous	10 (22.7)	6 (13.6)	4 (9.1)	
Multiparous	17 (38.7)	4 (9.1)	9 (20.5)	
Race/Ethnicity				8.12
Caucasian	16 (36.4)	8 (18.2)	10 (22.7)	
Asian	2 (4.5)			
Hispanic	3 (6.8)	1 (2.2)	2 (4.5)	
Education				3.81
≤ High School	1 (2.2)	0 (0)	1 (2.2)	
Attended College	3 (6.8)	1 (2.2)	4 (9.1)	
≥ 4 yr. College Degree	14 (31.8)	9 (20.5)	6 (13.6)	
Income				1.04
<$75,000	6 (13.6)	3 (6.8)	6 (13.6)	
≥ $75,000	14 (31.8)	7 (15.9)	7 (15.9)	
Live with Partner				5.00
Yes	21 (47.7)	10 (22.7)	11 (25.0)	
No	0 (0)	0 (0)	2 (4.5)	
Infant Feeding				3.62
Breast	17 (38.7)	10 (22.7)	9 (20.5)	
Bottle	4 (9.1)	0 (0)	4 (9.1)	
Type Birth				1.43
Vaginal	16 (36.4)	8 (18.2)	12 (27.3)	
Cesarean	5 (11.36)	2 (4.5)	1 (2.2)	
Baby wakes > 3 times per night				2.77
Yes	16 (36.4)	6 (13.6)	9 (20.5)	
No	5 (11.4)	5 (11.4)	6 (13.6)	
Experience caring for infants				1.82
Yes	13 (29.5)	5 (11.4)	10 (22.7)	
No	8 (18.2)	5 (11.4)	3 (6.8)	
Personal history depression				21.40*
Yes	4 (9.1)	4 (9.1)	13 (29.5)	
No	17 (38.7)	6 (13.6)	0 (0)	
Family history depression				3.66
Yes	12 (27.3)	5 (11.4)	11 (25.0)	
No	9 (20.5)	5 (11.4)	2 (4.5)	
Infant Gender				5.46
Boy	6 (13.6)	4 (9.1)	9 (20.5)	
Girl	15 (34.1)	6 (13.6)	4 (9.1)	
Weeks Postpartum				3.57
≤ 12	16 (36.4)	10 (22.7)	9 (20.5)	
>12	5 (11.36)	0 (0)	1 (2.2)	
Practical help at home				3.48
Yes	21 (47.7)	9 (20.5)	13 (29.5)	
No	0 (0)	1(2.2)	0 (0)	

Note. Data are reported as n (%) unless otherwise noted.

* p<0.001

Table 5

Hierarchical Multiple Regression of PPD Symptom Severity on Sleep Quality Measures.

Model		B	SE B	β	t	Δ R^2
1	(Constant)	95.35	19.58		4.87	0.32
	Infant gender	−10.84	9.01	−.17	−1.20	
	Income	−5.16	2.81	−.25	−1.84	
	Number of infant awakenings	6.61	2.26	.41	2.92	
2	(Constant)	−561.59	317.38		−1.77	0.20
	Infant gender	−14.99	8.74	−.24	−1.72	
	Income	−2.19	2.79	−.11	−.79	
	Number of infant awakenings	4.35	2.18	.27	2.00*	
	Wake after sleep onset	6.85	2.85	1.19	2.40*	
	Sleep latency	1.80	.73	.32	2.46*	
	Sleep efficiency	−6.31	3.13	−1.04	−2.01*	
	Wake episodes	2.97	1.92	.25	1.55	

*p<0.05