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The Relationship Between Sleep and Mood in Postpartum Women

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(Volume 1 of 1)

This thesis is submitted in part fulfilment of the degree of Doctorate in Clinical Psychology (D.Clin.Psychol.)

October 2006

Word Count:

19,954

General Abstract

There is a well established association between sleep disturbance and major depression, yet the notion of a relationship between sleep and puerperal mood has only recently gained attention from researchers. The literature review explores the evidence for sleep disruption during pregnancy and the postpartum period, critically reviews existing studies investigating sleep and puerperal mood and identifies areas for further research. The review concludes that the limited evidence available supports an association between sleep and puerperal mood, but suggests that not all women with disturbed sleep will develop depressive symptoms. Perception of sleep disturbance, hormonal abnormalities or a unique EEG profile may discriminate between those women that develop postpartum depression and those who do not. Further studies are needed to clarify the nature of this relationship.

The empirical paper reports a study which explores the relationship between sleep and mood in women with and without a history of depression, utilising both objective and subjective sleep measures. A significant association was found between subjective but not objective sleep at one week postpartum and depressive symptoms in subsequent weeks. Women with a history of depression displayed greater subjective sleep disturbance and greater depressive symptoms than women without a history of depression. A significant effect of postpartum week was found for subjective sleep efficiency and depressive symptoms, with sleep improving and depressive symptoms reducing with time since birth. If replicated, this finding will enable professionals to identify women at an increased risk of developing postpartum depression and to offer interventions aimed at reducing sleep distress.

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Acknowledgements

I would like to give thanks to Catherine Brignell and Andy Mayers for their guidance and support in producing this thesis. I would also like to thank Dr Alain Gregoire and his team at the Southampton and New Forest Perinatal Service for their assistance with recruitment. Particular thanks go to Nigel Curtis and Kay Brown, who went beyond the call of duty in their efforts to support the study. Additional thanks go to the regional representatives of the National Childbirth Trust, for publicising the study to local members. Finally, I would like to thank all of the new mothers who participated and made this research possible.

Literature Review*

Sleep disturbance and puerperal mood: A review of the literature

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*Applying guidelines for publishers for submission to the British Journal of Clinical Psychology (Appendix 1)

Abstract

Purpose

The current review examines what is known about alterations in sleep during pregnancy and the postpartum and considers the evidence for a link between sleep and perinatal mood.

Method

Relevant articles were identified using the databases Medline, Embase and Ovid, and through scanning the reference lists of articles identified via the online search.

Results

Studies using a variety of sleep assessment measures support the occurrence of significant sleep alterations during pregnancy and postpartum period. The nature and extent of these changes has been found to be affected by variables such as parity, feeding method and history of depression. There is limited evidence to support and association between sleep and puerperal mood, with studies suggesting that greater sleep disruption is associated with poorer mood. This association may be explained by level of subjective distress in response to sleep disruption, by hormonal abnormalities or by an EEG profile which is unique to postpartum depression.

Conclusions

Existing research is limited and has been hampered by methodological shortcomings. Further research is needed to clarify the changes that occur throughout pregnancy and postpartum and their relationship with postpartum mood.

Introduction

Pregnancy and the postpartum are recognised periods of vulnerability to mental health problems. Rates for the onset of psychiatric disorder are dramatically higher in the early puerperium, particularly in the first month, than for non-pregnant women of the same age (Frank, Kupfer, Jacob, Blumenthal & Jarrett, 1987). A number of possible explanations have been put forward for the increased rate of difficulties within this period, including hormonal changes, and non-biological factors such as poor social support. More recently, researchers have proposed an association between sleep disturbance and perinatal mood disorders. The current article explores the existing evidence for this link. To identify relevant articles, online searches were conducted of the databases Medline, Embase and Ovid, using different combinations of the search terms 'sleep' 'depression' 'puerper*' 'perinatal' 'pregnan*' 'postpartum' and 'mood'. Additional articles were identified through scanning the reference lists of articles identified via the online search.

Postpartum depression

The postpartum period is generally defined as the first six months after delivery (Lee, 1998). Postpartum depression is believed to affect 10-15% of all childbearing women (O'Hara and Swain, 1996). Two thirds of women who develop major depression in the postpartum period have no previous history of depression, whilst in women with a history of depression one quarter may experience a new episode during the postpartum period (Coble, Reynolds, Kupfer, Houck, Day & Giles, 1994).

Postpartum depression does not have a separate diagnostic category within the DSM-IV (APA, 1994). The word 'postpartum' is given as a specifier, used to denote the time of onset. Thus the criteria for diagnosing major depression also apply to postpartum depression. To qualify for a DSM-IV (APA, 1994) diagnosis of major depression with postpartum onset, an individual must present with onset within four weeks of delivery. However, the similarities between physical symptoms of depression and normal childbirth, including sleep disturbance, loss of energy, diminished concentration and weight loss, often complicate the diagnosis of depression during this period. Moreover, symptoms may not reach peak intensity until some three to five months postpartum.

Postpartum depression is distinct from postpartum 'blues', which affect 75-80% of women in the first three to seven days after delivery (Lee, 1998). Women with postpartum depression may experience great anxiety, difficulties with concentration, agitation, spontaneous crying, and a lack of interest in their child. Sufferers are often reluctant to come forward because of feelings of guilt about their negative or depressive feelings, since they believe that the birth of a child should be a happy time (Steiner, 1990).

Postpartum depression is associated with increased marital stress, family breakdown and child behaviour problems, and can negatively affect a child's cognitive development (Cogill, Caplan, Alexandra et al. 1986). These outcomes, coupled with the reluctance of women to seek help, make the identification of risk factors and the development of reliable screening tools an important goal.

Sleep

Sleep results from alterations in the balance of different major neurotransmitter systems within the brain. It is characterised by a progression through four non-rapid eye movement states (labelled Stages 1-4) followed by rapid eye movement (REM) sleep. This progression typically takes around 90 minutes and repeats throughout the night, with an increasing amount of REM sleep occurring in each successive cycle (Ross, Murray & Steiner, 2005).

Stage 1 sleep is generally thought of as a transitional sleep state, representing less than 5% of total sleep. Excessive Stage 1 sleep is considered a marker for poor quality sleep. Stage 2 sleep represents about 50% of total sleep, and has a characteristic electroencephalographic signature, the K-complex. Stage 3 and 4 sleep are biologically similar, and are often collectively referred to as slow-wave sleep or delta sleep. Slow wave sleep is considered to be restorative sleep, as when someone is sleep deprived, he or she enters this state readily. Rapid Eye Movement (REM) sleep, by contrast, is not believed to be restorative in function. REM is a distinct state associated with dreaming. It is the state which most closely resembles wakefulness, and people often find it easier to wake from this state than from other sleep stages. Nonetheless there are important differences in brain function between REM and wakefulness, including marked increases in limbic activity and reductions in activity in the prefrontal cortex. A typical young adult will spend less than 5% of the night awake, 55% of the night in light (Stage 1 and 2) sleep, 20% in slow wave sleep and 20-25% of the night in REM sleep (Lee, Zaffke & McEnany, 2000).

A link between sleep and depression

Researchers have long noted an association between sleep disturbance and psychiatric disorders. Such an association should perhaps not come as a surprise, given that many of the neurotransmitter systems involved in sleep have been shown to have multiple functions, including those of relevance to psychiatric disorders. That sleep disturbance is one of the most common symptoms of psychiatric disorders also lends support to the notion of an interaction between the two (Buysse, Nofzinger, Keshavan, Reynolds, & Kupfer, 1999). Whilst sleep disturbance is associated with a number of psychiatric disorders, the current review will focus only on the relationship between sleep and depression.

In an epidemiological study, Ford & Kamerow (1989) found a significantly greater prevalence of major depression amongst those with insomnia or hypersomnia. The risk of developing new major depression was also much greater in those with insomnia at two time points, one year apart, than in those without. An association between sleep disturbance and depression was also found in a subsequent epidemiological study by Breslau, Roth, Rosenthal and Andreski (1996). Breslau et al. (1996) noted that there was an increased lifetime prevalence of major depression amongst individuals with a history of sleep disturbance, and the risk of a developing a new major depression was four times higher in those with a history of insomnia. This association remained even when using a definition of major depression which removed sleep disturbance from the diagnostic criteria.

Assessment of sleep in depressed individuals has revealed significant differences from healthy controls, including a reduction in the time from sleep onset to the point of entering REM sleep, known as REM latency. Decreased REM latency, decreased slow wave sleep and increased wakefulness are present in 40-70% of outpatients with major depressive disorder (Armitage, Roffwarg, Rush, Calhoun, Purdy & Giles, 1992). Other characteristics noted amongst patients with depression include difficulties initiating sleep and enhanced REM sleep (Ross, Murray & Steiner, 2005). Giles, Jarrett, Roffwarg and Rush (1987) found that reduced REM latency during depression was associated with increased incidence of recurrence and decreased time to recurrence of depression. Furthermore, therapeutic interventions to treat depression have shown that improvements in depressive symptoms are associated with an increase in REM latency (Ross et al., 2005), and that critically timed sleep deprivation or "wake therapy" can lead to improvements in depressive symptoms (Parry, Curran, Stuenkel, Yokimozo, Tam, Powell et al. 2000).

Sleep in pregnancy and the postpartum period

Despite evidence to suggest a relationship between sleep disturbance and depressive symptoms, research into risk factors for postpartum depression has primarily been directed at psychosocial factors, whilst the association between sleep changes and depressive symptoms in this group has, until recently, been largely overlooked. This is somewhat surprising, given that changes to sleep patterns have long been recognised to occur both in pregnancy and the postpartum period. Hormonal changes, a growing foetus during pregnancy and the presence of a newborn infant with erratic sleep-wake

patterns in the early postpartum period each contribute to sleep disturbance. We will now consider what is known about sleep changes during pregnancy and the postpartum.

Physiological and anatomical changes during pregnancy and the postpartum

During pregnancy changes occur to a number of endocrine systems, including marked increases in production of the sex steroids oestrogen, progesterone and prolactin, and in production of the steroid hormone cortisol. Alterations in the levels of these hormones in non-pregnant individuals have been found to have significant effects on sleep. Increases in oestrogen have been shown to lead to decreases in REM sleep (Fang & Fishbein, 1996). Associations have been made between prolactin levels and REM sleep, REM latency and slow wave sleep in non-pregnant women (Parry, Mendelson, Duncan, Sack & Wehr, as cited in Driver & Shapiro, 1992). Administration of progesterone has been shown to cause drowsiness, earlier sleep onset and increases in non-REM sleep (Friess, Tagaya, Trachsel, Holsboer & Rupprecht, 1997). Progesterone also has inhibitory effects on smooth muscle, which can affect urinary frequency (Lee, 1998). Infusions of cortisol or cortisol raising hormones in men have led to reduced REM and increased time spent awake (Born, Spath-Schwalbe, Kern & Fehm, 1989). This is significant, as cortisol concentrations increase twofold in pregnancy and fourfold during labour (Cousins, Rigg, Hollingsworth, Meis, Halberg, Brink, et al. 1983).

Anatomical alterations also make sleep difficulties a more likely phenomenon. As the pregnancy progresses, increases in the size of the uterus to accommodate the growing foetus lead to compression of the bladder and reduced bladder capacity. The enlarging uterus also leads the diaphragm to be restricted, causing breathing to become shallower

and the intestines and oesophageal sphincter to be displaced, making reflux and heartburn more likely, particularly when lying on the back (Lee, 1998). The large abdominal mass and associated discomfort may also cause disturbance of normal sleep and make movement during sleep a more deliberate action. A correlation between increased REM sleep and body weight has been noted in non-pregnancy related studies (Adam, 1987) although this may be explained by increased rates of sleep disordered breathing amongst overweight individuals.

Thus there is good reason to anticipate significant alterations to the sleep patterns of pregnant women. However, many experimental studies of the effects of hormonal changes have examined effects in men. Studies suggest that sex differences exist in sleep patterns in humans, and that these may increase in magnitude under biological challenges, including drug administration (Manber & Armitage, 1999). Other studies have utilised synthetic compounds, which may produce very different effects than the natural physiological changes of pregnancy (Ross et al. 2005). The potential interactive effects of simultaneous increases to several endocrines, particularly when coupled with significant anatomical changes, also make the nature of pregnancy related sleep changes difficult to predict. Direct examination of sleep in pregnancy is therefore necessary.

Subjective reports

Evidence from questionnaire studies suggests that sleep disturbance does indeed represent a common feature of pregnancy. In a survey of 100 women in their 38th week of pregnancy, Schweiger (1972) found that 68 reported having experienced some level of alteration to their normal sleep pattern during the course of their pregnancy. Sleep

disturbance increased in prevalence with each trimester, with 13% reporting disruption in the first trimester, 19% in the second and 66% in the third.

In a subsequent survey of 127 women by Mindell and Jacobson (2000), 97% reported some symptoms of sleep disturbance during the course of their pregnancy. However, only a third of these women identified themselves as having a sleep disorder, suggesting that most women viewed sleep disturbance as an inevitable and untreatable aspect of the pregnancy experience.

Sleep disturbances are also commonly reported in the postpartum period. Tribotti, Lyons, Blackburn, Stein and Withers (1988) conducted a survey of 231 postpartum women and found that 66% reported sleep disturbance, with a higher prevalence amongst first time mothers. Sleep disturbances were reported to occur from the day of delivery throughout the first three months postpartum.

In addition to examining the prevalence of sleep problems within this population, subjective reports have been used to plot the course of sleep disturbance throughout pregnancy and the postpartum. Schweiger (1972) found that the first trimester of pregnancy was characterised by increased daytime sleepiness and increased total sleep time due to the resultant daytime napping. In the second trimester, nocturnal awakenings significantly increased, whilst in the third total sleep time dropped, reports of nocturnal insomnia increased and daytime sleepiness was once again reported. A similar pattern was reported by Suzuki, Dennerstein, Greenwood, Armstrong and Satohisa (1994), who examined sleep logs. They found that total sleep time and daytime sleepiness increased in the first trimester, but also noted increased nocturnal

insomnia during this period. In the second trimester, Suzuki et al. (1994) noted a normalisation of total sleep time. In the third trimester, as in Schweiger's (1972) sample, total sleep time demonstrated significant decreases relative to previous trimesters, whilst insomnia and daytime sleepiness increased.

A pattern has also been noted to postpartum sleep disturbance. Horiuchi & Nishihara (1999) examined the sleep patterns of eight women from five to 12 weeks postpartum using continuous sleep logs. Over this period, they noted that total sleep time increased, whilst wake time at night gradually decreased and a gradual transition from interrupted to non-interrupted sleep was observed during weeks 9-12.

Thus subjective accounts point to a picture of changing sleep disturbance throughout pregnancy and the early postpartum. Subjective reports suggest that sleep disturbance is most pronounced in the final trimester, and does not remit with the birth of the infant. Instead, sleep patterns gradually improve over the course of the first three postpartum months. However, none of the above studies employed objective measures to quantify the changes being reported, and there is evidence to suggest that people have difficulties in assessing their own sleep, particularly with respect to transitions between sleep and wake states (Lockley, Skene & Arendt, 1999). Furthermore, subjective accounts cannot clarify whether sleep disturbance during the postpartum is explained entirely by infant waking, or whether there is a biological component to the pattern of disturbance. Clearly, objective studies of sleep in normal pregnancy are also necessary to ascertain the true nature and extent of these sleep disturbances.

Polysomnographic studies

Polysomnographic studies, including electroencephalography (EEG) are considered to represent the gold standard for objective measurement of sleep parameters (Kushida, Chang, Gadkary, Guilleminault, Carillo & Dement, 2001). However, due to their complexity, polysomnographic studies are less often performed in pregnant women who are not suspected of sleep disorders (Santiago, Nolledo, Kinzler & Santiago, 2001). Polysomnographic studies are costly to conduct. Furthermore, the methodology is highly intrusive at a time when women are experiencing fatigue, hormonal changes and the physical discomfort resulting from birth. For example, electroencephalography involves placing six electrodes and one ground electrode around the cranium to record electrical activity across the brain. Until recently, studies required participants to sleep in a laboratory, often away from their infant. It is possible that women prepared to participate in such research are unrepresentative of the wider population. Nonetheless, several longitudinal and single trimester studies do provide information on sleep changes in pregnancy and the postpartum.

In one of the first studies to investigate sleep patterns during pregnancy and the early postpartum period, Karacan, Heine, Agnew, Williams, Webb and Ross (1968) conducted a laboratory based EEG study with seven healthy females. Participants were compared with a group of non-pregnant age matched controls. In concordance with findings from subjective accounts, Karacan et al. (1968) found that total sleep time and napping were greatest in the first trimester, whilst night awakenings increased progressively through pregnancy and did not resolve entirely following delivery. Karacan et al. (1968) noted that during the final trimester, when subjective reports have

suggested greatest disturbance, significant increases were seen in Stage 2 sleep and in nocturnal awakenings, whilst a significant reduction in slow wave sleep was observed. Karacan et al. (1968) noted that increased postpartum wakings relative to early pregnancy could not be entirely explained by infant waking, as during the study infants slept away from the mother.

Subsequent studies have produced inconsistent findings. Driver and Shapiro (1992) conducted a longitudinal laboratory based polysomnographic study of five women during pregnancy and postpartum. Sleep was measured between eight and 16 weeks gestation, then at two month intervals until birth and at one month postpartum. In contrast to Karacan et al's findings, Driver and Shapiro (1992) found that time spent in slow wave sleep, particularly Stage 4 sleep was significantly higher at 17-27 and 28-39 weeks when compared with 8-16 weeks gestation. A significant reduction in REM sleep was also noted at 28-39 weeks gestation as well as at postpartum when compared with 8-16 weeks gestation. An increase in time spent awake during gestation was noted, but there was no significant difference in the number of wakings. Driver and Shapiro (1992) suggested that the inconsistency in findings could be explained by the lack of within subject data over the course of pregnancy in other studies. They posited that the increase in slow wave sleep seen in their subjects could serve a compensatory and restorative function, in response to the increasing physical and metabolic demands of pregnancy.

A trend towards an increase rather than decrease in slow wave sleep was also noted in a study by Hertz, Fast, Feinsilver, Albertario, Schulman and Fein (1992), although this trend was not statistically significant. Hertz et al. (1992) compared women in the final

trimester of pregnancy with non pregnant controls and found that the pregnant women showed significantly greater wake time after sleep onset, lower sleep efficiency (time spent sleeping as a proportion of total time spent in bed), increased Stage 1 sleep and decreased REM sleep when compared with controls.

Brunner, Munch, Biedermann, Huh, and Borbely (1994) examined the sleep patterns of nine women across all three trimesters of pregnancy. Unlike previous authors, Brunner et al. (1994) found no change in slow wave sleep using conventional measures. However, utilising a spectral analysis technique revealed a progressive decrease in slow wave sleep over the course of pregnancy, suggesting that method of analysis may have important implications for outcome, particularly in studies with small sample sizes.

Interestingly, a relationship has been found between history of affective disorder and sleep patterns during pregnancy and the postpartum. Coble, Reynolds, Kupfer, Houck, Day and Giles (1994) conducted a longitudinal EEG study from 12 weeks into pregnancy up to eight months postpartum, comparing the sleep characteristics of 14 women who had a history of depression with 20 women with no history of affective problems. The women with a history of depression had been asymptomatic for a year prior to the study and did not report any known psychosocial risk factors for depression such as poverty or poor social support. Women with a history of affective disorder showed greater changes in sleep from early pregnancy through to the second month postpartum. In particular, whilst decreases in sleep time were greatest for both groups between 36 weeks gestation and one month postpartum, decreases were two to three times greater in women with a history of depression. The most pronounced changes to sleep for both groups occurred at four weeks postpartum.

The influence of other variables on perinatal sleep has also been explored. Lee, McEnany & Zaffke (2000) explored the association between measured progesterone levels and polysomnographic sleep in 31 women in the lead up to pregnancy, during pregnancy and postpartum. EEG recordings were taken in the women's own homes for two consecutive nights within days four to 10 and 16 to 25 of the menstrual cycle and then at 11 to 12 weeks, 23 to 24 weeks and 35 to 36 weeks gestation, and three to four weeks and 11 to 12 weeks postpartum. Lee et al. found that prior to pregnancy, REM sleep and mood state were related to lowered progesterone levels in the menstrual cycle but postpartum REM sleep and mood state were related to increased wake time and not to changes in progesterone levels.

Waters and Lee (1996) examined the effect of parity on sleep patterns and fatigue in 12 first time mothers (primigravidae) and 19 experienced mothers (multigravidae) in the third trimester of pregnancy and first month postpartum. Waters and Lee (1996) noted significant differences between the sleep patterns of primigravidae and multigravidae. Sleep efficiency decreased significantly for primigravidae between the pre and postpartum period, whilst the difference between the two time points was not significant for multigravidae. Furthermore, primigravidae showed significantly lower sleep efficiency than multigravidae at one month postpartum. Multigravidae reported a significantly higher participation in household chores than primigravidae both in the third trimester of pregnancy and at one month postpartum. Despite completing fewer household chores, primigravidae showed a trend towards increased fatigue from pregnancy to postpartum, although there were no significant overall differences between the two groups in their reported levels of fatigue.

A subsequent study of the effects of parity also found significant differences between new and experienced mothers. Lee, Zaffke & McEnany (2000) used home based monitoring to compare 16 multigravidae with 13 primigravidae and found a significant effect of parity on sleep efficiency, with multigravidae showing lower sleep efficiency due to more frequent awakenings at all time points except one month postpartum. Lee et al. (2000) also found that multigravidae showed a trend towards greater total sleep time than primigravidae, but this trend was non-significant. REM sleep and slow wave sleep were not influenced by parity.

Waters and Lee (1996) suggest that that differences between the two groups may reflect the greater challenge faced by primigravidae in adopting a new role. Waters and Lee (1996) posit that the stresses of maternal "role acquisition" experienced by primigravidae may result in greater fatigue and sleep disruption that those of the "role expansion" experienced by multigravidae.

Some evidence exists to suggest that method of feeding may have significant effects on postpartum sleep pattern. Blyton, Sullivan and Edwards (2002) compared sleep in 12 breastfeeding, seven bottle feeding and 12 age matched control women using EEG. Blyton et al. (2002) found that breastfeeding women showed significantly more time awake after sleep onset and thus significantly reduced sleep efficiency when compared with both bottle feeding and control women. Furthermore, lactating mothers spent a significantly greater percentage of total sleep time in slow wave sleep when compared with bottle feeding mothers and controls. This enhancement occurred at the expense of time spent in Stage 1 and 2 sleep, which normally occupies 55% of total sleep time, but occupied only 35% in the breastfeeding mothers. There was no correlation between the

age of the infant and time spent in slow wave sleep. Nonetheless, the study included women from one to over seven months postpartum, which is a broad time frame and could be considered a shortcoming. Moreover, previous studies have suggested that sleep alterations are most prominent in the first month postpartum, and thus other more significant differences occurring in the early postpartum may have been missed.

The finding that parity and feeding method have significant effects on sleep patterns has important consequences for the interpretation of the existing research literature. Studies such as Hertz et al. (1992) and Brunner et al. (1994) utilised both primigravidae and multigravidae without exploring differences between groups, and equally information is not always available on feeding method. Although not yet directly compared, the effects of experimental setting may also need to be taken into account when interpreting results. Lee (1998) suggests that the decision to utilise home monitoring in her studies resulted from discovering that participants looked forward to visiting the sleep laboratory, viewing it as an opportunity to recover from sleep deprivation experienced at home. Conversely, home monitoring may increase the likelihood of interference from uncontrollable external factors, such as other family members or external noise. This may go some way to explain the inconsistent findings across studies. Interpretation of the existing evidence base is also made difficult by the use of small sample sizes which lack statistical power, and by reliance on predominantly white, married, middle class samples.

Furthermore, it should be noted that, with the exception of Karacan et al. (1968), the studies mentioned above examined nocturnal sleep patterns but did not consider daytime napping amongst the women in their sample. This is problematic, as napping

has been found to be common within pregnancy and the postpartum, and studies of sleep in healthy, non pregnant individuals has found that daytime napping can significantly reduce REM latency and slow wave sleep during the subsequent nocturnal recording (Southmayd, Cairns & David, 1991).

To summarise, a number of polysomnographic studies support the suggestion of sleep changes throughout pregnancy and the early postpartum. Alterations to REM and slow wave sleep have been the most commonly noted changes, although the direction and size of effects has varied between studies. Methodological issues, including failure to consider the total duration of sleep over 24 hours including naps, differences in where sleep is assessed (home vs. laboratory) and reliance on small sample sizes are likely to have contributed to this variation.

Actigraphic studies

In light of the costs and intrusiveness of polysomnography, many sleep studies have opted for other, less invasive, approaches to the measurement of sleep. Actigraphy involves the use of a compact activity monitor, typically strapped to a participant's wrist, which gives an approximation of sleep. Whilst actigraphy cannot detect sleep stage, it can provide information on sleep presence or absence and nocturnal disturbance and is both cheaper and less intrusive than EEG (Mayers & Baldwin, 2006). Actigraphy has been found to compare well with sleep EEG in terms of sleep onset (r = .77) and offset (r = .88) and total sleep time (r = .57) (Lockley, Skene & Arendt, 1999). Moreover, the compact size of the monitor makes recording over 24 hour periods less intrusive for the participant, meaning that recording of daytime napping is more viable

than with polysomnography. Unfortunately, as with EEG studies, research findings using actigraphy have been limited by their reliance on small, non representative samples and have primarily consisted of descriptive rather than hypothesis driven studies.

In one of the first studies to use actigraphy in the study of sleep patterns in pregnant and postpartum women, Shinkoda, Matsumoto and Park (1999) used wrist actigraphy to examine sleep patterns from late pregnancy to three months postpartum in four Japanese women. Sleep-wake data was assessed continuously and divided into nine, week long sections, which were analysed by averaging daily sleep parameters for each week of pregnancy or postpartum for each participant. Actigraph data was supplemented by information from sleep logs, completed by the participant. Shinkoda et al. (1999) found that sleep efficiency was significantly lower and waking after sleep onset (WASO) longer throughout the whole postpartum period when compared with during pregnancy. Sleep efficiency was lowest and WASO longest at two weeks postpartum, after which both began to recover. Total sleep time was also significantly shorter in the first and second postpartum weeks, and sleep latency shortened in the first to third postpartum weeks.

Using a slightly larger sample, Kang, Matsumoto, Shinkoda, Mishima and Seo (2002) utilised actigraphy to examine the sleep patterns of 10 Japanese women from five weeks before delivery to 15 weeks postpartum. Five of the women were primigravidae and five multigravidae. Kang et al. (2002) noted that sleep efficiency and total sleep time showed significant weekly effects. When compared with late pregnancy, total sleep time and sleep efficiency were significantly reduced in the first 11 weeks following

delivery, but by week 12 were no longer significantly different. Both parameters showed a pattern of gradual improvement as the weeks went on. WASO was most frequent during the weeks just after delivery, and was significantly poorer than in late pregnancy from weeks one to 10 postpartum.

In a similar study, Matsumoto, Shinkoda, Kang and Seo (2003) examined actigraphic data for 10 Japanese women from the 34th week of gestation to the 15th week postpartum, and compared data with that of 10 non-pregnant controls. Data was collected continuously and then divided into four periods, late pregnancy, first postpartum period (first to fifth week) second postpartum period (sixth to 10th week) and third postpartum period (11th to 15th week). As in previous studies, total sleep time and sleep efficiency decreased in the postpartum period, whilst WASO increased. The number of awakenings, length and number of daytime naps also increased in late pregnancy and the first postpartum period, but tended to decrease in the middle and last postpartum periods. Using the control data as a basis for comparison, Matsumoto et al. (2003) concluded that nocturnal sleep patterns had not returned to pre-pregnancy patterns even by 11-15 weeks postpartum. However, as Matsumoto et al. (2003) did not directly compare the pre and post pregnancy sleep patterns of the 10 women in their study, conclusions about whether these patterns had returned to baseline levels must be interpreted with caution.

Only one actigraphic study has examined the sleep patterns of fathers as well as mothers during pregnancy and the postpartum. The findings support the assumption that sleep changes are greater for women both in pregnancy and in the postpartum period than for their cohabiting partners. Gay, Lee and Lee (2004) looked at sleep patterns and fatigue

in 72 couples during the last month of pregnancy and first month postpartum. Both parents experienced greater sleep disruption during the postpartum than in pregnancy, with less night time sleep and greater night time awakenings. However, mothers sleep patterns were more disrupted than those of their partners at both time points. Compared with fathers, mothers had less sleep at night and slept more during the day both in pregnancy and in the postpartum period. Furthermore, fathers' sleep patterns remained stable over time, whilst mothers experienced significantly less sleep during the night and more during the day after the baby was born than during pregnancy. The finding that sleep disruption was greater for mothers at both time points suggests that puerperal sleep disruption has a biological basis. However, the finding that disruption was significantly greater for mothers during the postpartum period suggests that role expectations may also contribute to the degree of sleep disruption experienced by women, as in Western societies mothers take main responsibility for attending to the infant.

It should be noted that, whilst correlations between sleep diaries and actigraphy for total sleep time, sleep efficiency and sleep latency were high, correlations for waking after sleep onset in all studies were low. Thus the validity of actigraphy as a measure of night waking may be questionable. Furthermore, with the exception of Gay et al.'s (2004) study, the small sample sizes make it difficult to draw generalisable conclusions.

The paucity of actigraph studies conducted on Western samples also restricts the generalisability of results. Sleeping arrangements are culturally influenced, and whilst in most Western countries parents sleep separately from their infant, it is more common for Japanese parents to co-sleep in the same room, or the same bed, as their infant

(Yamazaki, Lee, Kennedy & Weiss, 2005). This cultural difference is a significant one, as breastfeeding women who co-sleep have been found to have a greater total sleep time over a 24 hour period than those who sleep in separate room from their infant (Quillin & Glenn, 2004).

In summary, findings from actigraphic studies suggest lower sleep efficiency, shorter total sleep time and increased waking after sleep onset during the postpartum period than in late pregnancy. These disturbances are most pronounced in the first two weeks postpartum, after which a gradual improvement is seen. However, actigraphy has only recently begun to be employed in perinatal sleep research and studies have largely been conducted with very limited non-Western samples in purely descriptive studies. Further research is needed to extend and replicate these findings using other populations.

Thus subjective reports, polysomnography and actigraphy suggest that sleep changes occur throughout pregnancy and the postpartum, and that sleep disruption is greatest during the final trimester of pregnancy and the first four weeks after delivery. This disruption is likely to have psychological consequences.

Sleep and postpartum mood

Sleep and postpartum blues

Postpartum 'blues' occur in 75%-80% of women around three to five days after giving birth (Lee, 1998). Such blues are typically confined to the first week postpartum and are widely considered to be a normal consequence of hormonal changes following the

birth. However, postpartum blues have been identified as a risk factor for the subsequent development of postpartum depression. For example, Hannah, Adams, Lee, Glover and Sandler (1992) found that an Edinburgh Postnatal Depression Scale (EPDS) score of 13 or more at five days postpartum, along with previous history of postnatal depression, was a significant predictor of postpartum depression at six weeks. Teissedre & Chabrol (2004) also found a high correlation between EPDS scores at two to three days and at four to six weeks postpartum.

The possibility of a relationship between sleep disruption and the development of postpartum 'blues' was explored in a study of 63 women by Wilkie and Shapiro (1992). Postpartum sleep was assessed using a sleep diary which the women completed daily for the first 10 days following the birth. A significant relationship was found between sleep disruption in late pregnancy and postpartum blues. Women who experienced sleep loss due to night time labour and delivery also reported greater emotional distress in the early postpartum period than those who experienced labour and delivery during the day. Thus sleep disturbance during late pregnancy and sleep loss as a result of labour were associated with subsequent mood.

The relationship between postpartum sleep and mood was somewhat less clear. Wilkie and Shapiro (1992) found that subjective perception of sleep quality immediately postpartum was significantly associated with mood on a number of days following the birth, but that the correlations were weakest at the point when blues symptoms peaked. This suggests that the relationship between sleep and mood may be more complex, and that the effects of sleep disturbance upon mood may be delayed rather than immediate. No significant correlations were found between time spent asleep or number of

awakenings and mood in the early postpartum period. Wilkie and Shapiro (1992) concluded that even if sleep disruption postpartum does have some effect on mood in the postpartum period, it is not contributing specifically to the development of postpartum blues.

Wilkie and Shapiro (1992) also noted that not all women who experienced a prolonged night time labour showed evidence of postpartum blues, whilst others who delivered during the day reported depressive symptoms. They suggested that some women may be more susceptible to the effects of disturbed sleep, whilst others may be protected against this effect.

One shortcoming of this study is that sleep disruption in late pregnancy was not assessed objectively or using sleep diaries. Instead, at the time of recruitment (between 36 weeks and term) participants were asked to rate whether their sleep was better, the same, worse or much worse than their normal, non-pregnant sleep pattern. They were also asked to report if they were experiencing difficulties in getting off to sleep, early waking or broken sleep. From this information, a single score for sleep disturbance over the final trimester was assigned to each participant. The use of different sleep assessment tools pre and postpartum is problematic in that it does not allow for within-subjects comparisons. Had the sleep diary been used at both time points, it would have been possible to ascertain which aspects of sleep disruption in late pregnancy were most associated with the subsequent development of the blues, and whether the finding that only subjective distress was significantly linked with postpartum mood is also true for this period.

Contrasting findings have been reported in a similar study by Mead-Bennett (1990) who found no relationship between sleep loss in late pregnancy, labour and delivery and negative mood in the early post-partum. Mead-Bennett (1990) examined the effects of sleep loss upon mood on the first postpartum day in 28 primigravid women. Participants were asked to complete a questionnaire on their sleep patterns prior to pregnancy and to complete a seven day sleep log, two weeks prior to their expected delivery date. The Multiple Affect Adjective Checklist was administered in the third trimester and again on the first postpartum day to assess levels of anxiety, hostility and depression. Mead-Bennett (1990) found that whilst there was a significant difference between sleep pre-pregnancy and sleep during the third trimester, no significant relationships were found between sleep disturbance in pregnancy and postpartum mood, or between sleep losses due to labour and delivery and postpartum mood.

However, there are several methodological limitations to Mead-Bennett's (1990) study. The mood measure employed was normed for use with college students, job applicants and psychiatric patients, but not with postnatal women. It is unclear why Mead-Bennett (1990) opted to use this measure and not the EPDS, which has been designed specifically for use with this population. Her assessment of sleep can also be criticised. As in Wilkie and Shapiro's study, Mead-Bennett (1990) used different methods for assessing sleep patterns at each of the time points. Sleep prior to pregnancy was assessed using a questionnaire, which may have been susceptible to recall biases. In addition, no assessment of perceived sleep quality or satisfaction was made, and thus it is unclear whether participants were content with the sleep that they obtained during pregnancy. Finally, Mead-Bennett (1990) assessed mood only on the first day after birth, yet research suggests that postpartum blues do not typically develop until three to

five days postpartum (Lee, 1998). Mead-Bennett herself acknowledged that the investigation of sleep experiences later in the postpartum may have revealed an association between sleep loss and mood.

Thus few studies of the relationship between sleep and mood in late pregnancy, during labour and in the first few days of the postpartum have been conducted. The few that have been conducted have been fraught with methodological difficulties and have presented mixed findings. There is a desperate need for further studies to investigate this issue.

Sleep and subsequent postpartum mood

Studies of the relationship between sleep disturbance and mood beyond the first postpartum week are also limited. Karacan et al. (1968) were the first to speculate that there may be an association between the sleep changes of pregnancy and postnatal emotional disturbance, suggesting that late pregnancy insomnia may be a manifestation of sub clinical depression, and that stage four suppression particularly could represent a marker for the subsequent development of postpartum depression. However, the impact of sleep disturbance in pregnancy on subsequent mood was not examined within their own study.

Coble et al. (1994) compared sleep in women with and without a history of affective disorder and predicted that disrupted sleep during pregnancy would precede the onset of depression during the postpartum period in those women with a history of depression. All women showed depressive symptom elevation, especially in late pregnancy and in

the first two to three months postpartum, when sleep disruption was greatest. However, Coble et al. (1994) found no association between mental health outcome and sleep during the first eight months postpartum for the women with a history of affective disorder. Coble et al. (1994) concluded that whilst sleep disturbance may be necessary for the development of affective problems postpartum, it is not sufficient.

Swain, O'Hara, Starr and Gorman (1997) compared sleep patterns, mood states and cognitive functioning of 30 women in the first three weeks postpartum with 28 non-postpartum controls. Sleep was assessed using sleep diaries. Overall sleep time for the two groups was similar, but postpartum women reported more time awake after retiring, more night wakings and more naps than controls. Swain et al. (1997) found a significant interaction between the week of the study and the amount of time spent awake at night for new mothers but not for controls, with postpartum women's time awake and number of wakings gradually decreasing across the study. Whilst postpartum women's sleep had improved by week three, sleep patterns were still significantly more disturbed than those of controls.

Postpartum and non-postpartum women differed on negative mood rating scales only during the first week, when new mothers reported significantly higher levels of dysphoric mood. This effect was eliminated after controlling for time awake at night, leading Swain et al. (1997) to conclude that loss of night time sleep was directly associated with negative mood during this period. Modest declines in memory and psychomotor performance were also associated with sleep loss.

Wolfson, Crowley and Bassett (2003) examined sleep patterns and mood ratings in 38 mothers at four time periods; during the last trimester of pregnancy, at two to four weeks postpartum, 12-16 weeks postpartum, and 12-15 months postpartum. At each time period sleep-wake patterns were assessed using a sleep diary which was completed for a seven day period. Wolfson et al. (2003) found significant sleep differences at two to four weeks compared with other periods. Women reported later rise times, more time awake due to disruptions and longer nap times at two to four weeks than at any other time point. There were no changes over the four time periods in total sleep time, bedtimes or sleep latencies.

Wolfson et al. (2003) found that at time point two, when sleep disruption was greatest, more depressive symptoms were reported than any other time period. This supports previous findings that women experience greater depressive symptoms in the early postpartum weeks. Wolfson et al. (2003) found no differences in sleep patterns between women who were depressed and those who were non-depressed at time point two. However, mothers who displayed depressive symptoms at time point two reported different sleep patterns at time point one, when compared with non-depressed mothers. These differences included longer nap times, longer total sleep times and later rise times.

However, both Wolfson et al.'s (2003) study and Swain et al.'s (1997) relied entirely on subjective estimates of sleep. No objective measure, such as polysomnography or actigraphy was used to verify the accuracy of the estimates made by participants. Participants were also not asked to subjectively evaluate the quality of their sleep experiences. A further criticism is that the sleep diary utilised by Wolfson et al. (2003)

did not discriminate between sleep disturbances caused by infant's sleeping behaviour and those that were not. Thus it is not possible to assess whether depressed women showed a different pattern of spontaneous versus infant related waking than non-depressed women.

One limitation of many postpartum sleep studies is that they do not control for the potential confound of depression with onset in pregnancy, and thus the effects of postpartum sleep disruption may become confused with the symptoms of a pre-existing depression. Chaudron, Klein, Remington, Palta, Allen and Essex (2001) explored potential risk factors for the subsequent development of postpartum depression in women who were not depressed at one month postpartum. They found that four variables were predictive of the development of depression between one and four months postpartum, namely history of depression, poor social support, thoughts of death or dying, and of most relevance to this review, difficulty in getting to sleep at one month postpartum. Number of sleep complaints of all kinds was not related to development of depression. However, in Chaudron et al.'s (2001) study, no sleep logs, EEG or actigraphic data was collected on sleep patterns. It is therefore not possible to ascertain whether difficulty getting to sleep was objectively poorer in women who went on to develop depression, or if the discriminating factor was purely subjective.

To summarise, the majority of studies of the relationship between sleep and postpartum mood suggest some association between sleep disturbance and depressive symptoms. This relationship remains when controlling for depressive symptoms that may have been present during pregnancy. Nonetheless, there are gaps and limitations to existing research which mean that further investigation of this issue is urgently needed.

Infant sleep disturbance and maternal mood

Further evidence for the role of sleep in postpartum mood comes from studies that have focused on the effects of infant sleep disturbance and the results of interventions to address this.

Looking to extend the findings of Chaudron et al's (2001) study, Dennis and Ross (2005) examined the influence of sleep disruption at four weeks and eight weeks postpartum in women who were not depressed at one week postpartum, as evidenced by a score of below 13 on the EPDS. Dennis and Ross (2005) found that three variables were significantly predictive of an EPDS score of over 12 at four and eight weeks postpartum, these were less than six hours sleep in a 24 hour period over the previous week, a baby that cried often and mother reporting often feeling tired. Dennis and Ross (2005) argued that new onset depression in the first eight weeks postpartum is strongly associated with infant sleep, maternal fatigue and maternal sleep deprivation.

Thomas and Foreman (2005) examined the sleep diaries of 37 postpartum women and their infants to identify factors contributing to maternal sleep in weeks four to 10 postpartum. Thomas and Foreman (2005) concluded that maternal sleep was driven by infant sleep and feeding patterns. Interestingly, maternal age was a significant predictor of mother and infant total sleep, with older mothers and their infants sleeping less. Infant gender was predictive of infant total sleep time, mean sleep period and number of feeding episodes, with male infants demonstrating more feeds, less sleep and shorter mean sleep, but total sleep time did not differ between mothers of male versus female infants.

Unfortunately, whilst Thomas and Foreman (2005) did utilise the EPDS as a screening tool, they did not examine mood as a predictive variable, and thus no information was available on how variation in mood scores correlated with maternal sleep patterns. Furthermore, women with possible postnatal depression were excluded from the study, and thus Thomas and Foreman (2005) did not compare the maternal and infant sleep patterns with and without depressive symptomatology.

A study by Hiscock and Wake (2001) has directly examined the relationship between infant sleep and maternal mood. Hiscock and Wake (2001) conducted a cross sectional community survey of 738 mothers of infants aged between six and twelve months of age. They found that 46% of mothers reported that their infant's sleep was a problem. Sleep patterns characterising problematic sleep included taking longer to fall asleep, waking more often and for longer periods, taking shorter naps, needing to be nursed to sleep and sleeping in the parent's bed. Problematic infant sleep was a significant predictor of scores above the clinical cut off on the EPDS, even after adjusting for known risk factors for postnatal depression. However, mothers reporting good sleep quality in spite of an infant sleep problem were not more likely to report high depression scores.

Other studies have examined the effects of behavioural interventions for infant sleep problems on maternal mood. Leeson, Barbour, Romaniuk and Warr (1994) studied 20 families of 23 infants aged 8-12 months that had been admitted to a residential unit for infant sleep problems. Participants completed a depression measure and five day infant sleep diary prior to admission and at one month follow up. All infants demonstrated improvements of sleep and a significant improvement in parental depression scores was

also seen. 14 of 20 (70%) of mothers met the criteria for depression prior to treatment, compared with just two (10%) at follow up.

However, no information was collected on parental sleep patterns either prior to or following treatment, and thus it is not possible to ascertain whether improvements in parental mood were a result of improved parental sleep patterns, or due to other factors, such as improved confidence in parenting abilities.

Armstrong, Van Haeringen, Dadds and Cash (1998) also explored the association between infant sleeping behaviour and maternal mood, and examined the impact of a behavioural sleep intervention. One hundred and fourteen families attended a single one hour outpatient appointment at a sleep clinic, at which they were given advice on behaviour modification techniques such as controlled crying and rewards. Participants completed a child's sleep behaviour questionnaire and EPDS, which they were asked to complete again at two month follow up; 70 participants returned follow up questionnaires.

There were significant post-intervention differences in children's sleep behaviour, including improvements in the mean number of night wakings, time taken to settle at night and mean rating of the sleep problem. Improvements were also seen in maternal mood, with a lower mean EPDS score and lower proportion of women showing scores above the clinical cut-off post-intervention.

Armstrong et al. (1998) suggest that the use of the EPDS in isolation as a screening tool for postnatal depression may lead to the identification and incorrect treatment of women

whose primary difficulty is disrupted sleep resulting from their infant's sleeping behaviour. Armstrong et al. (1998) also highlight that infant sleep disturbance and maternal mood present a 'chicken and egg' dilemma, wherein chronic sleep disturbance may lead to parental mood difficulties, but equally the impaired ability of a mother to attend to her infant's needs that results from depression may result in behavioural problems including irritability, attachment difficulties and sleep problems in the child.

One limitation to Armstrong et al's (1998) study is that they did not include a control condition and thus it is possible that the improvements seen reflect a natural tendency for infant sleep problems to resolve or improve over time, rather than the direct result of an intervention. Furthermore, as in Leeson et al's (1994) study, the design did not include a measure of maternal sleep patterns. It would have been of particular interest to examine the sleep characteristics of women with an EPDS score of 12 or above, to ascertain whether particular sleep characteristics are predictive of which mothers of infants with sleep problems report the greatest depressive symptoms.

One randomised control trial has been conducted which supports the association between the use of behavioural interventions for infant sleep problems and subsequent improvements in maternal mood (Hiscock and Wake, 2002). Mothers from Hiscock and Wake's (2001) survey were eligible for participation in the trial if over the previous two weeks the infant had demonstrated at least one of the following problems: waking on more than five nights a week, waking more than three times a night, taking more than 30 minutes to fall asleep, or requiring parental presence to fall asleep. One hundred and fifty six eligible mothers were randomly assigned to one of two conditions. Mothers in the intervention group received three consultation appointments in which they were

taught about the use of controlled crying as an approach to managing sleep problems. Mothers in the control condition were mailed a single sheet describing normal sleep patterns but not techniques for managing sleep, which the intervention group also received. Outcomes were measured at two and four months after randomisation.

Hiscock and Wake (2002) found that at two months, more infant sleep problems had resolved or improved in the intervention group than the control group. Women in the control group were significantly more likely to have sought additional help. At two months, depression scores fell significantly further in the intervention group than in the control group, after controlling for additional help. Mothers within the intervention group were more likely to rate their own sleep quality as 'very good' and more likely to have had 'enough' sleep than those in the control condition. However, at four months these differences were no longer significant. The only factor predicting an increase in depression scores was the persistence of a sleep problem.

In summary, studies of infant sleep disturbance have found that maternal sleep is strongly influenced by infant sleep and feeding patterns. Mothers of infants with sleep problems report more depressive symptoms, except where mothers report good sleep quality in spite of their infant's problems, suggesting that maternal sleep mediates the effect of infant sleep on maternal mood. Interventions for infant sleep problems have been found to lead to improvements maternal sleep and reductions in depressive symptoms. However, existing studies have failed to include direct measures of parental sleep patterns or to control for other potential confounds, such as the effect of increased confidence in parenting abilities on mood.

Why aren't all women with poor sleep depressed?

Clearly the presence of sleep disturbance in the perinatal period is insufficient to explain postpartum depression. The percentage of women reporting sleep disturbance in the postpartum period far exceeds the percentage of women reporting symptoms of postpartum depression. Thus far, few explanations have been put forward for the emergence of depressive symptoms in some but not all sleep disturbed women. However, several possibilities do exist, which are discussed below.

A hormonal basis for both sleep and mood disturbance?

One possible explanation is that both sleep and mood disruptions during the postpartum period are explained by a third variable. Hormonal disturbances represent one possible candidate. Separate studies have found relationships between postpartum depression and levels of oestrogen, progesterone, cortisol and prolactin during the postpartum period. Significant alterations in the activity of these hormones have been noted during pregnancy and the postpartum.

However, these studies did not examine the effect of hormonal alterations on both postpartum mood and postpartum sleep patterns. Only one study has examined the effects of hormone levels on postpartum sleep, and this found that postpartum REM sleep and mood state were not related to progesterone levels (Lee, McEnany & Zaffke, 2000). The influence of other hormones, and the interaction between several hormones were not considered. Further research is needed to clarify the relationship between hormones, sleep and mood within this population.

A distinct sleep profile associated with postpartum depression?

A further possibility is that postpartum depression is associated with a pattern of objective sleep disturbance that is significantly different than that demonstrated by non-depressed women during pregnancy or the postpartum period, and thus can be identified by a distinct biological marker.

To date only one study, by Godfroid, Hubain, Dramax and Linkowski (1997) has examined sleep in women reporting current symptoms of postpartum depression. Godfroid et al. (1997) examined the EEG profiles of 24 depressed women to ascertain whether the polysomnographic profiles of postnatally depressed women are distinct from those of women with non-postpartum depression. Godfroid et al compared the profiles of eight women with a current diagnosis of postpartum depression, eight with a diagnosis of major depression and a history of postpartum depression, and eight women with a diagnosis of major depression but no history of postpartum depression. Godfroid et al. (1997) found that there was no difference between the profiles of those depressed women with a history of postpartum depression and those of depressed women without a history of postpartum depression. However, women with current postpartum depression showed significantly longer Stage 4 sleep, a strong tendency to shorter Stage 1 sleep and greater sleep efficiency than women with non-postpartum depression of the same severity. Godfroid et al. (1997) suggested that this finding provides support for the theory that postpartum depression represents a distinct and separate diagnostic entity.

Frank, Kupfer, Jacob, Blumenthal and Jarrett (1987) examined 52 women with at least one child and two or more previous depressive episodes in an attempt to identify features which might discriminate pregnancy related depressive episodes from those with a non-puerperal onset. Twenty four women reported experiencing one or more depressive episode either during pregnancy, in the first six months after delivery or both in pregnancy and postpartum. Frank et al. (1987) found no differences between pregnancy and non pregnancy related depression in response to treatment, whether they achieved full remission, or the likelihood of relapse. However, significant differences were noted in EEG profile with significantly longer REM time and more activity within the pregnancy related group. These differences were accounted for almost entirely by the women with purely postpartum episodes.

Thus whilst there is tentative evidence to suggest differences in sleep patterns between postpartum and non postpartum depression, findings are inconsistent and further research is needed to clarify this issue.

Impaired perception of sleep as a discriminating factor?

There is some evidence to suggest that the relationship between objective and subjective measures may differ between psychiatric groups and healthy controls. Insomniacs have been noted to overestimate sleep latency and duration of waking episodes, when compared with controls (Knab & Engel, 1988). One possibility is that subjective perception of sleep represents an important variable in distinguishing those who display psychiatric difficulties from those who do not.

Edinger and Fins (1995) examined the relationship between polysomnography recordings and subjective sleep perceptions of 173 individuals with insomnia. They found that insomniacs as a group produced sleep estimates that were significantly lower than actual sleep time which was measured by EEG. However, patients' sleep-time perceptions were widely distributed from underestimates to gross overestimates of actual sleep time. Thus insomnia may be associated with an impaired ability to judge sleep timing. This may be of relevance given that several studies have noted increased insomnia and decreased sleep efficiency amongst a significant proportion of women during the final trimester of pregnancy. It should be noted that Edinger and Fins (1995) did not include a control group in their study, and thus no information is available on how this group compared with healthy individuals in their ability to judge sleep timing.

Rotenberg (1993) also found that patients with psychiatric disorders may be unable to accurately judge sleep. He compared subjective perceptions of sleep quality in 75 individuals with a number of psychiatric disorders including depression, anxiety, hypochondriasis and conversion hysteria with those of 15 healthy controls. Rotenberg (1993) noted that the presence of REM sleep seemed more essential to estimation of sleep quality than duration of sleep before waking. Psychiatric patients were more likely than controls to deny having been asleep following awakenings from slow wave sleep, and reported they had not slept more often than healthy controls even when the sleep time contained REM. Thus there appeared to be significant differences in the subjective perception of sleep timing and quality between the healthy and psychiatric groups above and beyond objective sleep variations.

It is of interest to note that whilst objective sleep disturbances have been noted in 40-70% of individuals with major depressive disorder (Armitage et al. 1992), subjective or self-reported sleep disturbances are estimated to occur in over 80% of individuals with depression (Reynolds & Kupfer, 1987), supporting the notion of a discrepancy between objective and subjective sleep assessments within this psychiatric group.

Armitage, Trivedi, Hoffman and Rush (1997) examined the relationship between objective and subjective sleep measures in 52 depressed patients and 49 controls. With the exception of number of wakings, subjective and objective sleep measures were strongly correlated in both depressed individuals and healthy controls, suggesting that depressed individuals are not prone to the same sleep misperceptions as insomniacs. However, sleep quality and how rested individuals felt upon waking were not strongly correlated with objective sleep characteristics, particularly in the depressed group. Subjective sleep quality in the depressed group was significantly associated only with time awake, whilst in controls was related to number of wakings and amount of slow wave sleep. Therefore whilst depression does not seem to be associated with inaccurate perceptions of sleep timing, the relationship between objective sleep timing and subjective perceptions of sleep quality does seem to differ between depressed and non-depressed individuals.

Other studies assessing the correlation between objective and subjective sleep measures have also found a discrepant relationship within depressed individuals. Lee, Reynolds, Hoch, Buysse, Mazmudar, George et al. (1993) explored the correlation between objective and subjective measures in 15 depressed individuals and 15 matched controls. They found that following symptom remission, depressed individuals showed an

improvement of subjective sleep quality, which contrasted with the stability of objective sleep parameters such as REM latency and slow wave sleep ratio. Rotenberg, Indursky, Kayumov, Sirota and Melamed (2000) explored the relationship between measures in 30 depressed individuals and 10 controls and found a greater degree of error in sleep estimation amongst depressed individuals. Within depressed individuals, slow wave sleep correlated positively with estimated sleep duration, but not with sleep depth or sleep quality, whilst eye movement density in REM was correlated with subjective perception of number of wakings. Such findings suggest a complex relationship between objective measures and subjective perception of the sleep experience in depression.

Further evidence for a differing relationship between factors of sleep timing and subjective perceptions of sleep quality in depressed and non-depressed individuals can be found in a study by Mayers, Hooff and Baldwin (2003). Mayers et al. (2003) compared the sleep diaries of 20 depressed patients with 20 matched controls and found that the depressed group reported significantly poorer perceptions of sleep quality than controls, even though estimates of sleep timing did not significantly differ between groups. Mayers et al. (2003) posited that depressed individuals may experience greater "sleep distress" than healthy controls experiencing equivalent objective sleep disruption.

Thus whilst no research has directly explored this issue using pregnant or postpartum samples, research from other groups, including those with major depression, suggests that subjective perceptions of sleep in psychiatric groups may be distorted. It may be that the distinction between women who go on to develop postpartum mood disorders

and those who do not lies not in the level of objective sleep disturbance, but in their perceptions of the sleep experience. Further research is needed to explore this possibility.

Conclusions

Evidence from both subjective and objective studies supports the occurrence of significant sleep alterations that begin early in pregnancy and continue into the postpartum period. The extent of these changes has been found to be affected by variables such as parity, feeding method and history of depression. Sleep changes have been associated with depressed mood in non-pregnant samples, and there is some evidence to link sleep disturbance with postpartum mood. This association may be explained by greater subjective distress at sleep disruption, by hormonal abnormalities or by an EEG profile which is unique to postpartum depression. However, existing research is limited and has been hampered by methodological shortcomings. Further studies are needed to clarify the changes that occur throughout pregnancy and postpartum and their relationship with postpartum mood, utilising larger, more representative samples and consistent measurement strategies. A greater emphasis needs to be place on hypothesis testing research, such that a greater understanding of the way in which sleep is associated with postpartum mood disorder can be ascertained.

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Empirical Paper*

The relationship between sleep and mood in postpartum women

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*Applying guidelines for publishers for submission to Journal of Sleep Research (Appendix 2)

Summary

There is considerable evidence to support an association between sleep disturbance and major depression, yet few studies have explored the link between sleep and depressive symptoms in the postpartum period, a time at which sleep disturbances are widely reported. The present study explored relationships between objective and subjective sleep, mood and fatigue in 14 women with no psychiatric history and 7 women with a history of depression at one, three and five weeks postpartum. Actigraphy was employed as an objective measure of sleep, sleep diaries were used as a subjective measure. Sleep efficiency, defined as the percentage of total time in bed spent asleep, was used as the measure of sleep quality. Subjective sleep efficiency at week one postpartum was found to be correlated with depressive symptoms at weeks three and five. There was no evidence for an association between objective sleep efficiency and depressive symptoms. There was an effect of postpartum week on subjective sleep efficiency, depression and fatigue scores. Depression and fatigue ratings reduced as sleep efficiency improved with time since the birth. Women with a history of depression showed poorer subjective sleep efficiency and greater depressive symptoms than women without a history of depression. The implications of these findings are discussed, along with methodological shortcomings of the present study.

Key words: sleep efficiency, postpartum, depression

Introduction

Postpartum depression affects an estimated 10 – 15% of childbearing women (O'Hara & Swain, 1996). It is distinct from the postpartum 'blues', which affect 75-80% of women in the first three to seven days after delivery and have been attributed to the rapid fall in placental hormones during this period (Lee, 1998). Postpartum depression has been associated with increased marital stress, family breakdown and with disturbances in child emotional and cognitive development (Cogill, Caplan, Alexandra, Robson & Kumar 1986). Although there is currently no separate diagnostic category for postpartum depression within the Diagnostic and Statistical Manual of Mental Disorders (APA, 1994), two thirds of women who develop depression during the postpartum period have no previous history of depression (Coble, Reynolds, Kupfer, Houck, Day & Giles, 1994). This has led some authors to argue that postpartum depression may be distinct from major depression (e.g. Cooper and Murray, 1995) and may have a biological basis.

One biological factor which has recently gained attention within the perinatal literature is sleep. There is a well documented relationship between disturbed sleep and major depression. Differences in objective sleep patterns using EEG have been found in 40 to 70% of individuals diagnosed with major depression (Armitage, Roffwarg, Rush, Calhoun, Purdy & Giles, 1992). In a meta analysis of 177 objective sleep studies of psychiatric disorders, Benca, Obermeyer, Thisted and Gillin (1992) found that depressed individuals consistently showed shorter total sleep time, greater time to fall asleep (increased sleep latency), reduced slow wave sleep, were quicker to reach REM sleep (decreased REM latency) and spent longer in REM sleep than healthy controls.

Differences in subjective reports of sleep have also been noted, with depressed patients reporting poorer perceived quality of sleep than controls (Mayers, Van Hooff, & Baldwin 2003). Furthermore, the risk of developing major depression is significantly increased in individuals with a history of insomnia (Breslau, Roth, Rosenthal, & Andreski, 1996) and interventions which treat sleep disturbance result in a decrease in depressive symptoms (Morawetz, 2003).

Sleep disturbance is a prominent concern for many new mothers, and significant sleep changes have been observed during the postpartum period. Studies using EEG and sleep logs have found that postpartum women experience shorter total sleep time, greater night awakenings and poorer sleep efficiency (the percentage of time in bed that is spent asleep) than non postpartum women (e.g. Nishihara Horiuchi, Eto & Uchida, 2001; Horiuchi & Nishihara, 1999). These changes occur particularly, but not only, when sleep is interrupted by infant waking. Actigraphy, which involves wearing a compact activity monitor on the wrist or ankle, provides a less intrusive alternative to EEG studies. This makes it a good tool for use with perinatal samples. Actigraph studies have also found poorer total sleep time, poorer sleep efficiency and more awakenings in the early postpartum period, when compared with later on (Shinkoda Matsumoto & Park, 1999; Kang, Matsumoto, Shinkoda, Mishima & Seo, 2002). The incidence of depression is three times greater in this early period than at later stages (Cox, Murray, & Chapman, 1993).

Despite the strong case for a link between sleep and major depression, few studies have specifically assessed the relationship between sleep and mood in postpartum women. Using EEG, Coble, Reynolds, Kupfer, Houck, Day and Giles (1994) compared sleep

patterns of 14 women with, and 20 without, a history of affective disorder during pregnancy and the postpartum period. Coble et al. (1994) noted that depressive symptom elevation was greatest for both groups between late pregnancy and the first two to three weeks postpartum, when sleep disruption was also greatest. Women with a history of affective disorder reported greater depressive symptoms throughout pregnancy and the postpartum. They also showed greater sleep disruption, including greater changes in total sleep time and a reduction in REM latency, than the no history group.

Similar findings emerged from a study by Lee, McEnany and Zaffke (2000), who examined sleep and mood during pregnancy and postpartum in 31 women, using EEG. Like Coble et al. (1994) they found that the most negative mood ratings were reported at three to four weeks postpartum and that the most pronounced changes in sleep were observed for all participants between the third trimester of pregnancy and three to four weeks postpartum. Lee et al. (2000) divided participants into a positive affect group, who showed a less than 30% change in mood ratings from the third trimester to one month postpartum, and a negative affect group, who showed a greater than 30% change in mood ratings. The negative affect group showed significantly less REM sleep, shorter total sleep time and greater waking time at one month postpartum than the positive affect group. Lee et al. (2000) concluded that sleep and mood were significantly affected at one month postpartum as a result of increased awakenings during the night.

Thus EEG studies suggest that depressive symptoms are greatest at the time period when sleep disturbance is most pronounced, and that women reporting greater

depressive symptoms also show greater sleep disruption. However, whilst Lee et al.'s (2000) negative affect group showed a greater change in mood ratings, not all group members showed symptoms above the clinical cut off for depression. Furthermore, in Coble et al.'s (1994) study, only one participant went on to show clinically significant depressive symptoms. This led Coble et al. (1994) to conclude that whilst objective sleep disturbance may be necessary for the development of postpartum depression, it is not sufficient.

Studies of subjective reports of postpartum sleep suggest a more complex relationship between postpartum sleep and mood. Wilkie and Shapiro (1992) examined sleep and mood in the first ten days postpartum in 63 women, using sleep logs. Wilkie and Shapiro (1992) found that subjective perception of sleep quality was associated with mood on the following day for five of the ten postpartum days, but that correlations between sleep quality and mood were weakest at the point when depressive symptoms peaked. However, subjective ratings for sleep disturbance in the week prior to delivery were strongly correlated with emotional distress levels at one week postpartum.

A similar pattern was noted by Wolfson, Crowley, Anwer and Bassett (2003). They used sleep logs to assess the relationship between subjective sleep disturbance and mood in 38 women during the last trimester of pregnancy and at 2-4 weeks, 12-16 weeks and 12-15 months postpartum. As in other studies, Wolfson et al. (2003) found that women reported the greatest sleep disturbance at two to four weeks postpartum and that depressive symptoms were also greatest at this time point. However, Wolfson, Crowley, Anwer and Bassett (2003) found no differences between the sleep patterns of depressed and non-depressed women at two to four weeks postpartum. Instead, those

women who developed clinically significant symptoms at two to four weeks postpartum showed significantly different sleep patterns during the last trimester of pregnancy when compared with non-depressed women. These sleep patterns were characterised by later rise times, longer naps and greater total sleep time (excluding naps).

Thus findings from studies utilising subjective sleep reports support an association between sleep disturbance and depressive symptoms during the postpartum period, but suggest that sleep disturbance may be associated with mood disturbance in subsequent weeks, rather than having an immediate effect. The studies could also be interpreted as evidence that it is sleep during the final trimester of pregnancy and not postpartum sleep that is associated with postpartum mood disturbance. However, these studies suffer a significant methodological shortcoming, in that they do not control for the potential confound of depression with an onset in pregnancy. More studies are needed which control for this confound, to establish whether a relationship exists between sleep in the early postpartum and subsequent mood.

One subjective study that did control for the possible effects of pre-existing depression has found a significant relationship between postpartum sleep and subsequent postpartum mood. Dennis and Ross (2005) examined the influence of sleep disruption upon mood at four and eight weeks postpartum in women who were not depressed at one week postpartum. They found that the presence of three variables at four weeks were significantly predictive of a score above the clinical cut off on the Edinburgh Postnatal Depression Scale at eight weeks. These were less than six hours sleep in a 24 hour period, a baby that cried often, and a mother reporting often feeling tired. Dennis

and Ross (2005) concluded that postpartum depression was associated with infant sleep, maternal fatigue and maternal sleep deprivation.

Studies of infant sleep problems support an association between infant sleep patterns and maternal sleep and mood (e.g. Armstrong, Van Haeringen, Dadds & Cash, 1998) However, Hiscock and Wake (2001) found that mothers with poor infant sleep reported higher depression scores than those with better infant sleep, except if they reported high subjective sleep quality themselves. This suggests that the influence of infant sleep on maternal mood may be mediated by mothers' perceptions of their own sleep quality.

To date no studies of postpartum mood have utilised both subjective and objective measures of sleep. Furthermore, most studies have not asked participants to rate their perception of the quality of sleep that they have received. Consequently it is difficult to ascertain whether depressed mood during the postpartum is related to objectively greater sleep disturbance, or to differences in subjective perception of sleep quality. Interestingly, Mayers et al. (2003) found that individuals with major depression showed poorer perceptions of sleep satisfaction than controls, even though estimates of sleep timing (e.g. total sleep time, time awake) were similar. Furthermore, a study by Armitage, Trivedi, Hoffman and Rush (1997) found that within individuals with major depression, subjective perceptions of sleep quality were not strongly correlated with objective sleep characteristics. This suggests that subjective perceptions of sleep quality and not level of objective sleep disturbance may be critical in discriminating which women go on to show symptoms of postpartum depression. The use of both sleep diaries and an objective measure of sleep in combination would allow this hypothesis to

be tested, through comparing the relationship of both objective and subjective sleep measures with mood.

Whilst postpartum sleep and mood disturbances have been reported to be most severe during the first two to four postpartum weeks (e.g. Wolfson, et al, 2003), there is a paucity of published data on the interaction between sleep patterns, mood and postpartum week, in the early postpartum period. This is somewhat surprising, given that actigraph studies have noted a significant effect of time since birth on sleep disruption (e.g. Shinkoda et al., 1999). Swain, O'Hara, Starr, & Gorman (1997) compared sleep patterns and mood ratings of 30 women in the first three weeks postpartum with 28 non postpartum controls, using sleep logs. They found a significant interaction between the week of the study and degree of sleep disruption within the postpartum sample. Postpartum and non-postpartum women differed on negative mood rating scales only during the first week, when new mothers reported significantly higher levels of dysphoric mood. This effect was eliminated after controlling for time awake at night, leading Swain et al. (1997) to conclude that loss of night time sleep was directly associated with negative mood during the first week postpartum.

Swain et al (1997) proposed that during the first three postpartum weeks women make adjustments to their sleep patterns, and that it is important that these adjustments are made successfully to avoid the negative consequences of sleep disturbances, such as dysphoric mood. It is possible that, had Swain et al (1997) continued to collect data in the following weeks, both sleep and mood would have improved significantly as time progressed. Postpartum depression has a similar duration to depressions arising at other times, with episodes typically lasting from two to six months (Cooper and Murray,

1998). Information about the temporal relationship of sleep and mood disturbance in healthy women in the early postpartum period would increase understanding of women who may be at risk of continued clinically significant affective disturbance.

In addition, as with other studies, Swain et al.'s (1997) study was limited by its reliance on subjective information regarding factors of sleep timing. The introduction of an objective measure of sleep timing, and a measure of subjective perception of sleep quality, would provide a more comprehensive assessment of the relationship between sleep and mood across time. Furthermore, it may present evidence to challenge Swain et al.'s (1997) conclusion that loss of night time sleep was directly associated with mood during the early postpartum period. Objective loss of sleep may only be associated with negative postpartum mood if it leads women to perceive their sleep as disrupted or poor in quality. Actigraphy provides an ideal tool for measuring objective changes in sleep over time. When compared with EEG, it is less intrusive and can be worn day and night in the participants own home. This allows for consideration of the effects of day time napping and enables recording over a longer period. Actigraphy is therefore a more naturalistic methodology, and this is likely to be a particularly important consideration in the early postpartum period.

A number of other risk factors for postpartum depression have been identified within the literature, including self-esteem, social support, marital relationship and socioeconomic status (Beck, 2001). However, the most robust predictor of postpartum depression is a prior history of depression. Twenty five percent of all women with a history of depression experience a new episode during the postpartum period (Coble, Reynolds, Kupfer, Houck, Day & Giles, 1994). Coble et al. (1994) found that women with a history of depression show greater objective sleep disturbance in the postpartum

period than those without a history of depression, but that objective sleep disturbance was not associated with the development of postpartum depression in these women. As yet no study has compared subjective perceptions of sleep within postpartum women with and without a history of depression. If subjective perception of sleep quality and not objective sleep disturbance is associated with postpartum mood in healthy women, one might predict that women with history of depression would show poorer subjective perceptions of sleep quality than those with no history.

The present study is the first to look at the relationship between sleep and mood in the postnatal period, comparing subjective and objective measures. It will also examine the interaction between postpartum week, sleep patterns and mood, with the aim of extending the findings of Swain et al. (1997) on this issue. Both women with and without a history of depression will be examined, to explore whether women with a history of depression differ from those with no history in their objective and subjective sleep patterns.

Hypotheses

I. Poorer sleep quality in the first week postpartum, as assessed by both objective and subjective measures, would be associated with greater symptoms of depression and fatigue in subsequent weeks.

II. Poorer *subjective* perceptions of sleep quality would be associated with greater symptoms of depression and fatigue, even after controlling for differences in *objective* sleep quality (i.e. sleep efficiency).

III. In healthy women with no history of depression, a significant improvement in sleep efficiency would be seen between weeks one, three, and five postpartum. Mood and fatigue measures would follow the same pattern. In women with a history of depression, this pattern would differ.

IV. Women with a history of depression would show greater objective and subjective sleep disturbance and report greater symptoms of depression and fatigue than women with no history of depression.

Method

Design

The first and second hypotheses were assessed using a correlational design to investigate relationships between subjective sleep efficiency, objective sleep efficiency, depression and fatigue scores. A mixed model design was used to explore hypotheses three and four. The third hypothesis predicts a main effect of postpartum week (repeated measures) and an interaction, the fourth predicts a between groups difference. The factor postpartum week had three levels (weeks 1, 3 and 5) and group had two levels (history versus no history of depression).

Participants

A total of 21 participants were recruited via local midwives, advertisement on the website 'Netmums' and the National Childbirth Trust (NCT). Women with a history of depression were recruited via the local Perinatal Mental Health Service. The mean age of participants was 31.75 (SD = 3.96, range 24 to 39). Seven women had a history of

depression. Seven women were first time mothers (6 no history, 1 history of depression), whilst the remaining fourteen had other children.

When recruiting women with a history of depression, the initial approach was made by a member of the clinical team, who offered information about the study. Individuals who expressed an interest were telephoned by the researcher and asked to give permission to be contacted following the birth. The researcher was notified by the perinatal team once the participant had delivered.

To recruit women with no history of depression, midwives were asked to publicise the study at check up appointments and at birthing classes. Posters were also placed around local hospitals to increase awareness. Potential participants were informed of the study by their midwives during the third trimester of pregnancy, at approximately 32-36 weeks, with a view to recruiting at delivery. Stickers were placed in participants' files, reminding midwives to alert the researcher when the participant delivered.

In addition, information sheets were posted on the Netmums website, handed out to local NCT mother and baby groups and circulated with the NCT business meeting minutes, inviting women in their final trimester to participate. Women were asked to contact the researcher to discuss the study further and to give permission to be contacted nearer to their delivery date. Participants recruited in this way agreed to contact the researcher once they had delivered. In addition, a phone call was made one week prior to the due date, and if no news had been received, a further phone call made one week following the due date, to ensure that no potential participants were missed.

Women with serious obstetric complications or problems with the infant that lead to hospitalisation of the mother beyond the first week postnatally were excluded from the study.

Measures

Actigraph

An Actigraph is a compact activity monitor which can be strapped to a participant's wrist. Recordings were utilised to achieve an objective measure of sleep. Although it cannot detect sleep stages or REM states, the actigraph can provide information on sleep presence or absence and nocturnal disturbance. Actigraphs have been utilised previously in studies of postpartum women (e.g. Shinkoda et al., 1999, Kang et al., 2002) and have the advantage of being cheaper and less invasive than EEG studies. Actigraphy has been found to compare well with sleep EEG in terms of sleep onset (r = .77) and offset (r = .88) and total sleep time (r = .57) (Lockley, Skene & Arendt, 1999). Good correlations have also been found between actigraphy and sleep logs for total sleep time (r = .71), sleep efficiency (r = .74), time in bed (r = .81) and sleep latency (r = .64) (Shinkoda et al, 1999). Kushida et al. (2001) have suggested that the accuracy of actigraphy is further improved when used in combination with subjective ratings.

Adapted Pittsburgh Sleep Diary (PghSD; Monk et al. 1994)

This self-report diary was used to measure subjective ratings of sleep and is comprised of 15 items. Whilst the amended sleep diary has yet to be formally tested for validity and reliability, it has been used successfully in a number of studies examining subjective sleep reports in depression (e.g. Mayers et al, 2003). A copy of the amended diary has been included as Appendix 3.

Edinburgh Post Natal Depression Scale (EPDS; Cox, Holden & Sagovsky, 1987).

This ten item self report scale has been developed specifically to identify depression in new mothers. An overall score of ≥12 indicates a likelihood of depression. The EDPS has been found to have good sensitivity (86%), specificity (78%) and split-half reliability (.88) (Cox et al., 1987). It is quick and simple to complete and is sensitive to change in severity of depression over time (Cox et al., 1987). Furthermore, EPDS scores at five days postpartum have been found to be predictive of postpartum depression at six weeks postpartum (Hannah, Adams, Lee, Glover and Sandler, 1992).

Multidimensional Assessment of Fatigue Scale (MAF; Belza, 1995)

This 16 item self-report measure was used to assess subjective fatigue. The measure assesses four dimensions of fatigue: severity, distress, interference with daily activity and timing. It takes under five minutes to complete and participants can omit items that do not apply, making it a more accurate assessment of the impact of fatigue on activities of daily living. Scores range from 1 (no fatigue) to 50 (severe fatigue). The MAF has been shown to have high internal consistency (Cronbach's alpha = .93) and has high convergent validity (r = .84) with the fatigue subscale of the Profile of Mood States questionnaire (Belza, 1995). It has been used with a range of populations, including use in previous research with postpartum women (Williams et al., 1999).

Structured Clinical Interview for DSM-IV Axis I Disorders Clinician Version (SCID-CV; First, Spitzer, Gibbon & Williams, 1996)

To assess previous history and current depression, the depression questions from the SCID-CV (First, Spitzer, Gibbon & Williams, 1996) were administered to all participants. The SCID-CV was designed with separate modules for each class of

diagnoses and allows the researcher to administer only those modules of particular relevance, making it ideal for the purpose of this study.

Procedure

Once ethical approval had been obtained from the University (see Appendix 4) and the local regional ethics committee (see Appendix 5 and 6), initial contact with participants was made during the final trimester of pregnancy. At this stage participants were given information about the nature of the study and were asked for consent to be contacted following the birth. Copies of the information sheets given to potential participants for each group are included as Appendix 7 and 8.

Full informed consent was sought from participants a few days following the birth, as it was felt that at this point they would be more able to realistically judge whether they felt up to participating. This approach also averted the potential distress caused by having to exclude any potential participants who had only recently given full consent because of obstetric complications. Copies of the consent forms for participants are included as Appendix 9 and 10.

At this stage participants in both groups were formally assessed for history of and current depression using the depression questions from the SCID-CV. Individuals were separated into two groups, a history of depression and a no history group. Any individuals found to have a current depression at time point one were excluded from the study. Individuals reporting depression during pregnancy, but not at time point one, were not excluded. Participants were also asked to provide demographic information at this time.

Participants wore the Actigraph continuously for a 5 day period at 1 week, 3 weeks and 5 weeks post birth. During each 5 day period they completed the sleep diary nightly and on the fifth day completed the EPDS and MAF.

Any participants excluded at time point one because of current depression, or who went on to report scores of 12 or above on the EPDS during the course of the study were referred to the perinatal mental health team for further assessment.

Sleep parameters

For the subjective data, sleep parameters were calculated as follows. Diary total sleep time was the total number of night time minutes spent asleep, calculated using diary information alone. This equals the number of minutes from reported first attempt at sleep to reported wake time, less the time from first attempting sleep to sleep onset (sleep latency) and any night wakings. *Diary sleep efficiency* was total sleep time divided by total time spent in bed. To rate subjective sleep quality, participants were asked to place a mark along a 100mm line (e.g. where end points represented very good versus very poor sleep quality). To code this variable, the positioning of marks along the line were measured and numbers assigned from 0 to 100, starting from the right hand side of the page.

The actigraphs were programmed with an algorithm which assigned each minute as either sleep (-300) or waking (0). The criterion for a sleep episode was a series of 5 consecutive minutes coded as -300. This criterion was selected to prevent isolated minutes of motionlessness from being counted as discreet sleep episodes. Similarly, within night time sleep, a waking episode was defined as a series of 5 or more

consecutive 0's. Actigraph sleep onset was defined as the first series of 5 or more -300's that occurred following self-reported first attempt at sleep. Where an actigraph defined sleep episode was already underway at the reported 'first attempt' time, actigraph sleep onset was defined as the beginning point of this sleep episode. Actigraph wake time was defined as the end point of the last sleep episode occurring prior to the reported getting up time.

Actigraph total sleep time was the total number of night time minutes spent asleep between actigraph sleep onset and actigraph wake time. *Actigraph sleep efficiency* was actigraph total sleep time divided by total number of minutes between actigraph sleep onset and actigraph wake time. Variables were calculated for each day, then the mean for each 5 day recording period was used to provide a single score on each variable for each of the three time points.

Data Analysis

Data analysis was conducted using SPSS 13. Hypothesis one was tested using Pearson correlations, hypothesis two using partial correlations and hypotheses three and four using a series of ANOVAs. Missing data were dealt with in the correlational analyses using pairwise deletion, i.e. only participants who provided data for both the variables being correlated were included in each analysis.

As the data met parametric assumptions and Levene's test indicated that there were few departures from the homogeneity of variance assumption, parametric tests were used. Tabachnik and Fidell (1996) report that unequal sample sizes can cause problems and may inflate Type 1 Error in factorial designs. They suggest several methods for

minimising potential problems and a combination of these strategies was used. To minimise error for within-subjects factors, cases with incomplete data were excluded. To minimise error for between subjects factors, Tabachnik and Fidell's (1996) "Method 1" was used. This tests the same hypotheses as a regular mixed model ANOVA, but uses a regression type approach, where all main effects and interactions are tested after taking the others into consideration. The cell means used are weighted marginal means based on Type III Sums of squares. Type III sum of squares calculates the sum of squares of an effect adjusted for all other effects that do not contain it, and orthogonal to any effects that contain it. For clarity tables and graphs show standard unweighted means and standard deviations. Non-parametric tests were used to check that significant main effects were not due to type 1 error.

For ANOVA results, where Mauchly's Test of Sphericity indicated the assumption of sphericity was not met, Greenhouse-Geisser corrections were used. Uncorrected degrees of freedom are reported.

Results

Missing data

A total of 21 women participated in the study. However, not all participants provided data for all time points. Table 1 summarises the data available for each of the main variables used in the analysis. Table 2 gives means and standard deviations for each of the variables, by group and as a whole sample.

Table 1

Table of frequencies for variables

	Week 1	N	Week 3	N	Week 5	N
Diary	History	7	History	5	History	4
	No history	14	No history	14	No history	14
Actigraph	History	5	History	2	History	3
	No history	14	No history	13	No history	13
EPDS	History	6	History	6	History	5
	No history	14	No history	14	No history	14
MAF	History	6	History	6	History	5
	No history	14	No history	14	No history	14

Table 2

Means and standard deviations for all variables.

	Week 1	Mean (SD)	Week 3	Mean (SD)	Week 5	Mean (SD)
Diary sleep efficiency	History	.66 (.12)	History	.76 (.14)	History	.75 (.07)
	No history	.76 (.07)	No history	.76 (.08)	No history	.80 (.06)
	Whole	.73	Whole	.76	Whole	.79

	sample	(.10)	sample	(.10)	sample	(.06)
Actigraph sleep efficiency	History	.78 (.09)	History	.73 (.04)	History	.75 (.09)
	No history	.80 (.08)	No history	.82 (.07)	No history	.84 (.08)
	Whole sample	.80 (.08)	Whole sample	.81 (.08)	Whole sample	.82 (.09)
EPDS	History	16.50 (6.89)	History	15.67 (6.98)	History	13.60 (3.50)
	No history	6.64 (3.99)	No history	5.50 (4.18)	No history	4.07 (3.83)
	Whole sample	9.60 (6.70)	Whole sample	8.55 (6.90)	Whole sample	6.58 (5.65)
MAF	History	34.28 (3.76)	History	34.97 (7.01)	History	29.30 (5.66)
	No history	22.45 (9.00)	No history	19.47 (11.31)	No history	16.01 (9.93)
	Whole sample	25.99 (9.49)	Whole sample	24.12 (12.39)	Whole sample	19.51 (10.70)
Diary sleep quality	History	54.98 (19.79)	History	41.37 (11.34)	History	64.05 (10.99)
	No history	64.38 (18.24)	No history	61.97 (19.22)	No history	69.67 (19.26)
	Whole sample	61.25 (18.82)	Whole sample	56.55 (19.56)	Whole sample	68.42 (17.62)

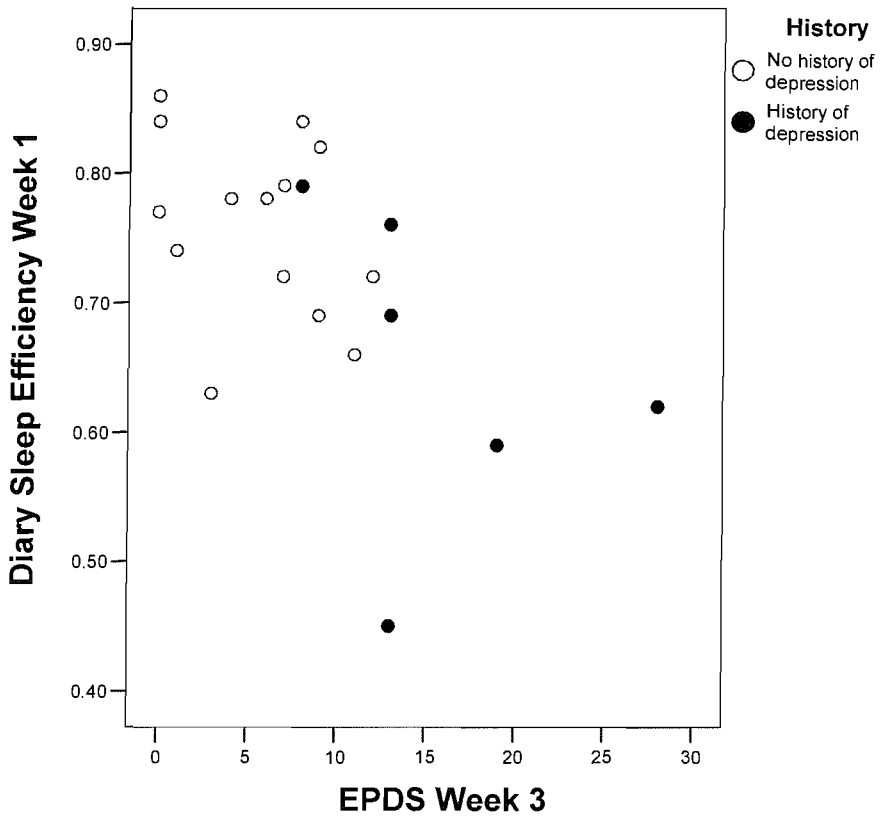
Note. Standard deviations appear in parentheses.

Association between sleep and mood

To test hypothesis one, Pearson correlations were used. A correlation between diary sleep efficiency at week 1 and EPDS score at week 1 revealed a trend towards a negative correlation between sleep efficiency and EPDS scores but this was not significant (r = -.425, n = 20, p = .062). A significant negative correlation was found between diary sleep efficiency at week 1 and EPDS score at week 3 (r = -.570, n = 20, $p < .01$, two tailed) and between diary sleep efficiency at week 1 and EPDS score at week 5 (r = -.490, n = 19, $p < .05$, two tailed). Poorer diary sleep efficiency was associated with higher scores on the EPDS. There was no evidence for significant correlations between actigraph sleep efficiency at week 1 and EPDS scores at week 1(r = -.302, p = .209), week 3 (r = -.140, p = .579) or week 5 (r = -.227, p = .365). Thus subjective, but not objective sleep efficiency at one week postpartum was associated with mood in subsequent weeks.

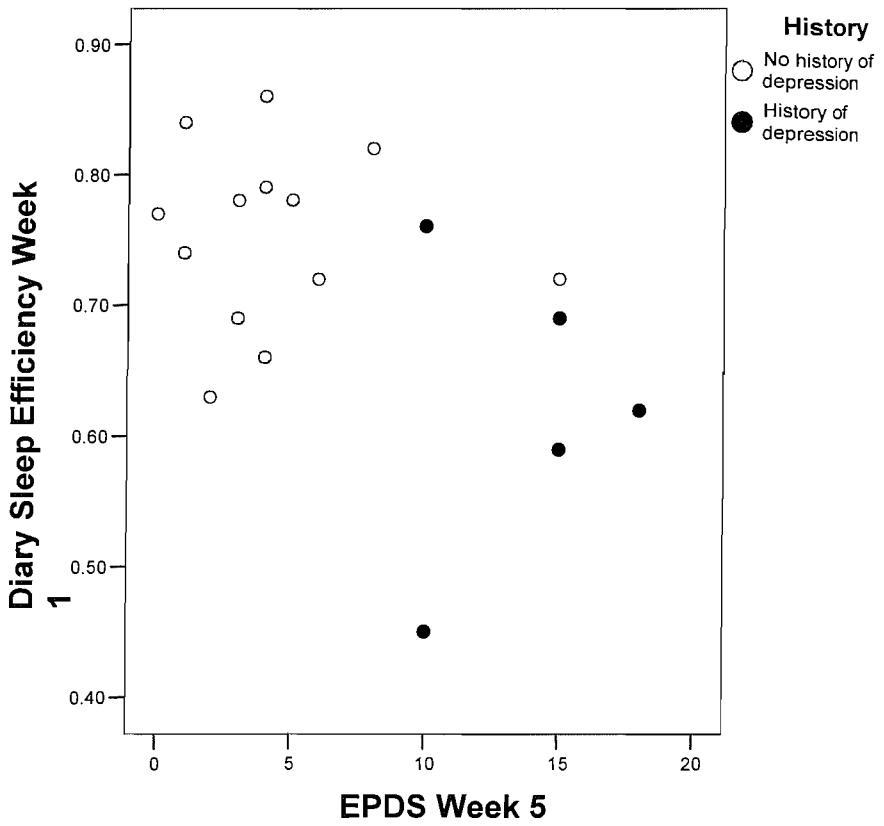
Figure 1 shows the association between diary sleep efficiency at week 1 and EPDS score at week 3. Participants with a history of depression are highlighted using a filled data point. The association between diary sleep efficiency at week 1 and EPDS scores at week 5 is shown in Figure 2.

Figure 1. Association between Week 1 Sleep Efficiency and Week 3 EPDS Score



Note: Increases in Diary Sleep Efficiency represent improved sleep, whilst decreases in EPDS scores represent a reduction in depressive symptoms.

Figure 2. Association between Week 1 Sleep Efficiency and Week 5 EPDS Score



Note: Increases in Diary Sleep Efficiency represent improved sleep, whilst decreases in EPDS scores represent a reduction in depressive symptoms.

There were no significant correlations between diary or actigraph sleep efficiency and MAF scores at week 1, 3 or 5.

Partial correlations

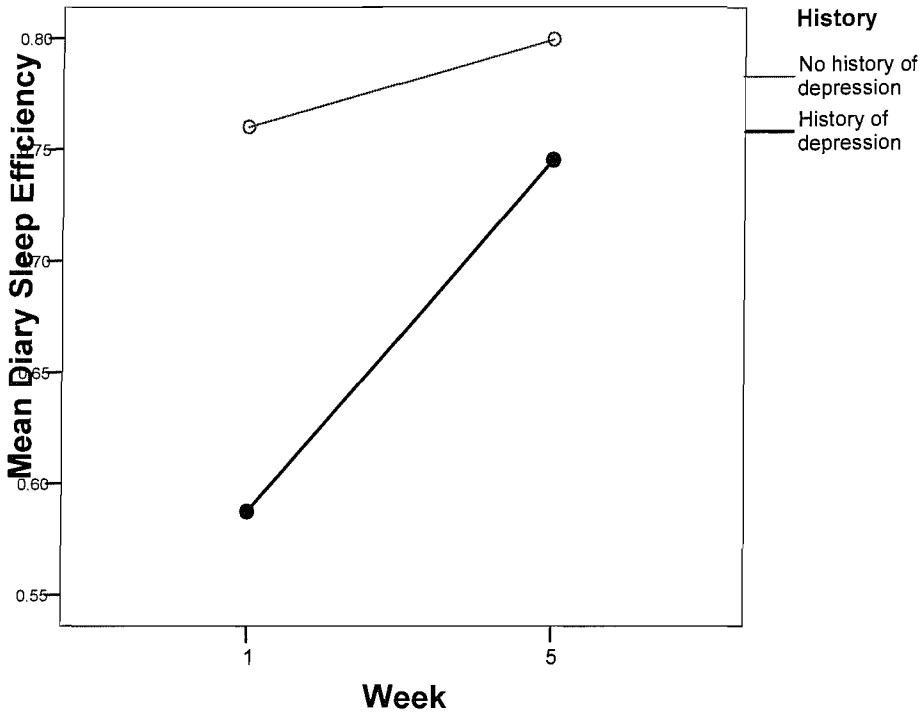
To test hypothesis two, partial correlations were conducted on significant correlations. A correlation between diary sleep efficiency at week 1 and EPDS score at week 3, controlling for the effect of actigraph sleep efficiency at week 1 was significant (r = -.595, n = 15, $p < .05$, two tailed). A correlation between diary sleep efficiency at week

1 and EPDS score at week 5, controlling for the effect of actigraph sleep efficiency, was also significant (r = -.539, n = 15, $p < .05$, two tailed).

Change in diary sleep efficiency over time

To test hypothesis three, a 2 x 2 mixed model ANOVA was conducted on diary sleep efficiency, with postpartum week as a within subjects factor (2 levels: week 1 and week 5) and history of depression as a between subjects factor (2 levels: history or no history of depression). Only postpartum weeks 1 and 5 were included in the analysis, as there were insufficient numbers providing data across all three time points. The interaction between postpartum week and history was significant (F (1, 16) = 7.94, $p < .05$). Significant main effects were found both for postpartum week (F (1, 16) =22.01, $p <$ .01) and for history of depression (F (1, 16) = 11.36, $p < .01$). Diary sleep efficiency improved with time since birth. Women with a history of depression showed significantly poorer sleep efficiency, but showed a greater improvement in sleep efficiency between week 1 and week 5. Figure 3 shows the relationship between postpartum week and diary sleep efficiency.

Figure 3. Effect of postpartum week on diary sleep efficiency



Note. Unweighted means are displayed for clarity.

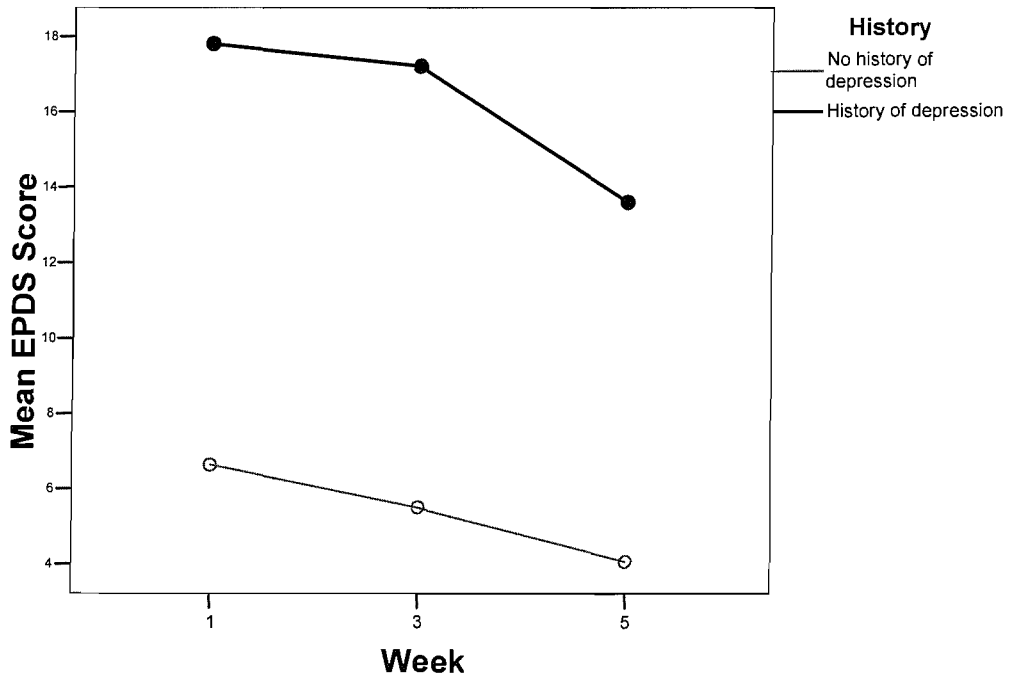
Change in actigraph sleep efficiency over time

A repeated measures ANOVA conducted on actigraph sleep efficiency, with postpartum week as a within subjects factor (3 levels: week 1, 3 and 5) was non significant ($F < 1$). Only women with no history of depression were included in the analysis, as there were insufficient numbers for a between subjects comparison. A t-test comparing actigraph sleep efficiency at week 1 in women with (n = 5) and without a history of depression (n = 14) found no significant differences between the two groups (t (17) = .59). There was insufficient data to compare the two groups at week 3 or 5.

Change in EPDS scores over time

A 3 x 2 mixed model ANOVA was conducted on EPDS scores, with postpartum week as a within subjects factor (3 levels) and history of depression as a between subjects factor (2 levels). Results revealed a significant effect of postpartum week (F (2, 34) = 7.28, $p < .01$), and a significant effect of history of depression (F (1, 17) = 26.64, $p <$ .01). There was no significant interaction between postpartum week and history of depression. In both women with and women without a history of depression, depressive symptoms showed a progressive decline as time since birth increased. EPDS scores were significantly higher at all time points for women with a history of depression. The effect of postpartum week on EPDS scores is displayed in Figure 4.

Figure 4. Effect of postpartum week on EPDS scores

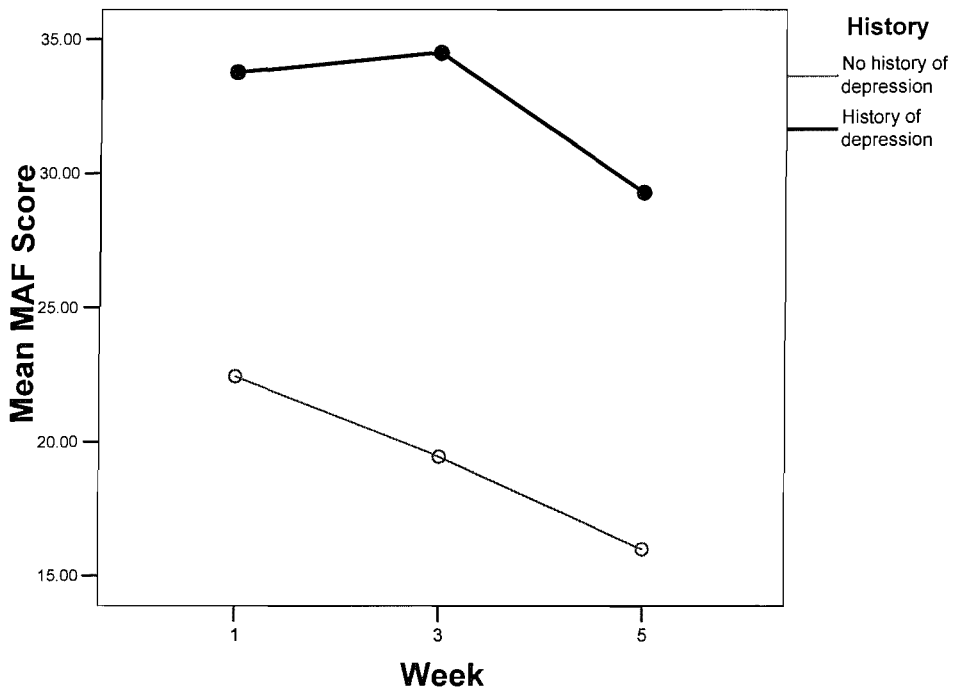


Note. Unweighted means are displayed for clarity.

Change in MAF scores over time

A 3 x 2 mixed model ANOVA on MAF scores, with postpartum week as a within subjects factor and history of depression as a between subjects factor, revealed a significant effect for postpartum week (F (2, 34) = 122.37, $p < .05$) and for history of depression (F (1, 17) = 9.37, $p < .01$) but no significant interaction between postpartum week and history. For all women, ratings of fatigue decreased as time since birth increased. MAF scores were significantly higher at all time points for women with a history of depression. The effect of postpartum week on MAF scores is displayed in Figure 5.

Figure 5. Effect of postpartum week on MAF scores.



Note. Unweighted means are displayed for clarity.

Correlations between measures

Pearson correlations were conducted between diary sleep efficiency and actigraph sleep efficiency, as displayed in Table 3. Results revealed no significant correlations between the two measures. An exploration of the relationship between items within the diary revealed that items 12-15 were highly correlated (see Appendix 12) and thus item 12, which asks participants to rate sleep quality, was chosen to represent these items. Correlations between diary sleep efficiency and diary sleep quality, and actigraph sleep efficiency and diary sleep quality were non significant.

Table 3

Pearson correlations between diary sleep efficiency, actigraph sleep efficiency and diary sleep quality

Correlation		Week 1	Week 3	Week 5
Diary sleep efficiency and actigraph sleep efficiency	*r*	-.113	-.106	.244
	Sig.	.645	.707	.362
	N	19	15	16
Diary sleep efficiency and diary sleep quality	*r*	.141	.100	.268
	Sig.	.543	.683	.283
	N	21	19	18
Actigraph sleep efficiency and diary sleep quality	*r*	-.130	.170	.415
	Sig.	.594	.545	.110
	N	19	15	16

Sleep quality and other sleep variables

The relationship between perceived sleep quality and other diary sleep variables was explored. Data was collapsed across weeks. Table 4 displays correlations between diary sleep quality and other diary variables. Results showed significant negative correlations between diary sleep quality and diary sleep latency (r = -.364, n = 60, $p <$ .01, two tailed) and diary number of wakings (r = -.360, n = 60, $p <$ .01, two tailed) when the two groups were merged. Correlations for the no history group revealed a significant negative correlation between diary sleep quality and diary sleep latency (r = -.479, n = 42, $p <$ .01, two tailed) and a significant positive correlation between diary sleep quality and diary length of wakings (r = .619, n = 19, $p <$ .01, two tailed). Thus for the whole sample greater sleep latency and greater number of wakings were associated with poorer ratings of sleep quality, whilst for the no history group alone greater sleep latency and shorter total sleep time were associated with poorer sleep quality.

Table 4.

Correlation between diary sleep quality and other diary sleep variables for whole sample and no history group.

			Diary sleep latency	Diary total sleep time	Diary number of wakings (WASO)	Diary length of wakings	Diary early morning awakening
Diary	Whole	*r*	-.364**	.002	-.360**	-.220	.083

sleep quality	sample	Sig.	.004	.989	.005	.091	.526
		N	60	60	60	60	60
	No history group	*r*	-.479**	.619**	-.026	-.005	.106
		Sig.					
		N	.001	.000	868	.976	.504
			42	42	42	42	42

**Correlation is significant at the 0.01 level (two tailed).

Non parametric tests

As missing data made the groups unequal sizes, in order to check for Type 1 Error, non parametric tests were used. Mann-Whitney test confirmed that there were group differences each week in mood, fatigue, and diary sleep efficiency, but not actigraph sleep efficiency. Friedman analysis-of-variance-by-ranks confirmed that there was an effect of week on mood, week, and diary sleep efficiency, but not actigraph sleep efficiency. We were not aware of a non-parametric alternative suitable for investigating the interactions.

Discussion

Findings

Subjective sleep efficiency at one week postpartum was found to correlate with depressive symptoms in subsequent weeks. This held even after controlling for objective sleep efficiency. A significant effect of postpartum week was found for subjective sleep efficiency, depressive symptoms and fatigue scores. Subjective sleep efficiency increased with time since birth, whilst depressive and fatigue symptoms declined. There was evidence a history of depression was related to poorer subjective sleep efficiency and more depression and fatigue.

As hypothesised, a significant association was found between subjective sleep efficiency at one week postpartum and depressive symptoms at three and five weeks postpartum. This relationship remained significant after controlling for the effects of objective sleep efficiency. This suggests that it is subjective perception of sleep efficiency, and not objectively recorded differences in sleep efficiency, that is an indicator of those women who may go on to show greater depressive symptoms.

The finding of an effect of subjective sleep on subsequent mood is in accordance with the findings of Wolfson et al. (2003) and Wilkie and Shapiro (1992), who also found an association between subjective sleep and mood in subsequent postpartum weeks. However, the current study offers an important extension to this literature by demonstrating that sleep in the postpartum period, and not only sleep during late pregnancy, is associated with subsequent postpartum mood.

The value of conducting partial correlations to control for objective sleep efficiency is questionable, given that correlations between objective sleep efficiency and mood scores were non significant. However, controlling for this variable did weaken the correlation between subjective sleep efficiency and mood, suggesting that objective differences in sleep do have some impact on the relationship between subjective perception of sleep and mood.

Also in line with hypothesised results, a significant effect of postpartum week was found for subjective sleep efficiency, depressive symptoms and fatigue scores. Subjective sleep efficiency increased with time since birth, whilst depressive and fatigue symptoms declined. The finding of a significant effect of postpartum week on subjective sleep efficiency is in line with the findings of Swain et al. (1997). Furthermore, the present study extends the findings of Swain et al.'s study, which only examined subjective sleep in the first three weeks postpartum.

As anticipated, women with a history of depression showed poorer subjective sleep efficiency and reported greater symptoms of depression and fatigue at all time points. There was insufficient data from the history of depression group to assess whether women with a history of depression showed significantly poorer objective sleep efficiency in weeks three and five postpartum than those with no history. However, a t-test at one week postpartum revealed no significant differences between the two groups. This is in contrast to the findings of Coble et al. (1994) who found significant differences in objective sleep quality between women with and without a history of depression throughout pregnancy and the postpartum period.

The finding that scores on the Multidimensional Assessment of Fatigue were not correlated with diary or actigraph sleep efficiency is contrary to the hypothesised results. Nonetheless, whilst fatigue is a diagnostic criterion of depression, several researchers have argued that postpartum fatigue is a separate and distinguishable concept from postpartum depression (Bozoky & Conwin, 2001). The findings of the present study provide some support for this argument, by demonstrating that depression, but not fatigue is correlated with subjective sleep efficiency.

Interpretation of results

One explanation for the contrast in findings between the current study and that of Coble et al. (1994) with respect to group differences in objective sleep parameters may be the use of different methods for assessing sleep in the two studies. Coble et al. (1994) used EEG to compare groups and found differences in total sleep time and REM latency between women with and without a history of depression. The present study utilised actigraphy, a method which is unable to measure sleep stages and so could not assess differences in REM latency. The differing findings on total sleep time may be a result of lower sensitivity of actigraphy as a measure of sleep timing. Lockley, Skene and Arendt (1999) suggest that actigraphy is only marginally acceptable as a method for the measurement of exact sleep timing, and is more appropriate for documenting longitudinal changes in patterns or schedules of sleep. Future studies may wish to replicate the current design, substituting polysomnography for actigraphy. However, as polysomnography is a more intrusive procedure for the measurement of sleep than actigraph, the difficulties with recruitment experienced in the present study are likely to increase as a result of such as substitution. Alternatively, the null result may be a

consequence of the small sample size in the history of depression group. The limitations of the present study are discussed in greater detail below.

On close examination of the results, the correlations between subjective sleep efficiency and subsequent EPDS scores appear to be driven almost entirely by the history of depression group. Thus the exclusion of this small sample of women would result in the correlation becoming non significant. One possible explanation for this finding is that women with a history of depression are more sensitive to the effects of environmental or physiological changes, leading them to perceive their sleep during the early postpartum as more disrupted than women without a history of depression.

Depression is often associated with a negative cognitive bias (Beck, 1976). The poorer subjective sleep perceptions of women in the history of depression group may be a consequence of a cognitive bias that has remained following remission of their other depressive symptoms. Another possibility is that subjective sleep disturbance represents a risk marker for developing depression. In support of this, one study has found that first degree relatives of depressed individuals show similar sleep reporting to their relatives (Mayers, van Hooff & Baldwin, 2003b). Alternatively, it is possible that the majority of the women in the history of depression group were experiencing a current depressive episode and that only women with a current clinical depression show this relationship between subjective sleep quality and depressive symptoms. This possibility is supported by the fact that many of the EPDS scores for the depression group were above the clinical cut off at week one. However, the use of the depression questions from the SCID at the point of recruitment should have screened out women

with a diagnosable depression, as this structured interview is based upon DSM-IV criteria for major depression.

There are several possible explanations for the absence of a significant correlation between diary sleep efficiency and actigraph sleep efficiency. One possibility is that participants experienced difficulties in recalling their sleep and wake times, and that the absence of a significant correlation is due to participant error when reporting sleep. Alternatively, the poor correlation may be a result of poor sensitivity of actigraphy in discriminating between sleep and waking. Actigraphic studies utilising other populations have also found poor correlation between measures. For example, In a study of non-depressed registered blind subjects, Lockley et al. (1999) found that actigraphy was poor at identifying transitions between sleep and wake states, and was prone to misperceiving inactivity during wakefulness as sleep and night time activity during sleep as waking periods.

It is worthy of note that the present study utilised sleep efficiency as an overarching sleep variable, and that this variable is made up of a number of separate sleep variables including total sleep time, sleep latency and number and duration of night time awakenings. It is possible that the level of correlation between subjective and objective measures differs across sleep variables and that participants vary in their ability to judge different sleep parameters. Argyropoulos et al (2003) compared subjective and objective sleep measures using EEG in depressed participants and found a good correlation between measures with respect to total sleep time and sleep latency, but a poor correlation for number of awakenings. Other EEG studies with depressed participants have also found poor correlation for awakenings (e.g. Armitage, Trivedi, Hoffman &

Rush, 1997), suggesting that depressed individuals are poor at judging the number of times that they wake at night. A more detailed analysis across a range of sleep parameters, including number and length of wakings after sleep onset, sleep latency and early morning awakening, may have uncovered further group differences. However, this would have increased the risk of Type 1 Error, through running multiple comparisons on a limited sample. This issue is explored further in Appendix 13.

That participants' ratings of sleep quality were also not significantly correlated with diary or actigraph sleep efficiency represents an interesting finding. If diary sleep efficiency and diary sleep quality are not correlated, this suggests that the two variables represent separate constructs, one relating to perception of sleep timing and the other to satisfaction with or perception of the quality of the sleep experience. Further discussion of this issue can be found in Appendix 12.

The results of correlations between diary sleep quality and other diary sleep variables suggest that diary sleep latency may be an important variable in determining the perceived quality of the sleep experience in postpartum women. Greater perceived time in first getting to sleep was associated with poorer ratings of sleep quality. In contrast, early morning awakening and length of awakenings were not significantly associated with diary sleep quality, suggesting that these variables are not critical in determining perceived quality of sleep.

Of interest is the finding that number of wakings was significantly associated with diary sleep quality when the sample was taken as a whole, but not when omitting women with a history of depression from the analysis. This suggests that number of wakings may be

more significant in determining perceived sleep quality for women with a history of depression than for healthy women. Similarly total sleep time was significantly associated with sleep quality for healthy women, but not for the sample as a whole. Therefore for women with a history of depression perceived total sleep time may be of less importance than perceived continuity of sleep in determining perceived sleep quality. The small sample size and use of multiple comparisons increase the risk of error, and thus it will be important to replicate these results.

One question which remains unanswered within research into sleep and depression is whether sleep disruption represents a cause or a symptom of depression. As the present study was correlational and did not involve the manipulation of variables, it is unable to provide an answer this question. However, it could be argued that pattern of results provides greater support for the symptom explanation than the causal explanation. This is because the observed relationship between diary sleep efficiency and subsequent depressive symptoms appeared to be driven by women in the history of depression group, and these women predominantly showed scores at or above the clinical cut off for depression on the EPDS at week one. Thus arguably the relationship between sleep and subsequent mood was true only in women with other symptoms of depression.
If replicated the current study will have important implications for professionals working within perinatal services. The findings suggest that subjective perception of sleep efficiency at one week postpartum may be an important issue for midwives and other health professionals to assess, particularly in women with a history of depression. Sleep diaries are relatively quick to complete, and the collection of this information may help to identify women at increased risk of developing depressive symptoms in subsequent weeks.

Limitations

Whilst the study presents some interesting findings, it suffers a number of methodological shortcomings which mean that the findings should be interpreted with caution. The use of unequal sample sizes is particularly problematic, as it increases the risk of Type 1 Error. However, in line with the suggestions of Tabachnik and Fidell (1996), a number of strategies were employed to reduce the possibility of this error. Furthermore, non parametric tests were used to check the validity of the findings, and these revealed the same pattern of results.

The small sample sizes used in the study are also problematic, as they may have limited the study's power to reflect group differences. A larger sample may have revealed additional significant differences, such as the difference in objective sleep efficiency between women with and without a history of depression predicted by the findings of Coble et al's (1992) study. It had originally been planned to recruit 20 women with a history of depression and 20 healthy controls. Power calculations had indicated that a sample of 20 per group would give 80% power to detect a correlation of .70 or higher with a significance level of $p < .01$. However, recruiting these numbers proved impossible for both groups, and was particularly difficult for the history of depression group. Those women who declined to participate, or who failed to provide data for all three time points reported that the requirements of the study came too soon after returning home from hospital or presented too great a time commitment to be acceptable.

One setback to recruitment stemmed from the reliance on midwives and perinatal team members to make the initial approach to suitable potential participants. Both midwives

and perinatal team members reported that they were expected to identify and approach candidates for a number of studies that were running simultaneously in addition to their normal clinical responsibilities, and found this very challenging. This may have led to failure to pick up a number of appropriate individuals. Were the study to be repeated, more support for and greater contact with midwives, e.g. through attending regular ward meetings, may have helped to raise the profile of the study. Direct initial contact with the participants by the researcher, for example through attending antenatal classes, may be an alternative solution to this problem. Administrative difficulties made this impossible for the current study.

Another difficulty with recruitment resulted from reliance on the perinatal service for identification of women with a history of depression. The perinatal service has strict criteria for referrals which restricted the availability of suitable potential participants for the study. Whilst the service is automatically notified when any woman with a history of mental health difficulties becomes pregnant, only women with severe mental health problems or a history of postpartum mental illness are assessed and offered a service. Women with a history of mild to moderate depression, particularly those with a history of single episode depression or with no current symptoms, are rarely seen for assessment by the service. This is likely to have contributed significantly to the difficulties with recruitment, as the most appropriate potential participants for the history of depression group may not have been seen by the service and therefore would not have received information on the study. Furthermore, of those women with a history of depression that are assessed by the service, only women reporting current symptoms remain on the caseload. Thus many of the women with a history of depression on the caseload of the service were inappropriate for the study as a result of

current depression at the time of recruitment and it is likely that several suitable candidates were missed as a result of team members failing to mention the study during a one-off assessment appointment.

One potential solution to this difficulty would have been to obtain permission from the ethics committee to directly contact the midwife or GP in cases where women were not assessed by the service, or were assessed but not taken on, to request that they highlight the study to the potential participant.

Given the difficulties with recruitment, it is possible that the small number of women that provided data for the history of depression group may have been unusual and not representative of the majority of women with a history of depression. This is particularly true given that only women with more severe difficulties are seen by the service, and thus women with a history of depression who were not seen or taken on by the perinatal team may have shown a picture much more similar to that of healthy controls. Future research may wish to adopt a different method of recruitment for women with a history of depression, such as advertising in GP surgeries or via midwives rather than utilising mental health services.

A further shortcoming of the study is the absence of information on participants sleep during late pregnancy. Wolfson Crowley, Anwer and Bassett (2003) found that depressive symptoms at 2-4 weeks postpartum were related to sleep disturbance during the final trimester of pregnancy, and not to sleep disturbance at 2-4 weeks postpartum. Wilkie and Shapiro (1992) also found that emotional distress at one week postpartum was associated with subjective sleep disturbance in the week prior to delivery. It is

possible that the association seen between sleep in the early postpartum and mood in subsequent weeks was in fact a residual or 'hangover' effect from a much stronger relationship between sleep disturbance in late pregnancy and mood in the early postpartum. However, without information from sleep in pregnancy, it is impossible to know this.

The absence of mood ratings in late pregnancy is also potentially problematic, as it raises the possibility of a confound arising from participants with depressive symptoms that emerged during pregnancy rather than in the postpartum period. However, the use of the SCID at the first meeting would arguably have served to screen out these cases. Furthermore, the introduction of additional measures may have further reduced willingness to participate in the study, as several participants commented that commitment to three time points so close to the birth of an infant was already a lot to ask.

With retrospect, it may have been beneficial to use the EPDS as a baseline measure at recruitment, in place of the SCID depression questions. This would have provided mood information on the week of the labour and birth, which could have been directly compared with subsequent EPDS scores. However, the EPDS is a screening measure and not a diagnostic measure for depression. Use of the SCID allowed for identification of current depression using DSM-IV criteria, as well as identification of history of depression. History of depression is an important variable to consider, as studies have found that individuals with a history of depression continue to demonstrate differing sleep patterns from controls following remission of depressive symptoms.

A further limitation of the present study is the absence of a non postpartum control sample. The current study focused on comparing postpartum women with and without a history of depression. However, future studies may wish to explore whether other, non postpartum samples also show a poor correlation between objective and subjective sleep efficiency, or whether this finding is specific to the early postpartum period. It is possible that the physiological changes associated with childbirth lead to an impaired perception of sleep timing, which naturally corrects itself over time. Alternatively, the poor correlation between measures seen in this study may be a reflection of a much wider trend, in which subjective and objective sleep efficiency are measuring very different concepts.

Were the study to be repeated, it may be beneficial to attempt to control for the effects of other variables known to affect maternal sleep. For example, studies have found that first time mothers show greater sleep changes than experienced mothers (Lee, Zaffke & McEnany, 2000), yet the present study included a combination of new and experienced mothers. However, combining women of differing parity has also been a feature of other studies. Another variable which has been shown to affect sleep patterns is feeding method. Breast feeding women have been found to spend significantly more time awake after sleep onset and to have significantly reduced sleep efficiency when compared with both bottle feeding and control women (Blyton Sullivan & Edwards, 2002). Sleeping arrangements have also been found to influence postpartum sleep patterns, with breastfeeding women who co-sleep with their infant showing greater total sleep time and shorter awakenings than breastfeeding women who sleep in a separate

room to their infant (Quillin & Glenn, 2004). Thus failure to control for these variables may have influenced the results.

Similarly, a number of women in the history of depression group were taking antidepressant medication at the time of participating in the study. Antidepressant medication has been shown to have effects on both subjective and objective sleep. Current evidence suggests that the effect of antidepressant medication on sleep is dependent on the class of antidepressant and the dosage (Mayers & Baldwin, 2005). For certain medications, the effect on subjective and objective sleep may be discrepant. For example, several SSRIs have been found to negatively affect objective sleep, particularly in the early stages of treatment, yet improvements in subjective sleep quality are reported at this time (Argyropoulos & Wilson 2005). Thus it is possible that medication may have presented a confounding variable in the current study, through masking the true effects of a history of depression on postpartum sleep. Given the difficulties with recruitment, and the limited sample size, it was not possible to control for the effects of this variable in the present study, and information on the number of women taking medication was not collected. Future research however may wish to exclude participants who are taking medication, or to record the type and dosage of medication in order to control for this variable.

The difficulties with recruitment in this study raise an important question about the representativeness of women who volunteer for perinatal research. It could be argued that those women that feel able to take on the additional task of participating in research at this time may have greater confidence in their own ability to cope with the physical and emotional consequences of a new baby than do those who decline to participate.

This confidence may also serve to reduce their susceptibility to depression, and influence their response to sleep disruption during the postpartum period. Were the study to be repeated, it may be of interest to include a measure of general self-efficacy.

Conclusions

In summary, the results of the present study provide support for a relationship between subjective sleep efficiency at one week postpartum and mood in subsequent weeks. This relationship was clearest in women with a history of depression, who showed greater subjective sleep disturbance and reported greater symptoms of depression than healthy controls. The study also demonstrated a significant effect of postpartum week on sleep and mood for both groups, with subjective sleep efficiency improving and depressive symptoms decreasing with time since birth.

The study provides an important extension to the existing literature, as it is the first study to look at the relationship between sleep and mood in the early postpartum comparing subjective and objective sleep measures, and the first to compare subjective and objective sleep measures in women with a history of depression. The findings have important implications for midwives and professionals working in perinatal mental health. Awareness of an association between poor subjective sleep in the first week postpartum and depressive symptoms in subsequent weeks will enable professionals to identify women at an increased risk of developing postpartum depression and to offer appropriate interventions aimed at reducing sleep distress. Nonetheless, the study has a number of methodological weaknesses, most notably its reliance on a limited sample size. If replicated, this finding may serve to increase our understanding of the

relationship between sleep and depression, and help to identify women at increased risk for postpartum depression.

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List of Appendices

[1] Ethical approval was originally given in August 2004 to conduct the study using only healthy women. In June 2005 a successful application was made to extend the study to include women with a history of depression. Dr Alain Gregoire of the Perinatal service was named as Principal Investigator for the study, the trainee was a named researcher.

Notes for Contributors

The British Journal of Clinical Psychology publishes original contributions to scientific knowledge in clinical psychology. This includes descriptive comparisons, as well as studies of the assessment, aetiology and treatment of people with a wide range of psychological problems in all age groups and settings. The level of analysis of studies ranges from biological influences on individual behaviour through to studies of psychological interventions and treatments on individuals, dyads, families and groups, to investigations of the relationships between explicitly social and psychological levels of analysis.

The following types of paper are invited:

- Papers reporting original empirical investigations;
- Theoretical papers, provided that these are sufficiently related to the empirical data;
- Review articles which need not be exhaustive but which should give an interpretation of the state of the research in a given field and, where appropriate, identify its clinical implications;
- Brief reports and comments.

The submission must include the following as separate files:

  - Title page consisting of manuscript title, authors' full names and affiliations, name and address for corresponding author - Editorial Manager Title Page for Manuscript Submission
  - Abstract
  - Full manuscript omitting authors' names and affiliations. Figures and tables can be attached separately if necessary.

Manuscript requirements

- Contributions must be typed in double spacing with wide margins. All sheets must be numbered.
- Tables should be typed in double spacing, each on a separate page with a self-explanatory title. Tables should be comprehensible without reference to the text. They should be placed at the end of the manuscript with their approximate locations indicated in the text.
- Figures can be included at the end of the document or attached as separate files, carefully labelled in initial capital/lower case lettering with symbols in a form consistent with text use. Unnecessary background patterns, lines and shading should be avoided. Captions should be listed on a separate page. The resolution of digital images must be at least 300 dpi.
- For articles containing original scientific research, a structured abstract of up to 250 words should be included with the headings: Objectives, Design, Methods, results, Conclusions. Review articles should use these headings: Purpose, Methods, Results, Conclusions: British Journal of Clinical Psychology - Structured Abstracts Information
- For reference citations, please use APA style. Particular care should be taken to ensure that references are accurate and complete. Give all journal titles in full.
- SI units must be used for all measurements, rounded off to practical values if appropriate, with the Imperial equivalent in parentheses.
- In normal circumstances, effect size should be incorporated.
- Authors are requested to avoid the use of sexist language.
- Authors are responsible for acquiring written permission to publish lengthy quotations, illustrations etc for which they do not own copyright.

For Guidelines on editorial style, please consult the *APA Publication Manual* published by the American Psychological Association, Washington DC, USA (http://www.apastyle.org).

Checklist of requirements

- Abstract (100-200 words)
- Title page (include title, authors' names, affiliations, full contact details)

- Full article text (double-spaced with numbered pages and anonymised)
- References (APA style). Authors are responsible for bibliographic accuracy and must check every reference in the manuscript and proofread again in the page proofs.
- Tables, figures, captions placed at the end of the article or attached as separate files.

Structured abstracts – The British Journal of Clinical Psychology

Authors should note that all papers submitted to the *British Journal of Clinical Psychology* must include structured abstracts. Papers will not be considered for publication unless they have a structured abstract in the correct format.

Articles containing original scientific research should include a structured abstract with the following headings and information:

Objectives	State the primary objectives of the paper and the major hypothesis tested (if appropriate).
Design	Describe the design of the study and describe the principal reasoning for the procedures adopted.
Methods	State the procedures used, including the selection and numbers of participants, the interventions or experimental manipulations, and the primary outcome measures.
Results	State the main results of the study. Numerical data may be included but should be kept to a minimum.
Conclusions	State the conclusions that can be drawn from the data provided and their clinical implications (if appropriate).

Review articles should include a structured abstract with the following headings:

Purpose	State the primary objectives of the review.
Methods	State the method used to select studies for the review, the criteria for inclusion, and the way in which the material was analysed.
Results	State the main results of the review.
Conclusions	State the conclusions that can be drawn from the review and their clinical implications if appropriate.

Journal of Sleep Research

Official Journal of the European Sleep Research Society

Edited by:
Jim Horne

Print ISSN: 0962-1105
Online ISSN: 1365-2869
Frequency: Quarterly
Current Volume: 15 / 2006
ISI Journal Citation Reports® Ranking: 2004: 8/87 (Behavioral Science); 54/198 (Neurosciences); 16/73 (Physiology)
Impact Factor: 3.400

The *Journal of Sleep Research* is an international journal that encourages important research papers presenting new findings in the field of sleep and wakefulness (including biological rhythms and dreaming). The Journal reflects the progress in this rapidly expanding field, promoting the exchange of ideas between scientists at a global level.

Author Guidelines

Manuscript Style

There are several categories of material:

Fast-track Short Papers
These should be approximately 2000 words in length, with a maximum of four figures or tables. Fast-track papers are rapidly reviewed and published.
Regular Research Papers
These are of a more usual length, and will preferably be oriented towards basic clinical and non-clinical findings.
Review Papers
These are intended to be well argued, preferably controversial reviews of topical subjects which, it is hoped, will generate debate.
Letters to the Editor
The Editor welcomes succinct correspondence relating to articles published in the journal, and of an academic and interesting nature.
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The journal presents symposia papers by invitation, covering topical subjects.

Title Page

This should contain a concise title of the article, a shortened version (no more than 50 characters including spaces) for the running head, names of the authors, their affiliations, and the full postal and e-mail address, fax and telephone number of an author to whom correspondence can be addressed.

Summary

This should be on a separate page, and less than 250 words. It should be followed by up to six key words.

Main Text

This should start on a separate page, and include an introduction, methods, results and discussion. The suggested points of insertion of figures and tables, etc., should be indicated. Authors should avoid abbreviations (except for those commonly understood), long sentences, and many juxtaposed numbers in sentences.

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Once completed, please return the form to the Editor at the following address:

Prof Jim Horne, Journal of Sleep Research, Dept of Human Sciences, Loughborough University, Loughborough, Leics LE11 3TU, UK (e-mail: j.horne@lboro.ac.uk; fax: +44 (0) 1509 228 480)

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Tables

These should include only essential data. Each table must be typewritten on a separate sheet and should be numbered consecutively in Arabic numerals, e.g. Table 1, and given a short caption.

Units

Measurements must be in SI units. Units, Symbols and Abbreviations (Royal Society of Medicine, 1988) is a useful guide.

SLEEP & NAPS DIARY

Please complete this diary in the morning

Date: (please note the date for *last* night)

Please answer the following questions as accurately as possible

1 At what time did you first attempt sleep last night? _____

2 How long did it take you to get to sleep? _____

3 How many times did you wake during the night because of your baby? _____

4 How long did these awakenings last in total? _____

5 How many times did you wake during the night that was not because of your baby? _____

6 How long did these awakenings last in total? _____

7 How long did you sleep in total? _____

8 At what time did you wake this morning? _____

9 At what time did you get up? _____

10 How often did you take a nap during the following day? _____

11 Indicate the time and length of each nap _____

Please answer the following questions by placing a mark along the line that most reflects how you felt about last night's sleep episode (a 'sleep episode' refers to the time from you first attempted sleep to when you finally got up)

12 How would you rate your sleep quality last night?
Very good _____ Very poor

13 How easily did you fall asleep?
Very easily _____ Not at all easily

14 How well refreshed did you feel when you woke up?
Very refreshed _____ Not very refreshed

15 Did you get enough sleep last night?
Just right _____ Not at all

Ethics Committee

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From: "Smith K.M." <K.M.Smith@soton.ac.uk>
To: ms1803@soton.ac.uk
Cc: "Brignell C.M." <C.Brignell@soton.ac.uk>
Subject: Ethics Application

Dear Melanie

Re: The relationship between sleep and mood post-partum in women with a history of depression

The above titled application was approved by the School of Psychology Ethics Committee on 9 August 2005.

Should you require any further information, please do not hesitate in contacting me. Please quote reference CLIN/03/83.

Best wishes,

Kathryn Smith

Secretary to the Ethics Committee

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RECEIVED - 2 SEP 2004

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Our Ref: CPW/sta

31 August 2004

Dr Alain Gregoire
Consultant Psychiatrist
Hampshire Partnership NHS Trust
Maple, Tatchbury Mount
Calmore
Southampton
SO40 2RZ

SOUTHAMPTON & SOUTH WEST HAMPSHIRE LOCAL RESEARCH ETHICS COMMITTEES
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Fax: 023 8036 4110

clair.wright@nhs.net
General Enquiries: sharon.atwill@nhs.net
Application Submission: submissions@gp-j82203.nhs.uk

Dear Dr Gregoire,

Full title of study: The relationship between sleep, mood and fatigue in postpartum women.
REC reference number: 04/Q1704/42
Protocol number:

The Research Ethics Committee reviewed the above application at the meeting held on 25 August 2004.

Ethical opinion

The members of the Committee present gave a favourable ethical opinion to the above research on the basis described in the application form, protocol and supporting documentation.

The favourable opinion applies to the following research site:

Site: Hampshire Partnership NHS Trust
Principal Investigator: Dr A Gregoire

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The documents reviewed and approved at the meeting were:

Document Type: Application
Version:
Dated: 28/07/2004
Date Received: 30/07/2004

Document Type: Investigator CV
Version:
Dated: 30/07/2004
Date Received: 30/07/2004

Document Type: Protocol
Version:

Dated: 30/07/2004
Date Received: 30/07/2004

Document Type: Copy of Questionnaire
Version: 1-Sleep & Nap Diary
Dated: 01/08/2004
Date Received: 30/07/2004

Document Type: Copy of Questionnaire
Version: Edinburgh Post Natal Depression Scale (EPDS)
Dated: 30/07/2004
Date Received: 30/07/2004

Document Type: Copy of Questionnaire
Version: Multi-Dimenional Assessment of Fatigue (MAF) Scale
Dated: 30/07/2004
Date Received: 30/07/2004

Document Type: GP/Consultant Information Sheets
Version: 1
Dated: 01/08/2004
Date Received: 30/07/2004

Document Type: Participant Information Sheet
Version: 1
Dated: 01/08/2004
Date Received: 30/07/2004

Document Type: Participant Consent Form
Version: 1
Dated: 01/08/2004
Date Received: 30/07/2004

Document Type: Other
Version: Evidence of R & D
Dated: 26/07/2004
Date Received: 20/08/2004

Document Type: Other
Version: Letter from Data Protection
Dated: 20/08/2004
Date Received: 20/08/2004

Management approval

The study may not commence until final management approval has been confirmed by the organisation hosting the research.

All researchers and research collaborators who will be participating in the research must obtain management approval from the relevant host organisation before commencing any research procedures. Where a substantive contract is not held with the host organisation, it may be necessary for an honorary contract to be issued before approval for the research can be given.

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Notification of other bodies

We shall notify the research sponsor, Hampshire Partnership NHS Trust that the study has a favourable ethical opinion.

Statement of compliance *(from 1 May 2004)*

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

REC reference number: 04/Q1704/42 **Please quote this number on all correspondence**

Yours sincerely,

Mrs Clair Wright
LREC Manager

Enclosures *List of names and professions of members who were present at the meeting and those who submitted written comments*

Standard approval conditions [SL-AC1 or SL-AC2]

RECEIVED 10 AUG 2005

SOUTHAMPTON & SOUTH WEST HAMPSHIRE
RESEARCH ETHICS COMMITTEES (B)
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STA/hph

04 August 2005

Dr A Gregoire
Consultant and Honorary Senior Lecturer in Psychiatry
Perinatal Mental Health Research
The Lodge
Tatchbury Mount
Calmore
Southampton
SO40 2RZ

Dear Dr Gregoire,

Study title: **The relationship between sleep and mood in postpartum women.**
REC reference: **04/Q1704/42**
Protocol number: **n/a**
EudraCT number: **n/a**

Amendment number:
Amendment date: **27 June 2005**

The above amendment was reviewed at the meeting of the Sub-Committee of the Research Ethics Committee held on 27 July 2005.

Ethical opinion

The members of the Committee present gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

NOTE: The Researcher should note that any future amendments should be provided on the Notice of Substantial Amendment Form, or they will be returned as invalid.

Approved documents

The documents reviewed and approved at the meeting were:

Covering letter dated 27 June 2005
Sleep & Naps Diary - version 2
Information Sheet (depressed) - version 1
Information Sheet (controls) - version 2
Consent Form (controls) - version 2
Consent Form (depressed) - version 1
History of Mood Disorders Questionnaire

Membership of the Committee

The members of the Ethics Committee who were present at the meeting are listed on the attached sheet.

Management approval

All investigators and research collaborators in the NHS should notify the R&D Department for the relevant NHS care organisation of this amendment and check whether it affects local management approval of the research.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

REC reference number:	04/Q1704/42	Please quote this number on all correspondence

Yours sincerely,

Mrs Sharon Atwill
Acting Committee Coordinator

E-mail: GM.E.hio-au.SWHRECB@nhs.net

Enclosures *List of names and professions of members who were present at the meeting and those who submitted written comments*

Hampshire Partnership NHS
NHS Trust
Perinatal Mental Health Research
The Lodge
Tatchbury Mount
Calmore
Southampton
SO40 2RZ

Tel: 023 8087 4330
Fax: 023 8087 4360

The Relationship between Sleep and Mood in Women following childbirth

Subject Information – please read carefully

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with friends, relatives or your midwife, if you wish. Ask if there is anything that you do not understand or if you would like more information. Take time to decide whether or not you wish to take part. Should you decide to take part in the study, you should keep this document in a safe place in case you need to look at it again.

A group called Consumers for Ethics in Research (CERES) publish a leaflet entitled 'Medical Research and You'. This leaflet gives more information about medical research and looks at some questions you may want to ask. A copy may be obtained from the researcher or from CERES, PO Box 1365, London N16 0BW.

Thank you for reading this.

What is the purpose of this study?
We are trying to understand sleep patterns during the weeks immediately after giving birth, and how these may be related to mood and fatigue. We are particularly interested to examine how much poor sleep just after giving birth increases the chance of depression relapse in women who have a history of depression.

Why have I been chosen?
You have been asked to take part because your details were taken from our records of women like you who are referred to our service who have a history of depression.

Do I have to take part?
Participation in this study is voluntary. It is up to you to decide whether to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason. This will have no influence on your future medical care.

What will happen to me if I take part?
We will ask you to fill in some questionnaires about fatigue (tiredness), mood, sleep patterns and ask you some basic information about your health and some details about your living arrangements and social support.

During the first, third and fifth week following the birth of your child we will ask you to wear an 'Actigraph' sleep recording device (on your wrist), over five nights (six days) on each occasion. This device is like a wristwatch and senses activity during the day and night, to determine when you are asleep or active. This might also include activity during a sleep episode. We would ask you to wear this for the entire recording period, 24 hours a day. You can wash with the Actigraph; although it would better if you removed it should wish to take a bath. You can wear it while bathing your baby. We would prefer that you wear this even when you go out; please inform the research staff if there is

reason why this might not always be possible. During the recording days we will ask you to complete a sleep/nap diary that will record your estimates of sleep duration and quality at night, and the presence of day time naps. If you do have to remove the Actigraph please make a note on the sleep diary for that day (but please keep this to a minimum). On the last day of each recording we will again ask you to fill in the questionnaires about your mood and fatigue. After 10 weeks we will ask you to complete the questionnaires once more. You will not be required to wear the actigraph again or complete the sleep diaries. We will also ask for your permission to look at your medical notes to get information about your health.

What are the disadvantages of taking part?

Wearing the actigraph devices may seem a little odd to start with, but this will soon pass.

What are the possible benefits of taking part?

By taking part in this study you will be helping us to understand more about the relationship between sleep and mood/fatigue in women who have just given birth.

Will my taking part in the research be kept confidential?

Your identity in this study will be treated as confidential. If you agree to take part in the research, you agree that any of your medical records may be inspected by the research team. They may also be looked at by people from the Ethics Committee and from regulatory authorities to check that the study is being carried out correctly. Your name and records will not be made known publicly. We will write to your GP to inform them of your participation in the study.

During the study certain personal information will be collected. This information will be general personal information (e.g. initials, date of birth) and medical information (e.g. medical history, physical and mental health condition). This information will be collected and processed in compliance with the applicable privacy laws.

You have the right to request disclosure of any personal data, that is maintained in an identifiable form and the right to request rectification of any data that is not correct and/or complete.

Who has reviewed the study?

This study has been reviewed and approved by the Southampton and South West Local Ethics Committee.

In case you need additional information concerning the study and your rights and obligations, you may contact:

Investigators names:	**Dr Alain Gregoire**	**Tel:**	**023 8087 4348**
	Andrew Mayers		**023 8087 4330**

At any time during the study.

If you consent to take part, you will be given a copy of this information sheet to keep as well as a copy of your signed consent form.

We will arrange a date and time to collect the Actigraph and the sleep diaries and questionnaires, and will also arrange the delivery and collection of these for the two subsequent recording sessions.

Thank you for taking part in this study

Hampshire Partnership NHS
NHS Trust
Perinatal Mental Health Research
The Lodge
Tatchbury Mount
Calmore
Southampton
SO40 2RZ

Tel: 023 8087 4330
Fax: 023 8087 4360

The Relationship between Sleep and Mood in Women following childbirth

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A group called Consumers for Ethics in Research (CERES) publish a leaflet entitled 'Medical Research and You'. This leaflet gives more information about medical research and looks at some questions you may want to ask. A copy may be obtained from the researcher or from CERES, PO Box 1365, London N16 0BW.

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We are trying to understand sleep patterns during the weeks immediately after giving birth, and how these may be related to mood and fatigue. We are particularly interested to examine how much poor sleep just after giving birth increases the chance of depression relapse in women who have a history of depression.

Why have I been chosen?
We would like you take part because we understand that you do not have a history of depression. We will be able to compare your data to women who do have a history of depression. You have been asked to take part because your details were passed to us by your midwife, after you told them that you might be interested in participating in this research.

Do I have to take part?
Participation in this study is voluntary. It is up to you to decide whether to take part. If you decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason. This will have no influence on your future medical care.

What will happen to me if I take part?
We will ask you to fill in some questionnaires about fatigue (tiredness), mood, sleep patterns and ask you some basic information about your health and some details about your living arrangements and social support. We will also ask you about whether you have a history of depression.

During the first, third and fifth week following the birth of your child we will ask you to wear an 'Actigraph' sleep recording device (on your wrist), over five nights (six days) on each occasion. This device is like a wristwatch and senses activity during the day and night, to determine when you are asleep or active. This might also include activity during a sleep episode. We would ask you to wear this for the entire recording period, 24 hours a day. You can wash with the Actigraph; although it would better if you removed it should wish to take a bath. You can wear it while bathing your baby.

We would prefer that you wear this even when you go out; please inform the research staff if there is reason why this might not always be possible. During the recording days we will ask you to complete a sleep/nap diary that will record your estimates of sleep duration and quality at night, and the presence of day time naps. If you do have to remove the Actigraph please make a note on the sleep diary for that day (but please keep this to a minimum). On the last day of each recording we will again ask you to fill in the questionnaires about your mood and fatigue. After 10 weeks we will ask you to complete the questionnaires once more. You will not be required to wear the actigraph again or complete the sleep diaries. We will also ask for your permission to look at your medical notes to get information about your health.

What are the disadvantages of taking part?

Wearing the actigraph devices may seem a little odd to start with, but this will soon pass.

What are the possible benefits of taking part?

By taking part in this study you will be helping us to understand more about the relationship between sleep and mood/fatigue in women who have just given birth.

Will my taking part in the research be kept confidential?

Your identity in this study will be treated as confidential. If you agree to take part in the research, you agree that any of your medical records may be inspected by the research team. They may also be looked at by people from the Ethics Committee and from regulatory authorities to check that the study is being carried out correctly. Your name and records will not be made known publicly. We will write to your GP to inform them of your participation in the study.

During the study certain personal information will be collected. This information will be general personal information (e.g. initials, date of birth) and medical information (e.g. medical history, physical and mental health condition). This information will be collected and processed in compliance with the applicable privacy laws.

You have the right to request disclosure of any personal data, that is maintained in an identifiable form and the right to request rectification of any data that is not correct and/or complete.

Who has reviewed the study?

This study has been reviewed and approved by the Southampton and South West Local Ethics Committee.
In case you need additional information concerning the study and your rights and obligations, you may contact:

Investigators names:	**Dr Alain Gregoire**	**Tel:**	**023 8087 4348**
	Andrew Mayers		**023 8087 4330**

At any time during the study.

If you consent to take part, you will be given a copy of this information sheet to keep as well as a copy of your signed consent form.

We will arrange a date and time to collect the Actigraph and the sleep diaries and questionnaires, and will also arrange the delivery and collection of these for the two subsequent recording sessions.

Thank you for taking part in this study

Hampshire Partnership NHS
NHS Trust

Perinatal Mental Health Research
The Lodge
Tatchbury Mount
Calmore
Southampton
SO40 2RZ

Tel: 023 8087 4348
Fax: 023 8087 4360

The Relationship between Sleep, Mood and Fatigue in Postpartum Women

Consent Form for Study Participants

Patient identification for this study.....

Name of researcher.....

	Please initial line to indicate agreement
1. I confirm that I have read and understood the Subject Information sheet Version 1 for the above study, and I have had enough time and opportunity to ask questions. I have received sufficient information and received satisfactory answers to my questions.	_____
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	_____
3. I agree to my GP being informed of my participation.	_____
4. I understand that the information I provide to this study may be looked at by responsible individuals. Such individuals are those representing ethics committees or research governance, whose role is to protect the interests of research participants. I give permission for these individuals to have access to my information. I have been told that my identity will be kept confidential.	_____
5. I have been given a copy of this signed and dated Subject Informed consent and Subject Information sheet.	_____
6. I consent to take part in this study.	_____

Name of participant	Date	Signature
Name of person taking consent	Date	Signature
Name of researcher	Date	Signature

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The Relationship between Sleep, Mood and Fatigue in Postpartum Women

Consent Form for Study Participants

Patient identification for this study.....

Name of researcher.....

	Please initial line to indicate agreement
1. I confirm that I have read and understood the Subject Information sheet Version 2 for the above study, and I have had enough time and opportunity to ask questions. I have received sufficient information and received satisfactory answers to my questions.	_____
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	_____
3. I agree to my GP being informed of my participation.	_____
4. I understand that the information I provide to this study may be looked at by responsible individuals. Such individuals are those representing ethics committees or research governance, whose role is to protect the interests of research participants. I give permission for these individuals to have access to my information. I have been told that my identity will be kept confidential.	_____
5. I have been given a copy of this signed and dated Subject Informed consent and Subject Information sheet.	_____
6. I consent to take part in this study.	_____

Name of participant	Date	Signature
Name of person taking consent	Date	Signature
Name of researcher	Date	Signature

Table 5.

Correlations between diary and actigraph sleep efficiency and mood and fatigue measures.

		Diary sleep efficiency week 1		Actigraph sleep efficiency week 1	
		Whole sample	No history	Whole sample	No history
EPDS week 1	*r*	-.425	-.025	-.302	.031
	N	.062	.933	.209	.917
	Sig.	20	14	19	14
EPDS week 3	*r*	-.570**	-.344	-.140	.402
	Sig.	.009	.228	.579	.154
	N	20	14	18	14
EPDS week 5	*r*	-.490*	-.118	-.227	.051
	Sig.	.033	.689	.365	.863
	N	19	14	18	14
MAF week 1	*r*	-.421	-.168	-.204	-.081
	Sig.	.065	.567	.402	.783
	N	20	14	19	14
MAF week 3	*r*	-.393	.011	-.134	.006
	Sig.	.087	.969	.595	.984
	N	20	14	18	14
MAF week 5	*R*	-.340	.120	-.370	-.370
	Sig.	.154	.682	.130	.192
	N	19	14	18	14

**Correlation is significant at the 0.01 level (two tailed)
*Correlation is significant at the 0.05 level (two tailed)

The results show that actigraph sleep efficiency is not significantly associated with EPDS or MAF scores at any time point, either for the whole sample or for the no history group. In contrast diary sleep efficiency is significantly associated with EPDS scores, but only when looking at the whole sample. There were no significant correlations between diary sleep efficiency and mood scores for the no history group, suggesting that the whole sample result is driven by women with a history of depression (see main empirical paper for further discussion of these findings).

Reliability of the Adapted Sleep Diary

As documented in the main article, the adapted sleep diary has yet to be assessed for reliability.

There are a number of methods for assessing the reliability of a measure. However, many of these methods are not suited to the sleep diary or were not within the scope of the study, making an assessment of reliability difficult in this case.

Test retest reliability

To demonstrate test-retest reliability, a measure would need to show consistency over time. However, one of the hypotheses for the study was that participants would demonstrate significant changes in diary sleep recordings from week to week. Nonetheless, correlations for diary sleep efficiency from week to week were high, which could be argued to be a sign of reliability. Diary sleep efficiency at week 1 was significantly correlated with efficiency at week 3 ($r = .642$, n = 19, $p < .01$, two tailed) and at week 5 ($r = .550$, n = 18, $p < .05$, two tailed), and diary sleep efficiency at week 3 was significantly correlated with efficiency at week 5 ($r = .823$, n = 17, $p < .01$, two tailed).

Split-half reliability

An alternative means of assessing reliability is split-half reliability. However, items 1-11 of the diary involve the recording of distinct sleep timing variables, which are not expected to be related e.g. number of wakings, estimated sleep latency, etc. In contrast, items 12-15 require participants to provide ratings of their sleep quality, ease of sleep

onset, how refreshed they felt and whether they received sufficient sleep. These items may represent a separate construct, which assesses satisfaction with the sleep experience. If the two groups of items assess separate constructs, then split-half reliability is an inappropriate tool for assessing the reliability of this measure.

Correlations were conducted between items 12 to 15 of the sleep diary, as displayed in Table 6. Items 12 to 15 were found to be highly correlated with one another, supporting the notion that these items measure a common construct relating to satisfaction with sleep experience.

Table 6.

Correlations between items 12-15 of adapted sleep diary.

		Sleep quality (12)	Ease of sleep initiation (13)	How refreshed felt (14)	Had enough sleep? (15)
Sleep quality (12)	*r*				
	Sig.	—	—	—	—
	N				
Ease of sleep initiation (13)	*r*	.669**			
	Sig.	.000	—	—	—
	N	60			
How refreshed felt (14)	*r*	.860**	.587**		
	Sig.	.000	.000	—	—
	N	60	60		

Had enough	*r*	.825**	.526**	.929**	
sleep? (15)	Sig.	.000	.000	.000	__
	N	60	60	60	

**Correlation is significant at the 0.01 level (two tailed).

The finding that diary sleep efficiency was not significantly correlated with diary sleep quality (p88) at any time point provides further support for the argument that the diary assesses two separate constructs, that of sleep timing and sleep satisfaction.

As diary sleep quality was not significantly associated with diary or actigraph sleep efficiency, it was decided to examine the correlation between diary sleep quality and EPDS scores. Results revealed a significant correlation between sleep quality at week 1 and EPDS scores at week 3 (3 (r = -.453, n = 20, $p < .05$, two tailed), but not at week 1 (r = -.249, p = .289) or week 5 (r = -.190, p = .435). Thus diary sleep efficiency was more consistently associated with subsequent mood than diary sleep quality, but mood did appear to be associated with subjective sleep quality in the week leading up to the mood rating .

Cronbach's alpha

Cronbach's alpha can also be used to assess the reliability of individual items. However, each question on the diary is used to calculate a separate sleep variable, and thus there is no reason to expect that the items would be related, as they are measuring different things.

Correlation between measures

The absence of a significant correlation between diary sleep efficiency and actigraph sleep efficiency at any time point was unexpected. In light of this finding, it was decided to explore whether this poor correlation was specific to sleep efficiency, or whether diary and actigraph measures were also poorly correlated on other sleep variables.

Sleep data was collapsed across weeks for the whole sample. Table 7 displays the correlations between diary and actigraph variables for the complete sample. Results revealed that diary and actigraph sleep measures were significantly correlated only for length of wakings after sleep onset ($r = .261$, n = 60, $p < .05$, two tailed). No other variables were significantly correlated.

Table 7.

Correlation between diary and actigraph sleep variables for the whole sample.

		Actigraph sleep latency	Actigraph total sleep time	Actigraph number of wakings (WASO)	Actigraph length of wakings	Actigraph early morning awakening
Diary sleep latency	*r*	.104				
	Sig.	.429	—	—	—	—
	N	60				
Diary total sleep time	*r*		.223			
	Sig.	—	.087	—	—	—
	N		60			

Diary number of wakings (WASO)	*r*			.110		
	Sig.	—	—	.403	—	—
	N			60		
Diary length of wakings	*r*				.261*	
	Sig.	—	—	—	.044	—
	N				60	
Diary early morning awakening	*r*					.252
	Sig.	—	—	—	—	.052
	N					60

*Correlation is significant at the 0.05 level (2 tailed).

Correlations were repeated using only data from participants in the no history of depression group. The results are displayed in Table 8.

Table 8.

Correlations between diary and actigraph sleep variables for the no history group.

		Actigraph sleep latency	Actigraph total sleep time	Actigraph number of wakings (WASO)	Actigraph length of wakings	Actigraph early morning awakening
Diary sleep latency	*r*	.583**				
	Sig.	.000	—	—	—	—
	N	42				
Diary total sleep time	*r*		.053			
	Sig.	—	.738	—	—	—
	N		42			
Diary number of wakings (WASO)	*r*			.218		
	Sig.	—	—	.166	—	—

	N			42		
Diary length of wakings	*r*				.298	
	Sig.	—	—	—	.055	—
	N				42	
Diary early morning awakening	*r*					.579**
	Sig.	—	—	—	—	.000
	N					42

**Correlation is significant at the 0.01 level (two tailed).

Results for the no history group revealed that diary and actigraph measures were significantly correlated for sleep latency ($r = .583$, n = 42, $p < .01$, two tailed), and for early morning awakening ($r = .579$, n = 42, $p < .01$, two tailed). Other sleep variables were not significantly correlated.

Implications

The use of multiple correlations increases the likelihood of error, and thus the results should be interpreted with caution. Nonetheless, these findings have important methodological implications for future sleep research. The poor correlation between measures may result from poor sensitivity of the actigraph, or from poor validity of the sleep diary. Alternatively, the absence of a correlation between objective and subjective sleep measures may provide information about the ability of individuals to judge their own sleep experience. Further research is needed to assess whether this is an isolated finding, as well as to explore how this pattern of results compares with other non-postpartum samples.

The significant correlations between the diary and actigraph measures of sleep latency and early morning awakening in the no history group suggest that whilst healthy women have difficulties in judging night time wakings, they are reasonably good at estimating when they fall asleep and wake up again in the morning. The finding that these variables were correlated in the no history group, but not significantly correlated when the sample included women with a history of depression is an interesting one. This may suggest an impairment in ability to judge transitional sleep states which is associated with history of depression.

There are no other published studies comparing subjective and objective sleep measures in postpartum women. However, Lockley et al. (1999) reported similar findings when comparing actigraphy and sleep diaries in a sample of visually impaired participants. In line with the present study, Lockley et al. found a poor correlation for number of night wakings. Unlike the present study, Lockley et al. also reported that the measures were not significantly correlated for sleep latency.

Other studies have compared subjective and objective measures in non-postpartum depressed samples. Argyropoulos et al. (2003) compared sleep diaries with EEG in depressed individuals and found that the measures were highly correlated for total sleep time and sleep latency, but not for number of awakenings. Similarly, Armitage et al. (1997) compared sleep diaries with EEG in depressed individuals and healthy controls and found that for both groups measures were highly correlated for total sleep time, time in bed and sleep latency, but not for number of awakenings.

Thus a number of studies comparing objective and subjective sleep measures have also found poor correlations between measures for number of wakings, in both depressed and non-depressed samples. However, results from EEG studies using depressed non-postpartum samples have found high correlations for sleep latency. This contrasts with the present study, which seems to suggest that women with a history of depression are impaired at judging sleep latency relative to healthy controls. This difference may be due to the use of actigraphy rather than EEG in the present study, to methodological problems, or to a specific difference between postpartum and non-postpartum samples. Further research is needed to explore this issue further.