Project MSSE:
Maternal Sleep and Social Environment
in the Short-Term Postpartum

By

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Abstract

The postpartum period is a time of considerable excitement and joy for new mothers as well as stress and change. While the majority of postpartum research has been conducted during the first three postpartum months, less is known about how to promote health and minimize maternal risk during the Short-Term Postpartum (3-6 months postpartum). This is an important time-frame of investigation as many U.S. women return to an employment setting during this time while integrating the existing demands of infant care. Accordingly, the current study sought to identify modifiable factors in the Short-Term Postpartum social environment that could enhance maternal well-being and sleep.

Seven days of daily social interaction diaries, sleep diaries and actigraphy were collected from 54 healthy, non-depressed, first-time mothers in in the Short-Term Postpartum. Multilevel modeling analyses revealed that daily fluctuation in frequency and valence of social interactions were related to nighttime sleep indices. In addition, improvements in nightly Sleep Quality, specifically, appeared to promote improvements in next-day maternal well-being and protect mothers from the negative effects of social discord. Group differences by employment status were examined; however, the majority of significant relationships were driven by within-person differences thereby supporting the need for examining within-person differences when making recommendations for enhancing maternal sleep and well-being in the postpartum.

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Introduction

The transition to motherhood can be an exciting and rewarding experience, however, it is also highly stressful and demanding. The birth of an infant brings about more widespread change than any other developmental phase of the family life cycle (Nystrom & Ohrling, 2004) and early researchers even characterized this transition as a crisis (Le Masters, 1959). The demands of caring for a new infant coupled with the stress of recovering from labor and delivery, all while negotiating new roles and responsibilities, are just a few of the stressors that can characterize the postpartum period (Goyal, Gay, & Lee, 2009; Shapiro, Gottman, & Carrére, 2000). Although many women make the transition without trouble, there is tremendous variability in adjustment to new motherhood and a small, but significant, number of women may be debilitated by their new role. Thus, it is critically important to identify modifiable factors that can minimize risk and promote health during the postpartum (Fowden, Giussani, & Forhead, 2006; Gicquel, El-Osta, & Le Bouc, 2008; Kuh & Ben-Shlomo, 2004).

There are approximately four million live births in the United States (U.S.) every year (US Census Bureau, 2008) and most U.S. women survive pregnancy and deliver healthy babies; fewer than 8 per 100,000 pregnant women die during child birth (US Census Bureau, 2007). The safety of pregnancy in the U.S. can largely be attributed to aggressive health promotion efforts aimed at achieving healthy pregnancies and deliveries. Indeed, pregnancy is often considered a time of great health promotion when pregnant women benefit from months of prenatal care, including frequent visits to medical professionals and recommendations to adopt numerous health behaviors aimed at creating and maintaining a healthy environment for the developing fetus (Ayoola, Nettleman, Stommel, & Canady, 2010; Vintzileos, Ananth, Smulian, Scorza, & Knuppel, 2002). In contrast with pregnancy, less is known about how to promote maternal health and well-being during the postpartum. Following childbirth, medical attention is focused on the baby, leaving new mothers with few opportunities to discuss physical and mental health concerns with medical professionals.

Defining the Postpartum Period

The postpartum has previously been defined as the time between the delivery of the placenta and the 6th-week postpartum where the uterus has returned to its pre-pregnant size (Blenning & Paladine, 2005; Cunningham, Gant, Leveno, & Larry, 2003). This time frame has important implications for postpartum health-related behaviors as it coincides with the typical single medical check-up many North American women receive at the 6th-week postpartum (WHO, 1998). However, many of the profound health-related changes women experience in the postpartum often occur well beyond the temporal parameters of uterine recovery (L. L. Albers, 2000; Cheng, Fowles, & Walker, 2006). As a result, many postpartum researchers, health professionals and new mothers alike, have called for a more broadly defined postpartum time frame that takes into account the changing health needs of women across the first postpartum year (L. Albers & Williams, 2002; Piejko, 2006; Smirnakis et al., 2005). In a review of maternal health needs occurring across the first postpartum year, Borders (2006) suggested that the postpartum be divided into three periods: the immediate postpartum period (Immediate-PPP, birth to 3 months), the short-term postpartum period (ST-PPP, 3 to 6 months), and the long-term postpartum period (L-PPP, 6-12 months). Border's definition of the postpartum includes time periods beyond the 6th week and thus allows for a more tailored assessment of modifiable factors that can improve health and well-being of women at different stages of the postpartum.

Postpartum Physical and Mental Health

There is little debate that the postpartum can be a mentally and physically vulnerable time for new mothers. After the physical recovery from labor and delivery, many mothers experience persistent physical health symptoms that can last well into the first postpartum year (Borders, 2006; Piejko, 2006; Schytt & Hildingsson, 2011; Walker, Im, & Tyler, 2012). Among these physical symptoms are muscle and joint pain, especially lower back ache (Russell, Dundas, & Reynolds, 1996; Russell, Groves, Taub, O'Dowd, & Reynolds, 1993), perineal pain and hemorrhoids (D. K. Gjerdingen, Froberg, Chaloner, & McGovern, 1993; Signorello, Harlow, Chekos, & Repke, 2001), sexual problems, dyspareunia, and/or vaginal pain (Andrews, Thakar, Sultan, & Jones, 2008; Glazener, 1997), and extreme tiredness or exhaustion (McBean, 2011; McQueen & Mander, 2003; J. Rychnovsky & L.P. Hunter, 2009). Also common are breast tenderness (Schwartz et al., 2002; Tait, 2000) and breast infections (Amir & Pakula, 1991; Mass, 2004) such as mastitis, which occurs most often from initiation of infant feeding. Primarily due to the combined toll of the aforementioned physical symptoms and the demands of infant care, another factor compounding postparutm physical health is the reduction in daily exercise or physical activity (Evenson, 2011; Evenson, Herring, & Wen, 2012; Symons Downs & Hausenblas, 2004). Similarly, the increased incidence of sedentary behavior in the postpartum may result in longer retention of pregnancy weight which may also negatively affect overall postpartum health (Gore, Brown, & West, 2003; Hinton & Olson, 2001; Keller, Allan, & Tinkle, 2006; Østbye et al., 2009). Combined, these data indicate that women’s overall physical health in the postpartum may be significantly compromised.

Given the host of physical problems women may encounter in the postpartum, it is not uncommon for women to also experience mental distress during this time. The most common severe mental health problem is postpartum depression (PPD), occurring in roughly 10- 15% of childbearing women worldwide (Beck & Gable, 2001; O'Hara & Swain, 1996; Sword, Busser, Ganann, McMillan, & Swinton, 2008) and in an estimated half-million American women (Wisner, Parry, & Piontek, 2002). PPD is distinguished from the more common "baby blues" reported by 50- 70% of mothers (Andrews-Fike, 1999). "Baby Blues" are characterized by a mildly depressed mood that develops between the first and fourth postpartum day and typically dissipates within the first two weeks (Gondiakis, Rabavilas, Varsou, Kreatsas, & Christodoulou, 2007). PPD, on the other hand, is characterized by a more severely depressed mood, including other symptoms such as anhedonia, irritability, crying spells, fatigue, sleep disturbance, anxiety, poor concentration, loss of sense of self and, in extreme cases, suicidal thoughts or actions (Patel et al., 2012; Silverman, 2007). These symptoms can manifest as early as two weeks and as late as one year, but usually peak between the sixth and twelfth postpartum week (Posmontier, 2008).

Although the precise cause(s) of PPD are unclear, the disorder might be conceptualized as a stress diathesis disorder. The physical and psychological stress from labor and delivery and the new demands of motherhood can trigger the onset of serve of a depressive episode (Cox, Holden, & Sagovsky, 1987; Runquist, 2007). However, there are several well understood diatheses, the most salient being a history of depression (Hobfoll, Ritter, Lavin, Hulsizer, & Cameron, 1995). Other factors implicated in the etiology of the disorder include sleep disturbance (Dørheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009; Karraker & Young, 2007; Okun et al., 2010; L. Ross, Murray, & Steiner, 2005; Runquist, 2007), marital distress (Beck, 2001; Boyce & Hickey, 2005; O'Hara, Schlechte, Lewis, & Wright, 1991), a lack of social support (Gottman, Driver, & Tabares, 2002; O'Hara & Swain, 1996; Simpson, Rholes, Campbell, Tran, & Wilson, 2003), stresses due to infant care, recent stressful life events, and lower socioeconomic status, age and general health (Beck, 1996). Although PPD remains the most common postpartum mental health issue, other mental health problems may arise in the postparutm, including bipolar disorder, anxiety disorders such as, obsessive-compulsive disorder and generalized anxiety disorders, and in rare cases, postpartum psychosis (for a review, see (Brockington, 2004).

Women who do not develop clinically significant mood disturbance symptoms in the postpartum may nevertheless experience fluctuations in subjective well-being. The construct of "subjective well-being" has been defined in a number of ways, but most generally attempts to capture an individual's broad judgments about his/her life as a whole (E. Diener, 2000; Ed Diener, Suh, Lucas, & Smith, 1999; Kahneman, Diener, & Schwarz, 2003). A variety of components have been used as measurements of this construct including high levels of life satisfaction (Keyes), high levels of Positive Affect, or experiencing more frequent positive or pleasant moods/emotions (Duarte, 2014), low levels of Negative Affect, or experiencing fewer negative or unpleasant moods/emotions, and low levels of Perceived Stress, or experiencing fewer self-appraised life stressors (E. C. Chang, 1998). Previous studies assessing well-being in pregnancy and the postpartum have related decrements subjective well-being to decreases in perceived life satisfaction (Nes et al., 2014), increases in depression symptoms (Lam, Hiscock, & Wake, 2003) and increases in perceived stress (Paarlberg et al., 1996). Taken together, the data regarding clinically significant mood disturbance symptoms and fluctuations in subjective well-being may indicate that women's mental health may be as fragile as their physical health during the postpartum.

The Short-Term Postpartum

Although many of the above-mentioned physical and mental problems can arise at different times during the first postpartum year and persist for varying lengths of time, much of the existing research on predictors and risk factors of maternal health has been conducted during the Immediate-Postpartum (birth to 3 months). However, the Short-Term Postpartum period is an equally important period of investigation for factors that can promote health and well-being among new mothers. By the 3rd-month postpartum, life with a new baby has begun to stabilize. Most women have recovered from the physical toll of labor and delivery (Klebanov, Brooks-Gunn, & McCormick, 2001; Lydon-Rochelle, Holt, & Martin, 2001; MacArthur, Lewis, & Knox, 1991; Thompson, Roberts, Currie, & Ellwood, 2002), lactation or a consistent feeding pattern has typically been established (Dennis, 2002; Riordan, 2005), and most infants have settled into a more consistent sleep-wake pattern (Bayer, Hiscock, Hampton, & Wake, 2007; Ghaem et al., 1998; Nishihara, Horiuchi, Eto, & Uchida, 2000). However, this period of relatively stability is also often met with another major transition: the return to employment. Within the United States, many women return to work during the Short-Term Postpartum because maternity leave typically covers 12-weeks of unpaid leave (United States Department of Labor). Consequently, mothers who return to work during this time must negotiate the demands of a conventional work schedule with the competing demands of a growing infant and any lingering physical and mental health issues.

Sleep in the Postpartum

One of the most commonly reported stressors of not only the Immediate-Postpartum, but also well beyond the first postpartum year is sleep disruption (Karraker & Young, 2007; L. Ross et al., 2005; Runquist, 2007). The abrupt reduction in total sleep time (Bei, Milgrom, Ericksen, &

Trinder, 2010), degradation in sleep quality (Gardner, 1991; Gay, Lee, & Lee, 2004), and dismantling of a consistent sleep routine (McBean, 2011) have been reported by women to be some of the most difficult experiences of new motherhood (Deave, Johnson, & Ingram, 2008; Kennedy, Gardiner, Gay, & Lee, 2007; Meltzer & Mindell, 2007; Nystrom & Ohrling, 2004). Scientific understanding of sleep disruption during the postpartum is critical, as it has been found to have deleterious effects on the mental and physical health of the new mothers. For example, postpartum sleeping difficulties have been tied to depression (C. L. Dennis & L. Ross, 2005; Dorheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2008; L. E. Ross, Sellers, Gilbert Evans, & Romach, 2004), mood deterioration (Bei et al., 2010; Goyal et al., 2009; Posmontier, 2008; J. Rychnovsky & L. P. Hunter, 2009), and indices of daytime dysfunction such as fatigue (Insana, Stacom, & Montgomery-Downs, 2011; Lee & Zaffke, 1999; J. Rychnovsky & L. P. Hunter, 2009) and sleepiness (Huang, Carter, & Guo, 2004; Insana & Montgomery-Downs, 2010; Lee, McEnany, & Zaffke, 2000).

These associations are echoed in the general population where sleep problems have been implicated in poor mental and physical health (Baldwin & Daugherty, 2004; Brissette, Cohen, & Seeman, 2000; P. Chang, Ford, Mead, Cooper-Patrick, & Klag, 1997; Cohen, Doyle, Alper, Janicki-Deverts, & Turner, 2009; Roman, Hagewoud, Luiten, & Meerlo, 2006; J. Scott, L., & Polman, 2006; Totterdell, Reynolds, Parkinson, & Briner, 1994; Wood & Magnello, 1992), impaired physical activity and social functioning (Affleck et al., 1998; Affleck et al., 2001), impaired cognitive functioning (Van Dongen, Maislin, Mullington, & Dinges, 2003), decreased job performance (Lockley et al., 2007) and increased risk of auto accidents (Bunn, Slavova, Struttmann, & Browning, 2005; Horne & Reyner, 1995; Leger, Janus, Pellois, Quera-Salva, &

Dreyfus, 1995). Collectively, these data suggest that although postpartum sleep disruption may be common in new parenthood, it may also have dire consequences.

Maternal sleep disruption in the Immediate-Postpartum is largely caused by infants' polyphasic sleep cycle (Ednick et al., 2009; Tikotzky et al., 2010) and nighttime infant care activities . In addition, the disruption in sleep during this time may also be amplified or maintained by the wake-promoting changes in maternal circadian modulating hormones, including progesterone and estrogen, (Bales et al., 2007; Beck & Gable, 2001; Bei et al., 2010) and elevated activity in the Hypothalamic Pituitary Adrenal (HPA) axis (Parry et al., 2008; Roth, Roehrs, & Pies, 2007). As a result, Immediate-Postpartum sleep in new mothers has been characterized as chronically, partially deprived (C. L. Dennis & L. Ross, 2005) with wake-time increasing by as much as 20% during the first 6-weeks (Horiuchi & Nishihara, 1999).

As women progress through the first postpartum year, the decline in total sleep duration may be less prevalent or problematic than the persistent degradation in sleep quality. A recent study longitudinally assessed a normal trajectory of maternal sleep in a non-depressed sample of 75 primiparous (first-time mothers) and multiparous (more than one child) women, between the 2^{nd}-week and 4^{th}-month postpartum using actigraphy and sleep diaries (Montgomery-Downs, Insana, Clegg-Kraynok, & Mancini, 2010b). The authors were surprised to find that the average duration of Total Sleep Time (TST) exceeded seven hours and did not change significantly across the four-month study period. This result is consistent with other studies that have used objective measures of sleep (like actigraphy) to assess non-depressed maternal sleep time during the Immediate-Postpartum. At 2-months postpartum, one study found that women averaged just over 7.5 hours of sleep per night (Dorheim et al., 2008) and another study reported a high average Sleep Efficiency (SE=TST/Time in Bed) of 89.2% for mothers from week 6 through 26 of the postpartum (Posmontier, 2008).

It is important to note that these seemingly longer periods of TST do not necessarily suggest a high quality of sleep. Although the mothers studied by Montgomery-Downs and colleagues (2010) averaged more than seven hours, their sleep was highly fragmented, with an average of two hours of wakefulness during the night. Fragmented sleep is characterized by intermittent disruptions in the normal progression of sleep architecture throughout the night (Bonnet & Arand, 2003; Stepanski, 2002). This type of sleep disruption often characterizes the sleep of individuals with Obstructive Sleep Apnea (OSA) and typically results in reports of un-refreshing sleep, next-day fatigue, and daytime sleepiness (Bennett, Langford, Stradling, & Davies, 1998; Chervin, 2000; Loredo, Ancoli-Israel, & Dimsdale, 2001). Fragmented sleep may be responsible for the dominant reports of poor sleep quality from mothers in the postpartum despite the seemingly long periods of TST. Although Montgomery-Downs and colleagues noted that fragmentation improved across the 2-week to 4-month period, there are very few studies that objectively assess sleep beyond the Immediate-Postpartum. Thus, there is no way to determine whether this kind of sleep disruption extends into the Short-Term Postpartum and beyond.

Breastfeeding and Sleep

Nearly every reputable health organization, including the American Academy of Pediatrics (AAP) and the World Health Organization (WHO), strongly promotes exclusive breastfeeding throughout at least an infant’s first year of life (and thereafter in addition to solid foods for as long as mother and baby prefer). This widespread recommendation stems from the empirical evidence supporting exclusive breastfeeding’s role in the health and development of infants as well as maternal health (Gartner et al., 2005; J. Ross & Piwoz, 2005; World Health

Organization, 2001) Though the relationship is not well understood, how a woman chooses to feed her infant may also have implications for her sleep.

Feeding status may be related to maternal sleep either directly through its effects on maternal biology or indirectly through its effects on infant sleep. In terms of infant sleep, some studies have reported that breastfeeding women subjectively rated their infant's TST as shorter than formula-feeding women (Lucas & St James-Roberts, 1998) and reported more frequent infant awakenings after sleep onset (DeLeon & Karraker, 2007; Poehlmann, Schwichtenberg, Bolt, & Dilworth-Bart, 2009; Quillin, 1997). Another study using infant actigraphy found that breastfed infants had more fragmented sleep than formula-fed infants (Tikotzky et al., 2010). However, other self-report studies of infant sleep have reported no differences in TST or number of awakenings between breastfed and formula-fed infants (Butte, Jensen, Moon, Glaze, & Frost, 1992; Thomas, 2000).

With respect to maternal sleep, less is known, and the data are even less consistent. In terms of objectively measured sleep with actigraphy, one study found that across the first month postpartum, breastfeeding mothers spent more time awake during the night but did not differ significantly from formula-feeders in terms of TST (Gay et al., 2004). Similarly, in a cross-sectional study using polysomnography at 3-months postpartum, no differences were found in TST between breastfeeders and formula-feeders, however, breastfeeders were found to have lower sleep efficiency, more awakenings after sleep onset and, interestingly, more slow wave sleep (SWS) (Blyton, Sullivan, & Edwards, 2002). SWS, or deep sleep, is characterized by the presence of delta waves and typically occurs in the first half of the night (reflecting a homeostatic drive to sleep after a period of wakefulness). This stage of sleep is thought to be particularly restorative and associated with subjectively feeling rested the next day (Javaheri &

Redline, 2012). Blyton's study found that breastfeeding women not only had more SWS overall, but also had significantly more SWS in the second half of night. The authors speculated that women who breastfeed have increased circulating prolactin levels which may be related to their higher incidence of SWS. It is important to note that this difference in sleep architecture between breastfeeding and formula-feeding women has not yet been replicated (Rosen, 2009).

Other studies have reported that breastfeeding women self-report longer TST than formula-feeding women (Kendall–Tackett, Cong, & Hale, 2010), a finding that has been substantiated by actigraphy (Doan, Gardiner, Gay, & Lee, 2007; Dorheim et al., 2008). More recently, Montgomery-Downs (2010) reported no significant differences in objective (actigraphy) or subjective sleep parameters between breastfeeding and formula-feeding women measured longitudinally, across postpartum weeks 2-12. These mixed findings may be due to the small number of studies assessing maternal sleep in the postpartum and/or the differing methodologies and research designs employed (objective vs. subjective, cross-sectional vs. longitudinal). Given the widespread recommendation of exclusive breastfeeding, it is important to continue investigating breastfeeding's relationship to maternal sleep as women may consider their sleep as a factor in choosing whether or not to breastfeed (Montgomery-Downs, Clawges, & Santy, 2010).

The Postpartum Social Environment

Although sleep disruption is considered one of the major stressors associated with the transition to parenthood, social support has been found to be one of the most robust predictors of maternal health and well-being during the postpartum (D. Gjerdingen, Froberg, & Fontaine, 1991; Miller, Hogue, Knight, Stowe, & Newport, 2012; Negron, Martin, Almog, Balbierz, & Howell, 2012; Uchino, Cacioppo, & Kiecolt-Glaser, 1996; Wandersman, Wandersman, & Kahn, 1980). Along these lines, it is important to understand how a mother's overall social network changes across the transition to motherhood in order to provide that support. The literature assessing the impact of the birth of a child on a mother's social environment suggests widespread changes in size, frequency of interaction and provisions of support from network members across the postpartum. While most research has been conducted on the changes that occur within the marital relationship after the birth of a child (C. P. Cowan & Cowan, 1995, 2000; P. A. Cowan & Cowan, 1984; Delmore-Ko, Pancer, Hunsberger, & Pratt, 2000; Doss, Rhoades, Stanley, & Markman, 2009; Shapiro et al., 2000), some studies have also documented changes in family and friendship relationships (Belsky & Rovine, 1984; Bost, Cox, & Payne, 2002; Gameiro, Boivin, Canavarro, Moura-Ramos, & Soares, 2010; Hammer, Gutwirth, & Phillips, 1982; McCannell, 1987; D. Scott, Brady, & Glynn, 2001).

Marital Relationship. The marital/primary relationship has been reported to change most dramatically after the birth of a child. Although some research suggests that couples report feeling closer (Deave et al., 2008) and more satisfied with the dyadic relationship as a result of having a child (C. P. Cowan & Cowan, 2000), other studies have documented an extended and pervasive decline in relationship satisfaction occurring across the transition to parenthood (C. P. Cowan & Cowan, 2000; Doss et al., 2009; Kurdek, 1999; Lawrence, Rothman, Cobb, Rothman, & Bradbury, 2008; Moss, Bolland, Foxman, & Owen, 1986; Pancer, Pratt, Hunsberger, & Gallant, 2000; Shapiro et al., 2000). Normative experiences of new parenthood that may contribute to this decline include, but are not limited to, negotiating new roles and responsibilities (Goyal et al., 2009; Shapiro et al., 2000), decreases in dyadic communication (Belsky & Isabella, 1985), increases in couple-related conflict (C. P. Cowan et al., 1985), feelings of ambivalence about parenting (Field, Diego, Hernandez-Reif, Figueiredo, et al., 2007), declines in sexual intimacy (Ahlborg & Strandmark, 2001; Kuang, 2000), declines in sleep quality and quantity (Karraker & Young, 2007; L. Ross et al., 2005; Runquist, 2007; Stremler et al., 2006), and managing difficult infant temperament and sleeping patterns (Meijer & van den Wittenboer, 2007).

The transition to parenthood also results in an overall decrease in dyadic focused time (despite couples actually spending more time together after the birth of a child) (P. A. Cowan & Cowan, 1984). Research has also indicated that such declines in postpartum dyadic-focused time and positive experiences specifically relevant to the dyad may contribute to poor dyadic adjustment to parenthood (MacDermind, Hutson, & McHale, 1990). Along these lines, many studies have documented that new mothers' perceptions of inadequate support from their partners resulted in feelings of resentment and increased conflict (Barclay, Everitt, Rogan, Schmied, & Wyllie, 1997; Hall, 1992; McBridge & Shore, 2001). In contrast, the perceived availability and actual provisions of emotional and physical support from partners have been found to be related to relationship satisfaction and maternal adjustment in the postpartum (Burke, 2003; Majewski, 1987; Power & Parke, 1984; Shapiro et al., 2000).

Family Relationships. Relationships with family members are also transformed during the postpartum, though not to the same degree as of the primary relationship. Most studies document increases in interaction with kin members after the birth of a child (Belsky & Rovine, 1984; Bost et al., 2002; Flaherty & Richman, 1989; Gameiro et al., 2010; Hammer et al., 1982; McCannell, 1987) and this finding is congruent with general social network research suggesting that family relationships are more durable during times of stress and change than other non-kin related network ties (Wellman, Yuk-Lin Wong, Tindall, & Nazer, 1997). Similarly, some authors have speculated that new parents, and new mothers in particular, not only perceive more support to be available from kin-related members, but also feel more comfortable asking for support from those members over non-kin related members (Simons & Johnson, 1996). Deave et al. (2008) found that new mothers were most likely to elicit support from female relatives, especially their own mothers, and that the support provided was both emotional and physical.

Friendship Relationships. While the birth of a child tends to bring about an increase in contact between family members, many studies have found that new parents, in turn, tend to withdrawal from friends and other non-kin related adults in the postpartum (Bost et al., 2002; Hammer et al., 1982; McCannell, 1987; Stueve & Gerson, 1977). Indeed, some studies have documented a robust decline in the frequency of contact with non-kin related adults in the postpartum (Stueve & Gerson, 1977) in addition to a decrease in the overall number of friend network relationships (Bost et al., 2002; Gameiro et al., 2010; McCannell, 1987). Reasons for the decrease in contact with friends after the birth of a child have been hypothesized to be related to the perceived unavailability of those network members to provide physical support with everyday childcare activities or emotional support, such as in empathizing with the demands of new motherhood (Simons & Johnson, 1996). Along these lines, Belsky and Rovine (1984) as well as McCannell (1988), found that contact with non-kin related parents of young children increased significantly for women after the birth of their child. Deave et al. (2008) similarly found that new mothers reported valuing the friendships the most with those individuals who had recently given birth or had experience with childcare.

Employment Status. Finally, maternal employment status is likely implicated in the change in postpartum social relationships given that the social network is often embedded in outside-home employment. Despite the key role of employment in establishing and maintaining social relationships, few studies assessing the change in social relationships across the transition to parenthood have reported the employment status of their participants. This is a noteworthy exclusion as working mothers are likely to experience different changes in their social networks in the postpartum in addition to using their social support contacts more frequently to cope with the demands of being both a mother and an employee. One exception was a small study of postpartum social networks by Hammer et al. (1982) who found that women who were employed during the postpartum reported larger social networks than non-employed mothers and non-employed mothers reported a smaller network of people seen with higher frequency. McCannell (1987) found minimal differences between employed and non-employed mothers in terms of overall network size and frequency of contact with network members, but noted that mothers who returned to outside employment after the birth of their baby reported experiencing less difficulty in adjusting to the maternal role than mothers that stayed home with their infants. McCannell acknowledged that this result may have been because employed mothers experienced fewer stresses of childcare typically over the course of a day than non-employed mothers.

The cumulative effects of postpartum social network changes on maternal well-being are complex. Collectively, these data may suggest that, to the extent that social network changes aid in the provision of support (both tangible and emotional) and do not increase feelings of maternal isolation, social network changes in the postpartum may confer a net positive or "buffering" effect on some of the inherent stress of new motherhood. Importantly, quantifying the effects of postpartum social network changes on maternal well-being, both overtime and across relationships, has not been previously investigated. Therefore, the current literature is limited in discerning how much, if any, of impact (positive or negative) postpartum social changes have on new mothers' well-being.

Postpartum Social Environment and Sleep.

Changes in the postpartum social network may also be related to maternal sleep characteristics; however only a small number of studies have investigated this relationship. In particular, these studies have reported on the negative impact of social stressors increasing sleep disturbance in an already sleep fragmented mother (Meijer & van den Wittenboer, 2007; Troxel, 2010; Troxel, Robles, Hall, & Buysse, 2007). However, less is known about the potential positive effects that the postpartum social environment may confer on maternal sleep. In the general population, social support and positive social interactions have been related to positive mental health (Brown, Nesse, Vinokur, & Smith, 2003; Burman & Margolin, 1992; Coyne & DeLongis, 1986; Fincham, 2003; Revenson, 1994; Robles & Kiecolt-Glaser, 2003; Seeman, Kaplan, Knudsen, Cohen, & Guralnik, 1987; Tower, Kasl, & Darefsky, 2002) and have also been hypothesized to buffer the negative systemic effects of stress during the postpartum (Gerin, Milner, Chawla, & Pickering, 1995; Hammer, 1983). In this way, social support and positive social interactions could have a positive, indirect effect on maternal sleep primarily through buffering the negative effects of stress on nighttime sleep. Importantly, this specific theory has not been previously investigated.

The Current Study

Given the physical and psychological vulnerability characterized by the postpartum, it is important to identify modifiable factors that can improve new mothers' health and well-being. The Short-Term Postpartum is a relatively understudied time during the postpartum, but no less significant, given that many women return to work during this time and must balance the demands of employment on top of the demands of caring for their infant. Accordingly, the current study sought to investigate modifiable factors in the social environment that could improve maternal sleep and well-being during the Short-Term Postpartum.

Previous research has characterized Immediate-Postpartum sleep as partially deprived and fragmented (Bei et al., 2010; Montgomery-Downs, Insana, Clegg-Kraynok, & Mancini, 2010a). However, maternal sleep during the Short-Term Postpartum has not been well studied. Although infants begin to have a more consistent and predictable sleep pattern during the Short-Term Postpartum (Bayer et al., 2007; C.L. Dennis & L. Ross, 2005; Ghaem et al., 1998; Nishihara et al., 2000), their sleep is not yet completely consolidated (Scher, 1991). Mothers who return to work during the Short-Term Postpartum may be more susceptible to the consequences of fragmented sleep due to the next-day demands of a conventional work schedule. Accordingly, an important scientific question for researchers to answer is whether there may be modifiable factors that would improve mothers' sleep in the Short-Term Postpartum and whether those factors would differ between employed and stay-at-home mothers. Importantly, it may not be possible to increase the duration of sleep in the Short-Term Postpartum, given the demands of new motherhood, however, there may be modifiable factors that improve sleep quality or promote more consolidated sleep.

Despite the mixed findings reported on the relationship between feeding status and sleep in the postpartum, it is possible that breastfeeding may promote higher quality sleep in the postpartum. Some studies have reported that four nucleotides in breast milk may have a hypnotic effect on infants (Sánchez et al., 2009) while other studies point to the soporific effects of prolactin (Spiegel et al., 1994) and its relation to slow wave sleep (Blyton et al., 2002). Additionally, lactating women have lower stress responses than formula-feeding counterparts documented by decreased stress report and cortisol responses (Altemus, Deuster, Galliven, Carter, & Gold, 1995; Heinrichs et al., 2001). The decrease in response to psychological stress appears to be especially potent immediately after breastfeeding (Heinrichs et al., 2001), an activity frequently done prior to bedtime and during the night, likely as a result of circulating levels of oxytocin (Boutet, 2006; Taylor, 2006; Uvnas-Moberg, 1997).

Given the hypothesis that breastfeeding stimulates parasympathetic activity and decreases sympathetic activity (Mezzacappa, Kelsey, & Katkin, 2005), it is possible that breastfeeding's role in the stress response may promote sleep during middle-of-the-night feedings and before bed after the final night feeding. Although night-feedings are likely to have complex sleep effects, breastfeeding may promote sleepiness due to the aforementioned stress-buffering response and soporific chemical properties of breast milk. Additionally, the Short-Term Postpartum may be an especially important time to examine the relationship between maternal sleep and feeding status given that many of the "kinks" of feeding patterns, such as latching difficulties, have been resolved by this point (J. A. Scott, Binns, Oddy, & Graham, 2006; Waldenström & Aarts, 2004) and infants' diets are not yet fully supplemented with solid foods (Alder et al., 2004; J. Scott, Binns, Graham, & Oddy, 2009).

Given the changes in social relationships experienced across the first postpartum year, the Short-Term Postpartum is also likely to be characterized by changes in the quantity and emotional valence of social interactions (Negative and Positive Social Interactions). As noted previously, the birth of a child is usually experienced as positive, however the transition may also be characterized by increased Negative Social Interactions arising from the declines in marital satisfaction (C. P. Cowan & Cowan, 2000; Doss et al., 2009; Kurdek, 1999; Lawrence et al., 2008; Moss et al., 1986; Pancer et al., 2000; Shapiro et al., 2000), altered roles and responsibilities (Field, Diego, Hernandez-Reif, Figueriedo, et al., 2007; Goyal et al., 2009), decreased intimacy (Kuang, 2000), and fluctuations in social network characteristics (Belsky & Rovine, 1984; Bost et al., 2002; Gameiro et al., 2010; Hammer et al., 1982; McCannell, 1987). These Positive Social Interactions and Negative Social Interactions are also likely to vary across the primary relationship, relationship with baby, relationships with friends and family, and for mothers who return to work, relationships with coworkers. Determining how, if at all, the frequency of Positive Social Interactions and Negative Social Interactions relate to day-to-day maternal well-being has not been previously investigated.

Finally, as noted previously, the relationship between postpartum social network characteristics and maternal sleep is somewhat poorly defined. Although social stressors have been tied to increased maternal sleep disruption (Meijer & van den Wittenboer, 2007; Troxel, 2010; Troxel et al., 2007), the true relationship of positive social network characteristics to maternal sleep remains unknown. Therefore, examining the relationship between daily Positive Social Interactions and Negative Social Interactions and maternal sleep may provide new insight into how a mother's social environment is implicated in her sleep and vice versa.

In summary, existing research on sleep and social relationships in the Short-Term Postpartum is incomplete and has been limited in its scope and in many cases by its methodology. The current study sought to improve upon the existing literature by using a repeated-measures design with reliable methods of sleep measurement (sleep diaries and actigraphy) to answer a number of unknown, but potentially important, questions about maternal sleep and well-being in the Short-Term Postpartum. First, to what extent does the social environment, including daily Positive Social Interactions and Negative Social Interactions (total across interactions with baby, spouse, family members, friends and coworkers), relate to objective and subjective maternal sleep characteristics? Second, to what extent does the social environment and objective and subjective maternal sleep characteristics predict daily reports of subjective well-being? Finally, how, if at all, do the aforementioned relationships differ as a function of maternal working status and/or infant-feeding method status? Ultimately, these specific inquiries are directed at investigating modifiable factors in the social environment that may exert indirect, but positive, effects on maternal sleep and well-being.

A Priori Study Hypotheses

The first three series of Model Hypotheses were designed to identify daily factors that would relate to nighttime sleep in the Short-Term Postpartum. In particular, we sought to test whether characteristics of the social environment, such as day-to-day variability in Positive Social Interactions and Negative Social Interactions, predicted significant changes in nightly total sleep time (TST), sleep fragmentation defined as time spent awake during the night or Wake After Sleep Onset (WASO), and subjective Sleep Quality ratings. In addition, we sought to examine whether these aforementioned relationships differed as a function or working status, infant-feeding method or and interaction between those groups.

<u>Model #1 Hypotheses:</u>

$H1_a$. Level 1 Variables:

Higher ***Sleep Quality*** ratings will be predicted by more Positive Social Interactions.

Higher ***Sleep Quality*** ratings will be predicted by fewer Negative Social Interactions.

$H1_b$. Level 2 Variables:

Breastfeeding mothers will have higher ***Sleep Quality*** than formula-feeding mothers.

Stay at home mothers will have higher ***Sleep Quality*** than employed mothers.

$H1_c$. Higher Order Interaction:

There will be a buffering effect of feeding status on the relationship between Employment Status and ***Sleep Quality***, such that, employed breastfeeders will have the highest ***Sleep Quality***.

<u>Model #2 Hypotheses:</u>

$H2_a$. Level 1 Variables:

Longer ***WASO*** will be predicted by fewer Positive Social Interactions.

Longer ***WASO*** will be predicted by more Negative Social Interactions.

H2$_b$. Level 2 Variables:

Formula-feeding mothers will have shorter ***WASO*** than breastfeeding mothers.

Employed mothers will have shorter ***WASO*** than stay at home mothers.

H2$_c$. Higher Order Interaction:

There will be a buffering effect of feeding status on the relationship between Employment status and ***WASO***, such that employed breastfeeders will have the shortest ***WASO***.

<u>Model #3 Hypotheses:</u>

H3$_a$. Level 1 Variables:

Daily variability in Positive Social Interactions will not be related to ***TST***.

Daily variability in Negative Social Interactions will not be related to ***TST***.

H3$_b$. Level 2 Variables:

Breastfeeding mothers will have shorter ***TST*** than formula-feeding mothers.

Employed mothers will have shorter ***TST*** than stay at home mothers.

H3$_c$. Higher Order Interaction:

There will be a negative synergistic effect of employment status and feeding status on ***TST***, such that, employed breastfeeders will have the shortest ***TST***.

Model Hypotheses series 4-6 were designed to identify nightly sleep characteristics and daily social interaction variables that were related to daytime indicators of maternal well-being: Daily Positive Affect, Daily Negative Affect and Daily Perceived Stress. In particular, we sought to test whether night-to-night variability in TST, WASO and Sleep Quality predicted daily changes in Positive Affect, Negative Affect and Perceived Stress. In addition, we sought to identify whether day-to-day variability in Positive Social Interactions and Negative Social

Interactions were also related to daily changes in Positive Affect, Negative Affect and Perceived Stress. We also sought to examine whether these aforementioned relationships differed as a function or working status, infant-feeding method or and interaction of both. Finally, in Models 5 & 6, we wanted to determine whether maternal sleep characteristics moderated the relationship between Positive/ Negative Social Interactions on Daily Positive Affect, Negative Affect and Perceived Stress.

Model #4 Hypotheses:

H4$_a$. Level 1 Variables:

Higher daily ***Positive Affect*** will be predicted by more Positive Social Interactions.

Higher daily ***Positive Affect*** will be predicted by fewer Negative Social Interactions.

Higher daily ***Positive Affect*** will be predicted by higher Sleep Quality.

Higher daily ***Positive Affect*** will be predicted by longer TST

Higher daily ***Positive Affect*** will be predicted by shorter WASO.

H4$_b$. Level 2 Variables:

Breastfeeding women will have higher daily ***Positive Affect*** than formula-feeding women.

Employment status alone will not be related to daily ***Positive Affect.***

H4$_c$. Higher Order Interaction:

Feeding status will buffer the relationship between TST and daily ***Positive Affect***, such that, breastfeeding will moderate the negative effect of shorter TST on daily ***Positive Affect.***

H4$_d$. Higher Order Interaction:

Positive Social Interactions will buffer the relationship between feeding status and daily ***Positive Affect,*** such that, a higher number of Positive Social Interactions will moderate the negative effect of formula-feeding on daily ***Positive Affect.***

H4$_e$. Higher Order Interaction:

Feeding status will moderate the relationship between Employment status and Positive Affect, such that stay at home breastfeeders are predicted to have the highest daily ***Positive Affect.***

<u>Model #5 Hypotheses:</u>

H5$_a$. Level 1 Variables:

Higher daily ***Negative Affect*** will be predicted by more Negative Social Interactions.

Higher daily ***Negative Affect*** will be predicted by fewer Positive Social Interactions.

Higher daily ***Negative Affect*** will be predicted by lower Sleep Quality.

Higher daily ***Negative Affect*** will be predicted by longer WASO.

Higher daily ***Negative Affect*** will be predicted by shorter TST.

H5$_b$. Level 2 Variables:

Formula-feeding mothers will have higher daily ***Negative Affect*** than breastfeeding mothers.

Employed mothers will have higher daily ***Negative Affect*** than stay at home mothers.

H5$_c$. Higher Order Interaction:

There will be a synergistic interaction between feeding status and employment status, such that employed formula-feeders are predicted to have the highest ***Negative Affect.***

H5$_d$. Higher Order Interaction:

The effect of daily Positive Social Interactions and Negative Social Interactions on daily ***Negative Affect*** will depend on the characteristics of sleep the night prior. Specifically, increases in nightly Sleep Quality and TST and decreases in nightly WASO will diminish the relationship between daily Negative Social Interactions and ***Negative Affect*** and enhance the inverse relationship between Positive Social Interactions and ***Negative Affect***.

Model #6 Hypotheses:

H6$_a$. Level 1 Variables:

Higher daily ***Perceived Stress*** will be predicted by more Negative Social Interactions.

Higher daily ***Perceived Stress*** will be predicted by fewer Positive Social Interactions.

Higher daily ***Perceived Stress*** will be predicted by lower Sleep Quality.

Higher daily ***Perceived Stress*** will be predicted by shorter TST.

Higher daily ***Perceived Stress*** will be predicted by longer WASO.

H6$_b$. Level 2 Variables:

Breastfeeding mothers will have lower daily ***Perceived Stress*** than formula-feeding mothers.

Stay at home mothers will have lower daily ***Perceived Stress*** than employed mothers.

H6$_c$. Higher Order Interaction:

There will be a synergistic interaction between feeding status and employment status, such that employed mothers who formula feed are predicted to have the highest ***Perceived Stress***.

H6$_d$. Higher Order Interaction:

The effect of daily Positive Social Interactions and Negative Social Interactions on daily ***Perceived Stress*** will depend on the characteristics of sleep the night prior. Specifically, increases in nightly Sleep Quality and TST and decreases in nightly WASO will diminish the relationship between daily Negative Social Interactions and ***Perceived Stress*** and enhance the inverse relationship of Positive Social Interactions and ***Perceived Stress***.

Methods

The study procedures described below were implemented in two phases. Phase I (Pilot Study) was approved by the Institutional Review Board of the University of Kansas (Lawrence Campus; HSC-L #19859) and recruited subjects between April 2012 and April 2013 (N = 9). Phase II was approved by the University of Kansas Medical Center's (Kansas City; HSC #13641) Institutional Review Board and recruited subjects between April 2013 and April 2014 (N = 45). Study procedures were nearly identical between Phases; participants enrolled in Phase I completed three fewer Baseline Measures, were not provided the option to complete baseline measures online, and information on delivery type, nightly assistance from partner tending to baby, and daily feelings of isolation were not collected.

Though not pertinent to hypotheses presented in the current study, Phase II participants provided two saliva samples for future serum cortisol and oxytocin analyses during one night of their study participation week. All other informed consent, participation payment, and follow up procedures were the same between study phases. The following methods section will highlight protocol differences denoted with study phase number (Phase I or Phase II) when necessary for reader clarification.

Participants

Participant Recruitment & Eligibility. Figure 1 (pg. 128) provides information related to participant recruitment, eligibility, retention, and study completion. Recruitment methods included online advertisements, in-person announcements at Maternal Support/Breastfeeding Support Groups, and distribution of flyers/brochures in the Lawrence and Kansas City area communities. All recruitment-related materials provided a brief overview of study procedures, the main inclusion criteria (first-time mother, one 3-6 month-old infant, cohabitating/parenting partner) and telephone/email contact information for the study coordinator.

One-hundred and sixty women expressed interest in participating in the study. Of the 143 women who responded to follow-up contact by the study coordinator, 133 women were provided with an Eligibility Survey to complete over the phone with the study coordinator or through an online survey. The purpose of the Eligibility Survey was to quickly assess whether a woman was eligible to participate in the study. Women were deemed eligible if they met the following *Inclusion Criteria:* a) over the age of 18 b) one child between 3-6 months c) no other children d) a cohabitating parenting partner (this constitutes inclusionary criteria because study outcomes are related to parenting-related social interactions in the postpartum) and e) able to speak and read English. Women were not eligible to participate if they met any of the following *Exclusion Criteria:* a) a history of sleep disorders other than insomnia (i.e., sleep apnea, narcolepsy), endocrine, or immune disorders b) current sleep medication use c) history of psychosis or history of manic episodes d) currently working a night shift occupation e) baby was in the Neonatal intensive care unit after birth and f) currently experiencing depressive symptoms. These exclusionary criteria were selected because they are either known to interfere with sleep or affect the feeding patterns typically established overtime during the postpartum.

Of the 118 women who provided complete Eligibility Surveys, 72 were deemed eligible to participate. Figure 1 (pg. 128) summarizes the exclusion criteria met for the 46 ineligible women (note that some women met more than one exclusion criterion). Participants deemed ineligible were provided with a brief explanation for their ineligibility and thanked for their interest. Women who met the exclusion criterion of experiencing current depressive symptoms, defined as experiencing a down or depressed mood most days over the past two weeks and/or a loss of interest or pleasure in activities previously found enjoyable over the past two weeks (N= 20), were also provided with a list of local and national mental health resources as well as encouraged to follow up with their medical and/or mental healthcare provider.

Enrollment. Eligible participants were notified of their eligibility and provided with a thorough overview of study procedures. Of the 72 participants who were deemed eligible to participate, 54 chose to enroll in the study. Enrollment consisted of scheduling a study start date and an in-person meeting for informed consent. Participants were asked to choose a study week that was “fairly normal” (partner in town, self/baby not currently ill, no recent travel across multiple time zones, etc.). Participants were offered the choice to meet for informed consent in their home (N= 35) or at the KU/KUMC campus in a private office (N=19). Table 1 (pg. 97) provides information related to Recruitment Location. Of the 54 women who enrolled and completed informed consent, 53 completed the full study protocol. One participant elected to end the study four days early due to a family emergency.

Procedure

The main study procedures across the participation week for enrolled participants included completing a daily online morning survey about their previous nights’ sleep characteristics, completing a nightly online evening survey about their social interactions, mood and stress experienced during the day and wearing an actiwatch each day of the study.

Data Collection. After completing informed consent, participants were provided with an actiwatch and instructed to wear it for seven continuous days and nights and to only remove it during bathing. Participants were then offered the choice to complete the baseline and daily measures online via a secure online survey site (Qualtrics, 2009), with paper and pencil, or have a research assistant call them and complete them over the phone. The latter two options were offered to ensure that potential low-income participants without home computer access were not systematically excluded. However, all consenting participants chose to complete the daily measures online via Qualtrics. Phase I participants completed the baseline measures with paper and pencil and Phase II participants were notified during the informed consent interview that they would receive emails with links to the baseline measures later that day and were asked to complete those measures as quickly as possible.

Participants were informed that the morning and evening measure email links would be sent at the same time every day of the study week: 5:00 AM for the morning measures and 8:00 PM for the evening measures. The study coordinator confirmed that participants did not typically wake before 5:00 AM or go to bed prior to 8:00 PM (and adjusted the delivery times accordingly for those participants who requested, N = 3). Participants were asked to complete the morning measures as close upon waking up as possible and the evening measures as close to their bedtime as possible.

Debriefing. Towards the end of the participation week, the study coordinator contacted the participants about a mutually agreeable meeting time for the actiwatch pickup and answered any questions the participants had about their week in the study. Participants were also offered the option of completing an online, anonymous feedback survey about their experience in the study.

Payment. During informed consent, participants were provided with a ClinCard debit card on to which money would be loaded at the conclusion of their participation week. Participants were informed of the pay schedule for their participation: $15 for completion of all the baseline measures, $5 for completion of all morning measures, $5 for completion of all evening measures and $10 for wearing the actiwatch ~24-hour/day. If participants completed all study related steps and measures, they would receive a $15 bonus. The maximum ClinCard debit card amount participants could earn was $50.

Privacy. Across all phases of recruitment, enrollment and active participation, potential and active participants were provided the option of communicating with the study coordinator through a secure study phone number/voicemail or through the study coordinator's registered email address with the University of Kansas/University of Kansas Medical Center. Contact information was destroyed for those women who were not interested in participating or were deemed ineligible to participate. Completed baseline and daily measures from enrolled participants coded with participants' unique ID numbers and saved on a password protected computer with updated firewall and antivirus programs. Study related materials with participant identifiable information were stored securely and separately from participant responses.

Measures

The following subset of measures from Phase I and II of the study were used for the aforementioned study hypotheses. For a full list of baseline and daily measure sample items, please refer to Tables 1 and 2 in Appendix A (pg. 123).

<u>*Baseline Covariates:*</u> Baseline covariates included participant age, annual household income, years of education, years married/partnered, infant age, and infant sleeping location (own room or parent's room).

In addition, order to account for potential differences between participants in terms of their mood, relationship satisfaction, maternal confidence and social support, scores from a number of baseline measures were also used as covariates. These scores included levels of marital satisfaction derived from the total score on the *Dyadic Adjustment Scale* [DAS; (Spanier, 1976)], levels of Positive and Negative Affect derived from composite scores on the *Profile of*

Mood States [POMS; (McNair, Lorr, & Droppleman, 1971)], and levels of maternal functioning derived from the *Barkin Index of Maternal Functioning* total score [BIMF; (Barkin et al., 2010)]. Finally, social support covariates were measured in three ways. An overall estimate of social support was derived from the *Interpersonal Support Evaluation List* total score [ISEL; (Cohen & Hoberman, 1983)] while ratings of emotional, informational and instrumental support were derived from the *Social Convoy Diagram* (Antonucci & Akiyama, 1987). The *Social Convoy Diagram* has respondents list the 10 closest persons to them in their life and then rate how much emotional, informational and instrumental support they perceive from each person (on a scale from 1-7, where 1 is none and 7 is very much). Average scores for each of the three support domains were subsequently calculated for each participant.

<u>Daily Covariates:</u> Daily covariates included daily napping duration, number of nightly baby-related awakenings, number of nightly awakenings from the participant's partner to tend to infant, daily caffeine use, daily alcohol use, daily exercise duration and weekend versus weekday measurement.

<u>Subjective Sleep:</u> The *Morning Measure* (completed upon arising) collected information related to perceived Bed Time, Rise Time, Total Sleep Time (TST), Sleep-Onset Latency (SOL), number of perceived awakenings (infant and non-infant related), and number of partner awakenings. In addition, participants assessed subjective sleep quality (SQ) by answering the following question, "On a scale from 1 – 7, where 1 is *extremely poor* and 7 is *extremely good,* how would you rate the quality of your sleep last night?" These questions are similar to questions used in sleep diaries frequently used in longitudinal sleep research (King, Oman, Brassington, Bliwise, & Haskell, 1997).

Objective Sleep: Actiwatch-2 devices (Respironics, 2009) were used to objectively assess nightly sleep. Actiwatches are small, wristwatch-like devices that record 24-hour movement data. Actiwatch-2 software uses algorithms to code intervals of sleep and waking behavior based on indices of movement and stillness. For the current study, actigraphy settings were set with a Medium arousal threshold and a 10-minute Sleep Latency Onset immobility threshold. This means that the actiwatch would begin coding for sleep after 10 minutes of uninterrupted stillness. Objective measures of sleep included Total Sleep Time *(TST)*, Sleep-Onset-Latency *(SOL)*,Sleep Efficiency [(Time Asleep/Time in Bed) x 100), (*SE)*], and wake after sleep onset, in minutes (*WASO)*. TST functioned as the primary indicator of objective sleep duration and WASO functioned as the primary indicator of sleep fragmentation (longer time spent awake during the night = increased fragmentation). Prior to analyses, data were cleaned of spurious and artifactual markers. *Morning Measure* reports and lux data collected from the actigraphs were used to verify bed and wake times.

Positive and Negative Daily Interactions: The *Evening Measure* (completed prior to evening sleep) collected information related to Positive Social Interactions and Negative Social Interactions experienced throughout the day. Please Refer to Table 2 in Appendix A for sample items (pg. 123). The Positive Social Interactions and Negative Social Interactions item presentation was modeled after the *Interpersonal Stress and Life Event Inventory (ISLE)*, a social interaction instrument that measures interaction frequency/quality with partner, child, family, friends/acquaintances and co-workers (A. J. Zautra, Guarnaccia, & Dohrenwend, 1986). The instrument was modified for a postpartum population to include baby interactions (including infant feeding characteristics) using items drawn from the *Childcare Activities Questionnaire* (CCAQ) (Montague & Walker-Andrews, 2002).

Positive Social Interaction and Negative Social Interaction scores were calculated by an index of frequency and quality of interactions. Daily interactions were rated by participants on a 7-point Likert scale of enjoyment where 1 was *not enjoyable at all* and 7 was *extremely enjoyable*. Interactions rated as a 4 or greater were counted as *positive* and interactions rated as a 3 or lower were counted as *negative*. The sum of positive interactions and the sum of negative interactions were respectively calculated for each social relationship (baby, spouse, family members, friends, coworkers) across each day, and for each participant. The sum total of all positive and negative interactions provided a total daily individual Positive Social Interaction and Negative Social Interaction score.

Maternal Well-Being: For the current study, maternal well-being was measured with composite daily positive and negative affect scores (McNair et al., 1971) and daily perceived stress total scores (Cohen, 1986).

Positive Affect and Negative Affect were assessed in the *Evening Measure* with a modified form of the *Profile of Mood States* (*POMS)* (McNair et al., 1971). The original *POMS* is a 65-item wordlist that asks respondents to rate the degree to which an adjective describes their current mood state on a 5-point scale (1, *not at all* – 5, *extremely*). Factor analysis revealed six unique mood factors of the POMS-65: Tension-Anxiety, Depression-Dejection, Anger-Hostility, Fatigue-Inertia, Vigor-Activity and Confusion-Bewilderment. The version of the *POMS* used for this study was shortened to 24 items from the original 65 based on previous daily diary research (Pressman et al., 2005; Usala & Hertzog, 1989). During the completion of the daily *Evening Measure*, participants were asked to rate how well each adjective described how they felt that day on a scale of 0-4 where 0 is *not at all accurate* and 4 is *extremely accurate*. The Positive Affect composite score was derived from the mean of the following 13 adjectives: quiet, passive, happy, cheerful, relaxed, calm, active, lively, enthusiastic, trusting, helpful, attached, and loving and the Negative Affect composite score was derived from the mean of the following 11 items: jittery, nervous, unhappy, sad, drowsy, tired, intense, overwhelmed, stressed, bored, and lonely.

Perceived Stress was assessed in the *Evening Measure* with the *Perceived Stress Scale* (Cohen, 1986). The Perceived Stress Scale is a10-item scale that asks respondents to rate the degree to which they have experienced different stressful situations over the day on a scale from 0 =“never” -4=“very often.” Sample items include “Over the day, how often have you found you could not cope with all the things you had to do?” and “Over the day, how often have you felt nervous or stressed?” Total scores on this measure range from 0 – 40, with higher scores indicating higher perceived stress.

Analytic Strategy

Given the nested nature of the data (i.e., repeated measures design) and the potential for variability to be present both at Level 1 (day-to-day, within person) and Level 2 (between persons), Multilevel Modeling (MLM) methods were used for investigation of the aforementioned hypotheses.

A modified “tear-down” approach was used in the following series of equations for each dependent variable wherein full, hypothesized models were initially estimated and non-significant parameters were individually removed based on overall model fit indices. Prior to estimating the full hypothesized models, null models (no predictors and only random effects of the intercept) were estimated for each dependent variable in order to obtain an Intraclass Correlation Coefficient (ICC). An ICC value not lower that 5% (meaning that all the variance in the dependent variable is due to Level 1 differences) or higher than 95% (meaning that all the variance in the dependent variable was due to Level 2 differences) indicates that MLM methods are appropriate for use with the given dependent variables.

After estimating each dependent variable’s null model, baseline covariates were entered one at a time, followed by daily covariates. Only significant covariates were retained in the models. The full, hypothesized model for each dependent variable was then estimated. Non-significant parameters were removed from the model one at a time starting with Cross-Level Interaction terms, then random effects of Level 1 predictors, then Level 2 predictors with fixed slopes, and finally Level 1 predictors with fixed slopes. After removing each parameter, changes in -2Log Likelihood Deviance statistics were calculated between current and alternative models. Resulting deviance statistics that were significant (based on residual degrees of freedom and chi square significance test) indicated that the removed parameter improved overall model fit and should therefore be retained in the model. Changes in overall ICC values were also calculated between full, hypothesized models and final fitting models in order to assess the change in percentage of variance explained at each level of the data.

Analyses for Models 1-3 were performed on 54 Level 2 units (individual participants), each with 7 Level 1 units (7 days of observations per person). Lagged analyses were performed for Models 4-6, because sleep characteristics were measured the morning after the collection of daily social and mood variables. The resulting dataset for Models 4-6 included 54 Level 2 units, each with six Level 1 units (6 days of observations per person).

Mean Centering. Continuous demographic covariates (maternal age, infant age, years of education, & years married/partnered) were centered on the lowest case value and that lowest value was subtracted from all other values in the variable. Continuous Baseline Measure covariates, including level of perceived health, social support total scores from the ISEL, emotional, informational and instrumental support scores from the Social Convoy Diagram, marital satisfaction total scores, maternal functioning total scores, and Positive and Negative Affect scores, were centered on the sample average score and subtracted from each participant's individual score.

Because Level 1 variables contain two sources of variance (differences between people and differences within person, across days), a "paired approach" was used for all Level 1 predictors in order to separate unique sources of variance (Affleck, Zautra, Tennen, & Armeli, 1999). Pairs of group mean-centered variables and individual, daily mean-difference variables were created from each Level 1 predictor variable (Positive Social Interactions, Negative Social Interactions, Sleep Quality, WASO, and TST). Group mean-centered Level 1 variables were calculated by subtracting the overall sample average for a given variable from each participant's weekly average score. Individual, daily mean-difference variables were calculated by subtracting each participant's weekly average score on a given variable from their daily score on that variable.

Missing Data. Participants completed nearly all Evening Measure items across all days of participation resulting in very low missing daily data. Randomly skipped items that factored into a total daily score were mean replaced (< .01 % of all cases). No *Morning Measure* items were missing. With respect to acrigraphy, six participants' actiwatches did not collect any objective sleep data. Rather than exclude these participants from the analyses, their observed perceived/ *Morning Measure* characteristics (TST, SOL, SE) were replaced for their missing actigraphy sleep characteristics (TST, SOL, SE). Because *Morning Measure* questions did not ask about duration of time spent awake during the night, actigraphy WASO values for those participants were imputed with a multiple-imputation regression equation based on existing predictive variables in the dataset (daily perceived TST, SE, SOL, SQ, daily number of caffeinated drinks consumed, daily number of alcoholic drinks consumed, infant sleeping location, infant age, employment status, and infant-feeding status). Five imputations were estimated and resulting pooled statistics (Coefficients & Standard Errors) were used in subsequent analyses.

Power. Given the recruitment difficulties of formula-feeding women, planned analyses examining group differences by infant feeding method status were subsequently underpowered. Although planned models were still estimated with the inclusion of a feeding method variable, the lack of significant findings relative to feeding-status is likely due to the underpowered nature of the sample in general.

Software. Descriptive analyses were performed with SPSS Version 20 (SPSS, 2011) and MLM analyses were performed with Liseral Version 8.80 (Joreskog & Sorbom, 2007).

Results

For matrix of correlations between all baseline and daily variables, please refer to Table 2 (pgs. 98-100).

Sample Characteristics.

Maternal Demographics. Table 3 (pg. 101) presents information related to participant demographics and provides comparisons by employment status [participants who were coded as Employed Outside the Home (EOH = 34) and participants who were coded as Stay-at-Home (SAH = 20)]. The final sample of participants was ethnically homogenous (93% White/Non-Hispanic) and well-educated, with roughly 72% of participants reporting completion of an undergraduate degree or higher. The sample was also economically robust with 63% of participants reporting an annual household income of more than $60,000 per year. At the time of participation, participants reported that they had been married/partnered for an average of 4.5 years.

Eight participants described their current employment status as "part-time." Given the current study's focus on social interactions, participants who reporting working at least two days outside the home (N = 3) were coded as employed and participants who reported working part-time from home were coded as stay at home (N=5). In total, 34 participants were coded as employed and the remaining 20 participants were coded as stay at home. Table 4 (pg. 102) presents characteristics from a subset of employed participants (N=28) who completed a Baseline Measure about their "return to work" characteristics. Of those who completed the measure, participants reported originally returning to work an average of 78.46 days after the birth of their baby. At the time of their participation week, employed participants had been working for an average of 63.79 days. In addition, although nearly all employed women reported some employment support and/or benefits, approximately half of the employed sample retained negative or mixed feelings about their postpartum return to employment.

Nearly three-quarters of the sample described their primary infant feeding method as exclusive breastfeeding while the remaining quarter of participants reported exclusively formula-feeding or using a "half and half" approach between breast-milk and formula. Although concerted efforts were made to recruit more formula-feeding women across the Lawrence and the Kansas City area, it is possible that the health promotion efforts of exclusive breastfeeding from Lawrence Memorial Hospital and the University of Kansas Medical Center as well as general community support of exclusive breastfeeding accounted for some of the difficulty in recruiting more formula-feeding women. In addition, given the aforementioned homogenous demographic nature of the sample in general, it is likely that a more socioeconomically and ethnically diverse sample might have also had more variability in infant-feeding method.

Infant Demographics. Table 5 (pg.103) provides information related to infant characteristics. The majority of participants reported a vaginal delivery of their infant. At the time of participation, infants had an average age of 4.5 months with slightly more female infants than male infants. Just over half of the sample reported that their baby slept in his/her own room as opposed to his/her parent's room, however, because this question was only asked in the baseline assessment, it is possible that we did not account for potential nightly changes in infant sleeping location. In terms of childcare use, nearly half of employed participants reported using some form of childcare assistance, with daycare identified as the most common form, while only one stay at home participant reported use of childcare assistance.

Baseline Characteristics. Table 6 (pgs. 104-106) provides information related to information collected from Baseline Measures, including participant's Body-Mass Index (BMI), postpartum health problems and perceived overall physical health, marital satisfaction characteristics, attachment style, maternal functioning, social support, loneliness, and sleep and mood characteristics over the previous month.

At baseline assessment, participants generally rated their overall physical health positively, however, participants also indicated experiencing a high frequency of postpartum physical health problems. The most common postpartum physical health problem reported was breast soreness, but roughly half of the sample also reported experiencing musculoskeletal pain and urogenital pain. In terms of body-mass index, about half of the sample's reported weight and height placed them in the Normal Weight Range while the other half of the sample was equally divided between the Overweight and Obese Range.

In general, participants reported high levels of relationship satisfaction as well as high degrees of consensus and cohesion when making decisions with their partners. With respect to relationship attachment style, the sample scored highest on the Dependent Style, suggesting that they feel they can depend on others to be available when needed and lowest on the Anxiety Attachment Style, suggesting that they have relatively few concerns about abandonment in their relationships. In a similar vein, participants indicated high overall social support and robust levels of emotional, informational, and instrumental support. In addition, participant responses suggested relatively low levels of perceived loneliness and high levels of confidence in their mothering abilities.

In terms of baseline mood characteristics, participants generally reported high levels of Positive Affect and low levels of Negative Affect. Interestingly, participants reported high levels of both Fatigue/Inertia and Vigor/Activity. With respect to baseline sleep characteristics, nearly three-quarters of the participants rated their sleep quality over the previous month as Good or

Very Good, however, participants also indicated a high degree of sleep disturbance and disruption.

Daily Social, Mood and Stress Characteristics. Table 7 (pgs. 107-108) presents information related to daily Positive Social Interactions, Negative Social Interactions, infant feeding frequency, health behaviors, Positive Affect, Negative Affect and Perceived Stress. Consistent with previous daily life events research (Seidlitz & Diener, 1993; Alex J Zautra & Reich, 1983), participants reported more positive interactions than negative interactions. Specifically, participants reported about seven times as many positive interactions as negative interactions. This dramatic difference was also likely due to the influence of Baby Positive Social Interactions factoring into the total Daily Positive Social Interactions score. In addition, stay at home mothers reported significantly more total Positive Social Interactions and more Baby Positive Social Interactions than employed mothers. Although Negative Social Interactions were generally infrequent across spouse, family, friend and coworker interactions, the majority of total daily Negative Social Interactions often arose from interactions with baby. This result may suggest an area of duality in the Short-Term Postpartum, namely, that interactions with baby are both the most positive *and* the most negative of all social network members.

With respect to daily perceptions of well-being, participants reported higher daily Positive Affect than Negative Affect and moderate levels of daily perceived stress. Daily alcohol use was generally infrequent across the sample, however, participants reporting consuming about one caffeinated drink per day. Daily exercise time was moderate across the sample and, though the difference was not statistically significant, it appeared that stay at home mothers averaged longer daily exercise durations than employed participants.

Subjective & Objective Sleep Characteristics. Table 8 (pg. 109-110) present information related to perceived time in bed (TIB), total sleep time (TST), sleep onset latency (SOL), number of baby and non-baby awakenings, number of partner awakenings, sleep quality and perceived feelings of restedness. Wherever relevant, actigraphy measured sleep characteristics are presented in tandem with perceived sleep characteristics as well as the correlation value between the two measurement modalities.

In terms of perceived sleep characteristics, participants reported spending an average of 8.75 hours in bed and 7.75 hours asleep, however, stay at home mothers reported significantly longer time in bed durations and total sleep time durations than employed mothers. Participants also reported taking approximately 20 minutes to fall asleep at night as well as roughly three awakenings during the night, the majority of which were coded as Baby-Related awakenings. employed mothers also generally reported more nighttime partner awakenings than stay at home mothers. The sample generally indicated high overall Sleep Quality and reported feeling well-rested from their nighttime sleep. Finally, participants reported spending an about 20 minutes napping during the day, however, employed participants napped roughly 10 minutes longer than stay at home mothers.

Perceived and actigraphy-measured sleep characteristics were strongly, positively correlated (and excluded participants for whom no actigraphy was collected, N = 6). Actigraphy-measured TIB and TST were approximately one half hour shorter than perceived TIB and TST averages and information collected about WASO indicated that participants spent roughly 50 minutes awake during the night. Sleep Efficiency and SOL averages were similar between actigraphy and *Morning Measure* reports, however, actigraphy estimated a much larger sample average of nighttime awakenings (*M* Acti-Wak = 35) than total perceived awakenings (*M* Perc-

Wak = 2.95). It is possible that the discrepancy is due to the actigraph coding sub-wake-threshold movement as a full awakening and the *Morning Measure* awakening variable only reflecting full-threshold (i.e., memorable) awakenings.

Non-Significant Baseline and Daily Covariates. For the following model results, only baseline and daily covariates that were significantly related to outcome variables will be discussed. Baseline covariates that were not significant in any model equations included annual household income, years of education, infant age, baseline level of maternal functioning, and baseline level of Positive Affect. Level 1 covariates that were not significant in any model equations included number of baby-related awakenings, daily napping duration, daily alcohol use and weekend versus weekday measurement.

Model #1 Results: Predictors of Sleep Quality.

Please refer to Table 9 (pg. 111) for results from Model #1. Analyses from Model #1 were conducted to identify predictors of nightly Sleep Quality. Specifically, it was predicted that Sleep Quality would vary as a function of employment status, infant-feeding method status and their interaction as well as variability in daily Positive Social Interactions and Negative Social Interactions.

Model #1 Null Model. Initial null model estimation indicated that 71.81% of the variance in Sleep Quality was due to Level 1 differences and 29.19% was due to Level 2 differences, suggesting that the majority of the variance in Sleep Quality was due to night-to-night differences, not between person differences.

Model #1 Fixed Effects. The best overall model indicated that Sleep Quality varied as a function of baseline levels of social support, infant sleeping location, nightly assistance in infant care from participants' partners and daily within-person differences in Negative Social

Interactions. The fixed intercept indicated that the sample had an average Sleep Quality rating of 4.973 when other fixed effects equaled zero (or the sample average value). The significant fixed slope of Baseline Instrumental Support (derived from the Social Convoy Diagram) indicated that participants who reported higher average levels of baseline instrumental support had higher average Sleep Quality ratings. The significant fixed slope of infant sleeping location indicated that average Sleep Quality ratings were higher for participants whose infants slept in their own room versus the same room as the participant. The significant fixed slope of number of partner awakenings indicated that Sleep Quality decreased as number of partner awakenings increased.

The significant fixed slope of group mean-centered Negative Social Interactions indicated that participants who generally had more Negative Social Interactions had lower average Sleep Quality ratings. The fixed slope of individual, daily mean-differences in Negative Social Interactions indicated that on days when participants had more Negative Social Interactions than their weekly average, their nightly Sleep Quality ratings were lower.

Model #1 Random Effects. The random intercept indicated that average Sleep Quality ratings varied significantly between persons and the random slope indicated that the rate of change in Sleep Quality ratings varied significantly within person, across days.

Model #1 Non-Significant Parameters. Between-person differences and within-person differences in Positive Social Interactions were not significant predictors of Sleep Quality. Additionally, no between-group differences in Sleep Quality were found for working status, infant-feeding method status or an interaction between those groups.

Model #2 Results: Predictors of WASO.

Please refer to Table 10 (pg. 112) for results from Model #2. Analyses from Model #2 were conducted to identify predictors of nightly WASO durations. It was predicted that WASO durations would vary as a function of employment status, infant-feeding method status and their interaction as well as variability in daily Positive Social Interactions and Negative Social Interactions.

Model #2 Null Model. The initial null model indicated that 70.63% of the variance in WASO was due to Level 1 differences and 29.64% was due to Level 2 differences, meaning that the majority of the variance in WASO was due to night-to-night differences, not between-person differences.

Model #2 Fixed Effects. The best overall model indicated that WASO durations varied as a function of years of marriage/partnership, employment status, infant sleeping location and daily caffeine use. The fixed intercept indicated that participants had an average of 38.75 minutes of WASO when all other fixed effects were equal to zero (or the sample average value). The significant fixed slope of years of marriage indicated that WASO increased by an average of 2.23 minutes for every additional year of marriage. The significant fixed slope of employment status indicated that participants employed averaged 9.04 fewer minutes of WASO than stay-at-home participants (who averaged roughly 39 minutes). The significant fixed slope of infant sleeping location indicated that participants whose infants slept in the same room as them averaged roughly 12 additional minutes of WASO than participants whose infants did not sleep in the same room as them. Finally, the significant fixed slope of daily caffeine use indicated that WASO durations increased by approximately three minutes for every additional drink of caffeine consumed.

Model #2 Random Effects. The significant random intercept indicated that average WASO durations varied significantly between participants and within participants, across days.

Model #2 Non-Significant Parameters. Between-person differences and within-person differences in Positive Social Interactions and Negative Social Interactions were not significant predictors of WASO. Additionally, no significant between-group differences infant-feeding method status or an interaction between work status and infant-feeding method status were found.

Model #3 Results: Predictors of TST.

Please refer to Table 11 (pg. 113) for results from Model #3. Analyses from Model #3 were conducted to identify predictors of nightly TST durations. It was predicted that TST durations would vary as a function of employment status, infant-feeding method status and their interaction, but not by variability in daily Positive Social Interactions and Negative Social Interactions.

Model #3 Null Model. Initial null model estimation revealed that 78.87% of the variance in TST was due to Level 1 differences and 21.13% was due to Level 2 differences, suggesting that the majority of the variance in TST was due to night-to-night differences, not person-level differences.

Model #3 Fixed Effects. The best overall model indicated that TST varied as a function of maternal age and within-person differences in daily exercise duration. The fixed intercept indicated that participants had an average TST of 456.775 minutes when all other fixed effects were equal to zero (or the sample average value). Because maternal age was centered on the youngest participant's age (27 years-old), TST durations decreased by approximately 4 minutes for every year increase in participant age. The fixed slope of group mean-centered Exercise Duration was not significant, but was retained in the model due to the inclusion of the significant parameter of individual, daily mean-differences Exercise Duration. The significant fixed slope of individual, daily mean-differences in Exercise Duration indicated that on days when participants exercised longer than their weekly average duration, their nightly average TST durations were longer.

Model #3 Random Effects. The significant random intercept indicated that TST durations varied significantly between persons and within persons, across days.

Model #3 Non Significant Parameters. As predicted, between-person differences and within-person differences in Positive Social Interactions and Negative Social Interactions were not significant predictors of TST. Additionally, no between-group differences in TST were found for working status, infant-feeding method status or an interaction between those groups.

Model #4 Results: Predictors of Daily Positive Affect.

Please refer to Table 12 (pgs. 114-115) for results from Model #4. Analyses from Model #4 were designed to identify predictors of daily Positive Affect. It was predicted that daily Positive Affect would vary as a function of variability in daily Positive/Negative Social Interactions and variability in nightly Sleep Quality ratings, WASO and TST durations. In addition, Daily Positive Affect was predicted to vary as a function of the interaction between employment and infant-feeding method status as well as the interaction between infant-feeding method status and nightly TST durations and daily Positive Social Interactions, respectively.

Model #4: Null Model. The initial null model estimated indicated that 34.37% of the variance in Daily Positive Affect was due to Level 1 differences and 65.63% was due to Level 2 differences, meaning that the majority of variance in Positive Affect was due to person-level differences, not day-to-day differences.

Model #4 Fixed Effects. The best overall model indicated that daily Positive Affect varied as a function of baseline levels of perceived health, emotional support (from the Social Convoy

Diagram) and marital satisfaction (from the Dyadic Adjustment Scale) as well as daily within-person differences in Positive Social Interactions, Negative Social Interactions and Sleep Quality. The fixed intercept indicated that participants had an average Daily Positive Affect score of 2.0335 when all other fixed effects were equal to 0 (or equal to the sample average value). The significant fixed slopes of baseline perceived overall health, emotional support and marital satisfaction indicated that participants with higher average scores on these measures had higher daily Positive Affect scores.

The fixed slopes of group mean-centered Positive Social Interactions and Negative Social Interactions were not significant, but were retained in the model due to the inclusion of the significant parameters of individual, daily mean-differences in Positive Social Interactions and Negative Social Interactions. The significant fixed slopes of individual, daily mean-differences in Positive Social Interactions and Negative Social Interactions indicated that on days when participants had greater than their personal-average number of Positive Social Interactions or fewer than their personal average number of Negative Social Interactions, their daily Positive Affect scores were higher. The significant fixed slope of group mean-centered Sleep Quality was not significant, but was retained in the model due to the inclusion of the significant parameter of individual, daily mean-differences in Sleep Quality. The significant fixed slope of individual, daily mean-differences in Sleep Quality indicated that, on days when participants had greater than their personal-average Sleep Quality score, their daily Positive Affect scores were higher.

Model #4 Random Effects. The random intercept indicated that average Daily Positive Affect scores varied significantly between participants and within participants, across days. The significant random slope of individual, daily mean-differences in Sleep Quality indicated that there was significant variability in how strong of an effect individual, daily mean-differences in

Sleep Quality had on daily Positive Affect scores. The covariance between the intercept and the random slope of individual, daily mean-differences in Sleep Quality was not significant.

Model #4 Non-Significant Parameters. Between-person differences and within-person differences in TST and WASO were not significant predictors of Positive Affect. Additionally, no between-group differences in Positive Affect were found for working status, infant-feeding method status or an interaction between those groups. Finally, there was no significant interaction between daily Positive Social Interactions and infant-feeding method.

<u>Model #5 Results: Predictors of Daily Negative Affect.</u>

Please refer to Table 13 (pgs. 116-117) for results from Model #5. Analyses from Model #5 were conducted to identify predictors of Daily Negative Affect. It was predicted that daily Negative Affect would vary as a function of variability in daily Positive Social Interactions and Negative Social Interactions and variability in nightly Sleep Quality ratings, WASO and TST durations. In addition, Daily Negative Affect was predicted to vary as a function of employment and infant-feeding method status as well as the interaction between those groups. Finally, daily Negative Affect was predicted to vary as a function of the interaction between nightly sleep characteristics and daily Positive Social Interactions and Negative Social Interactions.

Model #5: Null Model. The initial null model estimated indicated that 41.52% of the variance in Daily Negative Affect was due to Level 1 differences and 58.48% was due to Level 2 differences, meaning that the majority of variance in Negative Affect was due to person-level differences, not day-to-day differences.

Model #5: Fixed Effects. The best overall model for Negative Affect indicated that daily Negative Affect varied as a function baseline negative affect (derived from the Profile of Mood States questionnaire), within-person differences in Positive Social Interactions, Negative Social

Interactions, and Sleep Quality and an interaction between within-person differences in Sleep Quality and within-person differences in Negative Social Interactions. The fixed intercept indicated that participants had an average Daily Negative Affect score of .8365 when all other fixed effects were equal to 0 (or equal to the sample average value). The significant fixed slope of baseline Negative Affect indicated that participants with higher baseline Negative Affect scores had higher average daily Negative Affect scores.

The fixed slope of group mean-centered Positive Social Interactions was not significant, but was retained in the model due to the inclusion of the significant parameter of individual, daily mean-differences in Positive Social Interactions. The significant fixed slope of group mean-centered Negative Social Interactions indicated that participants who generally had more Negative Social Interactions had higher daily Negative Affect scores. The significant fixed slopes of individual, daily mean-differences in Positive Social Interactions and Negative Social Interactions indicated that on days when participants had greater than their personal-average number of Positive Social Interactions or fewer than their personal average number of Negative Social Interactions, their daily Negative Affect scores were lower. The significant fixed slope of group mean-centered Sleep Quality indicated that participants who generally had higher Sleep Quality ratings had lower daily Negative Affect scores. The significant fixed slope of individual, daily mean-differences in Sleep Quality indicated that, on days when participants had greater than their personal-average Sleep Quality score, their daily Negative Affect scores were lower. Finally, the significant interaction between individual, daily mean-differences in Negative Social Interactions and individual, daily mean-differences in Sleep Quality indicated that Sleep Quality moderated the relationship between individual, daily mean-differences in Negative Social Interactions and daily Negative Affect scores. In other words, the effect of individual, daily mean-differences in Negative Social Interactions on daily Negative Affect depended on the level of individual, daily mean-differences in Sleep Quality. For a visual representation of this interaction, please refer to Figure 2 (pg. 129).

When plotting and probing interaction effects, one should consider both the significance and magnitude of the relationship between y (daily Negative Affect) and x (individual, daily mean-differences in Negative Social Interactions) at different conditional values of z (individual, daily mean-differences in Sleep Quality). The simple slopes for all three conditional values of daily Negative Affect were significant, meaning that they are significantly different from 0. Specifically, on days when participants had greater than their average Sleep Quality rating (B=.1275, p <.05), the effect of individual, daily mean-differences in Negative Social Interactions on daily Negative Affect was diminished (i.e., daily Negative Affect was lower). Similarly, on days when participants had lower than their average Sleep Quality rating (B=.0957, p < .05), the effect of individual, daily mean-differences in Negative Social Interactions on daily Negative Affect was strengthened (i.e., daily Negative Affect was higher). Finally, on days when participants obtained their average level Sleep Quality rating (B=.0159, p <.05), the effect of individual, daily mean-differences in Negative Social Interactions on daily Negative Affect was marginally strengthened (daily Negative Affect was higher). The region of significance calculated for this interaction indicated that values of individual, daily mean-differences in Sleep Quality falling between .0693 and 3.0585 render the interaction nonsignificant and values outside this region render the interaction significant. Therefore, for this dataset, if daily differences in participant-average Sleep Quality ratings are greater than 3.0585 or less than .0693, a significant interaction exists.

Model #5: Random Effects. The significant random intercept indicated that average daily Negative Affect scores varied significantly between participants and the significant random slope indicated that the rate of change in daily Negative Affect varied within person, across days. The significant random slope of individual, daily mean-differences in Sleep Quality indicated that there was variability in how strong of an effect individual, daily mean-differences in Sleep Quality had on daily Negative Affect scores. The correlation between individual, daily mean-differences in Sleep Quality and the intercept was strong and negative, indicating that, for participants who had lower average daily Negative Affect scores, increases in individual, daily mean-differences in Sleep Quality had a stronger effect on decreasing daily Negative Affect scores.

Model #5 Non Significant Parameters. Between-person differences and within-person differences in TST and WASO were not significant predictors of Negative Affect. Additionally, no between-group differences in Negative Affect were found for working status, infant-feeding method status or an interaction between those groups. Finally, no significant interaction between nightly variability in Sleep Quality, TST and WASO and Positive Social Interactions or TST, WASO and Negative Social Interactions were found.

Model #6 Results: Predictors of Daily Perceived Stress.

Please refer to Table 14 (pgs. 118-119) for results from Model #6. Analyses from Model #6 were conducted to identify predictors of daily Perceived Stress. It was predicted that Perceived Stress would vary as a function of variability in daily Positive Social Interactions and Negative Social Interactions and variability in nightly Sleep Quality ratings, WASO and TST durations. In addition, Daily Perceived Stress was predicted to vary as a function of employment and infant-feeding method status as well as the interaction between those groups. Finally, daily

Perceived Stress was predicted to vary as a function of the interaction between nightly sleep characteristics and daily Positive Social Interactions and Negative Social Interactions.

Model #6: Null Model. The initial null model estimated indicated that 56.31% of the variance in Daily Perceived Stress was due to Level 1 differences and 43.69% was due to Level 2 differences, meaning that the majority of the variance in Perceived Stress was due to day-to-day differences, not person-level differences.

Model #6: Fixed Effects. The best overall model indicated that Perceived Stress varied as function of baseline levels of social support (derived from the Interpersonal Support Evaluation List questionnaire), within-person differences in Positive Social Interactions and Negative Social Interactions, between-person differences in Sleep Quality and an interaction between within-person differences in Sleep Quality and within-person differences in Negative Social Interactions. The fixed intercept indicated that participants had an average Daily Perceived Stress score of 15.388 when all other fixed effects were equal to 0 (or equal to the sample average value). The significant fixed slope of baseline social support indicated that participants with higher average baseline social support scores had lower average daily Perceived Stress scores.

The fixed slope of group mean-centered Positive Social Interactions was not significant, but was retained in the model due to the inclusion of the significant parameter of individual, daily mean-differences in Positive Social Interactions. The significant fixed slope of group mean-centered Negative Social Interactions indicated that participants who generally had more Negative Social Interactions had higher daily Perceived Stress scores. The significant fixed slopes of individual, daily mean-differences in Positive Social Interactions and Negative Social Interactions indicated that on days when participants had greater than their personal-average number of Positive Social Interactions and fewer than their personal average number of Negative Social Interactions, their daily Perceived Stress scores were lower. The significant fixed slope of group mean-centered Sleep Quality indicated that participants with higher average Sleep Quality ratings had lower average daily Perceived Stress scores. The fixed slope of individual, daily mean-differences in Sleep Quality was not significant, but was retained in the model due to the inclusion of the significant parameter of group mean-centered Sleep Quality.

Finally, the significant interaction between individual, daily mean-differences in Negative Social Interactions and individual, daily mean-differences in Sleep Quality indicated that Sleep Quality moderated the relationship between individual, daily mean-differences in Negative Social Interactions and daily Perceived Stress scores. In other words, the effect of individual, daily mean-differences in Negative Social Interactions on daily Perceived Stress depended on the level of individual, daily mean-differences in Sleep Quality. For a visual representation of this interaction, please refer to Figure 3 (pg. 130).

The simple slopes for two of the three conditional values of daily Perceived Stress were significant. Specifically, on days when participants had lower than their average Sleep Quality rating (B=.5824, p <.05), the effect of individual, daily mean-differences in Negative Social Interactions on daily Perceived Stress was enhanced (i.e., daily Perceived Stress was higher). On days when participants obtained their average level Sleep Quality rating (B=.1059, p <.05), the effect of individual, daily mean-differences in Negative Social Interactions on daily Perceived Stress was marginally strengthened (daily Perceived Stress was higher). Finally, on days when participants had higher than their average Sleep Quality rating, the effect of individual, daily mean-differences in Negative Social Interactions on daily Perceived Stress was unchanged (B=.3705, p >.05). This non-significant effect is explained by the significant fixed effect of group mean-centered Sleep Quality which indicated that participants who had higher sleep quality ratings in general also had lower Perceived Stress scores.

The region of significance calculated for this interaction also helps explain why higher than average sleep quality values were not related to changes in average Perceived Stress scores. Specifically, values of individual, daily mean-differences in Sleep Quality falling between .1265 and 209.289 render the interaction non-significant and values outside this region render the interaction significant. Therefore, for this dataset, if daily differences in participant-average Sleep Quality ratings were greater than 209.289 or less than .1265, a significant interaction existed. Because a difference value higher than 209.289 is not possible with these data, the interaction is only significant for values of individual, daily mean-differences in Sleep Quality that are at .1265 or lower.

Model #6: Random Effects. The significant random intercept indicated that average daily Perceived Stress scores varied significantly between participants and the significant random slope indicated that the rate of change in daily Perceived Stress varied within person, across days.

Model #6 Non Significant Parameters. Between-person differences and within-person differences in TST and WASO were not significant predictors of Perceived Stress. Additionally, no between-group differences in Perceived Stress were found for working status, infant-feeding method status or an interaction between those groups. Finally, no significant interaction between nightly variability in Sleep Quality, TST, WASO and Positive Social Interactions or TST, WASO and Negative Social Interactions were found.

Discussion

The transition to motherhood has been described as exciting and rewarding as well as stressful and demanding. Although many women navigate this transition successfully, other women struggle, both physically and mentally, during this time. Accordingly, the purpose of the current study was to investigate modifiable factors in the Short-Term Postpartum that could potentially improve sleep and subjective well-being in new mothers. In total, 54 first-time mothers in good physical and mental health participated in a week-long daily diary study that collected information on their daily social interactions and nighttime sleep characteristics. In general, maternal sleep characteristics and indicators of well-being were driven by within-person differences and daily fluctuations in social environment characteristics. Minimal differences by employment status were found providing further support for the unique and dynamic nature of maternal sleep and social environment characteristics.

Sleep

Participants in the current study generally slept well. Not only did they rate their nightly Sleep Quality favorably, they also achieved relatively long durations of nighttime sleep with relatively short periods of nighttime wakefulness. In addition, although total sleep time durations were consistent with previous research of sleep in new mothers (Dørheim et al., 2009; Montgomery-Downs, Clawges, et al., 2010), the sample was likely above-average in terms of their lack of nighttime wakefulness and high overall perceptions of sleep quality. In fact, mothers in the current study appeared to sleep so well that they were ostensibly immune to the expected deleterious effects of nocturnal baby-related awakenings on indices of sleep and next-day well-being. One possible explanation for this result is that mothers in this study simply did not experience enough baby-related arousals to impact their sleep characteristics or next-day reports of well-being. Post-hoc analyses supported this rational with the total number of nighttime awakenings (baby and non-baby related) demonstrating a greater negative influence on sleep characteristics and well-being indicators than one subset of awakenings alone.

One of the primary hypotheses for this study was that working mothers would have more sleep disruption than stay-at-home mothers and that this relationship would be moderated by infant-feeding method status. This hypothesis was ultimately not supported as feeding status was found to be unrelated to sleep-related outcomes and did not interact with employment status. Although employed and stay at home mothers rated their Sleep Quality similarly and did not differ in terms of objectively measured total sleep time, stay at home mothers self-reported longer sleep durations than employed mothers. This finding is consistent with previous research which has documented qualitative differences in maternal sleep characteristics by employment status, such that, employed mothers perceived that they slept significantly less than mothers not employed (Nichols & Roux, 2004), and adds to the literature by noting the occurrence of this group difference in the Short-Term Postpartum. Although all mothers in this sample overestimated their total sleep time, stay at home mothers overestimated to a greater extent than employed mothers. One possible explanation for these findings is that stay at home mothers' have less structured bed and wake times than employed mothers which may cause them to overestimate their total sleep duration.

Interestingly, employed and stay at home mothers also differed in the amount of objectively measured nighttime wakefulness (WASO). Although previous studies have examined potential differences in objective and subjective sleep characteristics by employment status (Insana & Montgomery-Downs, 2010; Insana et al., 2011; Montgomery-Downs, Insana, et al., 2010a; J. Rychnovsky & L. P. Hunter, 2009), no previous study has reported significant quantitative differences in objectively measured nighttime wakefulness by employment status. In the current study, employed mothers averaged 40 minutes of wakefulness during the night and stay at home mothers averaged approximately 10 minutes more. Although it was expected that employed mothers would have more sleep fragmentation, it is possible that the difference of WASO observed in the current sample is due to group differences in consolidated sleep. Like the difference observed in subjective reports of total sleep time, employed mothers' typical workday schedule renders their bed and wake times more consistent than stay at home mothers and this more fixed bed/wake schedule may result in an increased homeostatic sleep drive at night which would then raise their threshold for nighttime wake-promoting stimuli. Behavioral treatments aimed at improving sleep consolidation, such as Cognitive-Behavioral Therapy for Insomnia (CBTi), often implement such fixed bed and wake times as a way to capitalize on naturally occurring homeostatic sleep pressure (Williams, Roth, Vatthauer, & McCrae, 2013).

Importantly, nighttime WASO duration was not related to perceptions of Sleep Quality or next day perceptions of well-being (Positive/Negative Affect or Perceived Stress). Therefore, like the null effect of baby-related arousals, it is possible that the level of observed WASO in the current sample was simply not large enough to be perceived as intrusive in overall sleep quality or next-day perceptions of well-being. Nevertheless, for mothers who are negatively affected by nighttime WASO durations, adhering to a more fixed pattern of bed and rise times may help consolidate their sleep.

Although we did not find major differences in sleep as a function of maternal social role variables (like work status), we did find that baseline and daily social environment characteristics had an important relationship to sleep. Of all the observed sleep characteristics, Sleep Quality appeared to be the most influenced by daily social interaction variables. In particular, although positively rated social interactions experienced during the day were not related to any nighttime sleep characteristics, participants with higher levels of baseline instrumental support from the *Social Convoy Diagram* had higher average Sleep Quality ratings during the participation week. While the benefits of high quality and readily available social support to new mothers in the postpartum are well-known (D. Gjerdingen et al., 1991; Miller et al., 2012; Negron et al., 2012; Uchino et al., 1996; Wandersman et al., 1980), this finding adds to the literature on the benefits of high quality support in the Short-Term Postpartum by suggesting that broad increases in social support may also promote broad improvements in maternal Sleep Quality.

Just as the positive effects of the social environment conferred benefits to new mothers in this sample, so did the negative effects of the social environment confer costs. Consistent with the previous research examining the relationship of social discord to maternal sleep (Meijer & van den Wittenboer, 2007; Troxel, 2010; Troxel et al., 2007), increased frequency of daily negatively rated interactions appeared to have a robust, negative effect on Sleep Quality. However, this finding also adds to the literature on the relationship of social interactions to nighttime sleep by demonstrating the effect of Negative Social Interactions on sleep beyond the Immediate-Postpartum and well into the Short-Term Postpartum.

When assessing the sample overall, women who generally experienced more Negative Social Interactions were found to have lower overall Sleep Quality. In addition, on days when participants experienced more Negative Social Interactions than normal, their Sleep Quality ratings were commensurately lower. These findings highlight an important difference in between-person susceptibility to the effects of negative social experiences and daily susceptibility to negative social experiences. That is, the between-person differences in Negative Social Interactions could potentially be "explained away" by unaccounted third variables, such as personality styles or traits. For example, a more irritable personality style may beget more conflicted relationships and/or generally lower perceptions of Sleep Quality. However, the fact that Sleep Quality changed as a function of daily fluctuation in social discord means that, irrespective of potential third variables like personality styles or traits, changes in daily negative social experiences influenced nighttime Sleep Quality ratings.

Although the mechanism of action driving the relationship between Negative Social Interactions and sleep is still unclear, it is likely that conflicted social relationships lead to rumination and increased cognitive arousal, both of which have known wake-promoting effects (Gunn, Troxel, Hall, & Buysse, 2013; Tang & Harvey, 2004; Wicklow & Espie, 2000). In addition, daily Negative Social Interactions may increase nighttime levels of circulating stress hormones, such as cortisol, which would also disrupt sleep (Gur, Cevik, Sarac, Colpan, & Em, 2004; Vgontzas et al., 2003; White, Gunnar, Larson, Donzella, & Barr, 2000). Accordingly, these findings may indicate that, to the extent that new mothers are able to avoid additional negative social interactions during the day, they may see improvements in their Sleep Quality that night.

Nighttime parenting decisions also appeared to impact maternal Sleep Quality ratings. Although baby related arousals in general were not related to quantity or quality of sleep, partner involvement in nighttime feedings seemed to have a negative effect on sleep quality. When partners woke to assist with nighttime infant care, mothers reported lower quality sleep. However, this inverse relationship may be a measurement artifact. It is quite likely that mothers only reported partner awakenings that they recalled because they (the mothers) were also awakened. It is possible that there would be positive effects of partner awakenings, if those awakenings did not result in a "maternal awakening." Although partner awakenings that result in nighttime infant care are likely viewed as positive by mothers, the cumulative effect of a maternal awakening for each partner awakening on Sleep Quality may outweigh the positive effect of nighttime assistance.

Infant sleeping status also seemed to affect mothers sleep. Mothers whose infants slept in the same room as them reported more WASO (an average of 11 additional minutes) and lower Sleep Quality ratings than mothers whose infants did not sleep in the same room as them. However, this finding should be interpreted with caution. As noted previously, infant sleeping location was only assessed at baseline. We did not account for night to night variation in infant sleeping location, nor did we distinguish between infants who shared a room with parents (in a crib) versus infants who shared a bed with the parents (co-sleeping). In this way, it would be inappropriate to label infant sleeping location as a true modifiable factor that could improve sleep by shortening the duration of nighttime sleep. Follow up studies that assess infant sleeping location in greater detail and on a nightly basis would be needed in order to verify infant sleeping location as a modifiable, sleep-promoting factor.

Daily health behaviors reported in the study sample also appeared to function as modifiable factors that could enhance nighttime sleep. Specifically, on days when participants exercised longer than normal, their nighttime sleep duration increased modestly. While the magnitude of change in nighttime sleep duration was not particularly large, it appears that day-to-day increases in exercise duration may result in longer nightly sleep durations. Additionally, daily caffeine use appeared to be related to nighttime WASO. Specifically, for every additional caffeinated drink consumed, nighttime WASO increased by an average of approximately 3 minutes. Importantly, in the *Evening Measure* collection, participants were asked to report the number and type of caffeinated drinks consumed and while some participants listed sizes, such as, “two cans of coke” or “3 cups of coffee,” other participants did not provide size-related information. Therefore, daily caffeinated drink consumption totals may be over or underestimated based on participant description. Although we did not have specific a-priori hypotheses about health behaviors, recommendations to increase exercise and limit caffeine intake are certainly consistent with Sleep Hygiene recommendations (Sin, Ho, & Chung, 2009) and could be acted upon as a modifiable sleep-promoting factor in the Short-Term Postpartum.

Finally, maternal age was related to both sleep duration and nighttime wakefulness; older participants experienced shorter TST durations and participants who were married/partnered for longer had longer WASO durations. While it is possible that relationship between number of years married and WASO reflects underlying increases in marital discord observed in longer marriages that would intrude on nighttime sleep (Troxel et al., 2007), indicators of marital quality and satisfaction were not significantly correlated with number of years married. In fact, the only other variables significantly correlated with number of years married were maternal age, number of days of maternal leave and number of days participants had been working at the start of their study participation week. Accordingly, we viewed the significant relationship of nighttime WASO and number of years married as reflecting age-related changes in sleep rather than an underlying effect of marital discord arising from longer marriages.

Importantly, age-related decreases in total sleep time and increases in nighttime wakefulness (Carskadon & Dement, 2000; Ohayon, Carskadon, Guilleminault, & Vitiello, 2004) are well known in elderly populations, but are not typically observed in populations as young as the current sample. Nevertheless, maternal age remained a significant correlate with both subjective and objectively reported time in bed and total sleep time. Therefore, it is possible that, because the sample as a whole were generally “good sleepers,” the relative variability in maternal age was observable in a somewhat comparatively stable set of maternal sleep characteristics.

Overall, maternal sleep characteristics appeared to vary as a function of within-person differences rather than between-group differences. Although analyses for testing differences in infant-feeding method were underpowered, it is important to note the minimal group differences in maternal sleep characteristics between employed and stay at home mothers. In this way, recommendations for improving sleep in the postpartum would be better informed by individual characteristics than group membership status.

Maternal Well-Being.

Both at baseline and throughout the study week, participants from this study predominantly reported euthymic moods and relatively low levels of stress. Mothers in this sample also reported both high levels of energy and fatigue, perhaps illustrating the duality of the Short-Term Postpartum's relative increased levels of energy from the Immediate-Postpartum, but continuing experiences of exhaustion and tedium. In addition, the sample experienced far more positive than negative interactions, with stay at home mother reporting significantly more positive interactions than employed mothers. While the generally positive social and emotional characteristics of this sample may not generalize across all mothers in the Short-Term Postpartum, the impact of a strong social network was nevertheless well demonstrated in the findings related to maternal well-being.

From a macro social environment perspective, participants who rated their overall health higher, reported higher baseline emotional support on the *Social Convoy Diagram* and reported higher marital satisfaction were found to have higher average daily Positive Affect scores. Additionally, participants who reported higher baseline levels of general social support from the

Interpersonal Support Evaluation List had lower average perceived stress scores. These findings are consistent with previous research indicating the importance of relationship quality and availability of social support for maternal adjustment and well-being in the postpartum (Burke, 2003; Majewski, 1987; Power & Parke, 1984; Shapiro et al., 2000).

At the micro social environment level, maternal well-being differed by daily fluctuations in Positive Social Interactions and Negative Social Interactions. As noted previously, between-person differences in Positive Social Interactions and Negative Social Interactions can often be relegated to third variable influences. However, daily fluctuation in Positive Social Interactions and Negative Social Interactions appeared to "tip the scale" of how mothers in this sample viewed their well-being that day. That is, mothers reported lower stress and generally more positive moods on days when they experienced more Positive Social Interactions than normal or fewer Negative Social Interactions than normal. Conversely, mothers reported increased stress and predominantly more negative moods on days when they experienced more Negative Social Interactions or fewer Positive Social Interactions than normal. In this way, the micro social environment of daily fluctuations in Positive Social Interactions and Negative Social Interactions appeared to exert unique effects on mothers' overall perceptions of well-being (i.e., "good" or "bad") after controlling for between-person differences that have the potential to reflect third variable influences such as personality style or traits.

In a similar vein, Sleep Quality also demonstrated predictive value in relation to daily indicators of maternal well-being. Specifically, when mothers slept particularly well (higher than their personal average Sleep Quality), their next day Positive Affect scores were higher and their next day Negative Affect scores were lower. In addition, a good night's sleep also appeared to buffer the relationship between daily fluctuations in Negative Social Interactions and Negative

Affect. Moreover, women with higher levels of Sleep Quality overall were more immune to the negative effects of Negative Social Interactions on daily Perceived Stress. These findings champion the potential protective function of daily fluctuations in Sleep Quality on maternal well-being, such that daily improvements in sleep quality may promote enhanced well-being the next day regardless of the amount of social discord experienced that day (Hamilton & Catley, 2004).

The aforementioned relationships suggest additional areas of modifiability in the postpartum period. Namely, the more opportunities women have to engage positively with their social contacts, the better they may feel overall. The inverse would also be true for negative interactions. However, seeking out positive experiences with others may seem more under an individual's control than avoiding negative experiences. Similarly, the fact that within-person differences in Positive Social Interactions and Negative Social Interactions generally predicted indicators of maternal well-being, means that women may be better able to capitalize on differences in positive and negative interactions because they occur the day-to-day level. In other words, if a new mother has very few positive interactions one day of the week, that does not mean that she will not be able to capitalize on the potential benefits of having more positive interactions the next day.

In addition, the fact that sleep characteristics like TST and WASO were not related to next-day perceptions of well-being, but Sleep Quality was, may suggest a needed change in sleep-related recommendations for improving maternal well-being. That is, instead of recommending that a mother "sleeps when her baby sleeps" or that she should "sleep-train" her infant as soon as possible in order to avoid nighttime awakenings (both of which may have little impact on well-being), the focus of sleep-related recommendations may be more appropriately placed on improving subjective sleep characteristics. As noted previously, Sleep Quality appeared to be the most modifiable sleep characteristic in this sample. In this way, if women are able to capitalize on the environmental factors that can improve their nightly Sleep Quality (social support, avoidance of Negative Social Interactions, minimize intrusive nighttime infant-assistance from partner, etc.), they may see improvements not only in their next-day mood and perceived stress levels, but also be better "protected" from the harmful effects of daily social discord on indicators of well-being.

Finally, while analyses were underpowered to test for group differences in infant-feeding method, it is also important to note that the lack of significant group differences in employment status across this sample may indicate that variability in maternal sleep characteristics and perceptions of well-being are more a product of within-person differences than between person differences. In other words, both employed mothers and stay-at-home mothers can enjoy high quality sleep and robust well-being in the Short-Term postpartum.

Limitations. Although the current study improved upon several content and methodological gaps in the existing literature on postpartum sleep and social environment characteristics, it is not without its own set of notable limitations. The principal limiting factor of these data is the relatively small and homogenous sample of participants. The results discussed above may only apply to a small subset of the population of postpartum women (namely, white, upper-middle class, well-educated women) and therefore lack sufficient generalizability to a larger population of postpartum women. As noted previously, challenges in recruiting equal numbers of breastfeeding and formula-feeding women rendered analyses examining group differences in infant-feeding method underpowered and our relevant (and potentially important) research questions unanswered.

Generalizability in this sample is most limited by the nature of mothers' employment settings. Employed participants generally reported fixed working hours at their place of employment as well as high workplace support for their new maternal role. Nearly all employed participants reported that they were able to take maternal leave and return to their same or similar position. In addition, the majority of employed participants reported that their employment settings provided a variety of supports and services for them as new mothers. The costs of working to maternal sleep characteristics and well-being could be tremendously different for mothers who work in manual employment, the service-industry or settings less sensitive and supportive to the needs of a new mother. Moreover, employment positions with irregular hours or rotating shift schedules may be much more difficult to integrate with an infant sleep-wake schedule. In this way, the findings from this study specifically related to maternal employment status likely do not generalize the broader population of working mothers.

While the current study's protocol was very well tolerated by participants and resulted in little to no missing data among daily measures, an additional limitation of the current study is the lack of refinement on daily measure items included in the study. As noted in the results section, it would have been prudent to include an item on the morning diary that asked about the previous night's infant sleeping location in order to capture nightly variability in infant sleeping location and its potential effects on maternal sleep. Conversely, removing items from the daily measures that lack sufficient predictive power in a postpartum population would have reduced item-completion burden on participants. Specifically, some items adapted from the ISLE (A. J. Zautra et al., 1986) were almost never endorsed by participants (i.e., "Did you go to a game with friends today?"), perhaps indicating that that they do little to describe the daily interactions of a postpartum population. Additionally, it should also be noted that Positive Social Interactions, Negative Social Interactions, and Perceived Stress were reported at night and at the same time as the daily Positive Affect and Negative Affect reports. This method of data collection may have inflated relationships among variables. Although it would have been methodologically cleaner to have collected social interaction reports during the day, this concern must be balanced with the acknowledgement of increasing participant burden.

Future Directions. The current study has "set the stage" for additional inquiry into modifiable postpartum factors that can improve sleep and well-being in new mothers. It is important to understand how the impact of daily social interactions on nighttime sleep and well-being changes for mothers whose social networks are more restricted in general, lack a cohabitating/parenting partner or work in a wider range of employment settings. In addition, it would be important to investigate the relationship of nighttime sleep characteristics to next-day well-being in mothers currently experiencing clinically significant depression symptoms or other mood-related concerns. Finally, assessing the aforementioned relationships in multiparous women and/or women outside the Short-Term Postpartum would provide useful information on aspects of the results presented here that are unique to first-time mothers or unique to the Short-Term Postpartum and thereby improving the generalizability of findings.

Overall, the current study sought to identify modifiable factors in the social environment that could promote sleep and well-being in first-time mothers in the Short-Term Postpartum. Results from this study suggested that capitalizing on daily fluctuations in frequency and valence of social interactions may promote higher Sleep Quality at night. Moreover, improvements in nightly Sleep Quality appeared to promote improvements in maternal well-being the next day and protect mothers from the exacerbating effects of social discord. Importantly, the aforementioned relationships were principally a product of within-person differences in maternal sleep and social environment characteristics, rather than between-person differences, or group differences in working status. In this way, future recommendations for changing or improving maternal sleep and well-being in the Short-Term Postpartum would be better informed by the unique characteristics of individual mothers rather than a between-person or “one-size fits all” approach.

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Tables

Table 1

Recruitment Location Information

	EOH (N = 34)	SAH (N = 20)	Total (N = 54)
Facebook Advertisement	21 (62%)	8 (40%)	29 (54%)
Craigslist Advertisement	1 (2%)	1 (5%)	2 (4%)
Breastfeeding Support Group	8 (24%)	7 (35%)	15 (27%)
Word of Mouth/Flyers	4 (12%)	4 (20%)	8 (15%)

Table 2

Correlations between Baseline and Daily Variables.

A	mom age	inc	edc	yrs married	work status	feeding status	baby age	bmi	SR health	baby sleep loc	emo sprt	info sprt	instrum sprt	DAS total	DAS Cons	DAS AffExp	DAS Satisf	DAS Cohe	ISEL total	AAS Close	AAS Depend	AAS Anx	BIMF tot	UCLA tot	RTW days	RTW study
mom age	1	.227	.202	.299*	.227	-.068	.022	.243	-.235	-.070	-.059	-.097	-.128	-.274*	-.242	-.199	-.073	-.368**	-.216	.035	.010	.009	-.159	.186	.277	.165
inc	.227	1	.651**	.005	.116	.151	-.085	-.424**	.066	.001	-.157	-.052	.068	-.012	.042	-.170	.028	-.056	.161	.357**	.325*	-.005	.064	-.200	.149	-.162
edc	.202	.651**	1	-.106	.250	.001	-.012	-.326*	.041	-.033	-.142	-.194	.248	-.077	.010	-.191	-.001	-.190	.125	.159	.247	-.090	-.070	-.117	.128	-.057
yrs married	.299*	.005	-.106	1	.127	.067	-.111	.110	-.141	-.233	-.065	-.010	-.048	-.077	-.068	-.058	-.022	-.102	-.100	.086	.052	-.221	.134	.060	.456**	-.373*
work status	.227	.116	.250	.127	1	.066	-.033	.149	-.040	-.159	-.079	-.135	.098	-.218	-.198	-.178	-.125	-.187	-.055	-.068	.197	.019	.155	-.031	-.461**	.081
feeding status	-.068	.151	.001	.067	.066	1	.200	-.130	.003	.135	-.095	.016	-.215	-.065	-.099	-.107	-.078	.099	-.036	.108	-.012	.076	-.096	.099	.027	.193
baby age	.022	-.085	-.012	-.111	-.033	.200	1	.048	.125	.174	-.045	-.071	-.179	-.137	-.108	-.099	-.093	-.134	-.296*	-.499**	-.307*	.289*	-.129	.213	.148	.724**
bmi	.243	-.424**	-.326*	.110	.149	-.130	.048	1	-.373**	.035	-.116	-.145	-.273*	-.192	-.358**	.026	.019	-.108	-.379**	-.197	-.358**	.236	-.100	.509**	-.172	.223
SR health	-.235	.066	.041	-.141	-.040	.003	.125	-.373**	1	-.069	.179	.081	.054	.273*	.320*	-.047	.159	.254	.158	-.214	.073	-.117	.354*	-.415**	-.195	.066
baby sleep loc	-.070	.001	-.033	-.233	-.159	.135	.174	.035	-.069	1	-.394**	-.239	-.124	-.141	-.147	-.055	-.199	.028	-.205	-.115	-.182	.327*	-.284	.501**	-.008	.107
emo sprt	-.059	-.157	-.142	-.065	-.079	-.095	-.045	-.116	.179	-.394**	1	.754**	.476**	.225	.297*	.092	.098	.122	.421**	.194	.282*	-.299*	.214	-.531**	-.061	-.147
info sprt	-.097	-.052	-.194	-.010	-.135	.016	-.071	-.145	.081	-.239	.754**	1	.480**	.226	.262	.207	.103	.114	.342*	.336*	.310*	-.235	.170	-.390**	-.045	-.298
instrum sprt	-.128	.068	.248	-.048	.098	-.215	-.179	-.273*	.054	-.124	.476**	.480**	1	.245	.276*	-.007	.214	.141	.415**	.213	.546**	-.260	.116	-.298*	.016	-.505**
DAS total	-.274*	-.012	-.077	-.077	-.218	-.065	-.137	-.192	.273*	-.141	.225	.226	.245	1	.881**	.535**	.807**	.768**	.498**	.330*	.309*	-.387**	.247	-.467**	.153	-.374*
DAS Cons	-.242	.042	.010	-.068	-.198	-.099	-.108	-.358**	.320*	-.147	.297*	.262	.276*	.881**	1	.398**	.548**	.529**	.552**	.252	.319*	-.437**	.372*	-.566**	.121	-.421*
DAS AffExp	-.199	-.170	-.191	-.058	-.178	-.107	-.099	.026	-.047	-.055	.092	.207	-.007	.535**	.398**	1	.296*	.309*	.142	.349**	-.020	-.175	.126	-.164	.303	-.412*
DAS Satisf	-.073	.028	-.001	-.022	-.125	-.078	-.093	.019	.159	-.199	.098	.103	.214	.807**	.548**	.296*	1	.544**	.274*	.299*	.327*	-.242	-.021	-.260	.096	-.191
DAS Cohe	-.368**	-.056	-.190	-.102	-.187	.099	-.134	-.108	.254	.028	.122	.114	.141	.768**	.529**	.309*	.544**	1	.415**	.186	.161	-.235	.213	-.318*	.094	-.256
ISEL total	-.216	.161	.125	-.100	-.055	-.036	-.296*	-.379**	.158	-.205	.421**	.342*	.415**	.498**	.552**	.142	.274*	.415**	1	.389**	.648**	-.554**	.407**	-.817**	-.021	-.596**
AAS Close	.035	.357**	.159	.086	-.068	.108	-.499**	-.197	-.214	-.115	.194	.336*	.213	.330*	.252	.349**	.299*	.186	.389**	1	.452**	-.330*	.093	-.265	.265	-.601**
AAS Depend	.010	.325*	.247	.052	.197	-.012	-.307*	-.358**	.073	-.182	.282*	.310*	.546**	.309*	.319*	-.020	.327*	.161	.648**	.452**	1	-.511**	.323*	-.612**	.131	-.543**
AAS Anx	.009	-.005	-.090	-.221	.019	.076	.289*	.236	-.117	.327*	-.299*	-.235	-.260	-.387**	-.437**	-.175	-.242	-.235	-.554**	-.330*	-.511**	1	-.216	.623**	-.129	.397*
BIMF tot	-.159	.064	-.070	.134	.155	-.096	-.129	-.100	.354*	-.284	.214	.170	.116	.247	.372*	.126	-.021	.213	.407**	.093	.323*	-.216	1	-.469**	-.114	-.194
UCLA tot	.186	-.200	-.117	.060	-.031	.099	.213	.509**	-.415**	.501**	-.531**	-.390**	-.298*	-.467**	-.566**	-.164	-.260	-.318*	-.817**	-.265	-.612**	.623**	-.469**	1	.117	.348
RTW days	.277	.149	.128	.456**	-.461**	.027	.148	-.172	-.195	-.008	-.061	-.045	.016	.153	.121	.303	.096	.094	-.021	.265	.131	-.129	-.114	.117	1	-.582**
RTW study	.165	-.162	-.057	-.373*	.081	.193	.724**	.223	.066	.107	-.147	-.298	-.505**	-.374*	-.421*	-.412*	-.191	-.256	-.596**	-.601**	-.543**	.397*	-.194	.348	-.582**	1

*Significant correlations denoted: * p < .05, ** p < .01*

Table 2 Cont.

Correlations between Baseline and Daily Variables.

B	mom age	inc	edc	yrs married	work status	feeding status	baby age	bmi	SR health	baby sleep loc	emo sprt	info sprt	instrum sprt	DAS total	DAS Cons	DAS AffExp	DAS Satisf	DAS Cohe	ISEL total	AAS Close	AAS Depend	AAS Anx	BIMF tot	UCLA tot	RTW days	RTW study
PSQI DIST	.148	-.054	-.158	.045	-.072	.021	.059	.300*	-.130	.066	-.252	-.325*	-.357**	-.222	-.339*	-.011	-.128	-.044	-.389**	-.011	-.467**	.136	-.246	.456**	-.006	.491**
PSQI tot	.208	-.115	-.155	.114	-.136	-.042	.029	.307*	-.416**	.030	-.155	-.224	-.144	-.336*	-.410**	-.075	-.096	-.336*	-.485**	-.021	-.323*	.337*	-.304*	.537**	.118	.220
B PA	-.276*	-.128	-.227	-.195	.017	-.059	-.042	-.105	.266	.155	.391**	.337*	.113	.319*	.316*	.231	.016	.452**	.428**	-.050	.174	-.159	.347*	-.463**	-.242	-.152
B NA	.038	-.011	.039	.148	.025	.068	.047	.245	-.323*	.152	-.372**	-.256	-.001	-.229	-.315*	-.124	-.097	-.086	-.421**	-.049	-.255	.280*	-.247	.679**	.126	.060
dailynap	-.039	-.234	-.133	-.090	-.255	-.071	.141	.103	-.217	.022	.115	.044	-.023	-.160	-.089	.050	-.165	-.247	-.209	-.090	-.203	.233	-.113	.344*	-.107	.219
dailyexer	-.123	-.062	-.123	.173	-.320*	-.046	.074	-.154	.269*	.098	.005	-.037	.038	.259	.233	-.096	.198	.334*	.204	-.006	.032	-.144	.146	-.211	-.031	.065
dailycaff	.000	-.165	.025	-.106	.161	-.171	-.085	.123	.006	-.132	.195	.148	-.098	-.093	-.120	.117	-.119	-.043	.007	-.031	-.133	.065	.159	-.139	-.272	.228
dailyalc	.014	.087	.175	-.072	.069	-.233	-.132	-.127	-.009	-.163	.069	-.015	-.053	.024	.061	.032	.025	-.069	.121	.083	.049	-.142	.149	-.208	-.026	-.008
totPSI	-.044	-.108	-.217	.115	-.360**	.025	.038	-.170	.076	-.066	.181	.119	.071	.392**	.398**	.097	.243	.363**	.114	.050	.120	-.190	.074	-.090	.582**	-.004
totNSI	.246	.025	.118	.202	.060	.041	.181	-.050	-.237	-.171	-.086	-.079	-.188	-.252	-.204	-.007	-.234	-.259	-.254	.020	-.072	.117	.020	.141	.462**	.174
SR TIB	-.437**	-.249	-.232	-.060	-.363**	-.158	.022	-.037	.197	-.022	.107	.035	-.051	-.155	-.132	.127	-.293*	-.032	-.180	-.133	-.410**	.145	.024	.150	-.050	-.050
SR SOL	-.090	-.273*	-.301*	-.007	-.257	-.026	.369**	.126	.050	.215	-.131	-.036	-.400**	-.345*	-.261	-.057	-.454**	-.193	-.381**	-.411**	-.479**	.266	.014	.241	-.156	.558**
SR TST	-.410**	.004	-.012	.029	-.304*	-.106	-.140	.033	.079	-.162	.239	.126	.150	.092	.060	.217	-.016	.129	.018	.131	-.089	.008	.184	.017	.019	-.314
SR SE	.143	.367**	.318*	.176	.154	.115	-.222	.060	-.198	-.179	.160	.141	.292*	.315*	.266	.066	.381**	.161	.333*	.381**	.523**	-.285*	.170	-.238	.116	-.372*
SR totwak	.107	.028	-.078	-.240	-.038	.231	.248	.145	-.089	.469**	-.292*	-.313*	-.337*	-.305*	-.286*	-.215	-.177	-.261	-.374**	-.085	-.344*	.464**	-.252	.502**	.012	.263
SR partwak	.157	.223	.213	-.041	.255	-.087	-.087	.031	.027	.387**	-.298*	-.131	.085	.058	.091	.065	.036	-.028	-.026	.005	.045	.200	.297*	.107	-.027	-.233
SR SQ	-.100	.151	.173	.086	-.106	-.046	.003	-.077	.267	-.161	.133	.195	.219	.396**	.388**	.158	.380**	.191	.210	.035	.321*	-.325*	.042	-.391**	.084	-.169
SR rest	-.250	.022	.016	.001	-.188	-.005	-.104	-.064	.366**	-.069	.155	.158	.195	.474**	.415**	.304*	.365**	.363**	.205	.006	.286*	-.246	.223	-.353*	.128	-.366*
ATIB	-.296*	-.149	-.206	.012	-.387**	-.184	.036	.129	.216	-.044	.174	.016	-.081	-.098	-.142	.179	-.145	-.019	-.274	-.125	-.405**	.277	-.043	.235	.079	.010
ATST	-.338*	-.031	-.092	-.013	-.200	-.153	.004	.146	.176	-.112	.074	-.096	-.081	-.010	-.061	.164	-.067	.065	-.075	-.051	-.150	.090	.011	.098	.036	-.010
ASOL	.166	-.059	-.048	-.216	-.297*	-.039	.201	-.121	.096	.010	.014	-.029	-.102	-.259	-.206	-.099	-.270	-.173	-.249	-.238	-.256	.300*	-.069	.094	.098	.425*
ASE	-.077	.165	.132	-.039	.271	.041	-.051	.066	-.070	-.094	-.164	-.175	-.048	.127	.098	.025	.114	.128	.275	.146	.353*	-.270	.076	-.216	-.038	-.037
AWASO	-.088	-.222	-.119	.239	-.264	.010	-.137	.082	-.048	.045	.200	.169	.133	.002	-.043	.187	.015	-.038	-.162	.122	-.230	.027	-.092	.219	.113	-.482*
AWAK	-.225	-.171	.201	-.144	.066	-.408**	-.029	.194	.186	-.059	.076	-.118	.096	.136	.176	.071	.111	.002	.133	-.037	-.068	-.098	.207	-.096	-.054	-.172
dailyPA	-.175	.063	-.112	-.019	-.149	-.079	-.090	-.132	.422**	-.056	.444**	.387**	.123	.546**	.500**	.312*	.289*	.565**	.420**	.059	.210	-.284*	.344*	-.542**	-.063	-.174
dailyNA	.238	-.175	.000	.094	.087	-.037	.103	.256	-.342*	.095	-.168	-.149	-.123	-.381**	-.459**	-.120	-.172	-.293*	-.341*	.135	-.312*	.302*	-.321*	.528**	.142	.155
dailyPSS	.397**	-.074	.132	.076	.146	-.091	.118	.202	-.414**	-.004	-.322*	-.324*	-.145	-.493**	-.505**	-.295*	-.229	-.450**	-.442**	-.067	-.230	.345*	-.392**	.564**	.195	.303

Significant correlations denoted: * $p < .05$, ** $p < .01$

Table 2 Cont.

Correlations between Baseline and Daily Variables.

C	PSQI DIST	PSQI tot	B PA	B NA	daily nap	daily exer	daily caff	daily alc	tot PSI	tot NSI	SR TIB	SR SOL	SR TST	SR SE	SR tot wak	SR part wak	SR SQ	SR rest	ATIB	ATST	ASOL	ASE	A WASO	AWAK	daily PA	daily NA	daily PSS
PSQI DIST	1	.472**	-.285*	.211	-.061	.030	-.079	-.015	-.063	-.041	.285*	.152	.146	-.275*	.396**	-.180	-.499**	-.425**	.382**	.287*	.160	-.086	.080	.067	-.301*	.334*	.289*
PSQI tot	.472**	1	-.448**	.392**	.165	-.139	.018	-.040	-.039	.139	.079	.134	.147	.011	.406**	-.098	-.426**	-.356**	.243	-.001	.257	-.340*	.351*	-.064	-.500**	.560**	.544**
B PA	-.285*	-.448**	1	-.479**	.034	.103	.273*	.020	.107	-.346*	-.020	.051	.000	.023	-.155	.141	.145	.312*	-.079	-.021	-.183	.068	-.061	.117	.713**	-.379**	-.570**
B NA	.211	.392**	-.479**	1	.101	-.058	-.250	-.155	-.026	.257	.149	-.121	.143	-.075	.179	.040	-.145	-.145	.245	.100	.095	-.212	.350*	.013	-.455**	.473**	.445**
dailynap	-.061	.165	.034	.101	1	-.215	-.127	-.329*	-.139	.044	.048	.075	.008	-.050	.069	.062	-.014	-.027	.063	-.001	.036	-.119	.149	-.092	-.189	.076	.055
dailyexer	.030	-.139	.103	-.058	-.215	1	-.115	-.157	.388**	-.062	.210	.233	.087	-.213	-.015	-.095	.031	.139	.161	.229	-.026	.108	.023	-.092	.314*	-.126	-.141
dailycaff	-.079	.018	.273*	-.250	-.127	-.115	1	.505**	-.114	.025	.013	.207	.078	.027	-.094	.083	-.139	-.128	-.011	-.165	.024	-.261	.143	.283	.185	.104	-.001
dailyalc	-.015	-.040	.020	-.155	-.329*	-.157	.505**	1	-.013	-.015	.050	-.122	.026	-.038	-.135	.007	.052	-.123	-.028	-.131	-.003	-.188	.061	.365*	.039	.056	.072
totPSI	-.063	-.039	.107	-.026	-.139	.388**	-.114	-.013	1	.169	-.007	.038	.071	.068	-.069	-.081	.119	.211	.035	.039	.037	-.004	.029	-.108	.279*	-.195	-.084
totNSI	-.041	.139	-.346*	.257	.044	-.062	.025	-.015	.169	1	-.071	.139	-.101	-.044	.064	-.056	-.160	-.199	-.086	-.163	.226	-.121	.092	-.227	-.358**	.345*	.475**
SR TIB	.285*	.079	-.020	.149	.048	.210	.013	.050	-.007	-.071	1	.283*	.701**	-.576**	.111	-.281	-.235	.005	.884**	.665**	.320*	-.285*	.340*	.229	.041	.107	-.067
SR SOL	.152	.134	.051	-.121	.075	.233	.207	-.122	.038	.139	.283*	1	.103	-.364**	.171	-.134	-.230	-.133	.244	.155	.184	-.101	-.007	-.064	.054	.001	.000
SR TST	.146	.147	.000	.143	.008	.087	.078	.026	.071	-.101	.701**	.103	1	.157	-.014	-.191	-.110	.122	.781**	.687**	.003	-.108	.376**	.257	.177	-.007	-.203
SR SE	-.275*	.011	.023	-.075	-.050	-.213	.027	-.038	.068	-.044	-.576**	-.364**	.157	1	-.241	.164	.261	.161	-.382**	-.161	-.514**	.308*	-.011	-.039	.142	-.170	-.163
SR totwak	.396**	.406**	-.155	.179	.069	-.015	-.094	-.135	-.069	.064	.111	.171	-.014	-.241	1	.076	-.533**	-.398**	.113	-.040	.189	-.201	.053	.002	-.356**	.361**	.319*
SR partwak	-.180	-.098	.141	.040	.062	-.095	.083	.007	-.081	-.056	-.281	-.134	-.191	.164	.076	1	-.083	-.054	-.303	-.417**	-.134	-.209	.059	.109	-.114	-.087	-.034
SR SQ	-.499**	-.426**	.145	-.145	-.014	.031	-.139	.052	.119	-.160	-.235	-.230	-.110	.261	-.533**	-.083	1	.819**	-.169	.082	-.384**	.339*	-.095	.141	.433**	-.545**	-.471**
SR rest	-.425**	-.356**	.312*	-.145	-.027	.139	-.128	-.123	.211	-.199	.005	-.133	.122	.161	-.398**	-.054	.819**	1	.149	.366*	-.288*	.320*	-.018	.082	.598**	-.622**	-.624**
ATIB	.382**	.243	-.079	.245	.063	.161	-.011	-.028	.035	-.086	.884**	.244	.781**	-.382**	.113	-.303	-.169	.149	1	.803**	.307*	-.239	.314*	.192	.108	.079	-.093
ATST	.287*	-.001	-.021	.100	-.001	.229	-.165	-.131	.039	-.163	.665**	.155	.687**	-.161	-.040	-.417**	.082	.366*	.803**	1	-.016	.382**	-.126	.153	.240	-.138	-.235
ASOL	.160	.257	-.183	.095	.036	-.026	.024	-.003	.037	.226	.320*	.184	.003	-.514**	.189	-.134	-.384**	-.288*	.307*	-.016	1	-.475**	-.060	-.134	-.279	.182	.265
ASE	-.086	-.340*	.068	-.212	-.119	.108	-.261	-.188	-.004	-.121	-.285*	-.101	-.108	.308*	-.201	-.209	.339*	.320*	-.239	.382**	-.475**	1	-.710**	-.071	.200	-.293*	-.210
AWASO	.080	.351*	-.061	.350*	.149	.023	.143	.061	.029	.092	.340*	-.007	.376**	-.011	.053	.059	-.095	-.018	.314*	-.126	-.060	-.710**	1	.223	-.065	.323*	.121
AWAK	.067	-.064	.117	.013	-.092	-.092	.283	.365*	-.108	-.227	.229	-.064	.257	-.039	.002	.109	.141	.082	.192	.153	-.134	-.071	.223	1	.053	.065	-.095
dailyPA	-.301*	-.500**	.713**	-.455**	-.189	.314*	.185	.039	.279*	-.358**	.041	.054	.177	.142	-.356**	-.114	.433**	.598**	.108	.240	-.279	.200	-.065	.053	1	-.554**	-.724**
dailyNA	.334*	.560**	-.379**	.473**	.076	-.126	.104	.056	-.195	.345*	.107	.001	-.007	-.170	.361**	-.087	-.545**	-.622**	.079	-.138	.182	-.293*	.323*	.065	-.554**	1	.798**
dailyPSS	.289*	.544**	-.570**	.445**	.055	-.141	-.001	.072	-.084	.475**	-.067	.000	-.203	-.163	.319*	-.034	-.471**	-.624**	-.093	-.235	.265	-.210	.121	-.095	-.724**	.798**	1

*Significant correlations denoted: * p < .05, ** p < .01*

Table 3

Participant Demographic Information

	EOH (N = 34)	SAH (N = 20)	Total (N = 54)
Maternal Age (in years)			
	M =30.62 (SD = 3.48)	M = 28.90 (SD = 3.86)	M = 29.98 (SD =3.69)
Race/Ethnicity			
White/Non-Hispanic	31 (91%)	19 (95%)	50 (93%)
Latina/Hispanic	1(3%)	0 (0%)	1 (2%)
Multiracial	2 (6%)	0 (0%)	2 (3%)
Other	0 (0%)	1 (5%)	1 (2%)
Annual Household Income			
$10,000-$19,999	1 (3%)	1 (10%)	2 (4%)
$20,000-$29,999	2 (6%)	2 (10%)	4 (7%)
$30,000-$39,999	3 (9%)	2 (10%)	5 (9%)
$40,000-$49,999	3 (9%)	3 (15%)	6 (11%)
$50,000-$59,999	2 (6%)	1 (5%)	3 (6%)
$60,000-$69,999	3 (9%)	3 (15%)	6 (11%)
$70,000-$79,999	8 (24%)	1 (5%)	9 (17%)
$80,000-$89,999	4 (12%)	2 (10%)	6 (11%)
$90,000-$99,999	3 (9%)	3 (15%)	6 (11%)
Over $100,000	5 (15%)	2 (10%)	7 (13%)
Highest Level of Education			
High School Degree	2 (6%)	2 (10%)	4 (7%)
Business/Trade School	1 (3%)	3 (15%)	4 (7%)
Associates Degree	3 (8%)	4 (20%)	7 (13%)
Undergraduate Degree	13 (38%)	6 (30%)	19 (35%)
Master’s Degree	14 (41%)	4 (20%)	18 (33%)
Doctoral Degree	1 (3%)	1 (5%)	2 (4%)
Years Married/Living with Partner			
	M = 4.96 (SD = 2.91)	M = 4.17 (SD = 3.13)	M = 4.66 (SD = 2.99)

Table 4

Participant Employment Characteristics

	Total (N = 28)
Return to Employment Time	
After Birth of Baby (in days)	M = 78.46 days (SD = 29.91)
By Start of Study Week (in days)	M = 63.79 days (SD = 43.05)
Feeling About Returning to Employment:	
Mostly Negative	12 (43%)
Mixed Feelings	6 (21%)
Mostly Positive	10 (36%)
Feel Supported at Work?	
Yes	24 (88%)
No	4 (12%)
Workplace Supports (N/% Yes)	
Space for Nursing/Pumping	25 (89%)
Electric Breast Pump Provided	14 (50%)
Refrigeration	27 (96%)
Breaks for Breastfeeding	24 (85%)
Healthcare/Educational Materials	3 (10%)
Other	5 (18%)
Employment Benefits (N/% Yes)	
Maternity Benefits	10 (35%)
Leave with no loss of seniority	20 (71%)
Return from leave to same or similar position	24 (85%)
Flex-time	12 (50%)
Part-time	11 (39%)
On-Site Daycare	1 (3%)
Other	7 (25%)

Table 5

Infant Characteristics

	EOH (N = 34)	SAH (N = 20)	Total (N = 54)
Delivery Type			
Vaginal	21 (62%)	10 (50%)	31 (57%)
Caesarean	9 (26%)	5 (25%)	14 (26%)
Unknown (Phase I Missing Data)	4 (12%)	5 (25%)	9 (16%)
Infant Age			
(in days)	M =137.41 (SD = 32.48)	M = 139.35 (SD = 26.46)	M = 138.16 (SD = 30.24)
Infant Gender			
Male	14 (41%)	11 (55%)	25 (46%)
Female	20 (59%)	9 (45%)	29 (54%)
Infant Sleeping Location			
In his/her own room	20 (59%)	8 (40%)	28 (52%)
In parent's bedroom	14 (54%)	12 (46%)	26 (48%)
Primary Infant-Feeding Method			
Breastfeeding	26 (76%)	14 (70%)	40 (74%)
Formula-Feeding	4 (12%)	3 (15%)	7 (13%)
Half & Half	4 (12%)	3 (15%)	7 (13%)
Childcare Assistance			
(N/% Yes)	25 (46%)	1 (5%)	26 (48%)
Nanny	1 (4%)	0	1 (2%)
Daycare	13 (52%)	0	13 (24%)
Family Member/Friend	9 (36%)	0	9 (16%)
Other	2 (8%)	1	3 (5%)

Table 6

Baseline Measures

	EOH (N = 34)	SAH N= 20)	Total (N = 54)
Body Mass Index (BMI)			
Normal Weight (18.5 - 24.99)	14 (41%)	12 (60%)	26 (48%)
Overweight (25.00-29.99)	9 (26%)	4 (20%)	13 (24%)
Obese (> 30.00)	11 (32%)	2 (20%)	13 (24%)
Postpartum Physical Symptoms			
(higher scores = greater severity)			
Breast Soreness (N/% Yes)	26 (76%)	18 (90%)	44 (81%)
Average Severity (1-7)	4.46	3.94	4.25
Gastrointestinal Distress (N/% Yes)	14 (41%)	5 (25%)	19 (35%)
Average Severity (1-7)	2.33	2.05	3.12
Musculoskeletal Pain (N/% Yes)	15 (44%)	15 (75%)	30 (55%)
Average Severity (1-7)	3.40	3.66	3.53
Urogenital Pain (N/% Yes)	11 (32%)	15 (75%)	26 (48%)
Average Severity (1-7)	4.00	4.53	4.31
Overall Physical Health (1-7)	5.12	5.20	5.15
(higher scores = better health)	(SD = .689)	(SD = .999)	(SD = .998)

Table 6 Cont.

Baseline Measures

	EOH (N = 34)	SAH N= 20)	Total (N = 54)
Dyadic Adjustment Scale (DAS-32)			
(higher scores = stronger endorsement)			
Consensus	3.85	4.03	3.92
Affective Expression	2.21	2.37	2.26
Satisfaction	4.17	4.28	4.21
Cohesion	3.35	3.60	3.44
DAS Total Score	117.38	122.75	119.37
	(SD = 11.02)	(SD = 12.12)	(SD = 11.98)
Interpersonal Support Evaluation List, ISEL			
(higher scores = more support)			
ISEL Total Score	40.12	40.65	40.31
	(SD = 4.68)	(SD = 4.82)	(SD = 4.73)
UCLA Loneliness Scale (UCLA-L)			
(higher scores = increased loneliness)			
UCLA-L Total Score	9.17	9.60	9.31
	(SD = 1.26)	(SD = 1.97)	(SD = 1.53)
CONVOY DIAGRAM: Social Network Support			
(higher scores = more support)			
Emotional Support (1-7)	5.22	5.36	5.27
	(SD = .764)	(SD = .998)	(SD =.848)
Informational Support (1-7)	4.43	4.76	4.55
	(SD = .773)	(SD = 1.63)	(SD =1.15)
Instrumental Support (1-7)	4.37	4.14	4.29
	(SD = 1.08)	(SD = 1.19)	(SD = 1.12)
Adult Attachment Scale, AAS			
(higher scores = stronger endorsement)			
Close Style	3.02	3.10	3.05
Dependent Style	3.76	3.44	3.64
Anxious Style	2.08	2.05	2.07

Table 6 Cont.

Baseline Measures

	EOH (N = 34)	SAH N= 20)	Total (N = 54)
Barkin Index of Maternal Functioning, BIMF			
(higher scores = higher functioning)			
BIMF Total Score	98.50	95.27	97.42
	(SD = 10.02)	(SD = 9.21)	(SD = 9.95)
Unknown (Missing Data)	4 (12%)	5 (25%)	9 (17%)
Profile of Mood States (POMS-65)			
(higher scores = stronger endorsement)			
Positive Affect	24.53	24.30	24.44
Tension/Anxiety	9.62	8.65	9.26
Depression/Dejection	5.71	5.45	5.61
Anger/Hostility	7.38	7.38	7.09
Fatigue/Inertia	10.06	10.05	10.06
Confusion/Bewilderment	6.71	7.15	6.87
Vigor/Activity	10.94	11.45	11.13
UCLA Loneliness Scale (UCLA-L)			
(higher scores = increased loneliness)			
UCLA-L Total Score	9.17	9.60	9.31
	(SD = 1.26)	(SD = 1.97)	(SD = 1.53)
Pittsburgh Sleep Quality Index (PSQI)			
Overall Sleep Quality			
Very Good/Fairly Good	26 (76%)	12 (60%)	38 (70%)
Fairly Bad/Very Bad	8 (24%)	8 (40%)	16 (30%)
PSQI Total Score	6.29	7.10	6.59
(higher scores = increased disruption)	(SD = 2.79)	(SD = 2.94)	(SD = 2.85)

Table 7

Daily Social, Mood & Stress Characteristics

	EOH (N = 34)	SAH (N= 20)	Total (N = 54)
Number of Infant-Feeds	5.89 (SD = 2.00)	7.60 (SD = 2.16)	6.52 (SD = 2.21)
*****Baby PSIs**	23.31 (SD = 12.49)	35.95 (SD = 20.96)	27.99 (SD = 17.11)
Baby NSIs	4.04 (SD =1.61)	3.98 (SD = 2.17)	4.02 (SD = 1.82)
Partner PSIs	6.73 (SD = 4.67)	9.03 (SD =3.76)	7.58 (SD = 4.46)
Partner NSIs	.555 (SD = .569)	.529 (SD = .592)	.545 (SD = .572)
Family PSIs	.748 (SD = .609)	.893 (SD = .933)	.802 (SD = .740)
Family NSIs	.029 (SD = .077)	.014 (SD = .044)	.024 (SD = .067)
Friend PSIs	.849 (SD = .665)	1.10 (SD = .877)	.942 (SD = .753)
Friend NSIs	.097 (SD = .171)	.057 (SD = .108)	.082 (SD = .151)
Coworker PSIs	.714 (SD = .469)	*	.463 (SD = .500)
Coworker NSIs	.109 (SD = .189)	*	.069 (SD = .159)
*****TOTAL PSIs**	32.35 (SD = 14.91)	47.01 (SD = 23.89)	37.78 (SD = 19.85)
TOTAL NSIs	4.82 (SD = 1.90)	4.59 (SD = 2.15)	4.74 (SD = 1.98)

****significant between-group difference (p <.05)*

Table 7 Cont.

Daily Social, Mood & Stress Characteristics

	EOH (N = 34)	SAH (N= 20)	Total (N = 54)
PSS Total Score	15.66	15.05	15.43
	(SD = 1.79)	(SD = 2.40)	(SD = 2.04)
Daily PA	1.99	2.16	2.05
	(SD = .483)	(SD = .626)	(SD = .541)
Daily NA	.856	.779	.827
	(SD = .390)	(SD = .504)	(SD = .433)
# of Caffeinated Drinks	1.26	.911	1.13
	(SD = 1.03)	(SD = 1.069)	(SD = 1.05)
# of Alcoholic Drinks	.309	.246	.289
	(SD = .457)	(SD = .414)	(SD = .439)
Exercise Duration	10.52	22.79	15.06
(in minutes)	(SD = 13.21)	(SD = 23.94)	(SD = 18.70)

Table 8

Subjective & Objective Sleep Characteristics

	EOH (N = 34)	SAH (N= 20)	Total (N = 54)
Time in Bed			
*****Perceived*	508.51	551.61	524.47
	(SD = 47.43)	(SD = 49.99)	(SD = 57.94)
***Actigraphy*	497.70	523.80	507.37
	(SD = 57.41)	(SD = 78.95)	(SD = 66.69)
Pearson's r			*r* = .780**
Sleep Onset Latency			
Perceived	15.83	21.85	18.06
	(SD = 11.22)	(SD = 12.80)	(SD = 12.08)
***Actigraphy*	15.65	19.84	17.19
	(SD = 21.71)	(SD = 22.14)	(SD = 21.76)
Pearson's r			*r* = .142**
Total Sleep Time			
****Perceived*	455.78	482.50	465.67
	(SD = 38.68)	(SD = 41.14)	(SD = 41.33)
Actigraphy	425.66	438.34	430.36
	(SD = 45.86)	(SD = 65.67)	(SD = 53.79)
Pearson's r			*r* = .658**
Sleep Efficiency			
Perceived	89.97%	88.27%	89.34%
	(SD = 4.39)	(SD = 7.98)	(SD = 5.96)
***Actigraphy*	85.75%	84.05%	85.12%
	(SD = 5.44)	(SD = 8.47)	(SD = 6.69)
Pearson's r			*r* = .139**

***actigraphy means and Pearson r values exclude participants for whom no actigraphy data were collected (EOH = 4, SAH = 2, Total N = 6).*

****significant between-group difference (p <.05)*

Table 8 Cont.

Subjective & Objective Sleep Characteristics

	EOH (N = 34)	SAH (N= 20)	Total (N = 54)
Wake After Sleep Onset			
Actigraphy	46.44	55.47	49.78
	(SD = 14.05)	(SD = 20.64)	(SD = 17.18)
Total Awakenings			
Perceived	2.91	3.02	2.95
	(SD = 1.30)	(SD = 1.32)	(SD = 1.31)
***Actigraphy*	36.86	32.38	35.20
	(SD = 11.57)	(SD = 8.82)	(SD = 10.77)
Pearson's r			*r* = .139**
Type of Awakenings			
Baby Related	2.18	2.37	2.25
	(SD = 1.69)	(SD = 1.78)	(SD = 1.73)
Non-Baby Related	.718	.632	.687
	(SD = .994)	(SD = .859)	(SD = .947)
Partner Awakenings	**(EOH = 29)**	**(SAH = 16)**	**(Total = 45)**
Perceived	.621	.200	.477
	(SD = 1.01)	(SD = .414)	(SD = .876)

	EOH (N = 34)	SAH (N= 20)	Total (N = 54)
Sleep Quality (1-7)	4.51	4.63	4.55
(higher scores = higher quality)	(SD = .797)	(SD = 1.09)	(SD = .911)
Feeling Rested (1-7)	4.18	4.47	4.29
(higher scores = more rested)	(SD = .877)	(SD = .925)	(SD = .898)
Napping Duration	24.50	14.42	18.16
(in minutes)	(SD = 23.49)	(SD = 15.41)	(SD = 19.23)

**actigraphy means and Pearson r values exclude participants for whom no actigraphy data were collected (EOH = 4, SAH = 2, Total N = 6).*

Table 9.

Fixed and Random Effects of Model #1: Predictors of Sleep Quality.

Fixed Effects	**Symbol**	**Coefficient**	**SE**	***p***
Intercept	γ_{00}	4.973	.140	< .05
mcINSUP (Mean-Centered Baseline Instrumental Support)	γ_{01}	.3241	.099	< .05
PART (# of partner awakenings)	γ_{10}	-.1847	.089	< .05
isleep (infant sleeping location)	γ_{02}	-.5597	.206	< .05
mcNSI (Mean-Centered differences in NSIs)	γ_{03}	-.0444	.051	< .05
devNSI (individual, daily mean differences in NSIs)	γ_{20}	-.0537	.026	< .05
Random Effects	**Symbol**	**Coefficient**	**SE**	***p***
Level 2 intercept (between person variability in SQ)	u_{0j}	.1939	.093	< .05
Level 1 intercept (within person, daily variability in SQ)	e_{1ij}	1.601	.141	< .05

$$\boldsymbol{SleepQual} = \beta_{0j} + \beta_{1j}PART + \beta_{2j}devNSI + e_{1ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01}mcINSUP + \gamma_{02}isleep + \gamma_{03}mcNSI + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$

$$\boldsymbol{SleepQual} = 4.973 + .3241mcINSUP - .5597isleep - .0444mcNSI - .1847PART - .537devNSI + u_{0j} + e_{1ij}$$

$$[u_{0j}] \sim N\,[0]\,,[.1939]$$
$$[e_{1ij}] \sim N[0]\,,[1.601]$$

Table 10.

Fixed and Random Effects of Model #2: Predictors of WASO.

Fixed Effects	**Symbol**	**Coefficient**	**SE**	***p***
Intercept	γ_{00}	38.756	5.19	< .05
MARR (years married)	γ_{01}	2.232	.698	< .05
EOH (employment status)	γ_{02}	-9.639	4.15	< .05
isleep (infant sleeping location)	γ_{03}	11.533	4.16	< .05
CAFF (# of caffeinated drinks)	γ_{10}	2.978	1.31	< .05
Random Effects	**Symbol**	**Coefficient**	**SE**	***p***
Level 2 intercept (between person variability in avg. WASO duration)	u_{0j}	132.412	40.12	< .05
Level 1 intercept (within person, daily variability in avg. WASO duration)	e_{1ij}	517.119	40.63	< .05

$$\boldsymbol{WASO} = \beta_{0j} + \beta_{1j}CAFF + e_{1ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01}MARR + \gamma_{02}EOH + \gamma_{03}isleep + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$

$$\boldsymbol{WASO} = 55.274 + 2.23MARR - 9.639EOH + 11.533isleep + 2.978CAFF + e_{1ij} + u_{0j}$$
$$[u_{0j}] \sim N\,[0]\,,[132.412]$$
$$[e_{1ij}] \sim N[0]\,,[517.119]$$

Table 11.

Fixed and Random Effects of Model #3: Predictors of TST.

Fixed Effects	**Symbol**	**Coefficient**	**SE**	***p***
Intercept	γ_{00}	456.775	11.51	< .05
mAGE (maternal age)	γ_{01}	-3.719	1.46	< .05
mcEXER (mean-centered exercise)	γ_{02}	.3227	.289	ns
devEXER (deviation in exercise)	γ_{10}	.3099	.131	< .05
Random Effects	**Symbol**	**Coefficient**	**SE**	***p***
Level 2 intercept (between person variability in avg. sleep duration)	u_{0j}	918.932	296.57	< .05
Level 1 intercept (within person, daily variability in avg. sleep duration)	e_{1ij}	4216.424	331.27	< .05

$$\boldsymbol{TST} = \beta_{0j} + \beta_{1j} devEXER + e_{1ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01} mAGE + \gamma_{02} mcEXER + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$

$$\boldsymbol{TST} = 456.775 - 3.719 mAGE + .3227 mcEXER + .3099 devEXER + e_{1ij} + u_{0j}$$
$$[u_{0j}] \sim N\,[0]\,,[918.932]$$
$$[e_{1ij}] \sim N[0]\,,[4216.424]$$

Table 12.

Fixed and Random Effects of Model #4: Predictors of Daily Positive Affect

Fixed Effects	Symbol	Coefficient	SE	*p*
Intercept	γ_{00}	2.0335	.051	< .05
mcHEALTH (group mean-centered baseline perceived health)	γ_{01}	.1290	.055	< .05
mcEMOSUP (group mean-centered baseline emotional support)	γ_{02}	.1944	.063	< .05
mcDAS (group mean-centered baseline marital satisfaction)	γ_{03}	.0119	.005	< .05
mcPSI (group mean-centered differences in PSIs)	γ_{04}	.0044	.003	ns
mcNSI (group mean-centered differences in NSIs)	γ_{05}	-.0547	.028	ns
mcSQ (group mean-centered differences in Sleep Quality)	γ_{06}	.1241	.066	ns
devPSI (individual, daily mean differences in PSIs)	γ_{10}	.0102	.002	< .05
devNSI (individual, daily mean differences in NSIs)	γ_{20}	-.0247	.007	< .05
devSQ (individual, daily mean differences in Sleep Quality)	γ_{30}	.0513	.024	< .05

Random Effects	Symbol	Coefficient	SE	*p*
Level 2 intercept (between person variability in daily PA)	u_{0j}	.1188	.027	< .05
devSQ/intercept (variability in rate of change in daily PA, based on devSQ)	u_{30j}	.0071	.008	ns
devSQ/devSQ (variability in individual, daily mean differences in Sleep Quality)	u_{33j}	.0106	.005	< .05

Level 1 intercept (within person, daily variability in avg. daily PA)	e_{1ij}	.1168	.011	< .05

$$\boldsymbol{PA} = \beta_{0j} + \beta_{1j} devPSI + \beta_{2j} devNSI + \beta_{3j} devSQ + e_{1ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01} mcHEALTH + \gamma_{02} mcEMOSUP + \gamma_{03} mcDAS + \gamma_{04} mcPSI$$
$$+ \gamma_{05} mcNSI + \gamma_{06} mcSQ + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30} + u_{3j}$$

$$\boldsymbol{PA} = 2.0335 + .1290 mcHEALTH + m.1944 cEMOSUP + .0119 mcDAS + .0044 mcPSI$$
$$-.0547 mcNSI + .1241 mcSQ + .0102 devPSI - .0247 devNSI + .0513 devSQ + e_{1ij} + u_{0j} +$$
$$u_{3j} SQ$$

$$\begin{bmatrix} u_{0j} \\ u_{3j} \end{bmatrix} \sim N \quad \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} .119 & \\ .0071 & .0106 \end{bmatrix}$$
$$[e_{1ij}] \sim N \quad [0], [.117]$$

Table 13.

Fixed and Random Effects of Model #5: Predictors of Daily Negative Affect.

Fixed Effects	**Symbol**	**Coefficient**	**SE**	***p***
Intercept	γ_{00}	.8365	.043	< .05
mcDEPDEJ (group mean-centered baseline negative affect)	γ_{01}	.0229	.008	< .05
mcPSI (group mean-centered differences in PSIs)	γ_{02}	-.0029	.002	ns
devPSI (individual, daily mean differences in PSI)	γ_{10}	-.0105	.002	< .05
mcNSI (group mean-centered differences in NSIs)	γ_{03}	.0584	.021	< .05
devNSI (individual, daily mean differences in NSIs)	γ_{20}	.0169	.008	< .05
mcSQ (group mean-centered differences in Sleep Quality)	γ_{04}	-.2079	.045	< .05
devSQ (individual, daily mean differences in Sleep Quality)	γ_{30}	-.0523	.021	< .05
devNSI * devsq (interaction)	γ_{40}	-.0186	.007	< .05
Random Effects	**Symbol**	**Coefficient**	**SE**	***p***
Level 2 intercept (between person variability in daily NA)	u_{0j}	.0828	.019	< .05
devSQ/intercept (variability in rate of change in daily NA, based on devSQ)	u_{30j}	-.0193	.007	< .05
devSQ/devSQ (variability in individual, daily mean differences in Sleep Quality)	u_{33j}	.0084	.004	< .05
Level 1 intercept (within person, daily variability in daily NA)	e_{1ij}	.0949	.009	< .05

$$\boldsymbol{NA} = \beta_{0j} + \beta_{1j} devPSI + \beta_{2j} devNSI + \beta_{3j} devSQ + \beta_{4j} devNSI * devSQ + e_{1ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01} mcDEPDEJ + \gamma_{02} mcPSI + \gamma_{03} mcNSI + \gamma_{04} mcSQ + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$
$$\beta_{4j} = \gamma_{40}$$

$$\boldsymbol{NA} = .8365 + .0229 mcDEPDEJ - .0029 mcPSI + .0584 mcNSI - .2079 mcSQ$$
$$- .0169 devPSI + .0169 devNSI - .0523 devSQ - .0186 devNSI * devSQ + e_{1ij} + u_{0j} +$$
$$u_{3j} SQ$$

$$\begin{bmatrix} u_{0j} \\ u_{3j} \end{bmatrix} \sim N \quad \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} .0828 & \\ -.0193 & .0084 \end{bmatrix}$$
$$[e_{1ij}] \sim N \quad [0], [.0949]$$

Table 14.

Fixed and Random Effects of Model #6: Predictors of Daily Perceived Stress.

Fixed Effects	**Symbol**	**Coefficient**	**SE**	***p***
Intercept	γ_{00}	15.388	.212	< .05
mcISEL (group mean-centered social support)	γ_{01}	-.1045	.048	< .05
mcPSI (group mean-centered differences in PSIs)	γ_{02}	-.0114	-1.03	ns
devPSI (individual, daily mean differences in PSI)	γ_{10}	-.0413	.014	< .05
mcNSI (group mean-centered differences in NSIs)	γ_{03}	.3839	.115	< .05
devNSI (individual, daily mean differences in NSIs)	γ_{20}	.1059	.048	< .05
mcSQ (group mean-centered differences in Sleep Quality)	γ_{04}	-.7617	.243	< .05
devSQ (individual, daily mean differences in Sleep Quality)	γ_{30}	-.0713	.102	ns
devNSI * devsq (interaction)	γ_{40}	-.0794	.040	< .05
Random Effects	**Symbol**	**Coefficient**	**SE**	***p***
Level 2 intercept (between person variability in daily PSS)	u_{0j}	.0828	.019	< .05
Level 1 intercept (within person, daily variability in daily PSS)	e_{1ij}	.0949	.009	< .05

$$\boldsymbol{PSS} = \beta_{0j} + \beta_{1j}devPSI + \beta_{2j}devNSI + \beta_{3j}devSQ + \beta_{4j}devNSI * devSQ + e_{1ij}$$
$$\beta_{0j} = \gamma_{00} + \gamma_{01}mcISEL + \gamma_{02}mcPSI + \gamma_{03}mcNSI + \gamma_{04}mcSQ + u_{0j}$$
$$\beta_{1j} = \gamma_{10}$$
$$\beta_{2j} = \gamma_{20}$$
$$\beta_{3j} = \gamma_{30}$$
$$\beta_{4j} = \gamma_{40}$$

$$\boldsymbol{PSS} = 15.388 - .1045mcISEL - .0114mcPSI + .3839mcNSI - .7617mcSQ$$
$$-.0413devPSI + .1059devNSI - .0713devSQ - .0794devNSI * devSQ + e_{1ij} + u_{0j} +$$
$$u_{3j}SQ$$

$$[u_{0j}] \sim N \ [0], [.0828]$$
$$[e_{1ij}] \sim N \ [0], [.0949]$$

Figures

Figure 1

Recruitment Consort Diagram

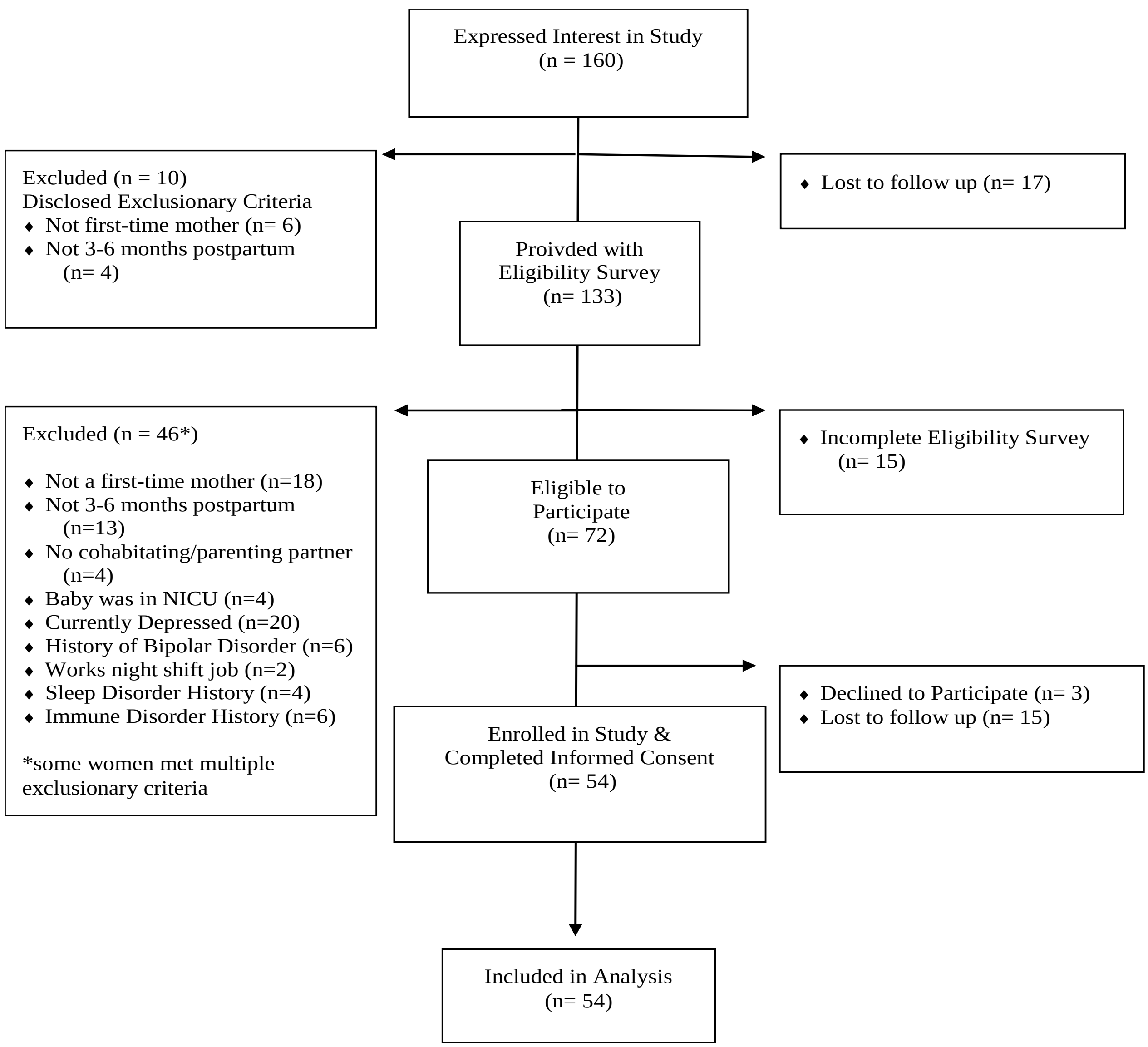


Figure 2.

Within-Person Differences Sleep Quality Moderates the Effect of Within-Person Differences in Daily NSIs on Daily Negative Affect.

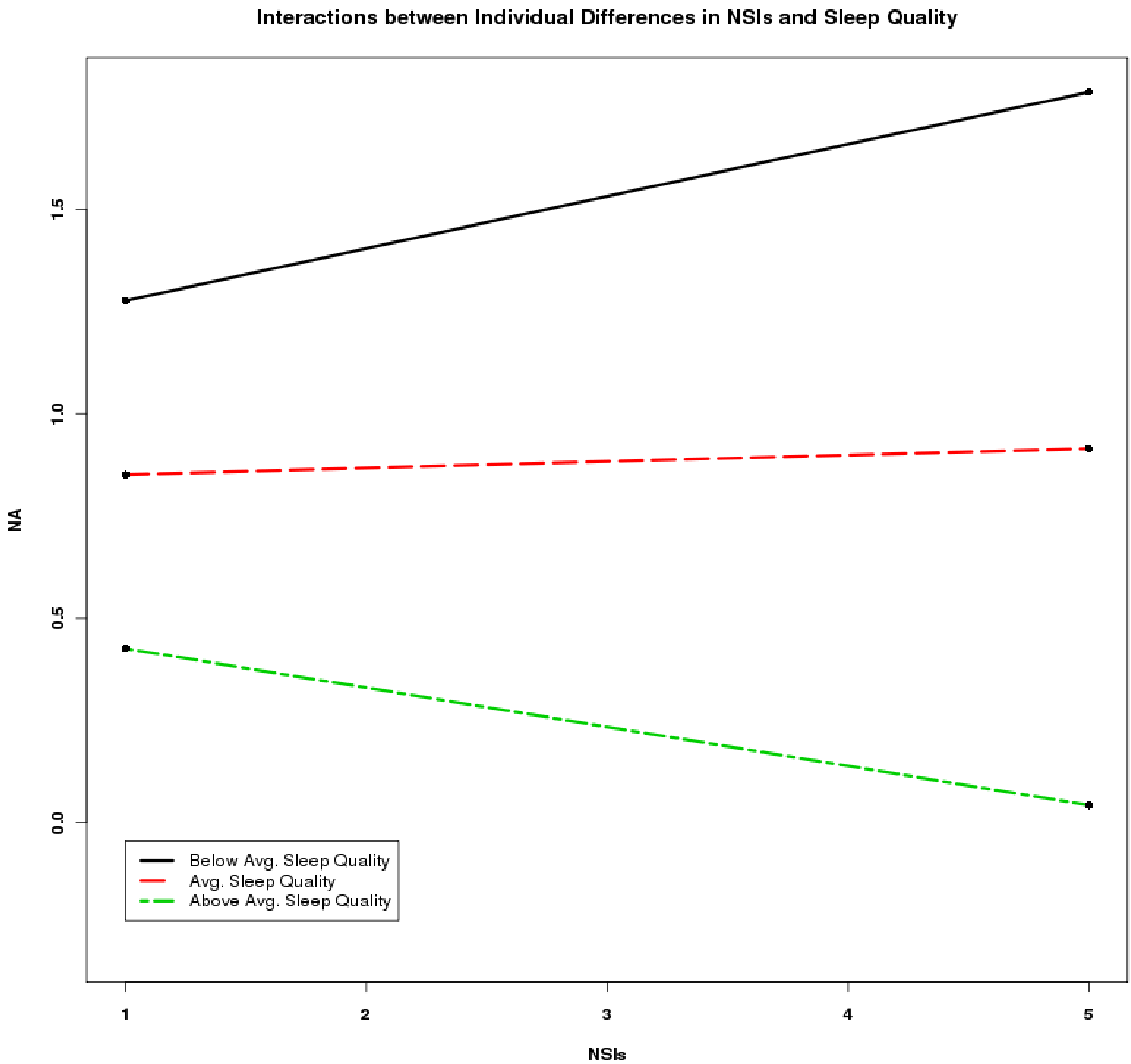
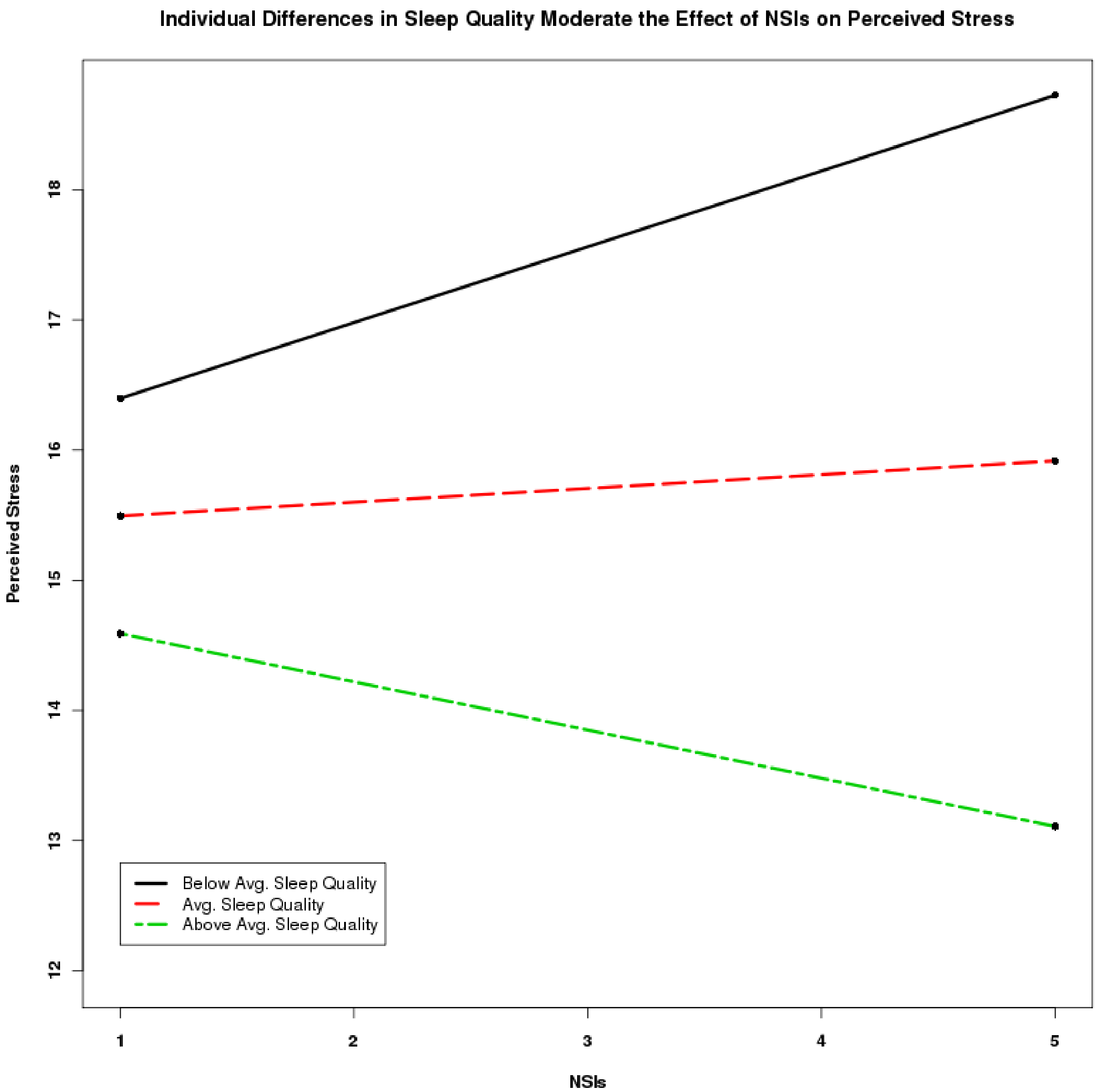


Figure 3.

Fixed and Random Effects of Model #6

Within-Person Differences in Sleep Quality Moderate the Effect of Within-Person Differences in NSIs on Daily Perceived Stress



Appendix A. Study Questionnaires and Sample Items.

1) SUMMARY OF BASELINE INTERVIEW AND QUESTIONNAIRE ITEMS

Baseline Variables	Scale	Sample Items	Rated	Aprrox. # of items
Demographics	N/A	age, ethnicity, family income, education, marital status, current working status, pre and post-birth employment information, breastfeeding status	N/A	10
Health Status	REACH II NIH (Resources for Enhancing Alzheimer's Caregiver Health) Body Mass Index, Post-childbirth symptoms PSQI- Pittsburgh Sleep Quality index (assessment of previous month's quality/quantity of sleep)	Existing health conditions, perceived health quality, health change since childbirth, height & weight, ratings of symptoms common following first child birth (e.g., *breast, gastrointestinal, general, musculoskeletal, and urogenital)*	Presence or absence of illness, symptom presence and severity (by interview and questionnaire), self-reported height and weight	15
Social Environment (baseline objective)	- Household Description - Paid/Free Child Care - Social Networks in Adult Life Convoy measure - Social Network Index - Feeding Characteristics (average)	- # of people in the household - details of child care assistance (quantity & quality) - network members initials listed based on closeness (closest 10 people in life) - perceptions of emotional,	N/A	20

		instrumental and informational support from those 10 people - number of people you interact with in various social roles regularly (e.g., relatives, parents, friends) - Where does baby sleep? (e.g., in own room, in parents room, in bed with parents, etc). - %feedings breast vs. formula, pumping frequency, formula vs. breast milk		
Social Environment (baseline perceived)	- Attachment (AAS) - Social Support: Interpersonal Support Evaluation List (ISEL) - Marital Quality (Dyadic Adjustment Scale/DAS) -Maternal Functioning (Barkin Index of Maternal Functioning, BIMF) -Workplace support (WKSP)	- **attachment**: *People are never there when you need them; I am comfortable depending on others, I know that others will be there when I need them* - **support**: *If I were sick, I could easily find someone to help me with my daily chores.; I feel there is no one I can share my private worries and fears with* **-marital quality**: *how often have you laughed together, calmly discussed something* **-maternal functioning:** *I trust my own feelings (instincts) when it comes to taking care of*	Likert scales (e.g., often to never; definitely true to definitely false), frequency measures (always to never) WKSP: open-ended responses	ISEL (12) DAS (34) AAS (21) BIMF (20) WKSP (10)

		my baby. **-workplace support:** *How do you feel about returning to work? (i.e., do you want to return to work?); Do you feel supported at your place of employment as a new mother?*		
Baseline Affect	- Profile of Mood States (past month assessment) -UCLA Loneliness Scale	**Mood:** *Over the past month, how often have you felt: Unhappy, Clear-headed, Lively* **Loneliness:** *how often do you feel shut out or excluded by others*	0=not at all/rarely to 4=extremely/often	POMS (65) UCLA (10)

2) SUMMARY OF DAILY DIARY ITEMS AND SLEEP DIARY ITEMS

Daily Measures	Scale	Sample Items	Rated	Times Measured	Approx. # of Items
Sleep Quality/Quantity	Morning Measure	*1. What time did you get into bed?* *2. What time did you try to go to sleep?* *3. How long did it take you to fall asleep?* 4. *How many times did you wake up in the night to tend to your baby?* *5. How many times did you wake up in the night not because of your baby?* *6. How many times did your partner wake in the night to tend to your baby?* 7. *What time did you wake up today?* 8. *How would you rate the quality of your sleep on a scale from 1-7, where 1 is very bad and 7 is very good?* *9. Did you take anything to help you fall asleep or that made you sleepy last night? (e.g., Tylenol PM, antihistamine, etc.)* *10. How rested do you feel on a scale from 1-7, where 1 is not at all rested and 7 is very rested?*	N/A	Mornings	10

PSI, with baby*	Selected CCAQ & Daily Events Checklist Items	1. Baby learned new behavior 2. Cuddled or Hugged baby. 3.Play with baby. 4. Spent special time with baby at bedtime. 5. Fed baby (formula or breast). 6. Bathe baby. 7. Dress baby. 8. Spend time talking to baby.	Rated on Frequency and Quality from: 1= extremely unenjoyable - 7=extremely enjoyable *Only positively rated items will be utilized for PSI (i.e., if rated undesirable it will not be included in the PSI sum score).*	Evenings	10
NSI, with baby*	Selected CCAQ & Daily Events Checklist Items	1. Missed work because of baby. 2. Had difficulty soothing baby. 3. Spent more time watching over baby than usual. 4. Responded to crying	1=extremely unenjoyable - 7=extremely enjoyable *-only negatively rated items will be included in NSI index*	Evenings	5
PSI, with partner*	Items from Daily Events	*1. Received special gift from partner* *2. Expressed love to*	1=extremely unenjoyable	Evenings	5

	Checklist	*partner* *3. Celebrated special occasion with partner* *4. Had long conversation with partner* *5. Kissed or had pleasing physical contact with partner*	- 7=extremely enjoyable *-only positively rated items will be included in the PSI partner index*		
NSIs, with partner*	Items from Daily Events Checklist	*1. Argued with partner* *2. Was critical of partner* *3. Was criticized by partner* *4. Partner less affectionate than usual*	1=extremely unenjoyable - 7=extremely enjoyable *-only negatively rated items will be included in this NSI partner index*	6	5
PSIs, with family member other than partner*	Items from Daily Events Checklist	*1. Praised by family member* *2. Visited with family members* *3. Talked with family member with whom you had not spoken in a while* *4. Helped family member with personal problem* *5. Received gift from family member* *6. Was helped by family*	1=extremely unenjoyable - 7=extremely enjoyable *-only positively rated items will be included in PSI family*	Evenings	6

		member with childcare	*index*		
NSIs, with family member other than partner*	Items from Daily Events Checklist	*1. Criticized or blamed for something by family member* *2. Had argument with family member* *3. Forced to visit family member when you did not want to*	1=extremely unjoyable - 7=extremely enjoyable *-only negatively rated items will be included in the NSI family index*	Evenings	4
PSIs, with friends and acquaintances*	Items from Daily Events Checklist	*1. Played sport or game with friends* *2. Went to party or social gathering* *3. Made new friends* *4. Went out with friends* *5. Received compliment from friend*	1=extremely unenjoyable - 7=extremely enjoyable *-only positively rated items will be included in the PSI friend index*	Evenings	5
NSIs, with friends and acquaintances*	Items from Daily Events Checklist	*1. Friend didn't return call* *2. Criticized by friend(s)* *3. Argued with friend(s)* *4. Encountered rude or unfriendly person*	1=extremely unenjoyable - 7=extremely enjoyable *-only negatively rated items will be included in the NSI friend index*	Evenings	5

PSIs, with co-workers*	Items from Daily Events Checklist	*1. Praised by superior at work* *2. Completed work on major task or project* *3. Helped by fellow employee*	1=extremely unenjoyable 7=extremely enjoyable *-only positively rated items will be included in the co-worker PSI index*	Evenings	5
NSIs, with co-workers*	Items from Daily Events Checklist	*1. People under your supervision failed to get work done* *2. Criticized by superior at work* *3. Authority to make decisions was decreased* *4. Disagreement with others about your job assignment*	1=extremely unenjoyable - 7=extremely enjoyable *-only negatively rated items will be included in the NSI co-worker index*	Evenings	5
Psychological Daytime Assessment	Shortened versions emotional affect (POMS), Perceived Stress Scale (PSS),	To what extent did you feel the following today? 1. stressed 2. overwhelmed 3. happy 4. lonely 5. tired 6. depressed 7. angry	Rated from not at all to very much so (items will be summed into daily categories of positive affect, negative affect, stress, and loneliness)	Evenings	POMS (24) PSS (10)
Health	Units of	- minutes spent in light,		Evenings	6

Behaviors Daytime Assessment	intake of cigarettes, alcohol, caffeine, exercise, and supplements (e.g., medication, vitamins)	moderate or intense aerobic activity - # of cigarettes or other tobacco products - # of alcohol drinks - # of caffeine drinks - units and types of medications/suppleme nts			