POOR MATERNAL SLEEP QUALITY AND POSTPARTUM DEPRESSION

THE IMPACT OF A POST-DELIVERY SLEEP PROTECTION INTERVENTION ON POSTPARTUM MATERNAL MENTAL HEALTH

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Descriptive Note

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Lay abstract

While the arrival of a child is a celebrated and joyous occasion, it can also be a source of duress and anguish, particularly for the mother. Postpartum depression is a mood disorder experienced by 10-15% of mothers after childbirth. One of the strongest risk factors for the development of postpartum depression is disrupted postpartum sleep quality. This thesis examined the impact of an intervention designed to protect and promote sleep of mothers during the postpartum period in an effort to improve mood, sleep quality, and anxiety symptomatology. By improving maternal mental health, not only do women benefit, but their children, their partners, and the healthcare system.

Abstract

INTRODUCTION: Poor sleep quality is a significant risk factor for the development of postpartum depression. This thesis examined the impact of a post-delivery intervention which promoted and protected sleep during the immediate postpartum period on maternal mood, sleep quality, and anxiety.

METHODS: 41 women with lifetime or current mood and/or anxiety disorders (12 receiving the intervention) were enrolled in this prospective naturalistic cohort study from the third trimester of pregnancy until 24 weeks postpartum. Depression, the primary outcome, was measured using the Edinburgh Postnatal Depression Scale at 12 weeks postpartum. Remaining outcomes (sleep quality and anxiety) were measured using self-report questionnaires (Insomnia Severity Index and State-Trait Anxiety Inventory, respectfully), and objective measures (i.e., actigraphy for sleep quality).

RESULTS: There were no significant differences between the comparison and intervention group in depressive symptomatology at postpartum week 12 (primary outcome). On our secondary outcomes, we found that there were no significant differences in subjective and objective sleep quality at postpartum week two, or anxiety symptomatology at postpartum week eight between the two groups. There were also no significant differences in breastfeeding rates between the two groups at postpartum week 24.

CONCLUSION AND FUTURE DIRECTIONS: Floor effects, specialized perinatal psychiatric treatment for a specific population, and low statistical power offer explanations for the observed null results. Strengths of our study include diagnosis of

mood/anxiety disorders using the gold-standard (i.e., clinician diagnosis), and use of objective sleep measures. Future studies may benefit from implementing this intervention in resource-poor settings, using adequately powered research designs.

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List of Abbreviations

5HTT: Serotonin transporter
ACTH: Adrenocorticotropic hormone
BPDI: Bipolar disorder Type I
BPDII: Bipolar disorder Type II
CBAS: Cognitive Behavioral Avoidance Scale
CRH: Corticotropin-releasing hormone
CTQ: Childhood Trauma Questionnaire-Short Form
DI: Demographic information
EBF: Exclusive breastfeeding
EPDS: Edinburgh Postnatal Depression Scale
GAD: Generalized anxiety disorder
HPA: Hypothalamic-pituitary-adrenal
IFIS: Infant Feeding Intentions Scale
IHG: In-hospital guidelines
ISI: Insomnia Severity Index
MDD: Major depressive disorder
NREM: Non-rapid eye movement
OCD: Obsessive-compulsive disorder
PDD: Persistent depressive disorder
PDQ: Post-Delivery Questionnaire
PPD: Postpartum depression
PTSD: Post-traumatic stress disorder
REM: Rapid eye movement
SAD: Seasonal affective disorder
SE: Sleep efficiency
STAI: State-Trait Anxiety Inventory
TAU: Treatment-as-usual
TST: Total sleep time
WASO: Wake after sleep onset

Declaration of Academic Achievement

Dr. Meir Steiner and other clinician-scientists at the Women's Health Concerns Clinic were responsible for creating the in-hospital guidelines intervention.

Dr Benicio Frey, Dr. Ryan Van Lieshout, and I were responsible for formulating the research questions associated with this study. I was responsible for creating the ethics protocol, screening and recruiting participants, collecting data, and performing the statistical analyses. I express my gratitude to Dr. Ryan Van Lieshout, Anastasiya Slyepchenko, and Calan Savoy who were always willing to provide their statistical expertise.

For the systematic review and meta-analysis that is primarily cited throughout Chapter 2, Dr. Benicio Frey and Dr. Ryan Van Lieshout were involved in creating the initial research question, providing help in the interpretation of data, and revising the final manuscript. I was responsible for creating the search strategies, with the help of Jo-Anne Petropoulos and Stephanie Sanger. I was also responsible for conducting the literature search, screening articles, extracting and analyzing data, and revising the manuscript. Dr. Cheryl Chow was involved in planning the searches and guiding the article selection and screening process. Melissa Furtado was involved in the article selection and screening process, and revising the first draft of the manuscript.

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CHAPTER 1 – REVIEW OF POSTPARTUM DEPRESSION AND ITS ASSOCIATED RISKS AND CONSEQUENCES

Postpartum Depression and Its Consequences

There may be no other period in a woman's life, where she experiences significant physiological and psychological changes, than during the postpartum period (Biaggi, Conroy, Pawlby, & Pariante, 2016). The postpartum period is a time of increased vulnerability for the development or recurrence of psychiatric disorders, especially postpartum depression (PPD) (Meltzer-Brody, 2011; Okun, 2015; Petersen et al., 2014; Wesseloo et al., 2015). As described in the most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), PPD is characterized by the presence of a major depressive episode during pregnancy or within the first four weeks postpartum. Women must also experience four of the following symptoms to be diagnosed with PPD: anhedonia, fatigue/decreased energy, poor concentration, significant weight loss/gain, psychomotor agitation/retardation, feelings of worthlessness, and/or recurrent thoughts of self-harm (American Psychiatric Association, 2013).

Meta-analyses have reported PPD prevalence rates of 13% (O'hara & Swain, 1996), but rates can range from 7.1% to 19.2% depending on the severity of the illness and screening tools used (Gavin et al., 2005). Women are at the greatest risk of developing PPD during the first three months postpartum and tend to remit after three to six months postpartum (Kettunen, Koistinen, & Hintikka, 2014; Munk-Olsen, Laursen, Pedersen, Mors, & Mortensen, 2006; Vliegen, Casalin, & Luyten, 2014). However,

recovery rates depend on treatment, population type, and previous psychiatric history, among other factors. For instance, Vliegen et al. (2014) conducted a narrative review of 23 longitudinal studies and found that 30% of mothers from community samples were still diagnosed with PPD from 3 months to 3 years postpartum, and 50% of mothers from clinical samples remained depressed at one year postpartum (Vliegen et al., 2014).

Symptoms of PPD can be debilitating for the mother. Indeed, women with PPD may feel helpless, worthless, and fatigued (Letourneau et al., 2012). As such, women with PPD have less optimal cognitive functioning including poorer working memory (Pio de Almeida et al., 2012), short-term memory (Pio de Almeida et al., 2012), and verbal problem-solving (Meena, Soni, Jain, Jilowa, & Omprakash, 2016). Women with PPD also report poorer relationship quality, decreased partner intimacy, and an overall decreased satisfaction with their partner (Małus, Szyluk, Galińska-Skok, & Konarzewska, 2016; Vliegen et al., 2014). Unfortunately, the effects of maternal depression extend beyond the mother. Indeed, maternal depression is the strongest risk factor for the development of paternal depression (Goodman, 2004). Up to 50% of fathers develop paternal depression if their partner is depressed (Goodman, 2004). Critically, infant outcomes and developmental milestones are more greatly impaired when both parents are depressed (Kerstis et al., 2016).

While it is important to consider both maternal and paternal depression when investigating the negative impact on offspring, the majority of the literature focuses solely on maternal depression as it has strong implications for offspring development (Stein et al., 2014). Converging evidence suggests that infants of depressed mothers

have reduced social interaction (Feldman et al., 2009; Hernandez-Reif, Field, Diego, & Ruddock, 2006; Ijzendoorn, Schuengel, & Bakermans–Kranenburg, 1999; Tomlinson, Cooper, & Murray, 2005), poor fear regulation (Feldman et al., 2009; Tomlinson et al., 2005), and display greater aggression (Avan, Richter, Ramchandani, Norris, & Stein, 2010; Ijzendoorn et al., 1999).

These poor cognitive, emotional, and behavioural outcomes may persist into adolescence in offspring as well (Stein et al., 2014). For example, Korhonen et al. (2012) found that PPD was associated with low social competence in male adolescents (Korhonen, Luoma, Salmelin, & Tamminen, 2012). Tuovinen et al. (2018) found that higher maternal depressive symptomatology, as assessed by the Center for Epidemiological Studies-Depression scale, had poorer childhood developmental milestones, as assessed by the Ages and Stages Questionnaire, during toddlerhood (Tuovinen et al., 2018). Finally, Murray et al. (2011) found that infants exposed to maternal depression had an almost 5-fold risk of experiencing depressive symptoms themselves by 16 years of age (OR = 4.99; 95% CI = 1.68-14.70) (Murray et al., 2011).

The negative impact of PPD goes beyond the family unit. In the United Kingdom, each case of perinatal depression costs £74,000 (Bauer et al., 2014). Taking perinatal depression, anxiety, and psychosis together, costs the United Kingdom health system £8.1 billion per year (Bauer et al., 2014). Importantly, almost 75% of these costs are attributed to the child, rather than the mother (Bauer et al., 2014). Locally, nearly 30,000 Ontario mothers develop PPD or postpartum anxiety, yet 85% of these women will not receive treatment. In Ontario alone, nearly $25 million is spent annually on untreated maternal depression (O'Brien, Laporte, & Koren, 2009).

Biological and Psychosocial Risk Factors for PPD

Introduction

Given the extensive and durable negative consequences associated with PPD, it is imperative to understand the biological and psychosocial factors that put women at risk for PPD. Similar to any psychiatric condition, no single causative factor for PPD has been identified (Lawson, Murphy, Sloan, Uleryk, & Dalfen, 2015). Rather, the interplay of biological and psychosocial risk factors can give rise to it. Further, cross-sectional studies of risk factors for PPD, must be interpreted with caution as these types of studies cannot elucidate the temporal sequence of the risk factor and outcome (Stein et al., 2014). Conversely, longitudinal studies have greater predictive power and provide greater clinical relevance for screening and interventions for PPD (Guintivano, Manuck, & Meltzer-Brody, 2018). The following sections review the most prominent risk factors and their associated levels of evidence.

Reproductive Hormones

The reproductive hormonal milieu across the perinatal period follows a characteristic pattern of steadily increasing throughout the pregnancy, and then a precipitous drop at childbirth (Yim, Tanner Stapleton, Guardino, Hahn-Holbrook, & Schetter, 2015). Given this hormonal pattern, much research has examined associations between perinatal gonadal hormones and mood. Largely, studies have found no association between perinatal hormonal levels and PPD (Chatzicharalampous et al., 2011; Ingram, Greenwood, & Woolridge, 2003; O'Keane et al., 2011; Yim et al., 2015). For instance, Chatzicharalampous et al. (2011) found no association between

serum estradiol levels measured from postpartum days one to four and depressive symptomatology at postpartum weeks one and six, measured through self-report questionnaires, in 57 women (Chatzicharalampous et al., 2011). By the same token, Ingram et al. (2003) found that neither antenatal or postnatal estriol predicted Edinburgh Postnatal Depression Scale (EPDS) scores at six months postpartum in 54 women (Ingram et al., 2003). One study did find a negative association between estradiol levels and postpartum mood, but this may have been due to the low specificity of the mood measure used, measuring 'baby blues' rather than depression (O'Keane et al., 2011).

Other lines of research have looked at multiple hormonal levels concurrently to determine if their interaction elicits different results. To recreate the steady increase and precipitous drop of estrogen and progesterone after childbirth, Bloch et al. (2000), induced a hypogonadic state in 16 multiparous postpartum women by administering a gonadotropin-releasing hormone agonist, followed by the administration of estradiol and progesterone for eight weeks, and finally, withdrew estradiol and progesterone to mimic the hormonal milieu at childbirth (Bloch et al., 2000). Five of the eight women with a history of PPD developed depressive symptomatology, while no women without a history of PPD (0/8) developed depressive symptomatology, after eight weeks (Bloch et al., 2000). Therefore, women with a previous psychiatric history may be more susceptible to develop low mood in the context of a reduction in estradiol and progesterone, in comparison to women with no previous psychiatric history (Bloch et al., 2000).

It is challenging to draw conclusions about the impact of gonadal sex steroids on PPD due to differences in methodology, measures, and time points amongst the

studies. Broadly, present research suggests that absolute levels of gonadal sex steroids and other hormones implicated during the perinatal period have little to no impact on postpartum depressive symptomatology.

Genetics

Since family psychiatric history is a strong predictor of PPD (Posmontier, 2008), recent research has begun exploring the impact of genetics on the development or recurrence of PPD. For instance, 42% of women with a family history of PPD developed the disorder after their first delivery, compared to only 15% who developed PPD with no family history (Forty et al., 2006). Another study with 580,006 sisters found that the heritability of perinatal depression was 44% (95% CI = 35%-52%) (Viktorin et al., 2016). Importantly, the researchers found that only two-thirds of the genetic variation of perinatal depression overlapped with non-perinatal depression (Viktorin et al., 2016). Knowing PPD has a genetic basis, other lines of research have attempted to identify specific genes associated with PPD. Systematic reviews of candidate gene studies in PPD indicate that the serotonin transporter gene (5HTT) is the most studied gene in this context (Couto et al., 2015; McEvoy, Osborne, Nanavati, & Payne, 2017). Research suggests that the long allele of the 5HTT gene has protective effects on the development of PPD (McEvoy et al., 2017; Yang, Fang, Du, & Hu, 2017), however this association may only hold true during the early postpartum period (McEvoy et al., 2017).

Inflammatory Markers and the HPA Axis

The perinatal period is a time of profound and remarkable change in the levels of maternal inflammatory markers. It remains unknown as to why the maternal immune

system does not attack the growing foreign fetus (Yim et al., 2015). As such, pregnancy was thought to be a time of immunosuppression, however, growing evidence suggests that it is instead a time of immunomodulation (Buglione-Corbett et al., 2018). Specifically, the first two trimesters are characterized by a rise in anti-inflammatory markers, whereas the third trimester is marked by a rise in pro-inflammatory markers (e.g., TNF-α, 1L-6, 1L-1β) (Buglione-Corbett et al., 2018).

The transcription and translation of anti- and pro-inflammatory markers are mediated by the hypothalamic-pituitary-adrenal (HPA) axis (Slavich & Irwin, 2014). Corticotropin releasing hormone (CRH) is released from the hypothalamus, which stimulates the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary (Cardon, Ron-Harel, Cohen, Lewitus, & Schwartz, 2010). ACTH travels through the bloodstream to stimulate the release of cortisol from the adrenal glands (Cardon et al., 2010). Cortisol has downstream effects in activating an anti-inflammatory response, suppressing growth and reproduction, and mobilizing energy stores. The HPA axis is regulated through a negative feedback loop, as cortisol binds to receptors in the hypothalamus, to prevent the release of CRH, and subsequently ACTH and cortisol (Cardon et al., 2010).

Mounting empirical evidence suggests that some, but not all, individuals with depression have a dysregulated HPA axis (Buglione-Corbett et al., 2018; Cardon et al., 2010). Specifically, some individuals with depression have higher levels of pro-inflammatory molecules, and in turn, individuals with chronic inflammatory disease have higher rates of depression (Buglione-Corbett et al., 2018). Knowing this association, longitudinal and cross-sectional studies have been conducted to investigate the role of

the HPA axis in PPD, however, the results have been largely inconsistent and limited evidence exists. For instance, Jolley et al. (2007) activated the HPA axis through an exercise challenge to determine if stress hormonal levels differed between the depressed (n=9) and non-depressed (n=13) group at six and 12 weeks postpartum (Jolley, Elmore, Barnard, & Carr, 2007). The results demonstrated that there were no significant differences in cortisol or ACTH levels between the two groups at both time points. However, depressed women, as screened by the Postpartum Depression Screen Scale, had no correlation between (high) ACTH and (low) cortisol levels, which is reflective of a dysregulated HPA axis (Jolley et al., 2007). However, Crowley et al. (2016) found that lower, not higher, levels of ACTH were associated with depressive symptomatology in women in their second trimester, after HPA activation (Crowley et al., 2016). In these studies, not only were these women sampled in different stages of the perinatal period, but the HPA axis can either be hyper or hypoactivated depending on the type of depression (melancholic or atypical) (Jolley et al., 2007).

Psychosocial Risk Factors

The most prevalent psychosocial risk factors for PPD include lack of social support (Khazaie, Ghadami, Knight, Emamian, & Tahmasian, 2013), poor marital relations (McCall-Hosenfeld, Phiri, Schaefer, Zhu, & Kjerulff, 2016), and low socioeconomic status (Posmontier, 2008). Moreover, a recent systematic review and meta-analysis of 15 studies demonstrated that immigrant women have a two-fold risk of developing PPD as compared to non-immigrant women (OR=2.10, 95% CI= 1.62-2.73) (Falah-Hassani, Shiri, Vigod, & Dennis, 2015). Lack of self-esteem (Cheadle & Dunkel Schetter, 2018; Shi, Ren, Li, & Dai, 2018), optimism (Cheadle & Dunkel Schetter, 2018),

and spirituality (Cheadle & Dunkel Schetter, 2018) also have shown to increase the risk of PPD.

The aforementioned risk factors may only be applicable to certain groups of women (i.e., role of genetics, socioeconomic status). However, one risk factor which seems to affect nearly all women, irrespective of genetics, social support, or income level, is poor postpartum sleep quality.

Poor Sleep Quality as a Risk Factor for PPD

Up to 30% of women report disturbed sleep quality in the postpartum period (Siebern, Suh, & Nowakowski, 2012), but these numbers may be higher for those who have pre-existing and/or comorbid psychiatric or sleep disorders (Lawson et al., 2015; Tham et al., 2016). Sleep disruption is most pronounced during the first postpartum month, especially the first two weeks postpartum (Hedman, Pohjasvaara, Tolonen, Suhonen-Malm, & Myllylä, 2002; Sharma & Mazmanian, 2003; Tomfohr, Buliga, Letourneau, Campbell, & Giesbrecht, 2015). Further, poor sleep quality is exacerbated for first time mothers (Rychnovsky & Hunter, 2009; Sharma & Mazmanian, 2003). Typically, sleep quality remains compromised until three months postpartum (Coo, Milgrom, & Trinder, 2014; Hedman et al., 2002), where it returns to pre-pregnancy levels. Aside from contributing to irritability, decreased alertness, and fatigue, poor sleep quality is a risk factor for the development of PPD (Lawson et al., 2015; Tham et al., 2016). Overall, researchers have found effect sizes ranging from 0.4 to 1.7 for the association between poor postpartum sleep quality and PPD (Bhati & Richards, 2015). Other systematic and narrative reviews highlight the robust association between poor

postpartum subjective and/or objective sleep quality and depressive symptomatology during the postpartum period (Lawson et al., 2015; Okun, 2016).

Major mechanisms underlying the association between sleep disturbance and PPD have not been extensively studied. However, the theories on cholinergic dominance and HPA axis dysregulation (the two major mechanisms associating poor sleep quality to non-perinatal depression) can reliably be extrapolated to the puerperal population due to the drastic hormonal changes which occur in the early postpartum period.

Mechanisms Underlying Poor Sleep Quality and Depression: Cholinergic Dominance.

The sleep architecture of a healthy individual typically transitions from a period of light non-rapid eye movement (NREM) sleep to a prolonged deep sleep phase, known as rapid eye movement (REM) (Wichniak, Wierzbicka, & Jernajczyk, 2013). Punctuated by a short awakening, the 90-minute cycle repeats itself, starting from NREM sleep once again (Wichniak et al., 2013). The average person transitions through 5-6 cycles in a single night, with each subsequent cycle shortening in duration (Wichniak et al., 2013). Neurohormones act in concert to balance wakefulness and sleep states (Wichniak et al., 2013). Specifically, the release of hypocretin and orexin from the hypothalamus stimulates noradrenergic, serotonergic, and histaminergic neurons in the locus coeruleus, dorsal raphe nucleus, and hypothalamus, to fire rapidly during wakefulness (Wang et al., 2015; Wichniak et al., 2013). Through a negative feedback loop, cholinergic neurotransmission from the brainstem results in transition to REM

sleep (Wichniak et al., 2013). Accordingly, REM-on neurons are cholinergic and REM-off neurons are monoaminergic (Palagini, Baglioni, Ciapparelli, Gemignani, & Riemann, 2013; Wang et al., 2015).

Up to 90% of individuals with depression experience difficulties with sleep (Palagini et al., 2013). More specifically, individuals with depression often suffer from decreased REM onset latency and increased REM length, especially during the first sleep cycle (Wang et al., 2015; Wichniak et al., 2013). The increased REM sleep length suggests that there may be a hyperactivity of cholinergic neurons. In a seminal study demonstrating an association between hyperactivation of cholinergic neurotransmission and depression, Gershon and Shaw (1961) found that exposure to insecticides which blocked acetylcholinesterase, an enzyme responsible for breaking down acetylcholine, caused depressive symptoms in those exposed (Gershon & Shaw, 1961). Since this original hypothesis, mounting empirical evidence bolsters support for this theory as the majority of antidepressants attempt to decrease neural acetylcholine levels or prevent the breakdown of monoamines (i.e., those involved in REM-off control) (Palagini et al., 2013; Wang et al., 2015; Wichniak et al., 2013).

Mechanisms Underlying Poor Sleep Quality and Depression: HPA Axis Dysregulation.

Cortisol may serve as one link between depression and poor sleep quality due to its involvement in the HPA axis and the suprachiasmatic nucleus, the body's internal clock. Cortisol increases immediately after awakening, and levels peak 30-45 minutes thereafter (Elder, Wetherell, Barclay, & Ellis, 2014). Cortisol levels then decline over the

course of the day, only rising once again during the first sleep period (Elder et al., 2014). Feelings of decreased alertness and fatigue are associated with low cortisol levels (Adam, Hawkley, Kudielka, & Cacioppo, 2006; Elder et al., 2014). Other studies have shown that feelings of loneliness, sadness, and rumination are associated with a higher cortisol awakening response in non-puerperal populations (Adam et al., 2006; Elder et al., 2014). As discussed earlier, there is inconsistent research regarding the link between HPA axis dysregulation and PPD and thus, further research is warranted (Crowley et al., 2016; Jolley et al., 2007).

Conclusion

The postpartum period presents as a vulnerable time for the development or recurrence of psychiatric disorders, especially PPD. Concurrently, women also experience poor sleep quality which can serve to trigger the development of or exacerbate the presence of existing depressive symptomatology. While research in non-puerperal populations has demonstrated that cholinergic dominance or HPA axis dysregulation, in part, may be mechanistic links underlying the association between poor sleep quality and depression, more rigorous research must be conducted with perinatal populations. What remains undisputed is the need for sleep-focused interventions to improve postpartum maternal sleep quality, and subsequently, postpartum mood.

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CHAPTER 2 – PHARMACOLOGICAL AND NON-PHARMACOLOGICAL SLEEP INTERVENTIONS FOR WOMEN WITH PPD

Introduction

Knowing that poor postpartum sleep quality is a significant risk factor for the onset or recurrence of PPD, it is important to protect and promote sleep quality during the postpartum period in an effort to improve maternal mood. Broadly, sleep-focused PPD interventions can consist of pharmacological and/or non-pharmacological components.

Sleep-Focused Pharmacological Interventions

Due to maternal apprehension in taking medication during breastfeeding, or worry that the sedative effects may impair maternal ability to provide attending care to the infant, there is a paucity of data on postpartum pharmacological sleep interventions. The only sleep-focused pharmacological study we found was aimed at improving *pre*-natal sleep quality. In this randomized controlled trial, women in the third trimester of their pregnancy were given trazodone or diphenhydramine and these were compared to placebo (Khazaie et al., 2013). The authors found that objective sleep efficiency improved for the two treatment groups, but not placebo, at six weeks postpartum (Khazaie et al., 2013). Accordingly, mood symptoms as measured by the EPDS, significantly improved in the two treatment groups , but not placebo, at two and six weeks postpartum (Khazaie et al., 2013).

The use of psychotropic medications during pregnancy and the postpartum period requires a careful consideration between risks to the fetus and risk of relapse for

the mother (Okun, Ebert, & Saini, 2015; Petersen et al., 2014). Fear of teratogenic effects, exposure in breastmilk, and long-term functional effects for the child are, in part, why pregnant and postpartum women prefer non-pharmacological treatments for certain psychiatric disorders (Goodman, 2009). In fact, being pregnant is a strong predictor of psychotropic medication cessation (Petersen et al., 2014). Acknowledging patient treatment preference is critical to the delivery of optimal healthcare, as research has shown that agreement between patient preference and treatment delivered is associated with treatment adherence and positive treatment outcomes (Goodman, 2009). Indeed, perinatal women endorse preferences for non-pharmacological treatments over medication and have poor compliance for the latter (Boath, Bradley, & Henshaw, 2004; Sleath et al., 2005). Further, women who did take medication during pregnancy reported anxious and regretful sentiments (Bonari et al., 2005).

Sleep-Focused Non-pharmacological Interventions

Owais et al. (2018) recently conducted a systematic review and meta-analysis of studies of 15 non-pharmacological sleep-focused interventions delivered during the postpartum period. The researchers found that massage (Cohen's d= -1.07, 95% CI= -1.34 to -0.79) and exercise (Cohen's d= -0.82, 95% CI = -1.28 to -0.37) interventions had the largest impact on maternal subjective sleep quality (Owais, Chow, Furtado, Frey, & Van Lieshout, 2018). Collectively, non-pharmacological interventions exerted effects of moderate size (Cohen's d = -0.54, 95% CI = -0.88 to -0.19) in improving postpartum maternal sleep (Owais et al., 2018). For context, in the literature, effect sizes between 0.24 and 0.36 have generally been reported of pharmacological treatments for subjective and objective sleep outcomes, respectively, in general

population samples (Winkler, Auer, Doering, & Rief, 2014). However, these studies generally use individuals with sleep problems that may have been more severe than those contained in the aforementioned meta-analysis.

In five of the 15 studies reviewed in the meta-analysis, researchers examined the impact of the non-pharmacological sleep interventions on maternal mood (Owais et al., 2018). In two interventions, where women at postpartum week six drank chamomile (Chang & Chen, 2016) or lavender (Chen & Chen, 2015) tea for two weeks to improve sleep quality found that mood symptoms significantly improved in the intervention group, but not placebo, at eight weeks postpartum. Further, in a small pilot study for cognitive behavioural therapy for insomnia, 12 postpartum women experienced significant improvements in their subjective sleep quality and mood symptoms after five weeks of therapy (Swanson, Flynn, Adams-Mundy, Armitage, & Arnedt, 2013). Finally, in two behavioural-educational sleep interventions for postpartum women, neither showed a significant improvement in mood symptoms, as measured by the EPDS, despite showing improvements in subjective and objective sleep (Stremler et al., 2013, 2006). Collectively, Owais et al. (2018) reported that positive effects on maternal depression were not found when the five aforementioned studies were meta-analyzed (Cohen's d = -0.08, 95% CI= -0.28 to 0.12) (Owais et al., 2018). This null finding may be because of the timing that mood symptoms were measured. Specifically, only one study (Stremler et al., 2013) measured depression at postpartum week 12, where the risk of PPD is known to be the highest (Kettunen et al., 2014; Vliegen et al., 2014).

While 15 postpartum sleep intervention studies were identified in the meta-analysis, they largely suffered from methodological constraints, precluding definitive

conclusions and treatment recommendations (Owais et al., 2018). For instance, only three out of the 15 studies included objective measures of sleep (Lee & Gay, 2011; Stremler et al., 2013, 2006). This limits the interpretation of findings as research suggests that there is low agreement between objective and subjective sleep measurements in perinatal women (Bei, Coo, Baker, & Trinder, 2015; Coo et al., 2014). Further, studies which included women with current mood or sleep disorders assessed their disease severity according to self-report questionnaires. As a result, we cannot be certain if these interventions may in fact be effective in women with physician-diagnosed mood and/or sleep disorders. Future studies would benefit from using diagnostic interviews to more fully ascertain a participant's baseline status, and women with mental disorders should be included in study samples in order to determine the effectiveness of treatments and their effects on symptomatology. In addition, of the 11 studies included in the primary analysis, only three had outcome assessment time points beyond immediate post-intervention termination (Chang & Chen, 2016; Chen & Chen, 2015; Stremler et al., 2013). This limits patients, clinicians, and researchers from fully understanding the effectiveness and durability of these interventions.

Rationale for an In-Hospital Sleep Protection Intervention

In the recent review by Owais et al. (2018), the median intervention exposure time for non-pharmacological sleep interventions was 14 days (Owais et al., 2018). Two weeks may be too long of a time to commit for a busy postpartum mother and may be prohibitive to intervention adherence (Owais et al., 2018). Rather, it may be prudent to deliver a more brief, sleep-focused intervention to optimize intervention adherence and participation. Further, it may be wise to capitalize on an environment that is natural for

an expectant mother to best enhance postpartum sleep quality. The post-delivery room in a hospital can serve as this environment.

Post-Delivery Hospital Environment

In 2011-2012, 97% of women living in Canada gave birth in a hospital (Canadian Institute for Health Information, 2013; Statistics Canada, 2016). Given how accessible and ubiquitous the post-natal hospital environment is for women living in urban areas, it serves as the optimal environment to deliver a sleep intervention. Further, protecting and promoting sleep quality during the first few days postpartum is crucial to maintaining both sleep quality and positive maternal mental health. Owais et al. (2018) conducted a systematic review and meta-analysis of 15 non-pharmacological interventions aimed at improving maternal sleep quality. Early (zero to three weeks postpartum) vs. late (four to eight weeks postpartum) intervention initiation was also compared using pairwise analyses (Owais et al., 2018). Significant improvements in subjective sleep quality scores were seen for interventions initiated between zero to three weeks postpartum but not for interventions administered four to eight weeks postpartum (Owais et al., 2018). This result suggests that sleep responded better to non-pharmacological interventions administered within the first three weeks postpartum (Owais et al., 2018). The aforementioned finding coupled with mounting empirical evidence, which demonstrates that the first two weeks postpartum have the most disturbed sleep quality (Sharma & Mazmanian, 2003; Tomfohr et al., 2015), suggest that the immediate postpartum period should be targeted for intervention implementation. To capitalize on the immediate postpartum period, interventions delivered during the post-natal hospital stay may be best poised to help women during

the postpartum period. Different features of an expectant mother's hospital stay can be modified in an effort to mitigate poor sleep quality that frequently follows delivery.

Length of Post-Delivery Hospital Stay and Maternal Preference

The length of post-natal hospital stay has been steadily decreasing over the past half-century (Cargill & Marte, 2007). In the 1950s, women with an uncomplicated vaginal delivery remained in the hospital for up to 14 days, whereas women today are discharged within 1-2 days for a vaginal delivery, and 3-4 days for a Caesarean delivery (Brown, Small, Argus, Davis, & Krastev, 2002; McLachlan et al., 2009; Zadoroznyj, Brodribb, Young, Kruske, & Miller, 2015). This decrease has been the source of much contention as hospitals struggle to balance the twin challenges of efficacy (i.e., patient satisfaction) and efficiency (i.e., limited hospital resources). In a retrospective case-control study Watt and et al. (2005) found that the most common reason for women wanting to extend their hospital stay included concerns about their own health, and their babies health (Watt, Sword, & Krueger, 2005). Specifically, the researchers found that 96% of women who were offered a longer post-natal hospital stay were satisfied with their post-natal care, compared to a 20% satisfaction level of women who were not offered an extended stay. These results are regardless of whether the women accepted the offer or not (Watt et al., 2005). Notably, post-natal care satisfaction has been shown to predict the onset or recurrence of PPD (Iwata et al., 2015). Therefore, to allow for sufficient time for women to recuperate from childbirth, partnered with the positive outcomes of adhering to patient preference, maternity wards may be best poised to protect mothers' sleep by offering an extended post-natal hospital stay (i.e., of three

days or more for an uncomplicated vaginal delivery) and subsequently improve their mood and/or anxiety symptomatology.

Private Post-Delivery Hospital Room

Hospital noise is often recorded at 60-70 decibels despite the World Health Organization recommending levels do not exceed 40 decibels. In addition to hospital noise, new mothers are often faced with constant disruptions due to routine ward checks (Adatia, Law, & Haggerty, 2014; Coleman, Morison, Paine, Powell, & Walraven, 2006). One study found that new mother-infant dyads faced 53 interruptions across a 12 hour period on the first day postpartum (Morrison & Ludington-Hoe, 2012). The incessant noise and disruptions that mothers face on the maternity ward are challenging for optimal postpartum recovery (Adatia et al., 2014). Disruptions and noise can be minimized if a mother has her own private hospital room.

Partial Infant Rooming-In

Rooming-in is a practice where new mother-infant dyads remain in the same hospital room for 24 hours per day (Chiou, Chen, Yeh, Wu, & Chien, 2014; Feldman-Winter & Goldsmith, 2016; Zuppa et al., 2009). Despite the benefits of exclusive rooming-in, this practice severely disrupts mothers' sleep due to short infant sleep-wake cycles, frequent routine care for the infant by hospital staff, and nearby noise from other patients and their infants (Feldman-Winter & Goldsmith, 2016; Hughes, Mohamad, Doyle, & Burke, 2018; Rychnovsky & Hunter, 2009). This may be especially true for women who have a difficult birth. For instance, Lai et al. (2015) found that women who had a Caesarean section and practiced full rooming-in were more fatigued, had greater

difficulty in infant-care, and had impaired maternal-infant bonding, compared to women who had a vaginal delivery (Lai, Hung, Stocker, Chan, & Liu, 2015). One study found that there was no difference in breastfeeding rates when infants were roomed in compared to those remaining in the nursery (Waldenstrom & Swenson, 1991). The same study also reported that mothers slept the same amount of time, whether their baby was in the nursery, or in their hospital room (Waldenstrom & Swenson, 1991). However, this study only measured subjective total sleep time, despite research suggesting that objective wake after sleep onset is a better indicator of sleep fragmentation (Shrivastava, Jung, Saadat, Sirohi, & Crewson, 2014) . Partial rooming-in, where the infant is roomed out during the night, may present as an alternative to maintaining undisrupted sleep.

Access to Lorazepam (As Needed)

For some women, childbirth and the post-delivery experience may generate anxiety. Having access to a pharmacological sleep aid may help in not only reducing their anxiety, but improving their sleep quality. Since there is much hesitation in taking psychiatric medication during the perinatal period due to potential teratogenic and longer term functional effects, it is crucial to provide a medication which can exert its therapeutic effects without harmful effects on the fetus/infant. Lorazepam is a benzodiazepine which has anxiolytic and sedative effects (Whitelaw, Cummings, & McFadyen, 1981). In a study conducted with 51 mothers, 35 of whom received oral lorazepam and 16 of which received intravenous lorazepam for 48-72 hours post-delivery, found that while lorazepam was present in the breastmilk, it was at non-therapeutic levels (Whitelaw et al., 1981). Further, babies born full-term had detectable

amounts of lorazepam excreted after eight days (Whitelaw et al., 1981). Therefore, lorazepam seems to have minimal effects on the infant, and also has a shorter half-life, in comparison to another anxiolytic, diazepam, which limits the risk of prolonged sedative effects which may inhibit a mother's ability to tend to her infant (Greenblatt & Divoll, 1983).

Benefits of Multi-Component Interventions

Multi-component interventions have garnered interest over the past few years due to their potential synergistic effects. A systematic review of 28 multi-faceted randomized controlled trials on depression found that 20 of them were effective in improving depressive symptomatology (Williams et al., 2007). Specifically for PPD, Hou et al. (2014) found that women with PPD undergoing cognitive behavioural therapy in conjunction with systemic family therapy experienced a significantly greater improvement in mood and sleep quality, as compared to the control group, which received postpartum care as usual (Hou et al., 2014). On the other hand, some researchers have found that multi-component interventions are no more effective than single-component interventions. In a recent study, researchers found that a multifaceted group-based psychotherapy treatment for pregnant women with depression was found to not be superior than counselling alone (Van Ravesteyn et al., 2018). However, this finding may be due to potential ceiling effects of the comparison intervention (Van Ravesteyn et al., 2018). While the literature on multi-component therapies is still growing, extant evidence indicates that participants may benefit from the different features and their potential synergistic effects.

Nearly two decades ago, clinician-scientists at the Women's Health Concerns Clinic noticed that the principal symptom of postpartum women with mood and/or anxiety disorders was poor sleep quality. From these clinical encounters, they created an in-hospital sleep intervention to protect and promote sleep quality during the immediate postpartum period for women at risk of developing postpartum mental disorders. Still implemented today, the quadripartite intervention consists of the expectant mother receiving a minimum 3-day hospital stay, a private hospital room (if resources are available), partial rooming-out of their newborn from 12:00AM-5:00AM, and access to lorazepam (as needed for sleep).

Steiner et al. (2001; unpublished data), conducted a retrospective chart review of 74 women who were offered the intervention and found that they had a lower incidence of PPD than anticipated. The small pilot study, partnered with overwhelming positive anecdotal evidence from women who have received this intervention, warrants a full-scale, prospective study to be conducted to further parse out the impact and potential of this intervention.

Objectives

Primary Objectives

To determine if the quadripartite intervention reduces clinically significant postpartum depressive symptoms in women with previous or current mood and/or anxiety disorders, at 12 weeks postpartum.

Secondary Objectives

There were three secondary objectives. First, to determine if the intervention improves subjective and objective sleep quality measured at two weeks postpartum. Second, to determine if the intervention prevents or reduces anxiety symptom worsening measured at eight weeks postpartum. Third, to determine if the intervention increases exclusive breastfeeding rates measured at 24 weeks postpartum.

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CHAPTER 3 – MATERIALS AND METHODS

Design

In this prospective naturalistic cohort study, we examined the impact of a post-delivery sleep protection intervention on our primary (depression) and secondary objectives (sleep, anxiety, breastfeeding). The intervention consisted of a) a minimum 3-day hospital stay, b) a private hospital room (if resources were available), c) overnight rooming-out of infant, and d) access to lorazepam (as needed), a pharmacological sleep aid. The length of the intervention was dictated by how long the mother remained in the hospital for her post-natal stay. Women were recruited during the third trimester of their pregnancy, which served as a baseline measurement. Follow-up occurred at postpartum week 2, 4, 8, 12, and 24. This study was approved by the Hamilton Integrated Research Ethics Board.

Participants

Pregnant women who signed a clinic-wide consent-to-contact-for-research form from the Women's Health Concerns Clinic at St. Joseph's Healthcare Hamilton were contacted. Specifically, women who met the inclusion criteria of being a) 18 years or older, b) diagnosed with a previous or current mood and/or anxiety disorder by their psychiatrist, and c) fluent in English were approached by research personnel to participate in the study.

Women were excluded if they were a) diagnosed with a sleep disorder, b) had a complicated pregnancy and/or birth (e.g., stillborn, miscarriage, or had their baby placed in the neonatal intensive care unit for more than 30 days), c) had a current alcohol or

substance use disorder, d) were currently taking medication for diagnosed sleep disorders, or were e) diagnosed with a psychotic disorder.

Group Assignment

Women were placed in the intervention (IHG) or treatment as usual (TAU) group at the discretion of their Women's Health Concerns Clinic psychiatrist, independent of the research study.

Measures

Primary outcome

Depression was assessed using the Edinburgh Postnatal Depression Scale (EPDS) (Cox, Holden, & Sagovsky, 1987)**,** a 10-item self-report questionnaire which assesses depressive symptoms in perinatal populations. Participants rate each item on a 4-point Likert scale ranging from "*Strongly Disagree*" to "*Strongly Agree*". Scores range from 0-30 with clinical cut-offs for minor/major depression varying from pregnancy to postpartum. Specifically, frequently used clinical cut-offs for minor depression during pregnancy and the postpartum period are 13 and 10, respectively (Matthey, Henshaw, Elliott, & Barnett, 2006). For major depression during pregnancy and the postpartum period, they are 15 and 13, respectively (Matthey et al., 2006). Since clinical cut-offs vary from study to study, we decided to take a pre-post intervention score ≥ 4 as a clinically meaningful difference in depression (Matthey et al., 2004). The EPDS was chosen as it is regarded as the 'gold-standard' to quickly screen for perinatal depression (Chorwe-Sungani & Chipps, 2017). Pooled sensitivity (0.80), specificity (0.81) and accuracy (AUC=0.96) have shown that the EPDS is an excellent and validated measure

to use in perinatal populations (Chorwe-Sungani & Chipps, 2017). The EPDS was administered at baseline (third trimester of pregnancy) and at 2, 4, 8, 12, and 24 weeks postpartum. The primary end point was taken at 12 weeks postpartum as the risk of PPD is highest during this time (Kettunen et al., 2014; Vliegen et al., 2014).

Secondary Outcomes

Subjective sleep was measured using the Insomnia Severity Index (ISI) (Bastien, Vallières, & Morin, 2001), a 7-item self-report questionnaire which retrospectively assesses sleep quality and attitude toward present sleep problems. Items are rated on a 5-point Likert scale ranging from "*None/Not at all worried*" to "*Very severe/Very much worried*". Scores range from 0-28 with higher scores representing greater symptom severity. Scores equal to or greater than 15 indicate moderate clinical insomnia. Internal consistency is high for both healthy and control populations (Cronbach's α = 0.90, 0.91, respectively) (Morin, Belleville, Bélanger, & Ivers, 2011). The ISI was chosen as other sleep measures validated with perinatal populations retrospectively measure sleep up to one month prior (i.e., Pittsburgh Sleep Quality Index), which may be subject to poor recall bias. It also has high sensitivity (0.94) and specificity (0.94) in discriminating between clinical and healthy populations, and has also been validated among other sleep measures and polysomnography (Smith & Wegener, 2003).

Objective sleep was measured using an actigraph (Actiwatch 2, Philips Respironics, Murrysville, PA). Actigraphs are wrist-worn devices which monitor sleep and activity using an internal accelerometer. While polysomnography is the gold standard for objective sleep measurement, actigraphs offer the advantage of being non-

invasive, and allow measurements to be conducted in a natural environment (i.e., participants' homes). Research has shown a 93% concordance rate between polysomnography and actigraphy (Iwata et al., 2015). Participants wore actigraphs on their non-dominant hand continuously for 7 days, except during bathing or swimming. In addition to wearing the actigraph, participants were also required to complete a sleep diary, to aid in interpretation of the actigraphy data (Carney et al., 2012). If anomalies occurred in the actigraphy data, then the sleep diary was used to supplement missing or anomalous information. Four parameters from the actigraph were collected: Total sleep time (TST), sleep efficiency (SE), number of awakenings, and wake after sleep onset (WASO). TST is the total amount of sleep measured in minutes during the recording period from sleep onset to sleep offset (Shrivastava et al., 2014). SE is measured as the total amount of sleep divided by the total amount of time spent in bed, and often defined as a percentage (Shrivastava et al., 2014). WASO is defined as the wakefulness that occurs after sleep onset, and is often measured in minutes (Shrivastava et al., 2014).

The ISI and actigraphy were collected at baseline (third trimester of pregnancy) and at 2, 4, 8, and 12 weeks postpartum. The primary end point was taken at two weeks postpartum as sleep is most disturbed during the first two weeks postpartum (Sharma & Mazmanian, 2003; Tomfohr et al., 2015). Second, in a review by Owais et al. (2018), the authors found that non-pharmacological sleep interventions had the greatest effect size when they were administered zero to three weeks postpartum (Owais et al., 2018).

Anxiety was assessed using the State-Trait Anxiety Inventory (STAI) (Speilberger et al., 1983), a 40-item self-report questionnaire which assesses present ("state") and stable, long-term ("trait") anxiety in participants. Participants rate each item on a 4-point

Likert scale ranging from "*Not at all/Almost never*" to "*Very much so/Almost always*". A total range of 40-160 is possible, with each subscale ranging from 20-80. Meades and Ayers (2011) conducted a systematic review of validation studies using the STAI in perinatal populations. The results suggest that clinical cut-offs at 40 (for each subscale) and 80 (total) should be used to screen for perinatal anxiety (Meades & Ayers, 2011). The STAI was chosen as it has excellent internal consistency for both the state and trait scale (Cronbach's α = 0.91-0.96) and has good predictive and discriminant validity to screen for perinatal anxiety (Meades & Ayers, 2011). The STAI was administered at baseline (third trimester of pregnancy) and at 2, 4, 8, 12, and 24 weeks postpartum. The primary end point was taken at eight weeks postpartum as six to eight weeks postpartum is a recommended screening window for perinatal anxiety (Misri, Abizadeh, Sanders, & Swift, 2015).

Exclusive breastfeeding (EBF) is defined as the infant's ingestion of only the mother's breast milk, precluding any milk powdered supplements or semi-solid foods. The World Health Organization recommends EBF for six months as breastfeeding provides several short-term and long-term health benefits for mothers and infants. Using a measure developed by Crume et al. (2011), women were asked about their infant feeding patterns (i.e., EBF, supplementation with formula, or exclusive-formula feeding) at 2, 4, 8, 12, and 24 weeks postpartum (Crume et al., 2011). This measure was used as it took into account both duration and exclusivity of breastfeeding (Crume et al., 2011). Since the intention to breastfeed is one of the strongest predictors of breastfeeding initiation and continuation, the Infant Feeding Intentions Scale (IFIS) was administered in the third trimester (Meedya, Fahy, & Kable, 2010; Nommsen-rivers &

Dewey, 2009) which is a 5-item self-report questionnaire which assesses the mother's intention to initiate breastfeeding and continue EBF at four, 12, and 24 weeks postpartum. Items are scored on a 5-point Likert scale ranging from "*Very much disagree*" to "*Very much agree*". A score < 8 indicates low intentions to breastfeed.

Covariates/Confounders

Participants were surveyed regarding avoidant tendencies using the Cognitive Behavioral Avoidance Scale (CBAS) (Ottenbreit & Dobson, 2004) in the third trimester of their pregnancy. The CBAS is a 31-item self-report questionnaire which assesses cognitive, behavioral, social, and non-social aspects of avoidance. Items are rated on a 5-point Likert scale ranging from "*Not at all true for me*" to "*Extremely true for me*" where higher scores indicate greater avoidant tendencies. The greater the score, the greater the avoidant tendencies. The CBAS was administered at the baseline visit only to determine if avoidant tendencies were associated with depression at 12 weeks postpartum, anxiety symptoms at eight weeks postpartum, or sleep quality at two weeks postpartum.

Childhood trauma was measured using the Childhood Trauma Questionnaire-Short Form (CTQ) (Bernstein, Stein, Newcomb, Walker, & Pogge, 2003). The CTQ is a 28-item self-report questionnaire which retrospectively assesses childhood trauma, including physical, sexual and emotional abuse, and physical and emotional neglect. Items are scored on a 5-point Likert scale ranging from "*Never true*" to "*Very often true*", with total scores ranging from 28-140. A score ≥ 6, depending on the subscale, is indicative of significant childhood trauma. In a community sample, the test-re-test

reliability of the CTQ has been show to be very good (0.79 to 0.86) and the internal consistency is acceptable to excellent, depending on the subscale tested (Cronbach's α = 0.66-0.92) (Scher, Stein, Asmundson, McCreary, & Forde, 2001). CTQ scores were taken as a continuous variable, with greater scores being more indicative of abuse and/or neglect (Bernstein et al., 2003). The CTQ was administered during the baseline visit to determine if childhood trauma was associated with depression at 12 weeks postpartum, anxiety at eight weeks postpartum, or sleep quality at two weeks postpartum.

Procedure

Participants, who consented to be contacted and were deemed eligible through an initial telephone screening were administered the EPDS, STAI, ISI, CTQ, IFIS, CBAS, and demographic information (including age, race, marital status, employment, household income, parity, and current medications) during the third trimester of their pregnancy. Psychiatric diagnoses were taken from the participant's medical chart. Presence of a sleep disorder was screened using the BRIAN Validation Tool, which assesses sleep disorders using criteria from the DSM-IV. Participants were also given instructions on how to wear and use the actigraph. They were instructed to wear it for 7 days continuously, from the initial meeting.

Participants were contacted one week prior to their expected delivery date, to determine if they had delivered earlier than expected. Once the actual delivery date was determined, the postpartum time points were appropriately aligned. For instance, at one week postpartum, participants were asked to complete a post-delivery questionnaire

(PDQ) to determine whether the in-hospital guidelines were used, and which features were used (i.e., 3-day post-natal hospital stay, private hospital room, overnight infant rooming-out, and lorazepam use). Participants completed the EPDS, STAI, ISI, actigraphy, and breastfeeding duration, at two weeks postpartum, the EPDS, STAI, ISI, actigraphy, and breastfeeding duration at four weeks, eight weeks, and 12 weeks postpartum. At 24 weeks postpartum, participants completed the EPDS, STAI, and breastfeeding duration. Participants were e-mailed questionnaires through REDCap, a secure web application for managing online surveys, at the appropriate postpartum time points. Actigraphs were either dropped off with the participants, or mailed to the participant's house.

Statistical Analyses

All analyses were completed using R 3.4.2 Software (R Development Core Team). Categorical data were analyzed through Chi-square tests. Normality of continuous data and homogeneity of variances were determined through Shapiro-Wilk test and Bartlett's test, respectfully. If data were parametric, then unpaired t-tests were used to determine any significant differences between the TAU and IHG group at the primary end point. If data were non-parametric, then Mann-Whitney U tests were used to determine differences between the two groups at a single end point. Missing continuous data was handled through multivariate imputation by chained equations method, using R 3.4.2 software. Specifically, predictive mean matching was used as this method is preferred if data is non-parametric. Conditions for imputation required the continuous data to be missing completely at random, meaning it had no relation to the observed/collected data (Bhaskaran & Smeeth, 2014).

Multivariate linear regressions were conducted to determine the association of group assignment to the primary (depression) and secondary (sleep and anxiety) objectives, while controlling for potential confounders. Criteria for conducting multivariate linear regressions (linearity, independence, normality, and homoscedasticity) were confirmed using R 3.4.2 software. If outliers were detected, they were removed to meet the assumptions for conducting multivariate linear regressions. Variance-inflation factors were calculated to determine if multicollinearity existed between the predictors. Statistical significance for all tests was taken at a *p*-value of 0.05.

	Third Trimester	PP Wk1	PP Wk2	PP Wk4	PP Wk8	PP Wk12	PP Wk24
Disorder Diagnoses	✓						
BRIAN Tool	✓						
DI	✓						
CTQ	✓						
IFIS	✓						
CBAS	✓						
PDQ		✓					
Breastfeeding duration			✓	✓	✓	✓	✓
EPDS	✓		✓	✓	✓	✓	✓
STAI	✓		✓	✓	✓	✓	✓
ISI	✓		✓	✓	✓	✓	
Sleep Diary	✓		✓	✓	✓	✓	
Actigraphy	✓		✓	✓	✓	✓	

Table 1. Time line of administration of self report and actigraphy measurements from the third trimester of pregnancy to postpartum (PP) week (Wk) 24. The checks indicate that the measure was administered at that given time point whereas the shaded areas indicate the measure was not administered at that time point.

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CHAPTER 4 – RESULTS

Demographic and Baseline Clinical Information

In total, 42 participants were recruited from the Women's Health Concerns Clinic. However, one participant delivered her baby without completing the baseline visit, and therefore, was excluded from subsequent analyses, with the exception of the age calculation. Thus, a total of 41 participants (12 in the IHG group, and 29 in the TAU group) were included in our study. All 41 women, with the exception of one participant, were diagnosed with a lifetime or current mood and/or anxiety disorder with personality disorders and lifetime substance use problems sometimes also being present. The most common mood disorder was major depressive disorder (MDD) (61% of participants) followed by persistent depressive disorder (PDD) (12% of participants). The most common anxiety disorder was generalized anxiety disorder (GAD) (44% of participants) followed by social anxiety (17% of participants). In all, 78% of our participants had comorbid mood, anxiety, or lifetime history of substance abuse or personality disorders (Please see Table 2).

Overall, the mean age of participants was 31 years (*SD*=5.13). The average age of participants in the IHG group was 29.58 years (*SD*=6.52) and for the TAU was 31.56 years (*SD*=4.46). Unpaired t-tests revealed that there were no significant differences in ages between the two groups (p=0.263). Further, there were no significant differences between the IHG and TAU groups on race, marital status, parity, educational attainment, and income level (Please see Table 3). The majority of our sample was Caucasian (76%), married (88%), and were having at least their second child (59%).

Most did not hold a university degree (51%), and had a combined household income level under $100,000 (59%).

There were no significant differences between the TAU and IHG on infant feeding intentions (p=0.861), avoidant tendencies (p=0.689), or childhood trauma (p=0.741) at baseline. Further, there were no significant differences between the two groups in EPDS (p=0.563), ISI (p=0.427), TST (p=0.396), SE (p=0.639), WASO (p=0.262), number of awakenings (p=0.988), or STAI (p=0.756) scores at baseline. Table 3 outlines participant demographic variables and other data collected during the baseline visit.

Utilization of Intervention Features by IHG and TAU Groups

Nine out of 12 women in the IHG group and 29 women in the TAU group indicated which features they used during their post-delivery hospital stay. Since this was a naturalistic study design, participants receiving the intervention were able to opt-out of any intervention feature. By the same token, some women in the TAU group may have received a private hospital room through their private insurance, or elected to room their baby in the nursery, regardless of whether they formally received the intervention or not. Unsurprisingly, women in the IHG group received the intervention features at higher rates than women in the TAU group, however this was not statistically significant. Specifically, 55% of women in the IHG group stayed 3 days or longer for their post-delivery hospital stay whereas 48% of women in the control group had a 3-day post-natal hospital stay or longer (p=0.475). For anxiolytic medication use, 33% of women in the IHG utilized this feature, compared to 24% in the TAU group (p=0.206).

Almost 56% of women in the IHG group practiced overnight rooming-out of their baby while only 24% of women in the TAU utilized this feature (p=0.564). Finally, 100% of women in the IHG group used a private hospital room for their post-delivery stay, compared with 62% of women in the TAU group (p=0.083). Therefore, regardless of receiving the guidelines or not, women in the TAU and IHG group utilized the intervention features to the same degree. Utilization of intervention features is shown in Figure 1.

Primary Outcome

Depression

Our primary objective was to determine if there was a clinically significant decrease in EPDS scores from baseline to postpartum week 12 in the IHG group. The IHG group decreased by 1.17 points whereas the TAU group decreased by 3.62 points. Further, postpartum week 12 EPDS scores were compared between the TAU and IHG groups. There were no significant differences in depressive symptomatology in women in the TAU and IHG group at baseline (p=0.563) or at postpartum week 12 (p=0.397). Table 4 and Figure 2 outline the results between the two groups across time. Multivariate linear regressions were conducted to determine the association of group assignment to postpartum week 12 scores, controlling for potential confounders. Belonging to the IHG group was not significantly associated with postpartum week 12 EPDS scores, controlling for baseline EPDS scores (β=2.60, p=0.107). When adding CBAS and CTQ scores as potential confounders, in addition to baseline EPDS scores,

the association between IHG group assignment and postpartum week 12 EPDS scores approached significance (β=3.06, *p*=0.077).

Secondary Outcomes

Subjective Sleep

Subjective sleep was assessed from the third trimester of pregnancy to postpartum week 12. The IHG group met the clinical cut-off for moderate insomnia (*M*=15.67, *SD*=6.99) while the TAU group approached the cut-off (*M*=13.79, *SD*=6.71) at baseline. There were no significant differences in subjective sleep quality at postpartum week two between the TAU and the IHG groups (*p*=0.741). Belonging to the IHG group was not significantly associated with postpartum week two ISI scores, controlling for baseline ISI scores (β=-1.20, *p*=0.459). When adding CBAS and CTQ scores as potential confounders, in addition to baseline ISI scores, the association between IHG group assignment and postpartum week two ISI scores remained statistically not significant (β=-0.969, *p*=0.553).

Objective Sleep

There were no significant differences between the two groups in WASO (*p*=0.777), TST (*p*=0.122), SE (*p*=0.076), or number of awakenings (*p*=0.505) at postpartum week two, as indicated in Table 4. One assumption for conducting linear regressions (linearity) was not met for TST and SE. Instead, changes in these two parameters from baseline to postpartum week 2 were calculated and analyzed. There were no significant differences between the two groups in TST (*p*=0.395) or SE

(p=0.193) when looking at change in these parameters from baseline to postpartum week two.

Belonging to the IHG group was not significantly associated with postpartum week two WASO, controlling for WASO at baseline (β=0.64, p=0.952). When adding CBAS and CTQ scores as potential confounders, in addition to baseline WASO, the association between IHG group assignment and postpartum week two WASO remained statistically not significant (β=0.56, p=0.958). Similarly, belonging to the IHG group was not significantly associated with postpartum week two number of awakenings, controlling for baseline number of awakenings (β=-0.83, p=0.534). When adding CBAS and CTQ scores as potential confounders, in addition to baseline number of awakenings, the association between IHG group assignment and postpartum week two awakenings remained statistically not significant (β=-0.93, p=0.493).

Anxiety

There were no significant differences in anxiety scores at postpartum week 8 between the TAU and IHG groups (p=0.807). Belonging to the IHG group was not significantly associated with postpartum week eight STAI scores, controlling for baseline STAI scores (β=-1.85, p=0.772). When adding CBAS and CTQ scores as potential confounders, in addition to baseline STAI scores, the association between IHG group assignment and postpartum week 8 scores was still not statistically significant (β=-3.52, p=0.533).

Breastfeeding

Another secondary outcome was to compare EBF rates at 24 weeks postpartum between the TAU and IHG groups. Of our 42 participants, only 24 completed questionnaires for the postpartum week 24 time point. Chi-square analyses revealed that there was no difference in the frequency of women exclusively breastfeeding from postpartum week two to postpartum week 24 (p=0.130) between the two groups. Figure 4 represents the percentage of women who exclusively breastfed from postpartum week two to postpartum week 24.

	TAU (n=29)	IHG (n=12)	p-value
Mood Disorders (%)			p=0.698[a]
MDD	16 (55.2%)	9 (75.0%)	
PDD	2 (6.90%)	3 (25.0%)	
BPDI	1 (3.4%)	0 (0%)	
BPDII	2 (6.9%)	2 (16.7%)	
SAD	2 (6.9%)	0 (0%)	
Unspecified depression	1 (3.4%)	0 (0%)	
Anxiety Disorders (%)			p=0.168[a]
GAD	15 (51.7%)	3 (25.0%)	
Social	6 (20.7%)	1 (8.3%)	
OCD	5 (17.0%)	1 (8.3%)	
PTSD	3 (10.3%)	2 (16.6%)	
Panic	2 (6.9%)	0 (0%)	
Anxious distress	3 (10.3%)	5 (33.3%)	
Comorbidities (%)	21 (72.4%)	11 (91.7%)	p=0.077[b]

Table 2. Diagnoses of women in the TAU (n=29) and IHG (n=12) groups. [a]Fischer's test were performed as frequency of cells were <5. [b]Chi-square analyses were performed as frequency of cells were >5. There were no significant differences in the presence of mood disorders, anxiety disorders, or comorbidities across the TAU and IHG groups.

	TAU (n=29)	IHG (n=12)	p-value
Age (SD)*	31.56 (4.46)	29.58 (SD=6.52)	t=0.97, p=0.348
Race (%)			χ^2=5.48, p=0.241
Black	0 (0%)	2 (17%)	
Caucasian	23 (79%)	8 (67%)	
East Asian	1 (4%)	0 (0%)	
Middle Eastern	3 (10%)	1 (8%)	
Mixed	2 (7%)	1 (8%)	
Marital Status (%)			χ^2=3.56, p=0.168
Married/Co-habiting	27 (93%)	9 (75%)	
Separated	0 (0%)	1 (8%)	
Single	2 (7%)	2 (17%)	
Education (%)			χ^2=1.96, p=0.580
University+	16 (55%)	4 (33%)	
College	9 (31%)	5 (42%)	
High School	2 (7%)	1 (8%)	
Less than high school	2 (7%)	2 (17%)	
Income^ (%)			χ^2=4.23, p=0.375
0-24,999	3 (11%)	3 (25%)	
25,000-34,999	5 (18%)	2 (17%)	
35,000-49,999	0 (0%)	0 (0%)	
50,000-74,999	6 (21%)	1 (8%)	
75,000-100,000	1 (4%)	2 (17%)	
100,000+	13 (46%)	4 (33%)	
Parity (%)			χ^2=0.46, p=0.497
Nulliparous	13 (45%)	4 (33%)	
Primiparous+	16 (55%)	8 (67%)	
Outcomes at Baseline			
IFIS mean (SD)	12.69 (4.04)	11.54 (5.33)	W=180.5, p=0.861
CBAS mean (SD)	69.83 (24.85)	66.67 (16.55)	t=0.40, p=0.689
CTQ^ mean (SD)	53.48 (19.30)	57.09 (25.49)	t=-0.33, p=0.741
EPDS mean (SD)	12.65 (4.83)	11.50 (7.68)	t=0.58, p=0.563
ISI mean (SD)	13.79 (6.72)	15.67 (6.98)	t=-0.80, p=0.426
TST mins (SD)	397.63 (76.46)	387.70 (57.10)	W=188, p=0.396
SE % (SD)	80.12 (13.35)	80.19 (7.61)	W=175.5, p=0.639
WASO mins (SD)	54.20 (17.01)	62.96 (18.06)	W=122, p=0.262
No. of awakenings (SD)	21.87 (6.65)	21.74 (4.78)	W=160.5, p=0.988
STAI mean (SD)	91.86 (17.88)	89.67 (25.86)	t=0.31, p=0.756

Table 3. Baseline sociodemographic characteristics of women in TAU and IHG groups. Participants did not significantly differ on any sociodemographic parameter or on the primary or secondary outcomes assessed at baseline.

*TAU (n=30), IHG (n=12)
^TAU (n=28), IHG (n=12)

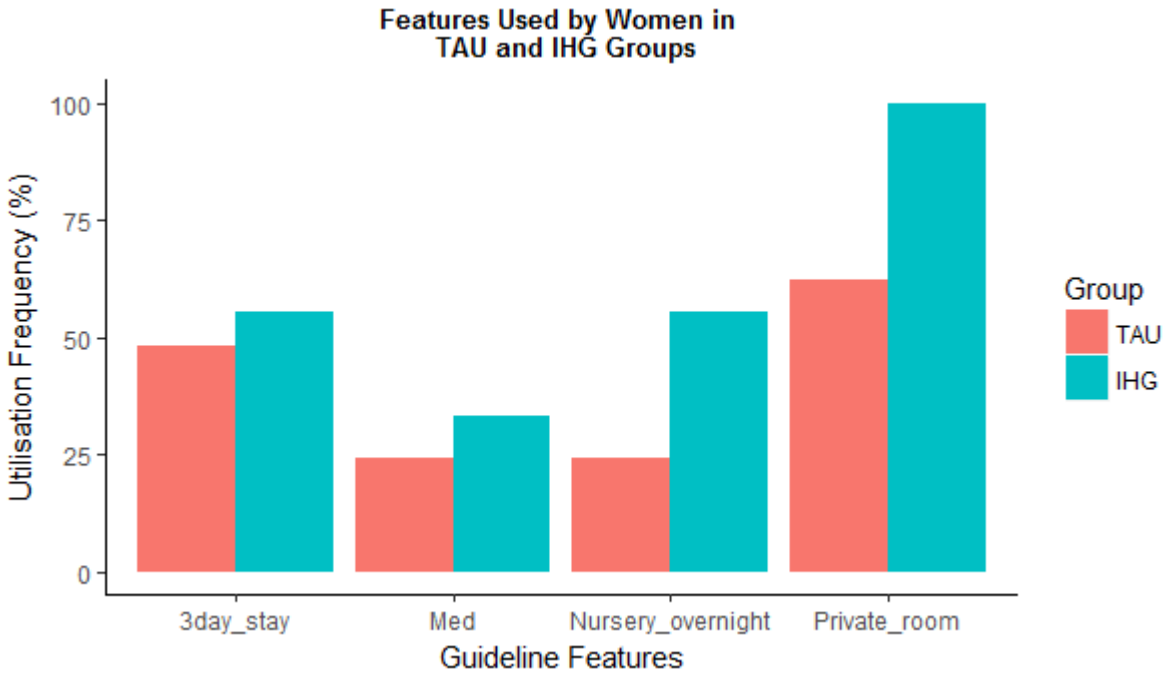

Figure 1. Features of participants' post-delivery hospital stay for TAU and IHG groups. Chi-square analyses revealed there were no significant differences in intervention utilization between the two groups ($p>0.05$).

Outcome mean (SD)	TAU (n=29)	IHG (n=12)	Time point	p-value
EPDS	9.03 (5.47)	10.33 (4.48)	PP Wk12	W=144, p=0.397
ISI	13.28 (3.96)	12.92 (6.50)	PP Wk2	W=162, p=0.741
WASO^	76.19 mins (30.52)	73.30 mins (22.51)	PP Wk2	t=0.28, p=0.777
TST^	404.97 mins (61.06)	365.59 mins (64.73)	PP Wk2	W=211, p=0.122
SE^	81.13% (6.67)	77.01% (7.47)	PP Wk2	W=218.5, p=0.076
No. of awakenings^	20.29 (4.06)	18.46 (4.29)	PP Wk2	W=182, p=0.505
STAI	86.03 (18.26)	83.50 (21.79)	PP Wk8	W=183, p=0.807
EBF at 24 weeks postpartum, n (%)*	5 (31.25%)	4 (44.44%)	PP Wk24	χ^2=2.30, p=0.130

Table 4. Means and standard deviations of primary and secondary outcomes at their respective postpartum (PP) time points. Depression, subjective and objective sleep quality, and anxiety did not differ between the TAU and IHG groups at their respective time points, as assessed through unpaired t-tests (parametric data) or Mann-Whitney U test (non-parametric data).
^Only 11, instead of 12, participants in the IHG group had usable actigraphy data for measuring WASO, TST, SE, and number of awakenings.
*Only 16 women from the TAU group and 9 women from the IHG group reached PP Wk 24.

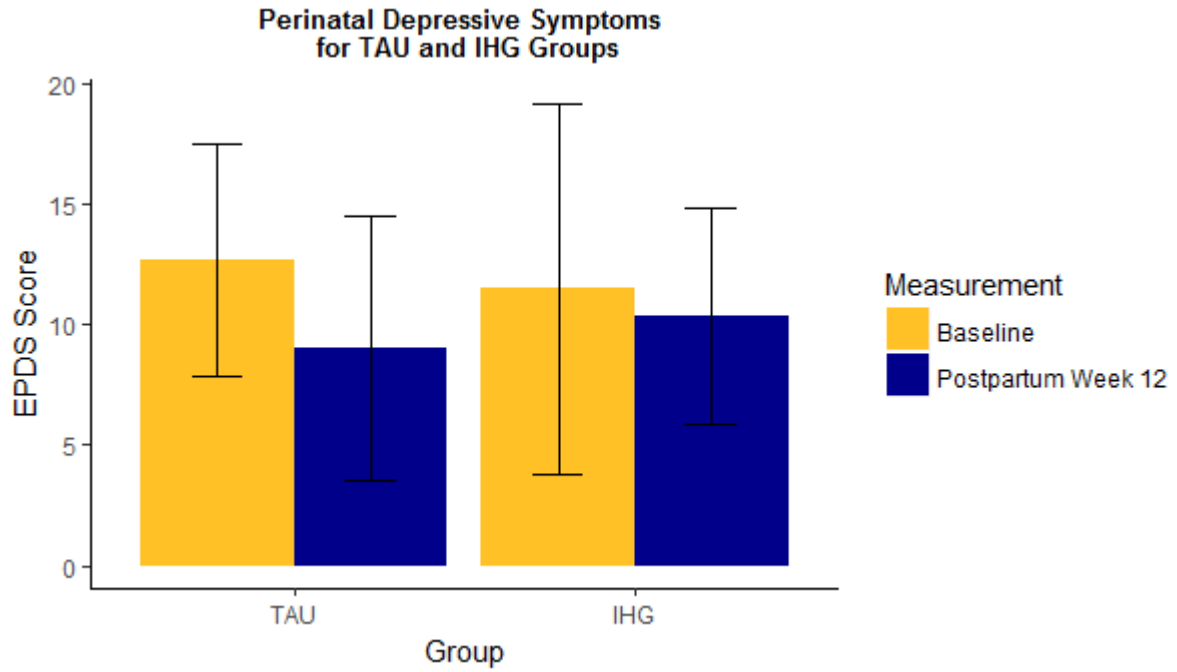

Figure 2. EPDS scores of TAU and IHG groups at the third trimester of pregnancy (baseline) and postpartum week 12. Mann-Whitney U test revealed that there was no significant differences in EPDS scores between the two groups at 12 weeks postpartum (*p*=0.397)

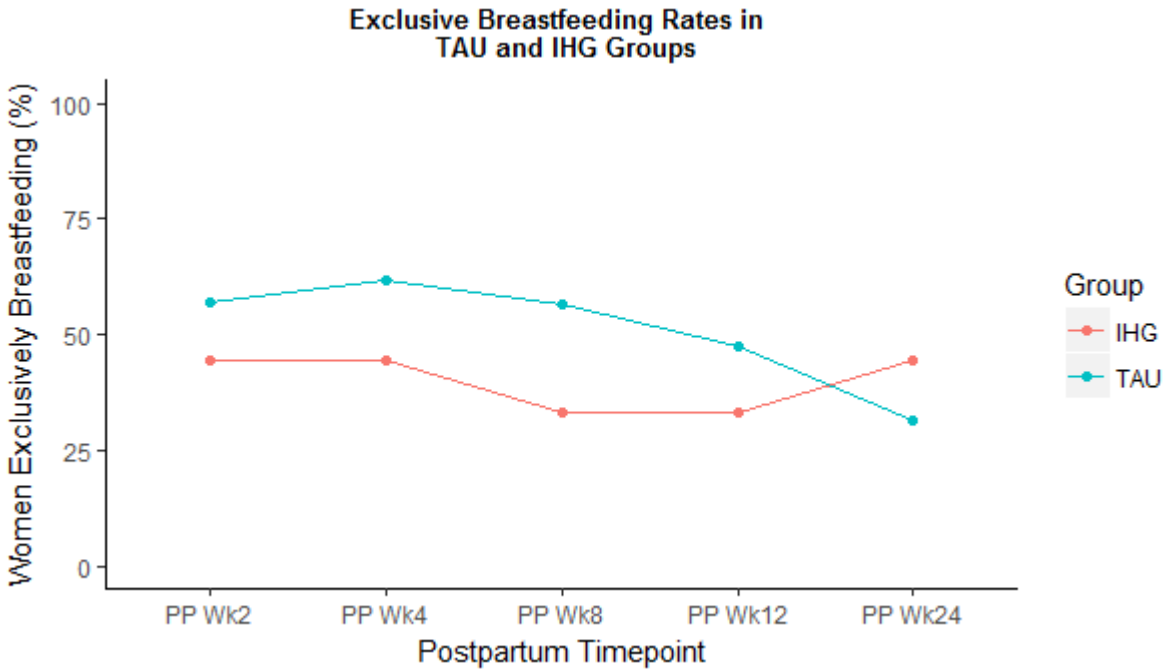

Figure 3. Exclusive breastfeeding rates for TAU and IHG groups from postpartum week 2 to postpartum week 24. Chi-square analyses revealed no significant differences in EBF rates between the TAU (n=16) and IHG (n=9) groups at PP Wk24 (p=0.130).

CHAPTER 5 – DISCUSSION

General Discussion

This prospective cohort study followed 41 women, 12 of which received an in-hospital sleep protection intervention, from the third trimester of their pregnancy to 24 weeks postpartum. The primary objective was to determine if there was a 4-point or more decrease in EPDS scores from baseline to postpartum week 12 for the intervention group. There were no clinically meaningful decreases of ≥ 4 points or statistically significant differences in EPDS scores between the two groups at 12 weeks postpartum. There were no statistically significant differences between the TAU and IHG groups in ISI scores, WASO, TST, SE, and number of awakenings at two weeks postpartum. Further, there were no significant differences in STAI scores at eight weeks postpartum. Lastly, we found no significant differences in EBF rates between the TAU and IHG at postpartum week 24.

Given the strong and robust link between poor postpartum sleep quality and depression, it was surprising that the sleep intervention did not decrease depressive symptomatology (our primary outcome) or have any significant impact on our other secondary outcomes. In addition to the possibility that this intervention may not have had an impact on the aforementioned outcomes, there may be several other reasons for these null results.

First, floor effects occur when the majority of participants score at or near the bottom limit of a measure. A score of 0-30 is possible on the EPDS, with clinical cut-offs of 15 during pregnancy and 13 during postpartum being indicative of major depression

(Matthey et al., 2006). In comparison, study participants had a score of 12.31 during the third trimester of their pregnancy and 9.41 at 12 weeks postpartum. Therefore, women were already experiencing low severity of depression and any improvements in their symptomatology may not have been clinically significant.

Second, over 75% of our participants were taking some form of psychiatric treatment during their enrollment in our study. Due to the combined effects of psychiatric medication, sleep hygiene techniques, cognitive behavioural therapy for anxiety and/or depression, and continued clinical care from their psychiatrists, the effects of the in-hospital sleep intervention on depression may have been less than would be expected in untreated women not receiving specialized perinatal mental health services.

Third, given the naturalistic design of the research study, participants did not have to accept or adhere to any or all of the intervention features. In fact, there was no significant difference in the use of the intervention features between women in the comparison or intervention group. In essence, participants from both groups used features of the sleep intervention to the same degree. This fact, partnered with already low severity of mood symptoms and their concurrent treatment at a speciality clinic, may explain why the intervention did not have a significant impact on the primary or secondary outcomes.

Fourth, this study suffered from low power. The lower the statistical power, the greater the risk of making a Type II error, where one concludes there is no effect when in fact there is one present. Based on the pilot study of this intervention by Steiner et al.

(2001; unpublished data), setting the statistical significance at 0.05 and power at 80%, 78 women were required in each group to detect clinically meaningful differences on our primary outcome. Anticipating a 20% attrition rate, we aimed to recruit 200 women. With only 41 women in our study, we may not have had enough power to detect clinically meaningful differences on our outcomes. Indeed, we conducted a post-hoc power analysis with an effect size of 0.238 (calculated from our primary EPDS endpoint) and found that our power was only 10%.

Fifth, 78% of participants had a comorbid mood, anxiety, personality, or substance abuse disorder. Research suggests that women with mental health comorbidities are more resistant to receive treatment, or require more frequent and rigorous treatment than postpartum women with a single mental health diagnosis (Grote et al., 2016; Misri & Swift, 2015). Therefore, our short 3-day intervention may not have been intense enough to significantly improve their postpartum mood and sleep quality.

Sixth, we included women of varying parity. Evidence suggests that multiparas have less disturbed sleep quality in the early postpartum period as compared to their nulliparous counterparts (Dørheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009; Signal et al., 2007). For instance, researchers measured objective sleep quality of 8 nulliparas and 11 multiparas from the second trimester of pregnancy to six weeks postpartum and found that nulliparas spent less time in bed, had poorer sleep efficiency, and fewer sleep periods in a 24-hour period, as compared to multiparas (Signal et al., 2007). In a retrospective cohort study (n=2830), researchers reported an association between being primiparous with poor postpartum global sleep quality (AOR 1.7, 95% CI 1.4-2.0) (Dørheim et al., 2009). By combining nulliparous, primiparous, and multiparous women

in our analyses, we may have washed out any potential interactions. Low power and sample size precluded us from separating these women and analyzing their sleep outcomes separately.

Seventh, women in our sampled ranged from exclusive breastfeeding, mixed-feeding, or exclusive formula feeding. The notion that formula satiates infants to a greater degree than breastmilk has been long-held advice, especially for new mothers or those vulnerable to poor sleep quality, to supplement their feedings with infant formula (Hughes et al., 2018; Tobback et al., 2017). Despite this adage, clinical evidence suggests the opposite: women who exclusively breastfeed have less disturbed sleep quality than those who exclusively formula feed (Doan, Gay, Kennedy, Newman, & Lee, 2014; Hughes et al., 2018; Tobback et al., 2017). Specifically, Hughes et al. (2018) collected subjective sleep quality of 30 nulliparous women for 48 hours following delivery. They found that women who exclusively breastfed had almost 3 hours greater total sleep time than women who exclusively formula fed (Hughes et al., 2018). Doan et al. (2014) used objective measurements (i.e., actigraphy) to demonstrate that women who exclusively breastfed had greater total and nocturnal sleep time at one month postpartum, as compared to women who formula fed (Doan et al., 2014). Finally, Tobback et al. (2017) found that women who exclusively breastfed (n=61) had greater subjective sleep quality than women who formula fed (n=44) (Tobback et al., 2017). Overall, the current evidence suggests that feeding method may, in part, affect sleep quality. Future studies, with enough statistical power, should consider conducting separate analyses for different infant feeding methods.

Finally, we found that there were no significant changes in anxiety at postpartum week eight between the TAU and IHG groups. Typically, anxiety tends to decrease from pregnancy to the postpartum period (Agrati et al., 2015). The relationship between poor sleep quality and postpartum anxiety is not as consistent as PPD and sleep quality (Lawson et al., 2015). For instance, Calcagni et al. (2012) conducted a prospective cohort study with nulliparas (n=28) and multiparas (n=26) from the third trimester of pregnancy to postpartum week two (Calcagni, Bei, Milgrom, & Trinder, 2012). The researchers found that poor subjective sleep quality was associated with postpartum anxiety, for nulliparous women only. In a cross-sectional study, researchers found that subjective sleep quality and perinatal anxiety had small correlations of 0.20 and 0.12 during pregnancy and postpartum, respectively, as compared to subjective sleep quality and depression (0.15 and 0.37 for pregnancy and the postpartum period, respectfully) (Swanson, Pickett, Flynn, & Armitage, 2011). Further, women meeting the clinical cut-off of moderate insomnia on the ISI had an increased risk of experiencing depression (OR 7.70, 95% CI 3.76-15.78) and anxiety (OR 2.55, 95% CI 1.39-4.69) (Swanson et al., 2011). Due to the lack of studies reporting robust and significant associations between poor postpartum sleep quality and anxiety, it follows that we did not see any significant differences in anxiety with our small sample size.

Strengths

There were a few strengths associated with this study. First, both subjective and objective (i.e., actigraphy) measures of sleep quality were used in this prospective cohort study. Current evidence suggests that while there is an association between subjective sleep quality and depressive symptoms, the evidence is less robust for

objective sleep quality and depressive symptoms (Coo et al., 2014; Lee, McEnany, & Zaffke, 2000; Okun et al., 2013). For instance, Coo et al. (2014) followed 29 healthy, pregnant women from the third trimester of their pregnancy to 12 weeks postpartum and found subjective sleep quality, not objective sleep quality (i.e., actigraphy) predicted PPD (R^2 = .43) and anxiety (R^2 = .51) scores, (Coo et al., 2014). Similarly, another study with 160 healthy pregnant women found that depressive symptoms in the first trimester were associated with subjective, but not objective (i.e., actigraphy), measures of sleep quality (Okun et al., 2013). However, one study found that decreased REM onset latency, as measured through polysomnography, of 31 women at one month postpartum was associated with negative mood (K. A. Lee et al., 2000). These inconsistent findings may be attributed to methodological differences such as length of recording, different measurements (e.g., actigraphy vs. polysomnography), or the sampling frame. Therefore, our study contributes to current literature by providing both subjective and objective measurements of sleep quality.

Second, participants were diagnosed with a mood and/or anxiety disorders through clinical interviews with their psychiatrist. Owais et al. (2018) found in their systematic review and meta-analysis that of the six non-pharmacological sleep intervention studies which included women with psychiatric disorders, none used the gold standard of diagnostic interviewing to diagnose these disorders (Owais et al., 2018). By standardizing this diagnostic method, this study was able to reduce random error from observer variability (Hulley et al., 2013).

Third, our multi-component intervention was designed based on patient preference. Specifically, clinician-scientists at the Women's Health Concerns Clinic

noticed that their postpartum patients with mood and/or anxiety disorders chief complaint was lack of sleep or disturbed sleep quality. Building off this anecdotal evidence, the in-hospital guidelines were designed for women vulnerable to experiencing a postpartum episode. Due to overwhelming positive feedback from its users, the in-hospital guidelines have since been implemented in 11 facilities across Southwestern Ontario, Canada, since its birth nearly two decades ago. Other sleep-focused interventions have been less rigorous in their research design and plan. For instance, Owais et al. (2018) conducted a systematic review and meta-analysis of 15 maternal-based, sleep-focused interventions delivered during the postpartum period. They found that nine of the 15 studies had a high risk of bias, as assessed by the Cochrane's collaboration tool for assessing risk of bias or The Newcastle-Ottawa scale. Further, five of the 15 studies were beverage or aromatherapy interventions which had very little experimental evidence to suggest these interventions may be effective in aiding sleep in the postpartum population (Chang & Chen, 2016; Chen & Chen, 2015; Keshavarz Afshar et al., 2015; Mirghafourvand, Charandabi, Hakimi, Khodaie, & Galeshi, 2016; Lee 2004). Given that our multi-component intervention was constructed based on both clinical experience and research rigour, it can contribute to perinatal clinical practice.

Limitations

There were several limitations associated with this study. First, a naturalistic observational design was employed for this study. In doing so, participants were not randomized to the IHG or TAU group, which may have resulted in selection bias. Despite there being no significant differences in baseline mood, sleep, or anxiety,

among other factors, women, and the clinical care they received, may have differed across groups. Additionally, over 75% of our participants were taking some sort of pharmacological or non-pharmacological therapy during their enrollment in our study. Due to these confounding factors, in part, may explain the null results seen in this study, and other naturalistic design studies (Velentgas, Dreyer, Nourjah, Smith, & Torchia, 2013).Further, there is inherently low internal validity with naturalistic design studies due to the many confounding variables that can only be controlled in post-hoc analyses.

Second, this study had a very small sample size and therefore may not have been adequately powered to detect clinically meaningful differences between the IHG (n=12) and TAU (n=29) group. Indeed, in a post-hoc power analysis, this study had a power of 10%.

Third, this study had a limited sampling frame. Specifically, women with lifetime or current mood and/or anxiety disorders were recruited from a speciality women's mental health research clinic. In addition to receiving concurrent therapies (e.g., sleep hygiene techniques, prenatal or postnatal cognitive behavioural therapy for anxiety and/or depression etc.), our participants came largely from affluent areas. As a result, our interpretation is limited to women receiving care in resource-rich areas with perinatal mental health services readily available.

Future Directions

Our study demonstrated that there were no statistically significant differences in postpartum depressive symptomatology in the intervention and comparison group. Explanations included floor effects, concurrent therapies being taken by our

participants, and the abundant resources offered to patients of the Women's Health Concerns Clinic and the greater Hamilton, ON area. Despite this intervention being delivered across 11 facilities across Southwestern Ontario, we only investigated the impact of this intervention in two facilities (McMaster Children's Hospital and St. Joseph's Healthcare Hamilton – Charlton Campus). Future research should explore the impact and potential differences in adherence to the intervention guidelines across the 11 sites. By the same token, it is important to explore whether this intervention is effective in resource-poor areas. Indeed, PPD rates are higher in impoverished settings, as compared to areas of higher socioeconomic status (Trabold, Waldrop, Nochajski, & Cerulli, 2013). It may be of value to offer this intervention in resource-poor areas, where perinatal women at risk of developing PPD may not have access to psychiatric or psychotherapeutic care. Third, future studies investigating the association of poor postpartum sleep quality and maternal depression should control for parity, breastfeeding status, and explore differences between participants recruited from tertiary care centres vs. the community. Finally, future research should focus on conducting adequately powered randomized controlled trials with placebo or active control groups given the superiority of experimental designs in terms of minimizing risk of bias. Randomized controlled trials comparing different intervention types would be of particular interest to women and their care providers.

Conclusion

In this prospective naturalistic cohort study, we examined the impact of an in-hospital sleep protection intervention for improving postpartum maternal mental health. We found no significant differences in depressive symptomatology between the

comparison and intervention groups at postpartum week 12. Further, there were no significant differences in both subjective and objective sleep quality at two weeks postpartum, or postpartum anxiety at eight weeks postpartum between the TAU and IHG groups. Reasons for the IHG group not showing significant differences against the TAU group include our intervention being delivered in a resource-rich area, our participants receiving concurrent therapies and treatment, and our small sample size. Future studies should investigate the efficacy of this intervention in a resource-poor area, determine if results differ between nulliparas and multiparas, and conduct studies of higher methodological quality (i.e., randomized controlled trial) to fully ascertain the impact of this intervention.

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