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Post-Partum Sleep and Breastfeeding Outcomes Among First-Time Mothers of Full-Term Newborns

Joanna Carrega

ACCEPTANCE

This dissertation, POSTPARTUM SLEEP AND BREASTFEEDING OUTCOMES AMONG FIRST-TIME MOTHERS OF FULL-TERM NEWBORNS, by Joanna K. Carrega, was prepared under the direction of the candidate's dissertation committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Nursing in the School of Nursing in the Byrdine F. Lewis College of Nursing and Health Professions, Georgia State University.

Shih-Yu Lee, PhD, RN
Committee Chairperson

Patricia Clark, PhD, RN, FAHA, FAAN
Committee Member

Joan Cranford, EdD, APRN, CNS

Steven Lloyd, PhD

11/27/2018
Date

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Regena Spratling, PhD, RN, CPNP
Director, PhD Program
Byrdine F. Lewis College of Nursing and Health Professions

Susan Kelley, PhD, RN, FAAN
Associate Dean and Chief Academic Officer for Nursing
Byrdine F. Lewis College of Nursing and Health Professions

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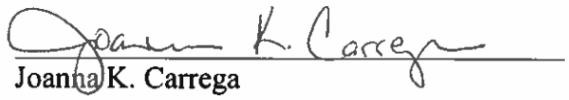

Joanna K. Carrega

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Joanna K. Carrega
2807 High Creek Run
Dacula, GA 30019

The director of this dissertation is:

Shih-Yu Lee, PhD, RN
Professor
Byrdine F. Lewis College of Nursing & Health Professions
Georgia State University
P.O. Box 4019
Atlanta, GA 30302-4019

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VITA

Joanna K. Carrega

ADDRESS: 2807 High Creek Run
Dacula, GA 30019

EDUCATION:

Ph.D(c).	2018	Georgia State University Atlanta, GA
MS/ne	2009	North Georgia College & State University Dahlonega, GA
BSN	2007	University of Phoenix Phoenix, AZ
ASN	1994	Broward Community College Fort Lauderdale, FL

PROFESSIONAL EXPERIENCE:

2011 – 2018	Assistant Professor, Nursing University of North Georgia, Dahlonega, GA
2011 – 2013	Clinical Instructor / Adjunct Faculty Georgia State University, Atlanta, GA
2007 – 2011	Nurse Educator, Obstetrics Northeast Georgia Health System, Gainesville, GA
2008 – 2009	Clinical Instructor – Obstetrics Brenau University, Gainesville, GA
2000 – 2007	Registered Nurse, Obstetrics / Pediatrics Gwinnett Medical Center, Lawrenceville, GA
1998 – 2000	Registered Nurse, Obstetrics Palmetto General Hospital, Hialeah, FL
1996 – 2000	Registered Nurse, Obstetrics Aventura Medical Center, Aventura, FL
1994 – 1996	Registered Nurse Priority Care Urgent Care Center, Coral Springs, FL

PROFESSIONAL ORGANIZATIONS:

2009 – present	Sigma Theta Tau International Tau Psi Chapter President
2011 – present	American Nurse Association, Member
2011 – present	Georgia Nurses Association
1998 – present	Association of Women's Health, Obstetrics, & Neonatal Nursing

HONORS:

2011- 2013	STEPS Grant Recipient
2009	Most Outstanding Graduate Student North Georgia College & State University

RELATED PRESENTATIONS:

Carrega, J. (2013) Breastfeeding Experiences Among African and Caribbean American Women. Business and Health Administration Association Annual Conference.

ABSTRACT

POST-PARTUM SLEEP AND BREASTFEEDING OUTCOMES AMONG FIRST-TIME MOTHERS OF FULL-TERM NEWBORNS

by

JOANNA K. CARREGA

Benefits of breastfeeding are well documented for both mother and infant. Most new mothers (81%) in the United States choose to breastfeed initially, but only 22% breastfeed exclusively through six months of age as recommended. Approximately 50% discontinue breastfeeding within three months. Perception of inadequate milk supply has been found to be an important factor associated with early breastfeeding cessation. Prolactin and oxytocin, the hormones responsible for production, maintenance, and release of human milk may contribute to low milk volume for some new mothers. Both are secreted in a diurnal manner paralleling the sleep-wake cycle.

A descriptive, correlational study design was used to examine impact of impaired sleep and its related health consequences (fatigue, hormone disruption, and mood changes) upon two breastfeeding outcomes: milk volume and discontinued breastfeeding among healthy postpartum mothers of healthy newborns at two weeks and one month postpartum. Factors that may have contributed to postpartum sleep disturbance (maternal characteristics and stress) were also examined.

A total of 29 primaparas, age 22-35, took part in this study. A home visit was conducted at two weeks' postpartum to collect self-report data for sleep, stress, fatigue,

depression, and anxiety. Test weights were performed to estimate breast milk volume by calculating the infant's body weight before and after breastfeeding. Breastfeeding status was collected at one month via phone interview.

All mothers were exclusively breastfeeding at two weeks' postpartum and most (90%) were breastfeeding exclusively one month postpartum. At two weeks postpartum, participants in this study were sleep disturbed (69.2%), fatigued (82.8%), reported symptoms of anxiety (27.6%), and had more clinically signficant depressive symptoms (27.6%) compared to postpartum women in the U.S. (12.8%). Age, education level, and perceived stress accounted for 43.2 % of the variance ($R^2 = .44$, $F (3, 25) = 6.35$, $p = .01$) in sleep disturbance. Sleep disturbance was a significant predictor for lower breast milk production during the second postpartum week (Beta = -.70, $p = .02$).

Findings highlight a need to develop stress-reduction interventions that might lead to better sleep during the postpartum period and might have a positive impact upon breast milk production. Appropriate screening for depressive symptoms and anxiety are needed for early detection and assistance for postpartum women who develop mood disorders.

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POSTPARTUM SLEEP AND BREASTFEEDING OUTCOMES AMONG FIRST-TIME MOTHERS OF FULL-TERM NEWBORNS

JOANNA K. CARREGA

A DISSERTATION

Presented in Partial Fulfillment of Requirements for the Degree of Doctor of Philosophy
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LIST OF ABBREVIATIONS

AA	African American
ACOG	American College of Obstetrics and Gynecology
ACTH	Adrenocorticotropic hormone
ALI	Allostatic Load Index
ANS	Autonomic nervous system
CCSD	Core Consensus Sleep Diary
CDC	Centers for Disease Control and Prevention
CRH	Corticotropin-releasing Hormone
EFA	Exploratory factor analysis
EPDS	Edinburgh Postnatal Depression Scale
GSDS	General Sleep Disturbance Scale
HAM-A	Hamilton Anxiety Index
HPA	Hypothalamic-pituitary-adrenal
IL-8	Interleukin – 8
LFS-7	Lee Fatigue Scale, 7-item
NREM	Non-rapid-eye-movement
NSF	National Sleep Foundation
PDS	Postpartum depression symptoms
PPD	Postpartum depression
PRAMS	Pregnancy Risk Assessment Monitoring System
PSG	Polysomnography
PSS-10	Perceived Stress Scale, 10-item

REM	Rapid-eye-movement
SCN	Superchiasmatic nucleus
SIDS	Sudden Infant Death Syndrome
STAI	State Trait Anxiety Inventory
STAI-S	State Trait Anxiety Inventory – State
TST	Total sleep time
U.S.	United States
US DHHS	United States Department of Health and Human Services
WASO	Wake after sleep onset
WHO	World Health Organization

CHAPTER I

INTRODUCTION

The health benefits of breastfeeding are well documented for both mothers and their infants (Schanler & LeTourneau, 2014). Experts recommend that infants receive human milk exclusively for the first six months of life, followed by continued breastfeeding plus solid foods until one to two years of age (Schanler & LeTourneau, 2014; World Health Organization [WHO], 2017). Maternal benefits of breastfeeding include reduced rates of postpartum hemorrhage, a leading cause of maternal death, and reduction in future risk for breast and ovarian cancer, diabetes, and cardiovascular disease (Coates, 2016; Schanler & LeTourneau, 2014). Infants who are breastfed have fewer ear infections, reduced morbidity and mortality, and have lower rates of sudden infant death syndrome (SIDS) compared to formula fed infants during the first year of life (Coates, 2016; Horta & Victoria, 2013a; Schanler & LeTourneau, 2014). Long-term childhood benefits include a reduction in future risk for obesity and diabetes (Horta & Victora, 2013b; Schanler & LeTourneau, 2014). Thus, supporting mothers in breastfeeding has long-term benefits for both mothers and their children.

Globally, breastfeeding outcome indicators are reported using the following parameters: (1) initiation rates among the population, (2) exclusivity rates, defined as percentage of infants among the population receiving no method of nutrition other than human milk through six months of age, and (3) duration of breastfeeding in number of months (Centers for Disease Control and Prevention [CDC], 2016; WHO, 2017).

In the United States (U. S.) breastfeeding duration and exclusivity rates, are lower than many other developed nations, with only 22% of new mothers in the U.S. exclusively breastfeeding at six months, compared to Hungary (44%), Czech Republic (40%), Japan (36%), and Italy (32%), and Canada (26%) (CDC, 2016; Government of Canada, 2015; Organisation for Economic Co-operation and Development, 2009). Though U.S. Breastfeeding rates have continued rise, outcomes continue to fall short of current Healthy People 2020 targets for two of the three outcome-measures, exclusivity at 6 months (22% vs. 26%), and duration for one-year goal (31% vs. 34%) (CDC, 2016). Measurement of these parameters alone among postpartum women does not capture reasons why women in the U. S. stop breastfeeding. Understanding the reasons for discontinuation may be helpful in developing interventions to foster breastfeeding.

In recent years, several initiatives have been implemented to improve breastfeeding rates and support in both hospitals and community settings across the U.S. In 2011, the Surgeon General published a "Call to Action" for nurses and other health professionals to provide more consistent breastfeeding support in clinical practice (U. S. Department of Health and Human Services [U. S. DHHS], 2011a). During the same year, the Surgeon General called for an increase in number of hospitals designated as "Baby Friendly" across the nation. To receive Baby Friendly designation, hospitals must complete a ten-step, evidence-based program with proven success in improvement of breastfeeding rates (U. S. DHHS, 2011b).

Despite these initiatives, 60% of new mothers in the U. S. do not meet their intended breastfeeding goals (Antsey et al., 2016). While most new mothers (81%) in the U.S. choose to breastfeed initially, only 22% breastfeed exclusively through six months

of age as recommended (CDC, 2016). Among these women, almost half discontinued breastfeeding exclusively by three months postpartum (CDC, 2016). Maternal perception of inadequate milk supply has consistently been found to be an important factor associated with early discontinuation of breastfeeding during these months (Odom et al., 2013; Rozga et al., 2015).

The first few postpartum weeks are vital for the establishment and maintenance of successful breastfeeding (Bigelow et al., 2014, CDC, 2016; Chiou et al., 2014). Prolactin and oxytocin, the hormones responsible for production, maintenance, and release of breast milk may contribute to low breast milk volume, a known contributor to early breastfeeding cessation, for some new mothers. Impaired sleep during the postpartum period may affect these two important hormones due to sleep plays a role in the pathways for production of both. This chapter will describe the significance of maintenance of adequate sleep during the postpartum period upon breastfeeding success.

Background and Significance

The postpartum period, or puerperium, begins with the delivery of the baby and ends at approximately six to eight weeks after delivery, when most physiological effects of pregnancy have resolved (Berens, 2014). During this time, most postpartum women experience some degree of sleep disturbance (Christian et al., 2018; Creti et al, 2017; Doan et al., 2014; McBean & Montgomery-Downs, 2015; Park et al., 2013; Titofsky et al., 2015); however, to date, there is a lack of research exploring the association between breastfeeding outcomes from a maternal sleep perspective.

Normal postpartum physiologic changes compounded with infant care responsibilities and irregular newborn sleep patterns are significant barriers to adequate

sleep among postpartum women (Stremler et al., 2017). During pregnancy, the placenta produces large amounts progesterone, a hormone known to have sleep-inducing properties (Balserak & Lee, 2017). Following delivery of the placenta at birth, there is a rapid decline in maternal progesterone levels, which precipitates maternal sleep disturbances. These sleep disruptions are most pronounced during the first postpartum weeks, with most severe symptoms experienced by primaparas (Stremler et al., 2017).

Successful lactation requires adequate release of the hormones prolactin and oxytocin from the pituitary gland (Wambach & Genna, 2016). Sleep modulates endocrine activity of the hypothalamic-pituitary-adrenal axes (Coleman et al., 2016; Van Cauter & Tasali, 2017). Prolactin release is highest following sleep onset (Balsarek & Lee, 2017; Van Cauter & Tasali, 2017), while oxytocin is also released in greatest quantities during the early morning hours (Balsarek & Lee, 2017) and following infant suckling during breastfeeding (Wambach & Genna, 2016). Disrupted sleep may alter homeostatic processes, a sleep determinate factor, which may further complicate sleep and ultimately have a negative impact breastfeeding (Coleman et al., 2016; Van Cauter & Tasali, 2017). Specifically, postpartum sleep disturbance may disrupt secretion of prolactin and oxytocin and have negative effects on maternal milk supply and breastfeeding success.

Sleep disturbance has been considered normal for the postpartum period; however, it may initiate a cascade of events that disrupt maternal psychological and physiological homeostasis (Stremler et al., 2017) and warrants further study. To date, very little is known about the impact of sleep disturbance upon maternal hormones necessary for adequate breast milk production and breastfeeding. The next section will

present a conceptual model proposed for the study of postpartum sleep and its impact upon breastfeeding performance and success.

Conceptual Model of Impaired Sleep

The Impaired Sleep Model (Lee, 2003) was used as a guide for the study of sleep disturbances among postpartum women and its impact upon breastfeeding performance and success. This model illustrates the deleterious effects of sleep impairment upon mental and physical health. The following illustrates an adaptation of the existing model for use in a study of postpartum women who are breastfeeding (Figure 1).

Figure 1.

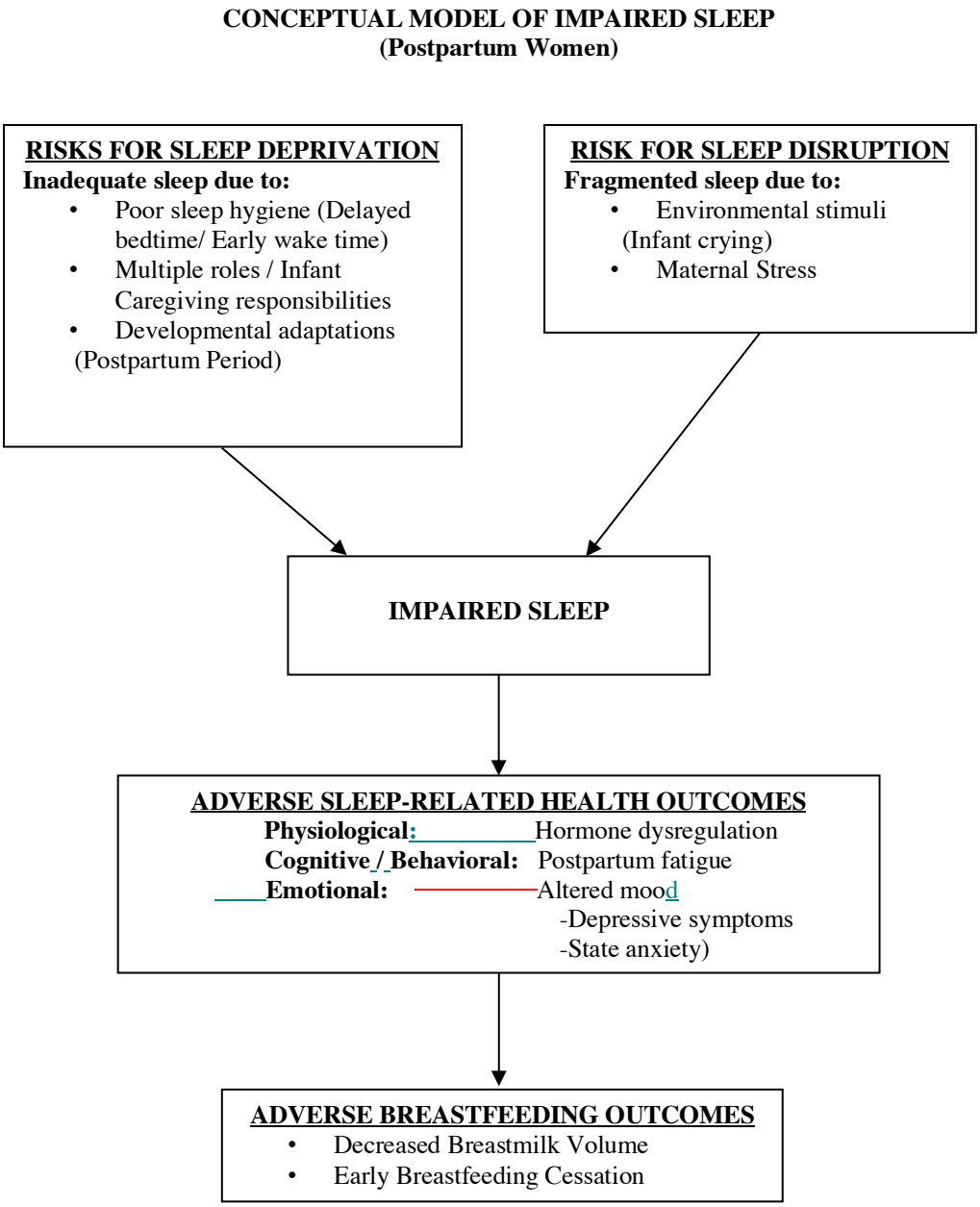


Figure 1. Adapted from original "Conceptual Model of Impaired Sleep" published by Lee, K.A. in 2003.

Conceptual Definitions and Terms

According to the model, sleep impairments result from two factors: sleep deprivation and sleep disruption. Sleep deprivation is a decrease in sleep time and is often referred to as sleep debt. Sleep disruption, or fragmented sleep, refers to awakenings that occur following sleep onset (Lee, 2003). Adverse sleep-related health outcomes are the consequences of sleep impairment and include deterioration of physical and psychological well-being (Lee, 2003) that could ultimately affect breastfeeding ability among postpartum mothers. For this reason, two adverse breastfeeding outcomes, decreased milk supply and early breastfeeding cessation, have been added to the model as an outcome variable for this study.

Risk Factors for Sleep Impairment

Risk factors for sleep deprivation and sleep disruption classified as environmental, personal, and developmental (Lee, 2003). The next section addresses the specific risk factors applicable to postpartum women.

Risk Factors for Postpartum Sleep Deprivation

Risk factors for postpartum sleep deprivation include developmental adaptations to the maternal role; multiple role/caregiver responsibility experienced by new mothers and lack of good sleep hygiene practices. Transition to the maternal role is a significant developmental event and represents a time of considerable reordering of personal goals, responsibilities and relationships (Mercer, 2004). Factors that may contribute to this transition may include but are not limited to maternal age, marital status, degree of partner/family support, socioeconomic status, birth experience, and life stress. Though most new mothers adapt well during this time, difficulty with transition to motherhood

may be a result of or result in adverse consequences to maternal physical and mental health, including development of sleep disturbances, anxiety, and depressive symptoms (Parfitt & Ayers, 2014).

New mothers must often juggle multiple roles, including wife and caregiver of other children and/or other family members, and manage roles held outside of the home (Stremler et al., 2017). Despite increasing involvement of fathers in the care of their infants, society continues to view mothers as the primary caregivers for infants within the home (Araujo Martins et al., 2014). Thus, additional responsibilities and complexity of roles held by new mothers in modern society could lead to additional life stress and further affect both quantity and quality of postpartum sleep.

Sleep hygiene refers to a set of behaviors known to promote optimal sleep. Good nighttime sleep requires good sleep hygiene practices. These include: maintaining a consistent daytime and nighttime schedule, keeping the bedroom environment, dark, quiet, and cool when trying to sleep (Lee, 2003; Ramar & Olson, 2013), maintaining adequate nutrition and exercise, minimizing caffeine, alcohol, and nicotine intake, engaging in nighttime tension reduction activities, and reducing time spent in bed trying to fall asleep (National Sleep Foundation [NSF], 2015). Due to the demands of transition to their new maternal role, it is quite challenging postpartum women to practice good sleep hygiene.

Risk Factors for Postpartum Sleep Disruption

Risk factors for postpartum sleep disruption include environmental stimuli or maternal stress. Infant crying may be the most significant environmental risk factor for disrupted nighttime sleep among postpartum women (Lee, 2003). During their first few

months, most infants wake often, leading to frequent awakenings in maternal caregivers (Sharkey et al., 2016; Yoshida et al., 2015). The number of awakenings per night is highly variable between infants (Yoshida et al., 2015). For this reason, the degree of nighttime sleep disruption among new mothers may differ significantly.

For this study, stress refers to psychological stress. Psychological stress may affect postpartum sleep via a mechanism known as allostatic load. Allostatic load refers to a measure of cumulative effects of chronic psychological stress. When allostatic load is chronically high during periods of continuous stressful stimuli, maladaptive physiological functioning, such as sleep disturbance, may occur (Juster, 2016).

Like sleep, human stress response is regulated by via the HPA axis, though in conjunction with the autonomic nervous system (ANS) and immune system (Oken et al., 2015). Immediate HPA response to a perceived stressor includes release of corticotropin-releasing hormone (CRH) from the hypothalamus, known for promoting wakefulness and producing sleep disturbances, and subsequent release of adrenocorticotropic hormone (ACTH) from the anterior-pituitary gland and cortisol, a major glucocorticoid in humans, from the adrenal cortex. ANS activation activates the sympathetic nervous system resulting in increased cardiovascular tone and glucose metabolism (Juster, 2016; Oken et al., 2015).

Chronic psychological stress has been attributed to a wide range of health problems, including sleep disturbance (Bublitz et al., 2016; Hux et al., 2017; Oken et al., 2015; Okun et al., 2014). Chronic activation of the HPA system has been shown to alter diurnal cortisol levels and cortisol awakening response (Juster et al., 2016; Oken et al., 2015). Changes in normal sleep patterns may lead to further disruption of HPA

homeostasis through altered timing and amount of HPA hormone release (Juster et al., 2016). Imbalance between HPA hormones and sleep patterns may result in adverse health consequences described in the next section.

Adverse Sleep-Related Health Outcomes

Sleep-related adverse health outcomes include changes in normal physiological, cognitive/behavioral, and psychological function. In the current study, the physiological change of interest is dysregulation of the endocrine hormones important to successful breastfeeding, prolactin and oxytocin.

The cognitive/behavioral health outcome of interest is maternal fatigue. Fatigue is one of the most commonly reported health concern among postpartum women (Badr & Zauszniewski, 2017). Fatigue will be defined as a "subjective response to environmental demands that exceed resources" (Lee et al., 1994) resulting in a "sense of exhaustion, lack of energy, or tiredness" (Lerdal et al., 2013). Perceived fatigue may be physical or psychological, acute or chronic, fluctuate over the course of time, and differ from sensations of sleepiness, physical weakness, or sadness (Lee et al., 1994; Lerdal, 2013). Studies support an association between impaired sleep and postpartum fatigue (Badr & Zausniewski, 2017; Doering et al., 2017; Giallo et al., 2015; McBean & Montgomery-Downs, 2013). To date, very few studies have examined associations between postpartum fatigue, breastfeeding duration and exclusivity, and milk volume.

Adverse psychological health outcomes examined were symptoms of psychological distress and include depressive symptoms and anxiety (Lee, 2003). Postpartum depression and anxiety are common among postpartum women, with depression estimated to effect approximately 1 in 9 new mothers (Ko et al., 2017) and

anxiety impacting as many as 17% (Fairbrother et al., 2017). Though strong associations have been identified between anxiety and sleep disturbances in the general population (Marcks et al., 2010), sleep research among perinatal populations has focused primarily on postpartum depression (Christian et al., 2018; Okun & Okun, 2016; Park et al., 2013; Sharkey et al., 2016). In addition, few studies have examined associations between symptoms of depression and anxiety and breastfeeding outcomes as outlined in the proposed study.

Adverse Sleep-Related Breastfeeding Outcomes

Diminished average daily maternal breast milk volume as measured in milliliters were proposed as an adverse sleep-related breastfeeding outcome resulting from alteration of endocrine functioning and hormone dysregulation. In addition, diminished capacity for continued breastfeeding, or early breastfeeding cessation, were proposed related to cognitive/psychological, and emotional sleep related health consequences. Theoretically, adverse sleep-related health consequences, HPA dysregulation resulting in altered release of prolactin or oxytocin, increased level of fatigue, and/or degree of depressive symptoms or anxiety, may further diminish average daily maternal breast milk volume and may lead to discontinued breastfeeding.

Theoretical Assumptions

There are a few theoretical assumptions that may be applicable when adapting this model to the study of new mothers who are breastfeeding. The first is that most postpartum women will experience sleep deprivation and/or sleep disturbance due to the developmental task of transition to motherhood and infant caretaking responsibilities. Second, is that mothers whom desire to breastfeed will continue to do so when

physiological and psychological health is intact. Finally, sleep-related adverse health outcomes will lead to decreased breastfeeding success.

Hypothesis and Research Questions

The purpose of this study was to examine the impact of impaired postpartum sleep upon breastfeeding outcomes. A descriptive, correlational study was conducted among first-time mothers with full-term, healthy newborns to examine associations between maternal sleep impairment and breast milk supply at two weeks postpartum. Adverse sleep-related health outcomes are also described.

Hypotheses

Hypotheses to be tested are:

In a sample of first-time mothers of full-term, healthy newborns:

H1: Impaired sleep (self-report nocturnal sleep of less than seven hours and sleep quality score three or above measured by General Sleep Disturbance Scale) will be positively associated with breast milk volume less than 650 ml in a 24-hour period, at the early postpartum stage.

H2: Impaired sleep will predict early breastfeeding cessation at two weeks and at one month postpartum.

Research Questions

This study seeks to answer the following questions:

1. To what degree is postpartum sleep impairment explained by selected personal characteristics (age, education, financial status, degree of partner/family support, and mode of delivery) and degree of maternal stress?

2. Which adverse health consequences of impaired sleep, fatigue or mood status (symptoms of depression and anxiety), contribute the most variance for decreased breast milk production and breastfeeding cessation?

Significance of this Study to Nursing

This study adds to the current literature by offering a unique examination of impaired sleep during the postpartum period upon breastfeeding outcomes. Though empirical evidence supports associations between impaired maternal sleep and adverse health outcomes such as fatigue and depressive symptoms, the degree of impaired sleep needed to induce deleterious effects upon maternal milk volume breastfeeding success remains unknown. Knowledge gained from this study could be used by the nursing disipline for future development of interventions to improve both postpartum sleep and breastfeeding outcomes (rates, duration, and exclusivity) among childbearing women.

CHAPTER II

REVIEW OF LITERATURE

This chapter summarizes a review of literature conducted to examine what is currently known about postpartum sleep and its potential impact upon human milk production and breastfeeding performance from both physiological and psychological perspectives. A brief overview of normal human lactation and sleep physiology is first presented to enhance understanding of the potential consequences of sleep impairment during the postpartum period.

Physiology of Human Lactation

Human lactation is accomplished via adequate changes in maternal breast tissue, release of the hormones prolactin and oxytocin from the pituitary gland, and effective removal of milk from the breast by the newborn (Wambach & Genna, 2016). The developmental cycle of lactation occurs in four phases: mammogenesis, lactogenesis, galactopoiesis, and involution. For purposes of this review, only lactogenesis and galactopoiesis will be discussed.

Lactogenesis refers to the time of transition from pregnancy to lactation and occurs in two distinct phases known as Lactogenesis I and Lactogenesis II. Lactogenesis I begins mid-pregnancy and ends within the first few postpartum days. During this period, maternal prolactin is regulated by the endocrine system via the anterior pituitary gland and stimulates the mammary epithelial cells, known as lactocytes, to produce milk.

Milk produced during this phase is known as colostrum. A normal increase in circulating maternal progesterone during pregnancy inhibits colostrum release until time of birth (Wambach & Genna, 2016).

Lactogenesis II occurs between the third and eighth postpartum day. Onset is triggered by a rapid decline in maternal progesterone and an increase in oxytocin secretion from the posterior pituitary gland following birth. During the immediate postpartum period, oxytocin facilitates milk ejection, or let down, as oxytocin release continues in response to stimulation of the breast by infant suckling. Copious milk secretion ensues during this phase and control of prolactin release shifts from the endocrine control by the hypothalamus to an autocrine, or supply and demand, system. Galactopoeisis begins on approximately the 9th postpartum day and lasts until the decision to discontinue breastfeeding is made. During this phase, milk production and supply are regulated primarily by infant feeding demand (Wambach & Genna, 2016).

Prolactin and oxytocin each has a unique physiologic function and role in relation to breastfeeding. Prolactin, secreted by the anterior pituitary gland, stimulates human milk production and is essential to maintenance of maternal milk supply. In non-pregnant women, normal prolactin levels are 20ng/mL or less compared to 90ng/mL at 10 days postpartum. Beyond this period, prolactin levels gradually decline but increase rapidly in response to infant suckling (Wambach & Genna, 2016). Oxytocin, released by the posterior pituitary gland, is responsible for the milk ejection reflex that stimulates breast contractions for milk release and transfer to the infant. Approximately 50-100 mU of oxytocin is required to elicit this reflex that occurs approximately one minute following stimulation of the breast tissue and return to baseline within minutes of the end

of the session. This process continues with each feeding for the duration of lactation, even when breastfeeding is extended over a long period (Wambach & Genna, 2016).

Physiology of Human Sleep

In healthy adults, normal sleep consists of falling asleep at night within approximately 10 minutes of turning lights out, followed by several hours of uninterrupted sleep. Upon awakening at the end of the sleep period, individuals should feel rested and have enough energy and mental attentiveness to complete daily activities (Lee, 2003). Though no consensus has been reached regarding the amount of sleep needed each night by healthy adults, seven to eight hours of nocturnal sleep per day is recommended by the National Sleep Foundation (NSF, 2015).

From a physiologic perspective, human sleep is regulated by the superchiasmatic nucleus (SCN) located in the anterior hypothalamus. The SCN stimulates sleep and wakefulness following a 24-hour, or circadian, pattern in response to exposure to light and dark (Rosenwasser & Turek, 2017). During periods of light and dark exposure, the SCN interacts with sleep-inducing and arousal-promoting regions of the brain by stimulating or inhibiting neurotransmitters associated with sleep and wakefulness (Gooley & Saper, 2017).

In adults, normal sleep occurs in a series of progressive, consecutive 90-minute cycles alternating between non-rapid-eye-movement (NREM) and rapid-eye-movement (REM) sleep. NREM sleep accounts for approximately 75% of a normal sleep period, and REM sleep accounts for approximately 25%. Sleep is entered through NREM sleep and alternates between varying proportions of NREM and REM sleep (Carskadon & Dement, 2017). NREM sleep is predominate during the first one-third of the sleep

period, whereas REM sleep episodes are longest during the second half of the night. This pattern is believed to reflect the homeostatic function of sleep, with more restorative sleep occurring when sleep needs are greatest (Carskedon & Dement, 2017). However, sleep characteristics are different during pregnancy and postpartum period due to hormonal changes and psychological status. The next section will describe what is currently known about postpartum sleep and factors that may contribute to sleep disturbance during this period.

Postpartum Sleep Characteristics

Over the years, several studies have examined normal postpartum sleep characteristics, using both subjective and objective measures. Portable polysomnography (PSG) was often used in earlier studies, while wrist actigraphy and sleep diaries are most common in studies that are more recent. Early PSG studies will be included in this review as they provide an understanding of postpartum sleep architecture.

Postpartum sleep can be characterized by a significant sleep deprivation and disruption. Additionally, in-home portable PSG studies found significant changes to sleep architecture from pregnancy to postpartum (Blyton et al., 2002; Lee et al., 2000; Nishihara & Horiuchi, 1998; Nishihara et al., 2004). Changes include decreased total sleep time (TST), increased wake after sleep onset (WASO), decreased sleep efficiency (proportion of time asleep compared to time in bed), and variation in time spent in various sleep stages (Lee et al., 2000; Nishihara & Horiuchi, 1998).

Actigraphy studies have been consistent with PSG studies in most instances, finding a significant reduction in TST and sleep efficiency and an increase in WASO from pregnancy to postpartum. Sleep disruption was most significant during the early

postpartum weeks, and improved over time. Studies (see Appendix A, Table 1) were comprised of healthy postpartum women with healthy newborns and findings were supported by subjective data (Insana & Montgomery-Downs, 2012; Montgomery-Downs, et al., 2010a; Montgomery-Downs, et al., 2010b; Park et al., 2013; Sharkey et al., 2016). Studies that used subjective measures to assess maternal sleep support actigraphy and PSG study findings. Across studies, a high prevalence of sleep disturbance and increased number of nighttime awakenings among postpartum women was found (Christian et al., 2018; Creti et al., 2017; McBean & Montgomery-Downs, 2015; Park et al., 2015; Titotsky et al., 2015).

In summary, the existing studies demonstrate postpartum women experience shorter sleep periods than the recommended seven hours per night and significant sleep disturbance. The insufficient total nocturnal sleep time might have a negative impact to both mothers and their newborns. The next section will discuss factors that may contribute to sleep disturbance during this period as described within the context of the Impaired Sleep Model.

Risk Factors for Postpartum Sleep Disturbances

The Impaired Sleep Model (Lee, 2003) signifies the postpartum period as a major developmental time-period that increases risk for sleep disturbance. Other risk factors include multiple role and nighttime caregiving responsibilities. On the other hand, risk factors for sleep disturbances could be poor sleep hygiene due to desynchronized circadian activity resulting from maternal caregiving, environmental stimuli (e.g., infant crying) and maternal stress (Lee, 2003).

Developmental Transition to Motherhood

The birth of a child is a significant life transition for new mothers. Though a decrease in maternal sleep quantity and quality during the early postpartum weeks has been established, few studies were found that explored the direct impact of transition to motherhood upon postpartum sleep from a developmental perspective. A summary of literature review findings is described below.

Parfitt and Ayers (2014) conducted a study that measured psychological adaptation to motherhood by following participants from the third trimester through the 14th postpartum week. In this study, mothers who experienced a greater number of postpartum psychological symptoms (anxiety, depression, or post-traumatic stress) had significantly more postpartum sleep deprivation than those without symptoms. Lack of partner support, negative feelings toward the baby, and feelings of parental inadequacy were significant contributors to postpartum psychological symptoms (Parfitt & Ayers, 2014).

Of interest, approximately half of study participants experienced mental health symptoms during pregnancy, suggesting that presence of psychological symptoms prior to birth may contribute to poor maternal role transition (Parfitt & Ayers, 2014). A recent study, found 76% of Taiwanese primiparas exhibited symptoms of anxiety and/or depression at four weeks and a high degree of stress during the first postpartum week (Wu & Hung, 2016).

Parity status or number of children, and its impact on maternal sleep disturbances has also been studied, though these studies are not recent and reported mixed findings.

Signal and colleagues (2007) found sleep disruption more pronounced among primaparas compared to multiparas, especially during the first postpartum week, suggesting there was little difference in nocturnal (8 pm-8 am) total sleep time or frequency of napping, primiparas' experiences significantly less sleep efficiency than multiparas during the second trimester and at six weeks postpartum (Signal et al., 2007). Another study found no significant differences in sleep parameters between primiparas and multiparas, however (Montgomery-Downs et al., 2010a). All of sleep deprivation will further desynchronize maternal circadian activity rhythms and resulted sleep disturbances.

Nighttime Infant Caregiving, Environmental Stimuli, and Maternal Sleep

Per the Impaired Sleep Model, nighttime infant awakening is a significant risk factor for disrupted sleep in the early postpartum period (Lee, 2003). At birth, infant circadian rhythm patterns are poorly developed, resulting in sleep-wake patterns that are drastically different from their mothers. Asynchronous maternal-infant circadian patterns are most pronounced during the first postpartum month and have been shown to improve over time (Thomas et al., 2014).

Infant sleep cycles are shorter than adult sleep cycles and differ in time spent in each sleep stage. Yoshida and colleagues (2015) measured nighttime infant sleep using polysomnography and wrist actigraphy. Infants in this study averaged approximately 5.5 cycles per 6-hour period, or approximately 65 minutes per cycle at three and four months of age. Within each cycle, time spent awake averaged 15-20%. Infant signaling for care was highly variable among infants, ranging from no signaling, or sleeping through the night, to strong signals (crying) for care. Patterns also varied from night to night among infants (Yoshida et al., 2015).

Infant feeding is a significant contributor to nighttime awakenings (Figueiredo et al., 2017; McGuire, 2013; Yoshida et al., 2015). Several studies have examined infant feeding methods in relation to nighttime infant sleep-wake patterns and have found breastfeeding infants wake more frequently during the night than formula fed infants (Figueredo et al., 2017; Maehara et al., 2017; Yoshida, et al., 2017). Figueiredo and colleagues (2017) conducted a study comparing sleep patterns of infants who were exclusively breastfed, partially breastfed, or exclusively formula fed at two weeks, three months, and six months. On average, infants woke on average approximately three times and were awake an average of four hours per night at two weeks of age. At three and six months of age, infants awoke twice and were awake approximately three hours per night. Exclusively breastfed infants had longer day and nighttime sleep periods at two weeks than partially breastfed infants, but shorter sleep time than both partially breastfed and exclusively formula fed infants at three and six months of age (Figueriedo et al., 2017).

Maehara and colleagues (2017) reported similar findings; however, while exclusively breastfed infants were fed more frequently at night, they required less time to return to sleep than partially breastfed and exclusively formula fed infants. In this study, partially breastfeeding and exclusively formula feeding mothers reported longer nighttime feeding sessions at one and two months postpartum compared to exclusively breastfeeding mothers. In addition, exclusively formula fed infants required more time returning to sleep at six months. Women in this study averaged 5 hours nighttime TST at one month postpartum, which increased to hours 6.4 hours TST at six months. Infant feeding method was not significant in mothers' self-reports of nighttime TST across periods except at two months. During this time, exclusive breastfeeding mothers reported

significantly more TST (Maehara et al., 2017). This finding is consistent with another study that reported exclusively breastfeeding women averaged 30 minutes more TST at one month postpartum than those who were supplementing with formula. Number of nighttime awakenings did not differ between feeding methods (Doan et al., 2014).

Finally, Froelich and colleagues (2015) explored infant feeding and its impact upon transition to motherhood. At two to three weeks postpartum, women described breastfeeding as being more difficult than expected and that they felt unable to establish a daily routine. Though sleep was not a direct outcome measure, mothers reported feeling unprepared for the time commitment of breastfeeding, reporting that their babies often fed hourly, including during the night (Froelich et al., 2015).

Stress and Postpartum Sleep

Stress is common among postpartum women due to maternal role transition, adjustments in family relationships, and nighttime infant caregiving demands (Flanagan et al., 2015; Ko et al., 2014). Additional stressors during this period may include women experiencing physical pain, marital strain, diminished social support (Flanagan et al., 2015). Multiple studies were found that support an inverse relationship between sleep quality and degree of maternal stress among pregnant and postpartum women. Across studies, higher degree of stress was associated with diminished sleep quality (Christian et al., 2018; Ko et al., 2014; Hux et al., 2017; Lee & Hsu, 2012; Okun et al., 2013). In addition, Ko and colleagues (2014) found poorer postpartum sleep quality was associated with increased physical pain, increased nighttime infant awakenings, while inversely correlated with diminished social support (Ko et al., 2014).

In recent years, there has been an increased study of chronic stress and its impact on physiologic consequences, such as allostatic load and sleep quality, during pregnancy and postpartum. Hux and colleagues (2017) compared allostatic load index and sleep quality in healthy pregnant women during the first trimester of pregnancy. In this study, allostatic load index and age, but not degree of subjective stress, was associated with poor sleep quality (Hux et al., 2017). A secondary data analysis found self-reported sleep quality was significantly associated with elevated evening cortisol level, a biological marker for stress, during the third trimester of pregnancy; elevation of cortisol predicted preterm birth (Bublitz et al., 2016).

Race was an important predictor of stress-related poor sleep quality in some studies. One study reported poor sleep quality was associated with elevation of Interleukin-8 (IL-8) among African American (AA) mothers, but not White mothers. Elevation of IL-8 was associated preterm birth among AA women in this study (Blair et al., 2015). Another found sleep disturbance was associated with subjective degree of parenting stress and increased inflammatory biomarkers at eight weeks postpartum among AA mothers, but not White mothers (Christian et al., 2018).

Impaired Postpartum Sleep and Adverse Health Outcomes

This section will describe what is known about sleep related adverse health outcomes among postpartum women. What is known about the effects of postpartum sleep impairment upon maternal breastfeeding hormone dysregulation, degree of fatigue, and maternal mood are discussed.

Postpartum Sleep and Hormone Dysregulation

HPA hormones are secreted in a diurnal manner paralleling the sleep-wake cycle. Sleep disturbances during the postpartum period may result in a cascade of effects that may alter homeostatic processes (Christian, et al., 2018). Recent evidence suggests there may be an association between sleep disruption and hormone dysregulation. Specifically, disrupted sleep circadian release of HPA hormones, subsequently results in decreased glucocorticoid sensitivity and prolonged/exaggerated inflammatory responses (Blair et al., 2015; Bublitz et al., 2016; Christian et al., 2018; Christian et al., 2013).

Only one animal study was found that examined the role of sleep deprivation on breastfeeding hormones of interest, prolactin and oxytocin. In this study, sleep deprived mice had higher levels of oxytocin and prolactin at gestational day 20, and were more likely to miscarry compared to mice who were not sleep deprived (Pardo et al., 2015). Progesterone levels were not measured, however, which may account for higher levels of oxytocin and prolactin seen in this study. During pregnancy, progesterone inhibits secretion of both prolactin and oxytocin. Low progesterone is associated with miscarriage and preterm birth, which may explain study findings. Oxytocin and prolactin level were not measured during the postpartum period (Pardo et al., 2015). To the researcher's knowledge, no studies have been conducted that have directly examined the impact of health consequences attributable to postpartum sleep disturbance upon breastfeeding hormones, prolactin or oxytocin.

Postpartum Sleep and Cognitive Change, Fatigue

Postpartum women consistently rank fatigue as a significant health concern following birth (Badr & Zausniewski, 2017). Fatigue is a feeling of exhaustion that accompanies a severe decrease in ability to perform physical and mental activities, unrelieved by sleep (Rychnovsky & Hunter, 2009). Research findings consistently support an association between postpartum sleep disturbance and postpartum fatigue using both objective and subjective measures (Badr & Zausniewski, 2017; Doering et al., 2017; Giallo et al., 2015; McBean & Montgomery-Downs, 2013). Sample sizes ranged from 21-253 included primiparas and multiparas post-vaginal or cesarean birth, mothers of term and preterm infants, and who were breastfeeding and formula feeding. Data collection ranged from the 2nd to 13th postpartum week.

Postpartum Sleep and Mood Changes, Depression and Anxiety

Postpartum depression is common among childbearing women reported to affect 12.8% of all postpartum women in the U.S. (CDC, 2015). An association between inadequate maternal sleep and subsequent development of postpartum depression has been supported across multiple studies (Creti et al., 2017; Doering et al., 2017; Lee & Hsu, 2012; Park et al., 2013; Sharkey et al., 2013). One study found that in a small sample of primaparas (n=25), subjective sleep disturbance, but not objective measures was a significant predictor of depressive symptoms from 2 to 14 weeks postpartum. More than one-third of women in this study had a prior diagnosis of depression, however (Park et al., 2013). Another found higher self-report of sleep disturbance, but not TST, was associated with more depressive symptoms at two and six months postpartum in a small sample of low-risk primaparas with healthy newborns (Creti et al., 2017).

Anxiety is a common mood disorder experienced by childbearing women (Taylor & Johnson, 2013); however, no studies were located that examined the association between maternal sleep characteristics and anxiety among healthy postpartum women. A recent meta-analysis found prevalence of postpartum anxiety to be approximately 8.5%. Anxiety disorders were varied ranging from generalized anxiety disorder to post-traumatic stress disorder. Previous history of anxiety disorder, onset of anxiety disorder during pregnancy, and traumatic birth experience were most associated with diagnosis of postpartum anxiety disorder in this study (Goodman, Watson, & Stubbs, 2016). Another review of literature found prevalence postpartum anxiety symptoms ranged from 13% to 40% across studies, and that symptoms of anxiety were more prevalent during the early postpartum period and decreased over time (Field, 2018). Previous history of anxiety disorder, onset of anxiety disorder during pregnancy, and traumatic birth experience were associated with diagnosis of postpartum anxiety disorder in both studies (Field, 2018; Goodman, Watson, & Stubbs, 2016).

No studies were located that examined the association between maternal sleep characteristics and anxiety among healthy postpartum women. Just one study was found that examined insomnia during pregnancy and subsequent development of postpartum anxiety. In this study, anxiety was found to be associated with insomnia during pregnancy and the postpartum period (Pereira et al., 2013).

Sleep-Related Health Consequences, Milk Supply, and Breastfeeding Cessation

Sleep disturbances have been associated with fatigue, depressive symptoms and anxiety among postpartum women. While there is evidence that disturbed sleep also, leads to hormone dysregulation among the general population, the literature related to

postpartum women is sparse. In fact, few studies have explored the association between the above sleep-related health outcomes and breast milk supply or breastfeeding outcomes measures. A summary of findings is described next.

Hormone Dysregulation, Milk Supply, and Breastfeeding Outcomes

Two studies were found that explored associations between sleep related health consequences of interest, mood change and breastfeeding hormone, oxytocin during the postpartum period. One found an association with decreased oxytocin and higher cortisol levels at 8 weeks postpartum among depressed mothers compared to mothers who were not depressed (Cox et al., 2015). Similarly, another found a decreased oxytocin response to breastfeeding during the eighth postpartum week in women with symptoms of depression or anxiety (Stuebe et al., 2013). Neither of these studies compared laboratory findings with breastfeeding initiation, duration, and exclusivity, however. No studies were found that directly examined sleep-related endocrine disruption with milk supply or breastfeeding outcomes measures.

Postpartum Fatigue and Breastfeeding

Though fatigue is one of the most commonly reported concerns during the postpartum period, very few studies have examined its impact upon breastfeeding. Only one recent study was found that examined fatigue and other factors in relation to breastfeeding cessation and timing of cessation. In this study, fatigue and inconvenience of breastfeeding was the number one reason for breastfeeding cessation (Brown et al., 2014). A much older study was found that investigated the relationship between infant feeding choice and subjective fatigue levels among exclusively breastfeeding mothers, exclusively bottle-feeding mothers, and those using both methods of infant feeding. This

study showed no association between infant feeding choice and degree of maternal fatigue (Callahan et al., 2006).

Studies that examined fatigue and insufficient milk supply were very old and results were inconclusive. One pilot study found a significant association with self-reports of fatigue and maternal perception of insufficient milk volume, but no association between maternal self-ratings of fatigue at three, six, and nine weeks postpartum and breastfeeding performance (Wambach, 1998). A larger, descriptive study compared milk volume at six weeks postpartum to subjective reports of fatigue. No association with self-report of fatigue level and maternal milk volume was found in this study (Hill et al., 2005). Neither study reported breastfeeding exclusivity, duration, or cessation rates among participants.

Postpartum Mood Changes and Breastfeeding

Postpartum depression has been linked to decreased breastfeeding initiation and duration rates. A recent secondary data analysis found a decrease in overall breastfeeding duration as well as length of exclusive breastfeeding among women with postpartum depression symptoms (PDS) than women without symptoms (Bascom & Napolitano, 2016). Castro-Dias & Figueredo (2015) conducted a systematic review of literature and found PDS consistently associated with decreased duration and increased cessation of breastfeeding across studies (Castro-Dias & Figueredo, 2015). Preexisting history of depression predicted decreased breastfeeding duration in another study (Lindau et al., 2015). Cox and colleagues (2015) found an association with decreased oxytocin and higher cortisol levels at 8 weeks postpartum among mothers with PDS compared to mothers without symptoms (Cox et al., 2015).

Studies that have examined maternal postpartum anxiety and breastfeeding reported similar findings (Adinsweo et al., 2013; Paul et al., 2013; Wouk et al., 2017). A large randomized control trial found maternal anxiety during the postpartum hospital stay as measured by the State-Trait Anxiety Inventory (STAI). State anxiety was significantly associated with breastfeeding cessation during the first six postpartum months (Paul et al., 2013).

A recent study followed 255 Canadian women 18-23 weeks of gestation through 12 months postpartum. Anxiety scores were measured using the Hamilton Anxiety Inventory (HAM-A) and the State-Trait Anxiety Inventory (STAI), state and trait subscales. Anxiety scores were compared to infant feeding status at 3, 6, and 12 months postpartum. In this sample, higher HAM-A and STAI-Trait scores at 3 months was significantly associated with decreased breastfeeding exclusivity at 6 months, and breastfeeding cessation at 12 months postpartum (Adedinsweo et al., 2013).

A large secondary data analysis reported similar findings. In this study, national data from the Pregnancy Risk Assessment Monitoring System (PRAMS) found women with anxiety symptoms during pregnancy and postpartum were less likely to initiate breastfeeding. Symptoms of anxiety were associated with a decrease in both breastfeeding exclusivity and duration at three months postpartum (Wouk et al., 2017).

Discussion

This review demonstrates that maternal sleep impairment is highly prevalent among healthy postpartum women, especially in the first few postpartum weeks. Across studies, postpartum sleep was characterized by decreased nocturnal total sleep time and sleep quality. Though methods for measurement and periods for data collection varied,

all studies demonstrated significant changes in maternal sleep patterns during the first postpartum month with gradual improvement over time.

Limitations identified across sleep studies, were the use of smaller, non-randomized, convenience samples among PSG and actigraphy studies, and that many were conducted outside of the U.S., limiting generalizability to American women. Those conducted in the U.S. often sampled educated, higher income Caucasian women, further limiting generalizability of findings to lower income and more ethnically diverse women.

Risk factors for impaired sleep as described in the model were supported in the literature. Transition to motherhood, especially for first time mothers, represents a time that is both stressful and disruptive to normal daily routines. Maternal-infant circadian pattern differences along with the demands of nighttime infant caregiving responsibilities, especially infant feeding, were found to be disruptive to normal sleep patterns across studies.

Psychological stress and subsequent inflammatory biomarkers were shown to negatively affect postpartum sleep. Several studies demonstrated physiologic changes associated with allostatic load during pregnancy, but only one study was found that measured ALI biomarkers during the postpartum period. ALI biomarkers were negatively affected maternal sleep during pregnancy and contributed to poor pregnancy outcomes. Literature regarding physiologic changes associated with stress during the postpartum period was sparse, however. Further study of the impact of both perceived stress and ALI biomarkers are warranted.

Adverse health related consequences described in the Impaired Sleep Model were supported in this review. Strong evidence to support relationships between impaired

postpartum sleep and symptoms of depression and fatigue was found. Far fewer examined associations between sleep and postpartum anxiety. Instruments used for subjective measurement of fatigue were varied and reporting of psychometric properties inconsistent. More consistency in measures used was noted in depression and anxiety studies. Further studies are needed that include larger samples and more consistency among instruments used to measure postpartum symptoms of fatigue, depression, and anxiety that include reporting of psychometric properties. More studies pertaining to a variety of mood presentations, especially anxiety, among postpartum women are needed.

Endocrine dysregulation resulting from sleep disturbance was limited to one animal study. However, this study contributed to understanding of how sleep-related hormone changes may contribute to preterm labor. How chronically disturbed sleep may ultimately impact oxytocin and prolactin in relation to breastfeeding remains unknown.

Very few studies directly examined the relationship between health-related consequences of impaired postpartum sleep and this study's breastfeeding outcome of interest, breast milk supply. Though many studies included both breastfeeding and bottle-feeding mothers, only a few postpartum sleep studies focused on differences in sleep patterns between the two groups. Only one discussed an association between severe maternal sleep impairment and maternal dissatisfaction with breastfeeding.

Despite the high prevalence of fatigue among postpartum women, few studies examined the association between maternal fatigue and breastfeeding outcomes. Literature pertaining to maternal anxiety and breastfeeding was also sparse. The proposed study will address the relationship of fatigue and breastfeeding outcomes.

Strong evidence was found supporting an association between postpartum depression and breastfeeding duration and cessation, though many studies not included in this review did not clearly define breastfeeding outcomes. Depression studies used larger sample sizes and were more consistent in instruments used to measure depressive symptoms. Studies that examined associations between impaired maternal sleep, depressive symptoms, fatigue, and anxiety upon breastfeeding outcomes were sparse and produced inconsistent results, warranting further investigation. No human studies examined the association between sleep-related changes in oxytocin or prolactin production, breast milk volume, or breastfeeding cessation. Research in this area is needed.

Conclusion

The Impaired Sleep Model provides a valid framework to guide the study of sleep and related health consequences. This review highlights the complexity of how severe maternal sleep impairment during the postpartum period may have negative physiological and psychological consequences for new mothers. How sleep impairment influences maternal milk production and breastfeeding cessation remains largely unknown. Examination of how variables such as maternal stress, depressive symptoms, anxiety, and fatigue known to be associated with sleep impairment affect breastfeeding success is an equally important area of study and warrants future research

CHAPTER III

METHODOLOGY

This chapter provides a detailed description of the research design. The study setting, sampling, protection of human subjects, instrumentation, study protocol and a plan for data analysis are described.

Research Design

The design used was a descriptive, correlational study, and followed healthy, first time mothers from two weeks postpartum through one month postpartum.

Participants and Setting

A two-phase recruitment process was used. For the first phase of recruitment, participants were recruited from childbirth classes offered at a large community hospital in the southeastern U.S, during their third trimester of pregnancy. Interested participants were screened for eligibility by the researcher via completion of a participant-screening questionnaire containing pertinent pregnancy information, medical information, and intended method of infant feeding.

Eligible participants entered phase two of recruitment that took place following hospital discharge at approximately 7-10 days postpartum. During this phase, telephone interviews were conducted to obtain pertinent labor & delivery information, current breastfeeding status, and to assure newborn inclusion criteria were met. Eligible participants signed an informed consent during this phase of recruitment.

Inclusion Criteria

Mothers who indicated they intended to breastfeed their newborns exclusively for the first few months following birth were the target sample. Intention to breastfeed was assessed during phase one and two of recruitment via researcher developed screening questionnaires. Additional inclusion criteria are: 1) healthy, English-speaking, first time mothers ages 18 and older, 2) birth of a healthy, full-term newborn (37 – 42 weeks' gestation), and 3) breastfeeding at time of discharge.

Exclusion Criteria

Mothers who planned to formula feed or who intended to supplement breast milk with formula following hospital discharge were excluded from this study. Additional maternal exclusion criteria were multiparity, diagnosed sleep disorder, diagnosed psychiatric illness, chronic medical condition, history of breast surgery, and birth-related complications such as excessive blood loss during birth (greater than 500 ml of blood loss during vaginal delivery or more than 1000 ml during cesarean delivery), preeclampsia, and gestational diabetes (Lee, 2003; Powers, 2016). Women under the age of 18 were not included as sleep architecture is altered in adolescence (Hagenauer & Lee, 2013).

Infant exclusion criteria included: any infant admitted to a special care nursery or neonatal intensive care unit, premature birth (born at less than 37 weeks' gestation), low birth weight (less than 2500 gm.), ankyloglossia (tongue-tie), congenital malformations, and/or suspected sepsis (Powers, 2016).

Protection of Human Subjects.

To ensure protection of participants, IRB approval was obtained from both Georgia State University and through the hospital where recruitment took place.

Informed consent was obtained upon enrollment into the study during the second phase of recruitment. To ensure participants' privacy and confidentiality, participants were assigned a numeric code, and no identifying data were reported in study findings. All data collected were kept in a locked cabinet in the researcher's office.

The Edinburgh Postnatal Depression Scale (EPDS) was used for data collection in this study. To ensure safety of participants who scored above the cutoff for depressive symptoms, a strict protocol was followed. Participants were assigned one of two categories, high risk for depression (total score $\geq$ 10) and high risk for harm to themselves as defined as a score of "1-3" on item 10 of the EPDS.

Participants deemed high risk for depression, but not high risk of immediate harm, were referred by the researcher to their primary care provider and provided a list of professional and community resources specific to postpartum depression. No participant recorded a positive response to item 10. In the event this had occurred, the protocol was for the researcher to confirm the response, contact the Licensed Professional Counselor consulting for the study, and request further evaluation. The researcher was to maintain direct observation with the participant until an action plan was established by the consultant.

Sample Size

To determine minimum sample size, a power analysis was conducted for hierarchal multiple regression analysis to be used to answer research question one using statistical software. Five predictor variables (age, education, financial status, degree of partner/family support, and mode of delivery) were entered into the calculation for set one and one predictor variable (degree of maternal stress) was entered for set two. Inputs

were calculated for a medium Cohen's f-square effect size of .15, power of .80, and probability of .05. Based on these factors, a minimum sample of 59 participants was determined to be needed (danielsoper.com, 2018).

Instruments

Measurement of study variables included both subjective and objective measures. The next section describes the instruments to be used in this study. Independent or predictor variables measured were: maternal sleep, stress, symptoms of anxiety and depression, and fatigue. Outcome variables were maternal milk supply and breastfeeding status.

Maternal Sleep

Maternal sleep was measured subjectively using the General Sleep Disturbance Scale (GSDS, Lee et al., 1991) and the Core Consensus Sleep Diary (CCSD, Carney et al., 2012).

General Sleep Disturbance Scale (GSDS)

The GSDS is a 21-item, self-report scale that assesses individuals' sleep disturbances in the past week. Items address a range of general sleep issues, such as perceived quality and quantity of sleep, sleep onset latency, awakenings after sleep onset, daytime sleepiness, and medications used to induce sleep (Lee et al., 1991). Responses are indicated using an eight-point Likert scale with a range from zero "no days" to seven "every day". The total score is an average of the items, ranging from zero to seven. A score above three indicates clinically significant sleep disturbance (Lee et al., 1991).

The GSDS has been widely used during pregnancy and the postpartum period and has demonstrated adequate internal consistency (Cronbach's α: .78 - .89) (Goyal et al.,

2009; Lee et al., 2007; Lee et al., 2012; Lee & Gay, 2011; Lee & Hsu et al., 2012; Lee & Kimble, 2009; Lee & Lee 2007; Lee & Lee, 2009; Tsai & Thomas, 2012) and test-retest reliability (Tsai & Thomas, 2012). Concurrent validity has been established when compared to objective measures of sleep using actigraph data (Lee et al., 2007). Predictive validity has also been demonstrated when comparing scores to morning fatigue severity scores (Lee et al., 2007).

To decrease study participants' burden, the sleep medication (6-item) subscale was not included in this study. Many sleep medications are contraindicated while breastfeeding (Proctor & Bianchi, 2012); thus, postpartum women are not likely to take sleep medications while breastfeeding. For this reason, screening for these medications was deemed unnecessary.

Core Consensus Sleep Diary (CCSD)

Postpartum sleep was measured for three consecutive nights between the 10th and 14th postpartum day. The CCSD is a 9-item, self-report sleep log that was used to collect total nighttime sleep in minutes, number of awakenings, and length of awakenings in minutes each night for the consecutive three-night period (Carney et al., 2012). The CCSD was developed by a panel of experts to standardize sleep diaries for use in clinical research (Carney et al., 2012). Respondents completed the sleep diary each morning, within one hour of awakening. Seven fill-in-the-blank items prompt respondents to describe the previous night's sleep, such as "what time did you go to bed?" "how long did it take you to fall asleep?", and "how many times did you wake up?" One Likert scale item, rates the previous night's sleep, with responses ranging from "very good" to "very poor". The final item was an open-ended response that allows respondents to enter

additional comments pertaining to factors that may have impacted sleep (Carney et al., 2012).

Sleep diaries have been widely used in sleep in perinatal research either in conjunction with other objective measures of sleep (Insana et al., 2011; Lee & Lee, 2007; Montgomery-Downs et al., 2010a; Montgomery-Downs et al., 2010b; Doan et al., 2014) or as a stand-alone sleep measurement (Yamasaki, 2005). Few studies have examined reliability and validity of sleep logs (Carney et al., 2012; Morgenthaler, 2007). Of those, many found respondents consistently underestimate TST and overestimate sleep onset latency, when compared to polysomnography and wrist actigraphy data (McCall & McCall, 2012; Morgenthaler, 2007). One study of healthy postpartum women did find sleep diary data to be highly correlated with wrist actigraphy data when intra-class correlations between subjective and objectives measures were calculated, however (Insana et al., 2011).

Stress

Maternal stress was measured with the Perceived Stress Scale (PSS-10). The PSS-10 is a self-administered questionnaire that measures "the degree to which situations in one's life are appraised as stressful" (Cohen, 1983). Each item asks respondents to rate how often they have "felt a certain way" over the past one-month on a five-point, Likert scale ranging with response ratings from zero, "never" to four, "very often" (Cohen et al., 1983). Possible total scores range from 0-40. A higher score indicated higher degree of perceived stress (Cohen et al., 1983). Scoring is further classified using the following cutoff scores: 0 to13 low stress, 14 to 26 moderate stress, and 27 to 40 high stress (State of New Hampshire, n.d.).

The PSS-10 has been used across several studies including studies of pregnant and postpartum women, and has demonstrated good internal consistency (Cronbach's α:.78-.87) (Barbosa-Leiker et al., 2013; Citvitki, 2015; Ko et al., 2014; Smith et al., 2014; Taylor, 2015) and good test-retest reliability (.81) (Ko et al., 2014). Construct validity was demonstrated by principal components factor analysis, which indicate two separate constructs, perceived degree of stress and perceived ability to cope in the PSS (Barbosa-Leiker et al., 2013; Cohen & Williamson, 1988; Smith et al., 2014; Taylor, 2015). Concurrent validity was established by comparing PSS-10 scores to life events scale in studies of college students and participants in a smoking cessation program. Across studies, higher PSS scores were significantly related to higher impact of life events scores (Cohen et al., 1983). Discriminant validity was established by comparing PSS-10 results with other established measures of stress and coping (Smith et al., 2014).

Fatigue

Fatigue was measured by using the 7-item Lee's Fatigue Scale (LFS-7), (Lee et al., 1991). Respondents rated fatigue by circling a number that indicated how they were feeling in the present moment on a 0-10 scale. Item descriptors for assessment of fatigue include adjectives such as "tired, sleepy, and drowsy" (Lee et al., 1991). Total scores were obtained by averaging the sum of items for a possible total fatigue score ranging from 0-10. A higher score indicated more fatigue severity (Tsai et al., 2014). The LFS has been widely used for measurement of fatigue among childbearing women and demonstrated a stable internal consistent coefficient (Cronbach's α: .86-.97) (Lee & Hsu, 2012; Lee & Zaffke, 1999; Tsai et al., 2014).

The LFS-7 has demonstrated adequate validity for measurement of fatigue among postpartum women. Construct validity has been established by exploratory factor analysis (EFA) and found a total of 88% - 94% variance accounted for fatigue while monitoring maternal fatigue severity during trimester and within three months following birth (Tsai et al., 2014). Discriminant validity was also established by comparing LFS to depressive symptoms (Tsai et al., 2014).

Depressive Symptoms

The Edinburgh Postnatal Depression Scale (EDPS) was used to measure presence of postpartum depressive symptoms (Cox et al., 1987). The 10-item self-administered EDPS has been widely used in postpartum research for the detection of postpartum depression. Participants rated symptoms present in the past seven days on a 0-3 scale, with higher scores indicating higher degree of symptoms. A score of 13 or greater indicates postpartum depression may be present (Cox et al., 1987).

The EPDS has demonstrated good reliability (Cronbach's α: .75-.91) across studies of pregnant and postpartum women (Bascom & Napolitano, 2016; Corrigan et al., 2015; Hartley et al., 2014; Kuo et al., 2012; Manber et al., 2013; Petrozzi & Gaglardi, 2013; Torecki et al., 2014; Zhong et al., 2014), and discriminant validity (sensitivity 87% /specificity 76%). When compared to another widely used instrument in perinatal research, the Postnatal Depression Scale, the EPDS demonstrates higher positive predictive value (58%) versus the PDSS (48%) (White, 2008).

Anxiety

Maternal anxiety was assessed using the State-Trait Anxiety Index (STAI) (Spielberger, 1983). The STAI is comprised of two separate scales that assess two distinct forms of anxiety. The first scale, S-Anxiety Scale measures state anxiety. The second, T-Anxiety Scale, measures trait anxiety. Both consist of 20 items and are self-administered. State anxiety thought to be an emotional reaction to stressful events and refers to feelings of apprehension, nervousness, or worry that is transient and fluctuates, often to a great degree over time. Trait anxiety refers to negative feelings of nervousness, worry, or tension related to perception of stressful situations that are more stable and variable between individuals (Spielberger, 1983). Due to a strong correlation between the two subscales (r = .65*)* and the transitional nature of the postpartum period, only the S-Anxiety Scale was used.

Each item in S-Anxiety Scale has a response scale from 1 to 4, with a possible score ranging from 20 to 80. Reverse scoring was performed for 10 items. A higher score indicates a higher level of anxiety. Mean state-anxiety scores provided in the manual for adult females was 35.2 (Spielberger, 1983).

The STAI has been widely used in research used in research and has established excellent reliability and validity. When tested in healthy working adults, college students, and high school students, both scales demonstrated excellent internal consistency (S-Anxiety α: .86 - .95, T-Anxiety α: .89 - .91). Test-retest reliability for the T-Anxiety Scale was also demonstrated in these groups (r = .76 - .77*),* but not for the S-Anxiety Scale, and was likely to be due to the transient nature of state anxiety (Spielberger, 1983).

The S-Anxiety Scale has demonstrated good construct and concurrent. S-Anxiety scale scores were higher among military recruits during training programs than the other groups and in college students before exams. S-Anxiety scores were lower for college students following exams. When compared to other validated measures of anxiety, the IAT Anxiety Scale, the Taylor Manifest Anxiety Scale, and the Zuckerman Affect Adjective Checklist, scores of the STAI were highly correlated *(r* = .73 - .85*)* (Spielberger, 1983).

A recent study confirmed the STAI S-Anxiety Scale as a valid measure in pregnant populations. Using an open-ended question, researcher compared results to S-Anxiety Scale scores. The S-Anxiety Scale was positively associated (p = .01) with participant's anxiety surround their current pregnancy and with overall anxiety (p = .005) (Gunning et al., 2010).

Breastfeeding Status

Hospital discharge breastfeeding status was collected via telephone interview with the mother at approximately 7-10 days postpartum. Additional data collected related to breastfeeding included the infant's birth weight and discharge weight which may indicate efficacy of infant feedings. Infant feeding status was measured at two weeks and one month postpartum. Postpartum measurement consisted of participants completing a simple researcher developed questionnaire to assess current infant feeding status: breast milk only, breast milk plus formula, or formula only.

Milk Volume

Breast milk volume was measured using a test weight procedure to estimate infant intake, (Meier et al., 1996). Test weighing has been widely used in clinical practice and

research, as it is easy to perform, relatively inexpensive, and does not disrupt normal breastfeeding processes (Powers, 2016). To perform the procedure the Medela Baby Weigh infant scale, a calibrated, electronic scale with integrative function allowing for infant movement and gram measurement sensitivity accurate to two grams, was used (Powers, 2016). The scale was calibrated per manufacturer guidelines between each use. The clothed infant was weighed just prior to feeding, and then again in the same clothing immediately following the feeding. The first weight was subtracted from the second weight. The difference between the two weights was calculated and recorded. Grams were converted in to weight in milliliters (1 gram = 1 milliliter). The difference between the first and second weight equated to milliliters consumed (Meier et al., 1996; Scanlon et al., 2002).

Test weights have proven to be a reliable and valid method for estimating infant breast milk intake with high correlations (.97) when compared to a reference standard of measured intake of formula or expressed breastmilk (Meier et al., 1990). Test weights have traditionally been performed over the course of a 24-hour period; however, studies have indicated shorter time intervals are sufficient, and results are more accurate when calculated for a minimum of two consecutive feedings (Scanlon et al., 2002). For this reason, mothers were instructed during the home visit on how to perform two additional weights and record their newborn's weight in grams for two subsequent feedings for a total of three test weights. Mothers received written instructions about weighing and an investigator developed form for recording weights. Mothers recorded the number of additional feedings and method of infant feedings for the 24-hour period. An estimate of maternal milk volume in milliliters was calculated by averaging the three test weights

performed, and multiplying the average per feed by the number of total feedings for the 24-hour period. No mothers in this study supplemented their babies with formula during this time.

Data Collection/Procedures

Upon initial contact with potential participants, a screening questionnaire was completed. If participants met the eligibility criteria and agreed to participate, written informed consent was obtained. General information regarding maternal characteristics, such as age, marital status, education level, income level, and cultural background were also obtained. The researcher developed a notification procedure, either a telephone call or text message, from the participant once delivery date was known.

Following hospital discharge, approximately 7-10 days postpartum, birth data were obtained from the mother via telephone interview to determine method and timing of delivery and to identify delivery complications that may complicate successful breastfeeding. Exclusive breastfeeding status was confirmed. Infant characteristics, such as birth weight and hospital discharge weight also were collected. To minimize missing data during both phases of recruitment, the researcher reviewed screening questionnaires for any incomplete entries. Participants were given the option of completing missing items or leaving unanswered per their comfort level. For those who met criteria during both phases of recruitment, data were collected at two time periods: at two weeks and at one month postpartum.

During phase two of enrollment, participants received the CCSD sleep diary with instructions for when and how to record their sleep and when they would receive reminders. A follow up telephone call was made or text message sent, per participant

preference, on the date sleep diary data was scheduled to begin to ensure understanding of sleep diary procedures and to minimize missing data. Participants recorded sleep using the CCSD three nights prior to the scheduled in-home visit agreed upon by the participant and researcher.

Data Collection Time One: Two Weeks Postpartum

At approximately two weeks postpartum, an early morning home visit was scheduled at the participant's convenience to administer the demographic questionnaire, GSDS, LFS-7, EPDS, PSS-10, and STAI. Sleep diary data were collected during this visit. A test weight was performed during the first available breastfeeding session by the researcher, immediately before and after breastfeeding. Detailed verbal and written instructions for performing subsequent test weights including use of the scale, recording of infant feedings and test weight data using a 24-hour feeding and test weight log was provided to the mother. The researcher returned to the home after 24 hours of data collection to retrieve the infant scale and test weight data at a time convenient to both the researcher and participant.

Data Collection Time Two: One-Month Postpartum

At one-month postpartum, a telephone call was made by the researcher to determine participants' breastfeeding status by administering the breastfeeding questionnaire. See Appendix B for a complete list of the researcher developed screening questionnaires. Study protocol and data collections procedures are outlined in Figure 2.

Figure 2. Study Protocol: Recruitment and Data Collection Procedures

Recruitment Procedure

Recruitment: Phase 1
Recruit from childbirth classes at approximately 36 weeks:

- Complete Participant Screening Questionnaire
- Once eligibility confirmed, move forward to Phase II

Recruitment: Phase 2
At approximately 7-10 days postpartum:

- Complete Delivery & Newborn Data Questionnaires
- Confirm Breastfeeding Status
- Provide Sleep Logs with written instructions
- Obtain Informed Consent

Eligible Participant Data Collection Procedures:

Time 1: Two Weeks Postpartum
Researcher to conduct in visit at approximately two weeks postpartum

- CCSD completed by participant for three consecutive nights prior to visit
- Early morning visit to:

Perform test weight procedure
Administer GSDS, LFS, PSS, EPDS, STAI- State Scale
Collect sleep logs

Time 2: One Month Postpartum
Follow-up telephone call made by researcher

- Breastfeeding Questionnaire completed

Data Analysis

Prior to analysis, all data were reviewed for completeness. Internal consistency reliability measures for all questionnaires were calculated using Cronbach's alpha coefficients as appropriate. Any missing data totaling 20% or less of total sample data was assigned the mean value of the sample for the item of measurement. Breastfeeding cessation was dummy coded. Descriptive statistics were used to describe maternal and infant characteristics and major study variables. Data were examined for normal distribution. Any non-normally distributed data was transformed using SPSS 23 for parametric analysis.

Hypotheses

Hypothesis one, H1: In a sample of first-time mothers of full-term, healthy newborns, impaired sleep (self-report nocturnal sleep less than seven hours, sleep quality score 3 or above measured by General Sleep Disturbance Scale) will be positively associated with breast milk volume less than 650 ml in a 24-hour period, at the early postpartum stage).

To test this hypothesis, several analyses were conducted, First, mean total breast milk volume was compared between participants reporting less than seven hours of sleep versus those reporting seven or more hours of sleep and between participants with GSDS scores 3 or above versus those with scores below the cutoff. Pearson correlation was first performed to test for associations among TST in minutes, TST less than seven hours, GSDS total score, GSDS score at or above the cutoff score and log-transformed 24-hour milk volume. Due to small sample size, a Chi-square analysis was also performed to test for associations among dichotomous variables (TST less than seven hours, GSDS score at

or above cutoff, and 24-hour milk volume less than 650 ml). Finally, to compare differences in mean true 24-hour milk volume between poor sleepers versus good sleepers, a Mann-Whitney U was performed.

Hypothesis two, H2: Impaired sleep will predict early breastfeeding cessation at two weeks and at one month postpartum, was not able to be tested, as all mothers in this study were still breastfeeding at the time of the two-week home visit, and at one month postpartum. Two were supplementing occasionally at the time of the two-week home visit but mostly breastfeeding and three were supplementing occasionally at one month postpartum.

Research Questions

Research question one, to what degree is postpartum sleep impairment explained by selected personal characteristics (age, education, financial status, degree of partner/family support, and mode of delivery) and degree of maternal stress, hierarchical linear regression analysis was used to determine how the independent variables, maternal characteristics and stress, contributed to the variance of impaired sleep.

Due to low sample size, Pearson product moments correlation was used as an initial test of associations among independent variables and GSDS total score before to running the regression model. For the regression analysis, maternal characteristics found to be significantly associated with GSDS score were entered as the first step followed by maternal stress.

Research Question Two: Which adverse health consequences of impaired sleep, fatigue or mood status (symptoms of depression and anxiety), contributed the most variance for decreased breast milk volume and breastfeeding cessation. For this analysis,

breastfeeding cessation did not occur and was unable to be analyzed. Pearson product moments correlation was used for initial test of associations among the independent variables with decreased breast milk volume before to running the regression model. Findings from all analyses are discussed in the next chapter.

CHAPTER IV

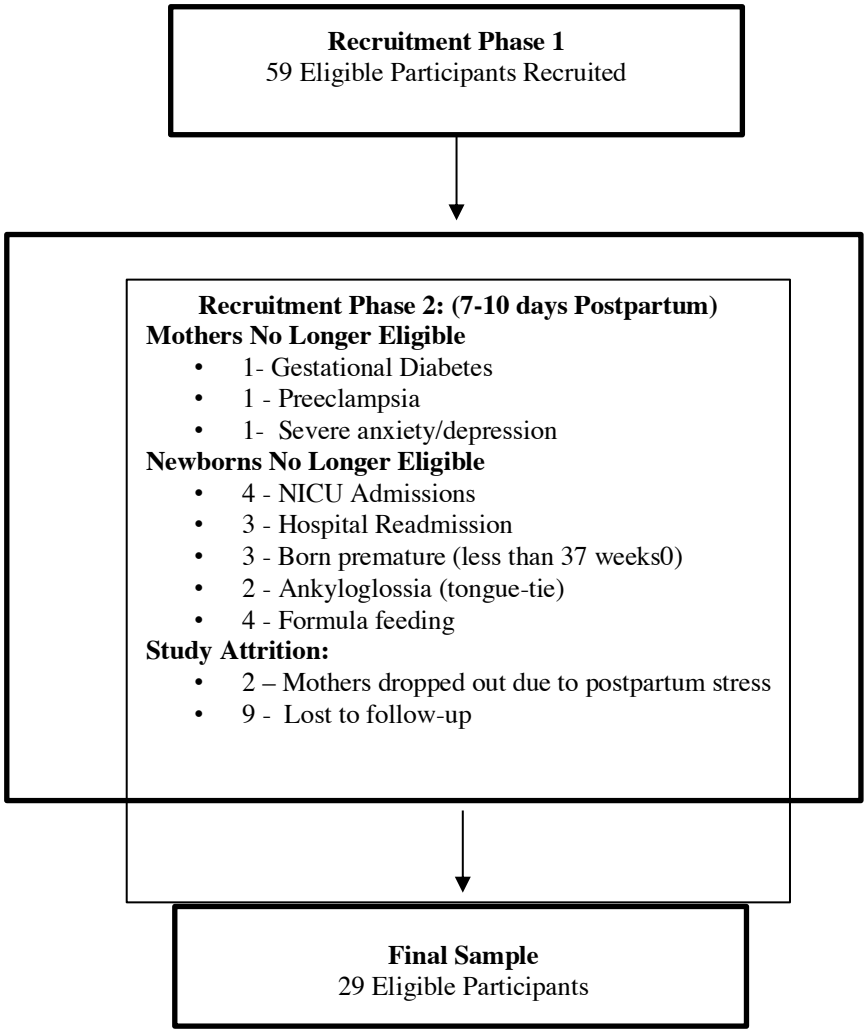
RESULTS

This chapter provides a detailed description of study results. Prior to analysis, data accuracy and completeness were ensured following the procedure outlined in Chapter III. Outliers, missing data, and normal distribution were evaluated. Missing data were minimal and totaled 20% or less of total sample. These data were assigned the mean value of the sample for the item of measurement. Non-normally distributed data was transformed using Log10 transformation procedure prior to parametric analysis. Internal consistency reliability measures for all questionnaires using Cronbach's alpha coefficients are reported. Sample characteristics, findings from all measurements used, and results of hypotheses/research questions testing are also reported.

Sample Characteristics

A total 59 participants were recruited during phase one. Of those recruited, 19 no longer met criteria during phase two due to the following: one maternal preeclampsia, one maternal gestational diabetes, one maternal report of severe depression/anxiety, four newborns with NICU admission, three newborns readmitted to the hospital within first two weeks, three premature births, two newborns with ankyloglossia, and four formula feeding at time of second phase recruitment (Figure 3). Of the remaining participants, 9 were unable to be reached and two dropped due to reported high degree of stress experienced during transition to the maternal role. The number of eligible participants remaining was 29.

Figure 3. Recruitment and Eligibility



Of the 29 mothers, ages ranged from 22 to 35 (M=29.6, SD=3.81) years, in this study, all were recruited from childbirth classes held at two of the hospital's campuses. Most of the study participants (Table 2) were Caucasian, married, and had an annual income above $50,000. All were high school graduates and reported excellent social support. Most delivered vaginally, and all newborns were full-term, healthy, and breastfeeding at the time of hospital discharge.

Table 2

Participant Characteristics

	n	%	*M*	*SD*	Range
Maternal Age	29		29.6	3.8	22-35
Ethnicity					
White	25	86.2			
Hispanic/Latino	1	3.4			
Asian/Pacific Islander	1	3.4			
Other	2	6.9			
Marital Status					
Married	27	93.1			
Single	2	6.9			
Education					
High School	6	20.7			
Bachelor's Degree	15	51.7			
Graduate Degree	8	27.6			
Household Income					
Less than 25,000	1	3.4			
25,001 - 50,000	6	20.7			
50,001 - 75,000	11	37.9			
75,000 - 100,000	5	17.2			
More than 100,000	5	17.2			
Prefer not to share	1	3.4			
Method of Delivery					
Vaginal	24	82.8			
Cesarean	5	17.2			
Newborn Gender					
Male	14	48.3			
Female	15	51.7			
Gestational Age	29		39.5	1.23	37.2 - 42.0
Birthweight	29		3336.8	331.6	2636.5 - 3997.3
Weight at two weeks	29		3613.4	213.9	2746 - 4120
Degree of Support	29		9.75	0.44	9.0 - 10.0

Description of Major Study Variables

As described in Chapter III, variables measured included maternal stress, sleep impairment and sleep quality, fatigue, depressive symptoms and situational anxiety. Prior to analysis, all instruments for these variables were evaluated for reliability as appropriate and Cronbach's alpha coefficients are reported in Table and all were adequate ($a \geq .70$) Results are summarized in Table 3.

Postpartum Sleep Characteristics

Nighttime TST was averaged using three consecutive nights of self-reported data collected from the CCSD sleep diary. At two weeks' postpartum, TST ranged from 248.33 – 560.0 minutes (4.12 hours to 9.33 hours) per night with an average of 6.87 hours. Half of participants reported less 7 hours nocturnal TST, which is recommended as the minimum to maintain health (NSF, 2015).

GSDS scores were measured by averaging the GSDS score. For most mothers, sleep at two weeks postpartum was clinically disturbed. More than half of mothers rated sleep quality as poor (GSDS cutoff score of ≥ 3).

Maternal Stress

Maternal stress (PSS-10) scores on average were lower than the average M=16.14 (SD=7.56) for U.S. women (Cohen, 1983; Janicki-Deverts, 2012). A one-sample t-test was performed and mean scores in this study were not statistically different than for all U.S women. Slightly more than half of the participants reported low perceived stress, more than one-third reported moderate stress, and few reported high levels of perceived stress.

Maternal Fatigue

Fatigue was measured by averaging the score of LFS items. The average LFS score was above the cutoff point of 3.3, which indicates clinically significant fatigue severity. The vast majority of women in this study had a total score greater than 3.3, indicating that at two weeks postpartum, mothers in this study experienced clinically significant fatigue.

Depressive Symptoms

Depressive symptoms were measured by calculating the sum of subjective responses to EPDS items. The mean EPDS score for the total sample was below the cutoff point of 10. Just over 27% had an EPDS score above the cutoff point of 10, indicating a high risk for developing postpartum depression. For these women, the study protocol was followed for these women based upon their depression risk category. All women responded "never" to item 10 (The thought of harming myself has occurred to me). All women received follow up care with their primary care provider and were doing reported that they were doing well at the one-month phone interview.

Anxiety

Maternal anxiety level was measured by the STAI-S. More than two thirds of women scored below 35, the national mean for U.S. women. A one-sample t-test was performed and found no significant difference in mean STAI-S score between women in this study and the U.S. general female population.

Breastfeeding Outcomes

All participants were breastfeeding exclusively at the second postpartum week. At one month postpartum; however, three (10.3%) were supplementing with formula. Reasons for supplementation were varied. Two reported poor infant weight gain and recommendation to supplement by their pediatricians as primary reason for supplementing, and one reported personal preference as the primary reason.

Average 24-hour breast milk volume was calculated using data collected from test weight log. The difference between in infants' weights before and after feeding were first calculated to determine estimated intake in milliliters for the feed. The average for three consecutive feedings was then calculated and multiplied by total number of feedings for the 24-hour period. For the sample, average estimated 24-hour milk volume was 602.22 ml (SD=213.86) and ranged from 375.43 ml to 1086.67 ml. Average infant weight gain was 276.62g (SD=256.1). Infant weight change at two weeks of age ranged from a loss of 411.28g to a gain of 725.11g compared to birth weight, and four infants (13.8%) had not regained their birth weight. Pearson's Product Moments Correlation was conducted to test for correlation between infant weight gain at two weeks and transformed 24-hour milk volume. A positive association was found between infant weight at two weeks and average 24-hour milk volume ($r = .411$, $p = .03$), indicating that greater infant weight gain at two weeks was associated with higher 24-hour milk volume. Of the 29 participants, most (75.9%) had a 24-hour total milk volume less than 650 ml at two weeks postpartum.

Table 3

Descriptive Statistics & Cronbach's Alpha Coefficient for Study Measures

Measurement	*N*	%	*M (SD)*	*Range*	*α*
Sleep Measures					
CCSD Nighttime TST (min)	29		412.31 (83.49)	248.33 - 560.0	
CCSD Nighttime TST (hrs.)					
≥ 7 hours	14	48.3			
Less than seven hours	15	51.7			
GSDS Score	29		3.59 (1.12)	1.36 - 6	.82
Score ≥ 3	20	69			
Score less than 3	9	31			
PSS	29		14.76 (6.75)	3.0 - 33	.91
Low (Score 0 - 13)	16	55.2			
Moderate (Score 14-26)	11	37.9			
High (Score ≥ 27)	2	6.9			
LFS	29		5.00 (2.17)	.57 - 8.71	.93
Score ≥ 3.3	24	82.8			
Score less than 3.3	5	17.2			
EPDS	29		7.55 (5.13)	1.0 - 26	.88
Score 10 – 12	6	20.7			
Score ≥ 13	2	6.9			
STAI-S	29		33.01 (9.95)	20 - 59	.93
Score ≥ 35	8	27.6			
Score less than 35	21	72.4			
Test Weights					
24-hour Milk Volume	29		602.22 (213.86)	375.48 - 1086.67	
≥ 650 ml	7	24.1			
Less than 650 ml	22	75.9			

Note: CCSD = Core Consensus Sleep Diary, GSDS = General Sleep Disturbance Scale; PSS = Perceived Stress Scale, LFS = Lee Fatigue Scale, EPDS = Edinburgh Postnatal Depression Scale, STAI – S = State Trait Anxiety Index - State

Results for Hypothesis and Research Questions

Hypothesis one and research questions were analyzed using procedures outlined in Chapter III. Hypothesis two was not tested due to all participants still breastfeeding at one month postpartum.

Hypothesis One

H1: In a sample of first-time mothers of full-term, healthy newborns, impaired sleep (self-report nocturnal sleep less than seven hours, sleep quality score three or above measured by General Sleep Disturbance Scale) will be associated with breast milk volume less than 650 ml in a 24-hour period, at the early postpartum stage.

Majority of the mothers (75.9%) produced less than 650 ml of breast milk in 24-hours. Prior to performing analyses, milk volume less than 650 ml and TST less than seven were dummy-coded. Log-transformed 24-hour milk volume was used for parametric analyses. Pearson's correlation analysis found no significant relationships between TST, TST less than seven hours, and GSDS total score with 24-hour milk volume. A negative relationship was found between those mothers with impaired sleep (GSDS at or above the cutoff score of three) and 24-hour milk volume (r = -.42, p = .03), indicating poorer sleep quality was associated with less milk production (Table 4).

Chi-square analyses performed to test for associations among dichotomous variables (TST less than seven hours, GSDS score ≥ 3, and 24-hour milk volume less than 650 ml) indicated the sample size was too small for adequate interpretation. Due to this finding, a Fisher's Exact Test was performed. No relationship between TST less than seven hours and 24-hour milk volume less than 650 ml (p = .54) and GSDS score ≥ 3 and 24-hour milk volume less than 650 ml (p = .11) were found.

Table 4
Pearson's Correlations of Sleep Impairment and Breastmilk Volume

	Variable	1	2	3	4	5
1	24-hour milk volume	--				
2	TST Average	.03	--			
3	TST 7 ≥ hours	-.01	.86***	--		
4	GSDS Score	-.34	.03	.04	--	
5	GSDS Score ≥ 3	-.42*	-.15	-.10	.75***	--

Note: *p=.05, ***p=.001; TST = Total Sleep Time; GSDS = General Sleep Disturbance Scale

Prior to transformation, average 24-hour breast milk volume for women reporting more disturbed sleep (GSDS score ≥ 3) was 183.05 ml less than those reporting less disturbed sleep. To test for differences between groups, an independent samples t-test was performed using log-transformed 24-hour milk volume and found women with more disturbed sleep (GSDS score ≥ 3) had significantly less 24-hour breast milk volume than those without disturbed sleep (t (27) = 2.378, p = .03). Due to the small sample size, a Mann Whitney U was also performed. Total 24-hour milk volume among women with more disturbed sleep (*Mdn* = 506.64 ml) was significantly lower than among those without disturbed sleep (*Mdn* = 639.00 ml, U = 46, z = -2.075, p =. 04)

Results indicate hypothesis one is partially supported. Self-reported nocturnal TST and TST ≥ seven hours were not associated with 24-hour milk volume. None of the independent variables were associated with 24-hour milk volume less than 650 ml at two weeks postpartum. Correlation found GSDS score at or above the cutoff score was significantly associated with lower 24-hour milk volume at two weeks postpartum.

Research Questions

R1: To what degree is postpartum sleep impairment explained by selected personal characteristics (age, education, financial status, degree of partner/family support, and mode of delivery) and degree of maternal stress.

Prior to analysis, mode of delivery was dummy coded. Due to small sample size, a maximum of three variables could be used for final regression analysis; therefore, a correlation coefficient of .30 or higher was used to select maternal characteristics for the regression analyses. If none were correlated at a level of .30 higher, the two maternal characteristics with highest correlation to the dependent variable were used (Mukaka, 2012).

Among the maternal characteristics, only annual income was related to TST average at a level of .30 or higher (r = -.40, p = .03), suggesting higher income was associated with decreased nocturnal TST for mothers. PSS-10 score was not significantly related to TST. None of the selected maternal characteristics were significantly related to GSDS score. PSS-10 scores were positively associated with GSDS score (r = .63, p=.001), indicating that higher PSS-10 score at two weeks postpartum was associated with higher GSDS score for new mothers. Due to these findings, the two maternal characteristics with the highest correlations with GSDS score, maternal age (r =.21, p=.285) and maternal education (r =.25, p=.185) were selected for regression analysis (Table 5).

Table 5
Correlations of Sleep Disturbance, Maternal Characteristics, and Perceived Stress (N = 29)

	Variable	1	2	3	4	5	6	7
1	TST	--						
2	Age	-.02	--					
3	Income	-.40*	-.01	--				
4	Education	-.06	.01	.29	--			
5	Delivery	.11	-.34	-.06	.24	--		
6	PSS -10	-.05	.15	-.18	.17	-.22	--	
7	GSDS Score	.03	.21	.13	.25	-.06	.63***	--

Note: $*p$ =.05, *** p = .001; TST = Total Sleep Time; PSS-10 = Perceived Stress Scale 10-item; GSDS = General Sleep Disturbance Scale

The first hierarchal linear regression was performed to evaluate if annual income and maternal stress significantly predicted nocturnal TST average. Annual income was entered in to the model first, followed by PSS score for the predictor variables and nocturnal TST average for the dependent variable. Annual income and PSS explained 18% of variance for TST (R^2 = .18, F (2, 26) = 2.78, p = .08) of the full model; however, the model was not statistically significant. Annual income was the only significant predictor (Beta = -.43, p =.03) of TST. This finding indicates that higher annual income, but not PSS-10 score predicted nocturnal TST average at two weeks postpartum in this study (Table 6).

Table 6
Regression Analysis Results Maternal Stress, Annual Income, and Total Sleep Time (N=29)

	Model 1			Model 2		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Annual Income	-27.93	12.22	-.40*	-29.43	12.55	-.43*
PSS - 10				-1.5	2.24	-.12
R^2		.16			.17	
F for change in R^2		5.221*			.42	

Note: *p = .05; PSS-10 = Perceived Stress Scale, 10-item

A second hierarchal linear regression was performed to identify significant predictors for self-reported sleep disturbance (GSDS). For this analysis, none of the selected maternal characteristics correlated at .30 or higher. The two with the highest correlations, maternal age and education level (r > .2), were entered in to the model first, followed by PSS-10 score. For the full model, age, education level and PSS accounted for 43.2 % (R^2 = .432, F (3, 25) = 6.348, p=.002); however, only PSS-10 was a significant predictor (Beta = .59, p =.001) of sleep disturbance (Table 7).

Table 7
Regression Analysis Results Age, Education, Maternal Stress and GSDS Score (N=29)

	Model 1			Model 2		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Age	.06	.05	.20	.03	.05	.12
Education	.26	.20	.25	.15	.16	.15
PSS - 10				.10	.03	.59***
R^2		.11			.43	
F for change in R^2		1.52			14.43***	

Note: ***p = .001; PSS-10 = Perceived Stress Scale, 10-item

R2: Which adverse health consequences of impaired sleep, fatigue or mood status (symptoms of depression and anxiety), contributed the most variance for decreased breast milk volume and breastfeeding cessation.

This question was only partially tested as all women were still breastfeeding at one month postpartum. Pearson's Correlation was first performed to test for associations between independent variables (LFS, log-transformed STAI-S, and log-transformed EPDS scores) and the dependent variable. PSS score and GSDS scores were also analyzed as stress was found to be a significant predictor of sleep disturbance in the previous analysis and GSDS scores were significantly associated with lower 24-hour milk volume. No statistically significant associations were found between any sleep-related health consequences of impaired sleep or maternal stress with 24-hour milk volume. Correlation results are summarized in Table 8.

Table 8
Correlations of Adverse Health Consequences of Sleep Impairment and 24-hour Breastmilk Volume (N=29)

	Variable	1	2	3	4	5	6
1	24-hour milk volume	--	.				
2	LFS - 7	-.11	--				
3	EPDS	.07	.48**	--			
4	STAI-S	-.02	.56**	.49**	--		
5	PSS-10	.02	.49**	.60***	.70***	--	
6	GSDS	-.34	.70***	.58***	.52**	.63***	--

*Note: * p =.05, ** p* = .01, ****p* = .001; LFS = Lee Fatigue Scale, 7-item; EPDS = Edinburgh Postnatal Depression Scale; STAI-S = State Trait Anxiety Index - State; PSS-10 = Perceived Stress Scale, 10-item; GSDS = General Sleep Disturbance Scale

Hierarchal linear regression also was performed to identify significant predictors for 24-hour milk volume. Due to very weak associations found among adverse health outcomes variables and the dependent variable, the two independent variables with the highest correlations, LFS-7 score (r = -.11, p = .57) and EPDS score (r = .07, p = .73) were selected for analysis. LFS-7 and EPDS scores were entered in to the model first, followed by GSDS score for predictor variables, and log-transformed 24-hour milk volume was the dependent variable. Maternal fatigue, depressive symptoms, and sleep quality 23.6% of total variance (R^2 = .24, F (3, 27) =2.58, p=.08). Only GSDS score was a significant predictor of 24-hour milk volume, (Beta = -.70, p = .02). Findings indicate poorer sleep quality predicted lower 24-hour milk volume. See Table 9.

Table 9

Regression Analysis Results Fatigue, Depressive Symptoms, Sleep Quality, and 24-hour milk volume (N=29)

	Model 1			Model 2		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
LFS-7	-.01	.01	-.18	.01	.02	.20
EPDS	.07	.09	.16	.16	.09	.38
GSDS				-.08	.03	-.70*
R2		.03			.24	
F for change in R2		.41			6.73*	

Note: *p = .05; LFS-7 = Lee Fatigue Scale, 7- item; EPDS = Edinburgh Postnatal Depression Scale; GSDS = General Sleep Disturbance Scale

Although there were no significant associations found among sleep-related health risk variables and 24-hour milk volume, significant relationships were noted among several of the independent variables. Maternal fatigue was positively associated with

depressive symptoms (r = .48, p =.01), maternal anxiety (r = .56, p =.002), and stress (r=.49, p=.007). These finding suggest higher degree of fatigue at two weeks postpartum was associated with higher maternal stress levels and depression and anxiety symptoms.

Depressive symptoms were positively correlated maternal anxiety (r =.49, p =.007), and stress (r =.60, p = .001). Higher maternal stress was positively correlated with maternal anxiety (r =.70, p = .001). These findings suggest higher degree of stress and fatigue at were associated with more depression and anxiety symptoms at two weeks postpartum. Further, higher anxiety was also associated with more depressive symptoms.

Sleep measures were highly correlated with all sleep-related health outcome measures. Poor sleep quality was positively correlated with maternal fatigue (LFS-7, r =.70, p =.001), depressive symptoms (EPDS, r = .58, p =.001), and anxiety (STAI-S, r =.52, p = .01). These findings suggest more disturbed sleep resulted in greater fatigue, depression, and anxiety symptoms for women in this study.

Conclusion

This chapter presented the results of a descriptive, correlational study that examined the impact of impaired sleep during the early postpartum period upon breastfeeding outcomes. A description of maternal and infant characteristics was reported. Findings from data collected during a home visit during the second postpartum week and via telephone interview at one month postpartum were presented. A discussion of study findings will be presented in the next chapter.

CHAPTER V

DISCUSSION AND CONCLUSION

This chapter provides an in-depth discussion of the significance of study findings. Impaired sleep and its impact upon healthy first-time mothers during the early postpartum period who are breastfeeding are described along with implications for nursing practice. Study strengths, limitations, and recommendations for future research are also presented.

Principle Findings

The Impaired Sleep Model was effective as an organizing theoretical framework for this study, as significant associations were found among many study variables. For example, higher maternal stress at two weeks postpartum was associated with more impaired sleep. Poor sleep quality was associated with more symptoms of fatigue, anxiety, and depression. These findings were all in the expected direction as proposed by the Impaired Sleep Model. This next section will summarize the findings of the major variables and compare with the existing literature.

Postpartum Sleep

Majority of the mothers in this study experienced sleep disturbances during the second postpartum week; over half reported sleeping less than seven hours per night. Most women (69%) rated sleep quality as poor during this period and had a GSDS score above the cutoff point for clinically significant sleep disturbance. These findings are

consistent with other studies that have found postpartum women experience shorter sleep periods than the recommended seven hours per night and significant sleep disturbance (Creti et al., 2017; Christian et al., 2018; McBean & Montgomery-Downs, 2015; Park et al., 2015; Park, et al., 2013; Sharkey et al., 2016; Titotsky et al., 2015).

Predictors of Postpartum Sleep Disturbance

In this study, perceived stress was the only significant predictors for self-reported sleep disturbances, which is consistent with previous studies (Christian et al., 2018; Ko et al., 2014; Hux et al., 2017; Lee & Hsu, 2012; Okun et al., 2013). Results from regression analysis were partially consistent with the literature. Strong associations between stress and sleep have been reported across studies (Christian et al., 2018; Ko et al., 2014; Hux et al., 2017; Lee & Hsu, 2012; Okun et al., 2013).

The finding that household income, not degree of stress was associated with TST was unexpected. In addition, most studies report lower income, not higher, to be associated with decreased TST, while some reported the opposite is true (Asgeirsdottir & Olafsson, 2015; Grandner et al., 2016). The use of a subjective measure of sleep opposed to an objective measure may have contributed to this finding.

The finding that higher degree of stress predicted poor sleep quality was consistent with other studies (Christian et al., 2018; Ko et al., 2014; Hux et al., 2017; Lee & Hsu, 2012; Okun et al., 2013). This discrepancy between the first and second analysis regarding the impact of stress on sleep might also be explained by use of a sleep diary only to measure of total sleep time. Inconsistency between the two analyses provides further support for the use of objective measurement of postpartum sleep in future studies.

Breastfeeding Outcomes

All women who completed the study were breastfeeding at one month postpartum and most were breastfeeding exclusively (90%). This is not consistent with what is currently reported in the literature, but may be explained by inclusion/exclusion criteria and timing of the second eligibility screen. Of women who were deemed ineligible and did not complete the study, four (7% of initially recruited sample) reported formula feeding at the time of the second screening. Newborns deemed ineligible, representing an additional 20% of the sample, had conditions known to increase risk of breastfeeding cessation. Finally, nine mothers were lost to follow up at one week postpartum. Though exact reasons for this are unknown, it is possible some mothers may have stopped breastfeeding, and therefore did not wish to be contacted by the researcher. These groups combined represented over 50% of the initially recruited sample, highlighting the low risk nature of women who completed the study versus those who did not. Additionally, all who completed the study were exclusively breastfeeding at the time of the second eligibility screen, increasing the likelihood of exclusive breastfeeding at one month postpartum.

Another possible contributing factor to breastfeeding rates for these mothers is that all reported an exceptional degree of social support, introducing a sampling bias. Strong social support found among study participants may be explained to some degree by participant characteristics previously reported. Degree of social support is unlikely to be exceptional for all U.S. women giving birth and is likely to vary much more than what was represented in this sample. Degree of social support has been reported to be an

important factor for breastfeeding duration across several studies (Asiudo et al., 2017; Brown, 2014; Rempel, Rempel, & Moore, 2017).

An additional finding that was unexpected was that average milk volume at two weeks postpartum was below 650 ml. Despite this, all but four newborns had regained their birth weight at two weeks of age. This finding might be explained by the small sample size. A larger sample may reflect milk volumes closer to the expected range for the general population. Findings may also introduce the possibility that lower milk volume should be anticipated than what is currently recommended for this period. Further study related to expected milk volume during the early postpartum weeks is warranted.

Association Between Postpartum Sleep and 24-hour Breast Milk Volume

In this study, poor sleep quality, found by using mean scores of the GSDS, was the only significant predictor for lower milk production during the second postpartum week. Those mothers with poor sleep quality had significantly lower 24-hour milk volume, and sleep quality was the most significant predictor of lower milk volume at two weeks postpartum. Those mothers with GSDS scores at or above the cut point, indicating clinical significance for sleep disturbance, had significantly lower 24-hour milk volume compared to women whose sleep was not impaired. Though there are no known studies of postpartum sleep impairment and its impact upon breast milk production to the researcher's knowledge, these findings are support findings from other studies that have reported associations between sleep disruption and alterations in circadian release of HPA hormones (Blair et al., 2015; Bublitz et al., 2016; Christian et al., 2018; Christian et al., 2013).

Though total sleep time was not significantly associated with 24-hour milk volume or milk volume less than 650 ml at two weeks postpartum, this may indicate that it may not be the hours of sleep, but the quality of sleep that is important. As previously stated, an objective measure of sleep such as actigraphy also may be a more accurate measure of postpartum sleep (McCall & McCall, 2012; Morgenthaler, 2007) Further study of the association between sleep disturbance and breast milk production in the early postpartum weeks is warranted.

Sleep-Related Health Consequences

For most mothers, degree of fatigue was significant during the second postpartum week. Most experienced a clinically significant fatigue severity. This is consistent with studies that have found fatigue as a significant health concern following birth (Badr & Zausniewski, 2017; Doering et al., 2017; Giallo et al., 2015; McBean & Montgomery-Downs, 2013).

The number of women who screened positive for risk of PPD was more than double the rate currently reported for all postpartum women in the U.S. (CDC, 2015). Women in this study reported highly disturbed sleep quality and quantity, which are consistent with the existing literature that suggest highly disturbed sleep may lead to the development of depressive symptoms in postpartum women (Creti et al., 2017; Doering et al., 2017; Lee & Hsu, 2012; Park et al., 2013). Another important consideration was the time screening occurred, at two weeks postpartum. A common condition known as the baby blues caused by normal physiologic postpartum changes may still be present up to 14 days postpartum. No current guidelines exist regarding best time for screening for postnatal depression; however, a recent meta-analysis found postpartum depression

instruments to be less sensitive if administered during the first postpartum month compared to later in the postpartum period (Owara et al., 2016). Another reported positive depressive symptoms screen at two days postpartum were highly correlated with depressive symptoms on postpartum days 30-40, however (Hachem et al., 2014).

Though all women with depressive symptoms scores above the recommended cutoff were referred for follow up with their primary health providers related to their symptoms, the rate of those who screened positive who later went on to develop PPD is unknown. This highlights a need for heightened diligence related to postpartum depression screening and supports American College of Obstetrics and Gynecology (ACOG) recommendations for routine screening of all women for PPD at least once during the perinatal period (ACOG, 2016). These findings highlight the need for future research focused on developing best practices for timing of postpartum depression screening

Anxiety mean scores for study participants were consistent with mean scores of the general population of U.S. women. Prevalence of anxiety symptoms among mothers was consistent with prevalence of anxiety symptoms found among postpartum women in the U.S. (Brown, 2018). Postpartum anxiety symptoms are often attributed previous history of anxiety, depression, or reported traumatic birth experiences (Field, 2018; Goodman, Watson, & Stubbs, 2016); however, none of the mothers in this study had a history of anxiety or depression, or reported traumatic birth at the time of the second eligibility screening.

High prevalence of anxiety symptoms in this sample of low-risk women may be partially explained by the timing of administration of the anxiety questionnaire. Field

(2018) found that across postpartum studies, anxiety symptoms were more prevalent in the early postpartum period and improved over time. Another possibility is that the sample was more educated than the general U.S. population, a demographic risk factor found to be associated with postpartum anxiety in one study (Field, 2018).

The strong association found between postpartum depressive symptoms and anxiety symptoms at two weeks postpartum is consistent with findings across studies of postpartum women (Brown, 2018). Brown (2018) suggests a combination of screening for both anxiety and depression during the postpartum period may provide a more comprehensive approach to identifying postpartum mood disorders. Findings from the current study support this recommendation as a potential area of future research.

Associations Between Sleep-related Health Consequences and Milk Volume

None of the sleep-related variables examined in research question two (degree of maternal symptoms of fatigue, anxiety, and depression) or maternal stress were associated with 24-hour milk volume at two weeks postpartum. These findings may indicate the possibility of different physiological pathways for sequelae of adverse health consequences resulting from sleep disturbance. For instance, disruption in circadian release of hormones important to breast milk production may have been due disrupted sleep cycles; whereas symptoms of fatigue and mood changes may have been caused by other physiologic mechanisms that have no impact upon breast milk production. In the study by Okun et. al. (2011), postpartum sleep disturbance, but not changes in pregnancy related hormones, including prolactin, were related to development of depressive symptoms. This may partially explain why sleep disturbance, but not stress, fatigue and mood changes were associated with 24-hour milk volume in this study. Further research

to better understand where to target interventions to facilitate postpartum breast milk production.

Despite prevalence of fatigue, and symptoms of depression and anxiety, all women in this study were still breastfeeding at one month postpartum. This finding is not consistent with the literature that has shown presence of the above symptoms to be associated with a decrease in breastfeeding exclusivity and early breastfeeding cessation (Brown et al., 2014; Castro-Dias & Figueredo, 2015; Paul et al., 2013; Wouk et al., 2017). A possible explanation for this outcome might be that all participants in this study received a home visit by a registered nurse who provided lactation support and community resources for symptoms of depression, if deemed necessary, during that time. The home visit may have served as an intervention for participants struggling with symptoms of fatigue, depression, and anxiety by providing emotional support needed for continued breastfeeding. No comparison group was used in this study; therefore, this conclusion is speculative.

Limitations and Strengths

This study has several limitations. The first is small sample size. However, we believe this is the first study to examine postpartum breast milk production from a sleep perspective. Recruitment via childbirth classes may have contributed to the small sample obtained. Classes were held on Saturdays at either one of two hospital locations and required participants to pay a small registration fee to attend. Childbirth classes were more poorly attended on one of the two campuses leading to frequent cancellations. Attendance across campuses ranged from approximately two to eight couples per class. Recruitment rates ranged from no participants to seven couples per class.

Although 59 participants were initially recruited, over half were either no longer eligible, had dropped from the study, or were unable to be reached at the time of the second eligibility screening. The fact that 20 of the 59 were no longer eligible is representative of the highly variable nature of birth experiences among perinatal populations. The high prevalence of stress seen in this sample may have hindered participation for those unable to be reached after delivery. These finding highlight the difficulty researchers may face who wish to study this population during the early postpartum weeks.

Homogeneity of the sample is another limitation of this study and results may not be generalized to the entire perinatal population. Compared to the U.S. population, women in this study were slightly older, predominately Caucasian (93.1), more likely to be married, and more educated. Most were married (93%) compared to 60% of women giving birth in the U.S. in 2015, and were less likely to delivery by cesarean with only 17.2% of study participants delivering via cesarean versus 31.9% of all births delivered by cesarean in the U.S. (Martin et al., 2018). Finally, mothers were more educated, with approximately 79% reporting a Bachelor's degree or higher versus just 33% of U.S. women. These finding indicate a homogenous study sample, and that many groups, especially high risk and minority groups, were underrepresented in this study.

Recruitment through childbirth classes through one hospital system may have contributed to the lack of diversity in the study sample and may explain why participants were better educated and more likely to be married than the general population. At the time of initial recruitment, most participants were accompanied by a support person who attended the class. This may explain why all mothers reported an exceptional degree of

social support in this study.

A strength and a limitation of this study was that data collection was limited to the second postpartum week and one month postpartum. While this strategy ensured participants met inclusion and exclusion criteria, were exclusively breastfeeding, and made it possible for all participants deemed eligible to complete the study, demographic data for all participants recruited and other baseline data such as sleep disturbance and degree of stress were not obtained. These data would have provided more information regarding risks for breastfeeding cessation during the first postpartum month and explained some of the study attrition from the time of initial recruitment to the second eligibility screen.

Another limitation related to data collection was the use of the diary as the only measure of postpartum sleep. The accuracy of the data collected in this study remains unclear making interpretation of study results difficult. However, recording the sleep time daily to obtain an average total sleep time may be better than recalling ones' average hours of sleep over a week. The fact that study results are inconsistent with current literature related to stress and postpartum sleep indicates that the use of an objective measure in addition to the use of the diary of postpartum sleep would be beneficial in future studies.

Breastfeeding outcomes were either unable to be measured or difficult to measure in some instances. Though it is exciting that all women who completed the study were still breastfeeding exclusively or mostly breastfeeding at the one month follow up, this is likely not reflective of all women initially recruited or the general population; thus, findings from this study cannot be generalized to larger groups.

Finally, the use of test weights to estimate breast milk volume is a strength of this study; however, to infer hormone disruption occurred because of sleep disruption using this measure is a significant limitation of this study. While this method was not invasive, requiring no lab monitoring or disruptive to breastfeeding for study participants, determining the mechanism or causality for lower breast milk volume related to postpartum sleep disturbance is not possible in this study. Further research is needed to determine if a relationship between disturbed sleep and low breast milk volume exists.

Implications for Nursing Practice

This study has several implications for nursing practice. This study highlights a need for better understanding among perinatal nurses regarding the high prevalence of sleep disturbance among postpartum women, factors that contribute to sleep disturbance during this time, and the potentially negative impact highly disturbed sleep during this period can have upon long-term physical and mental health. Screening for factors that may contribute to more disturbed sleep, such as life stress, during pregnancy and the early postpartum period and development of interventions to reduce stress during this time should be considered. This study provides support for the growing number of hospitals that have implemented policies that designated a scheduled time during the day for undisturbed sleep and rest for women admitted to postpartum nursing units. These programs should be continued to promote optimal postpartum sleep.

This study also highlights a need for better understanding among perinatal nurses of factors that impact new mothers' ability to successfully breastfeed their newborns during the early postpartum period. The high rate of mothers and newborns at risk for breastfeeding problem identified during recruitment in this study reinforce the need for

development of comprehensive programs aimed at early identification of mothers and infants at risk for breastfeeding difficulties. Once identified, there is a need for program development and nursing interventions that promote successful breastfeeding among high-risk groups during the early postpartum period.

An important consideration is the large portion of women initially recruited for this study who were at high risk for discontinued breastfeeding at the time of the second screen. Risk factors did not reflect maternal preference for method of infant feeding, but circumstances beyond the mothers' control. This highlights a need for health providers to provide emotional support all women who decide to breastfeed, regardless of the breastfeeding outcome. This also has implications for national initiatives that impose prescribed percentages of what is considered success in breastfeeding rates.

The use of test weights in this study was a simple and effective strategy for estimating 24-hour breast milk intake. Test weights were not disruptive to the breastfeeding process for women and provided reassurance surrounding milk volume for most women in this study. In contrast, test weights also detected mothers with low breast milk production and infants not gaining weight as they should at two weeks postpartum. This allowed for early follow up for breastfeeding problems for study participants. Though number of infants who did not regain birth weight in this study was approximately 14%, none of the mothers reported concerns about milk supply at the time of the two-week visit. This may indicate maternal perception may not be the best indicator of milk production and newborn intake in first time mothers.

Performing test weights during the first weeks of life may provide a more comprehensive approach for evaluation of adequacy of milk intake. Test weights provide

clinicians with measures of milk volume and rate of infant weight gain and may provide a better clinical picture than when either parameter is measured alone. Most lactation centers offer test weights as an evaluation method of infant milk intake. Referral to lactation for early breastfeeding support should be routine for all postpartum women who are breastfeeding.

A final implication for nursing practice in the care of postpartum women was the high prevalence of symptoms of depression and anxiety found in this study. Though the best time for screening for symptoms remains unknown, development of routine screening at some time during the perinatal period should be considered, as recognized by ACOG. Better understanding among perinatal nurses regarding screening methods for perinatal mood disorders and appropriate referrals to care providers specializing in perinatal populations is needed.

Recommendations for Future Research

Many implications for future research have been identified in this study. Recruitment for this study through childbirth classes was difficult and resulted in a small, homogenous sample that limited generalizability of study findings. A potential strategy for improvement for future studies might include expansion of recruitment local health departments, physicians and midwifery practices, and via social media. Expansion of recruitment to these areas may result in a more diversified sample that is more reflective of the general population, making results of future studies more meaningful.

This study also highlights a need for further research surrounding postpartum sleep. The high prevalence of postpartum sleep disturbance has been well documented across multiple studies. The high prevalence of disturbed sleep found in this study was

thus not surprising. These findings underscore a need for further research related to nursing interventions that may improve sleep quality during pregnancy and the postpartum period.

The use of a sleep diary measurement of postpartum sleep may not have provided an accurate measure of sleep for women in this study. A combination of objective measurement of sleep, perhaps via actigraphy, in combination with a sleep diary may provide more accurate measurement of postpartum sleep. Future studies of best methods of measurement of sleep in postpartum populations is needed.

Considering current initiatives aimed at improving breastfeeding rates in the U.S., more studies that focus on reasons mothers discontinue breastfeeding during the early postpartum period are needed. Understanding the reasons for discontinuation may be helpful in developing interventions to foster breastfeeding. It is unclear whether the two-week home visit acted as an intervention for continued breastfeeding in the current study. This would be an interesting area for future research.

Setting a cut-point for measurement of adequate breast milk was problematic in this study. Further research surrounding expected milk volume during the early postpartum weeks is needed. Larger, more diversified samples than what was obtained in the current study would also be required in such studies. An alternate approach that may be more effective is to measure and report 24-hour hour milk volume totals, rather than setting a cut-off point, in conjunction with rate of infant weight gain.

This study supports the need for future studies that explore the impact of postpartum sleep upon breast milk production. Future studies should include larger, more diverse samples than what was obtained in the current study and should use objective

measures in conjunction with subjective measures of sleep. Because causality of low milk volume among women in this study could not be definitively determined, researchers may consider inclusion of laboratory measurement of oxytocin and prolactin to compare with sleep measures and milk volume in future studies. Longitudinal designs that follow participants from pregnancy through the postpartum period should also be considered to capture additional factors that may lead to poor breastfeeding outcomes.

Finally, the higher than expected prevalence of depressive and anxiety symptoms among mothers in this study supports a need for further research in this area. Findings provide additional support for the inclusion of postpartum women as a vulnerable group as participants of nursing research. The fact that no guidelines exist for recommended timing of PPD screening using current instruments is problematic from both a research and clinical perspective. Further research surrounding optimal timing of administrations of currently available screening tools for perinatal mood disorders is needed. Future studies aimed at early detection of women at risk for postpartum mood disorders are also warranted. Studies that focus on development and testing of interventions that may prevent or reduce symptoms of perinatal mood disorders are needed.

Conclusion

Findings from this study add to the current body of knowledge surrounding postpartum sleep disturbance and development of known sleep-related adverse health consequences (fatigue, mood changes, and endocrine disruption) among perinatal populations. This was the first study to the researcher's knowledge to examine breast milk production as an indirect measure of sleep-related endocrine disruption. New mothers experienced a clinically significant sleep disturbance during the second

postpartum week. Breast milk production was lower among women who reported more disturbed sleep, and poor sleep quality was the only significant predictor of low breast milk volume.

Due to low sample size and other limitations of the current study, further larger scale research is needed to determine if highly disturbed sleep during the postpartum period is associated with lower breast milk production in the early postpartum weeks. Though disruption in release of prolactin and oxytocin may have contributed to this finding, these were not measured in the current study. How disturbed sleep influences breast milk production remains unknown and warrants further investigation of the pathways.

Study variables were selected and measured within the context of a well-established theoretical model, The Impaired Sleep Model. This model proved to be an effective framework for study of postpartum sleep and subsequent sleep-related related health consequences. Degree of stress was positively correlated with and predicted postpartum sleep disturbance. Adverse health consequences presented in the model were also present among women in this study. During the second postpartum week, most women experienced high levels of fatigue, prevalence of depressive symptoms was higher than expected for healthy, first time mothers, and symptoms of anxiety were present for just over one-fourth of participants.

High prevalence of moderate to high stress found in among women in this study highlight a need for further research to identify common stressors and develop stress-reduction interventions among perinatal population that might lead to better sleep during the postpartum period. High prevalence of symptoms of depression and anxiety among

study participants also has implications for both clinical practice and future research. Specifically, further research is need regarding optimal timing of screening for perinatal mood disorders so that best practices for early detection of women at risk may be implemented.

Finally, all women in this study successfully breastfed through the first postpartum month. The high volume of women unable to complete the study identified during the second phase of eligibility screening, however, highlights a needed area for further research. Future studies are needed to explore additional factors beyond the current study that help or hinder successful breastfeeding for new mothers.

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APPENDIX A

Table 1. *Postpartum Sleep Characteristics in Healthy Postpartum Mothers with Healthy Newborns*

Study	Purpose	Sample	Measurement	Results
Nishihara & Horiuchi, (1998) *Japan*	Study changes in sleep patterns from late pregnancy to postpartum in relation to infant movements at night.	10 healthy primiparas, ages 23 - 31, and their healthy, term infants (eight breastfeeding, two bottle feeding)	Portable PSG (Medlilog 9000) PSG recorded for one night at 36 weeks' gestation, and postpartum weeks one, three, and six. Infant ankle actigraph measured with maternal PSG at postpartum weeks one, three, and six.	Decreased sleep efficiency from pregnancy to postpartum ($p < .05$), stage 2 sleep ($p < .001$) at all time periods. Increased wake after sleep onset at one week ($p < .001$), three and six weeks ($p < .05$) . Positive correlation between maternal awakenings and periods of high infant activity. Positive correlations between maternal SWS and periods of low infant activity.

Lee (2000) *United States*	Describe changes in women's sleep patterns from pre-pregnancy to postpartum	29 healthy postpartum women with uncomplicated labor and birth. All breastfeeding and supplementing with formula; predominately white, upper middle class, married, and well-educated	Portable PSG (Medilog 9000) Nighttime PSG recorded for two consecutive nights during follicular and luteal phase of menstrual cycle, during pregnancy at 11-12 weeks, 23-24 week, at 35-36 weeks' gestation, and during postpartum at 3-4 weeks and 11-12 weeks.	At one month postpartum, TST was lower (379 ± 78.5 minutes) than all other time points ($p < .05$). Significant decreases in sleep efficiency ($p < .001$), REM sleep onset latency ($p < .05$), and stage two sleep ($p < .001$) was also reported during this time period. There was a significant increase in percentage of time awake and stages three and four sleep recorded from third trimester to one-month postpartum ($p < .001$). Multiparas had significantly less sleep efficiency than primiparas at all time points ($p < .05$) except at one-month postpartum.

Blyton, et al. (2002) *Australia*	Compare postpartum sleep quality and duration between exclusively breastfeeding and non-breastfeeding women; Quantify sleep architecture in lactating women	19 healthy postpartum women (4 - 30 weeks) ages 19 - 39 with healthy, term newborns, . 12 breastfeeding, 7 bottle feeding. 12 healthy, non-pregnant women, ages 19-39 (control group)	Compumedics Sleepwatch System portable PSG recorded for two consecutive nights.	TST and REM sleep similar among all groups. Breastfeeding mothers has significantly more SWS and WASO and less sleep efficiency and stages one and two sleep than bottle feeding and control groups ($p < .001$) . Bottle-feeding mothers had significantly less SWS for bottle feeding than control group ($p < .001$) .
Kang, et al., (2002) *Korea*	Understand sleep-wake behaviors from 35th week of pregnancy to 15th postpartum week	Five multiparous women, Five primiparous women ages 29.5 ±2.2 yrs. All breastfeeding	Wrist Actigraph - continuously measured for 20 weeks (1246 days); Sleep logs to record daily activities	TST and sleep efficiency was significantly lower at one week postpartum and during pregnancy. WASO highest at one week postpartum (175 min) and lowest at 35 weeks' gestation (50 min). Improvement in sleep patterns between 9th & 11th week postpartum

Matsumoto, et al. (2003) *Japan*	Investigate sleep-wake patterns during and after pregnancy	20 women - 10 pregnant and 10 non-pregnant	Wrist actigraph - continuously measured in pregnant women from 34 weeks of gestation through 16 weeks postpartum. Non-pregnant women recorded for 2 weeks. Sleep logs.	Significantly decrease in TST from late pregnancy to all postpartum time points. TST significantly lower at early and middle postpartum periods compared to non-pregnant control group. SE significantly decreased at all postpartum time periods when compared to late pregnancy and control group. WASO significantly increased in the postpartum period when compared to pregnancy and control groups.
Nishihara, et al. (2004) *Japan*	To compare EEG power spectra during SWS between breastfeeding mothers and non-pregnant women	12 healthy, exclusively breastfeeding primiparas, 9-13 weeks post-vaginal birth 12 healthy, non-pregnant women 12 healthy, term infants	Medilog 8-ch Portable PSG recorded for two nights at 9 - 13 weeks' postpartum or week following menses for non-pregnant women;	Significant decrease in TST and percent stage 2 sleep ($p < .001$), and increase in percent WASO and SWS ($p < .05$) among breastfeeding women compared to non-pregnant women.

Yamakazi, (2005)	Examine sleep wake cycles of and social rhythms are related to sleeping arrangements before and after birth	101 Japanese married primiparous parent couples	Sleep diary recorded for seven days at 32-36 weeks' gestation and at one-month postpartum.	Mothers TST decreased from 7:56 hr. ± 1:01during pregnancy to 6:34 ± 1:10 postpartum
Lee & Lee (2007)	Describe maternal sleep and fatigue in relation to mode of delivery during 1st postpartum week	21 postpartum Chinese-American mothers (6 post-cesarean; 15 post-vaginal delivery); All breastfeeding	Actigraphy three to five days postpartum; Sleep diary GSDS	Mothers post-vaginal birth averaged two hours more TST ($p < .001$), less percent WASO, 14% vs. 33% ($p < .002$), and less time spent sleeping during day 3% vs. 10% ($p < .03$) than mothers post-cesarean birth.
Signal, et al., (2007) *New Zealand*	Quantify change and variability in sleep duration and quality from pregnancy to postpartum	19 healthy, postpartum women 8 nulliparous 11 multiparous	Wrist actigraphy recorded for seven nights during second trimester, one week prior to delivery, one week postpartum and six weeks' postpartum; Sleep Diary	Largest changes in sleep during first postpartum week. Mother had 1.5 h less TST and greatest variability in sleep patterns. Sleep efficiency was greatest during second trimester and at six weeks' postpartum. Nulliparas had poorer sleep quality than multiparas.

Montgomery-Downs, et al. (2010a)	Describe normative course of maternal sleep during first four postpartum months	74 postpartum mothers, 93% White; 75% post-vaginal delivery; 85% primiparas; 75% exclusively breastfeeding	Wrist actigraphy- nocturnal sleep recorded between postpartum weeks 2 - 13 (50 mothers) and 9 through 16 (24 mothers); Sleep Diary	Postpartum TST was 7.2 hours ± .95 hours and highly fragmented. Mothers averaged two hours per night awake. Sleep efficiency improved from postpartum week two (79.7% ± 5.5%) to sixteen (90.2% ± 3.5%). Fragmented sleep decreased from postpartum week two (21.7% ± 5.2%) to week sixteen (12.8% ± 3.3%). Differences in sleep parameters between primiparas and multiparas were not significant.
Montgomery-Downs, et al., (2010b)	Explore maternal sleep and daytime function in relation to infant feeding method from postpartum weeks 2 - 12	80 postpartum mothers, ages 18 - 40, 89% married, 92% white, 75% post-vaginal birth, 87% primiparas, divided into three feeding groups (breastfeeding exclusively, formula feeding exclusively, both breast and formula-feeding	Wrist actigraphy - measured continuously in two phases (1) postpartum weeks 2 - 13 (56 mothers), and (2) postpartum week 8 – 16 (24 mothers). Sleep diary	No significant differences between feeding method and any sleep parameters in this study.

Insana, et al. (2011)	Identify actual or perceived sleep characteristics accounting for most variance in daytime function among postpartum mothers	64 - 68 healthy primiparas at postpartum week two; 59-65 healthy primiparas postpartum week seven, and 54-56 healthy primiparas at postpartum week 13 (some data lost to equipment malfunction)	Wrist actigraphy (Actiwatch 64) Electronic sleep diary	Average nocturnal TST was 426.28 minutes , total wake time 64.6 minutes - 114.14 minutes, and percent sleep efficiency ranged from 79.45 - 87.32. Sleep efficiency and sleep quality were lowest at two weeks' postpartum and highest at 13 weeks. Number of nighttime awakenings highest at two weeks and lowest at 13 weeks.
Bei, et al., (2012) Australia	Explore variation in maternal sleep from one week prior to delivery to one week post-delivery	24 mothers with term, healthy newborns, 75% vaginal delivery, 25% cesarean	Wrist actigraphy (Actiwatch 64) measured continuously, event markers to record bedtime and rise time	TST range 443.4 ± 117.7 minutes- 432.8 ± 49.9 minutes; TST lowest on postpartum day one, and highest six days prior to delivery. No significant difference in TST seven days prior to delivery and six days post-delivery; Percent sleep efficiency lowest on first postpartum day 58.4% (14.6%) and highest seven days prior to delivery 76.9% (7.9%). Sleep efficiency significantly decreased at seven days postpartum ($p < .05$).

Doan, et al., (2014)	Describe sleep duration and quality during 1st pp month and compare sleep among mothers who are breastfeeding exclusively to those who used formula	120 first time mothers, low-income, ethnically diverse	Wrist actigraphy recorded collected during last month of pregnancy & at one month postpartum Sleep diary GSDS	All women experienced significant reduction in nighttime TST from pregnancy to postpartum. Formula feeding mothers experiences significantly lower nocturnal TST (356 ± 67min) vs. breastfeeding mothers (386 ± 66 min)

Note: TST = total sleep time; WASO = wake after sleep onset; SE = standard error; SWS = slow wave sleep PPD = Postpartum Day; PSG = polysomnography; GSDS = General Sleep Disturbance Scale

Appendix B

SUBJECT SCREENING QUESTIONNAIRE

What is your current age (in years)? _____

SECTION A: PREGNANCY

ANSWER THE FOLLOWING QUESTIONS BY PLACING AN "X" IN THE SPACE TO INDICATE YES OR NO

1) Is this your first birth?
2) During this pregnancy, have you had any of the following:

	YES	NO
1) Gestational Diabetes		
2) High blood pressure (preeclampsia)		
3) Anemia (low iron in your blood)	_____	_____
4) Preterm labor (contractions 3 weeks prior to your due date)	_____	_____
5) Problems with your placenta (placenta previa/abruption)	_____	_____
6) Anxiety or mood disorder (depression, bipolar disorder, etc.)	_____	_____
7) Abnormal ultrasound or test that will require your baby to receive follow up care, surgery, or treatment after birth.	_____	_____
	_____	_____

SECTION B: INTENDED INFANT FEEDING METHOD

How do you plan to feed your baby? (Check one)

☐ Breastfeed Only ☐ Breastfeed + Formula ☐ Formula Only

SECTION C: MEDICAL HISTORY (INDICATE YES OR NO)

Before you were pregnant or at any time during this pregnancy, have you ever been diagnosed with:	YES	NO
1) Heart disease	_____	_____
2) Thyroid disorder	_____	_____
3) Anxiety or Depression	_____	_____
4) A mental health condition (bipolar disorder, schizophrenia, psychosis)	_____	_____
5) A sleep disorder (Sleep apnea, restless leg syndrome, insomnia, etc.)	_____	_____
6) Polycystic Ovarian Syndrome	_____	_____
7) Chronic Fatigue Syndrome	_____	_____
8) HIV or AIDS	_____	_____
9) Have you ever had breast surgery?	_____	_____

SECTION D: MEDICATIONS	YES	NO
1) Have you been prescribed any medications during this pregnancy other than prenatal vitamins?	_____	_____
2) If yes, have you taken prescription medications to help you sleep during this pregnancy?	_____	_____

List any medications (prescription, over-the-counter, or herbal remedies) you are currently taking:

_____

_____

_____

_____

Appendix C

DELIVERY AND INFANT DATA

DATE / TIME OF DELIVERY: _____/_____ METHOD OF DELIVERY: _____
LABOR INDUCTION: YES NO If yes, type: _____
ANESTHESIA / ANALGESIA: YES NO If yes, type: _____
HOURS OF LABOR (If applicable): _____
MATERNAL COMPLICATIONS (During Labor or Birth):
_____
_____
_____

INFANT SEX: _____ GESTATIONAL AGE: _____ WEEKS
BREASTFED WITHIN FIRST 2 HOURS OF LIFE: YES NO
BIRTHWEIGHT: _____ grams
INFANT COMPLICATIONS (During Labor or Birth):
_____
_____
_____

DISCHARGE DATA

METHOD OF INFANT FEEDING AT TIME OF DISCHARGE:

☐ Breastfeed Only ☐ Breastfeed + Formula ☐ Formula Only

IF SUPPLEMENTING:
HOW MANY TIMES/DAY? _____
HOW MANY OUNCES PER DAY?_____

INFANT DISCHARGE WEIGHT: _____

MATERNAL OR INFANT COMPLICATIONS (During Postpartum):
_____
_____
_____
_____
___

Appendix D

DEMOGRAPHIC QUESTIONNAIRE

Department of Nursing, Georgia State University

Please answer the following questions as honestly and accurately as possible.
ALL INFORMATION OBTAINED IN THIS STUDY WILL BE KEPT CONFIDENTIAL.

AGE: _____ years

a. Marital Status:

- ☐ Single
- ☐ Significant Other
- ☐ Separated
- ☐ Married
- ☐ Divorced
- ☐ Widowed

b. What is the highest grade level completed or degree you earned in school?

_____

_____

c. Self-Ethnic Identity:

- ☐ African American or Black
- ☐ Asian/Pacific Islander
- ☐ Caucasian or White
- ☐ Other [write in]:
- ☐ American Indian
- ☐ Hispanic, Latino, or Spanish Origin

_____

d. Annual Income:

- ☐ $0.00 to $25,000
- ☐ $25,001 to $50,000
- ☐ $50,001 to $75,000
- ☐ $75,001 to $100,000
- ☐ More than $100,001
- ☐ I would prefer not to share this information

e. Circle the number that indicates how you would rate your current degree of personal/family support (includes spouse, significant other, extended family, and/or friends):

Zero support 0 1 2 3 4 5 6 7 8 9 10 Exceptional support

Appendix E

POSTPARTUM INFANT FEEDING QUESTIONNAIRE

1. How are you currently feeding your baby? (Check one)
   □ Breastfeed Only □ Breastfeed + Formula □ Formula Only

2. For the past two weeks, how have you fed your baby most often?
   □ Breastfeed Only □ Breastfeed + Formula □ Formula Only

3. If breastfeeding and using formula, how often do you give your baby formula?

4. If using formula only, what was the most important reason you decided to stop breastfeeding?

Appendix F

TEST WEIGHTS: HOME VISIT

DATE: _____

TEST WEIGHT # 1: TIME: _____
Baby's weight before breastfeeding: _____ grams
Baby's weight after breastfeeding: _____ grams

TEST WEIGHT # 2: TIME: _____
Baby's weight before breastfeeding: _____ grams
Baby's weight after breastfeeding: _____ grams

TEST WEIGHT # 3: TIME: _____
Baby's weight before breastfeeding: _____ grams
Baby's weight after breastfeeding: _____ grams

24 HOUR FEEDING LOG:
Document all additional feedings for today until _____a.m. tomorrow

Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:
Time:	Feeding Type:

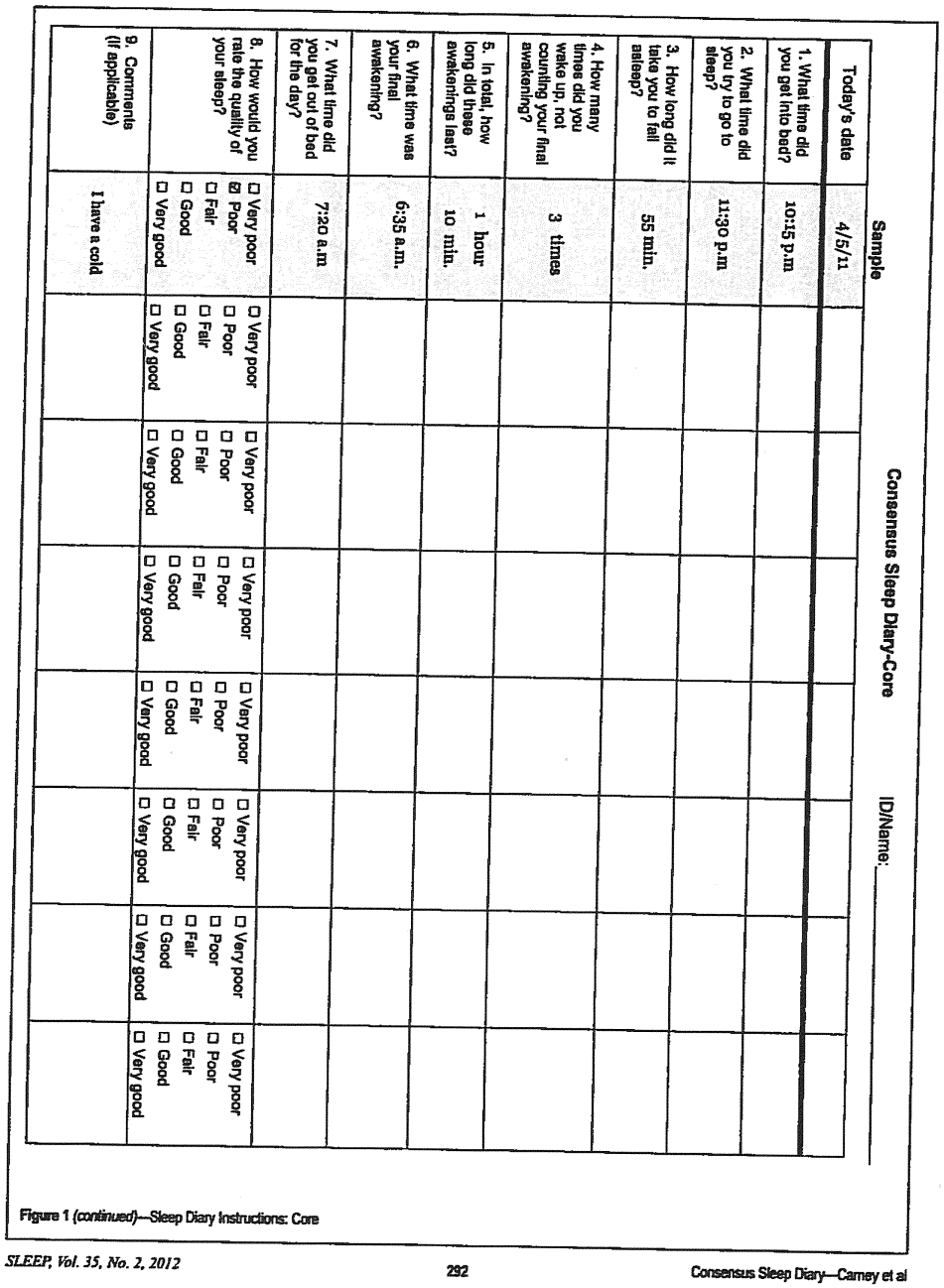
Appendix G

GENERAL SLEEP DISTURBANCE SCALE

How often in the PAST WEEK did you: (Circle the number of days for each)

	Never							Every day
1. have difficulty getting to sleep	0	1	2	3	4	5	6	7
2. wake up during your sleep period	0	1	2	3	4	5	6	7
3. wake up too early at the end of a sleep period	0	1	2	3	4	5	6	7
4. feel rested upon awakening at the end of a sleep period	0	1	2	3	4	5	6	7
5. sleep poorly	0	1	2	3	4	5	6	7
6. feel sleepy during the day	0	1	2	3	4	5	6	7
7. struggle to stay awake during the day	0	1	2	3	4	5	6	7
8. feel irritable during the day	0	1	2	3	4	5	6	7
9. feel tired or fatigued during the day	0	1	2	3	4	5	6	7
10. feel satisfied with the quality of your sleep	0	1	2	3	4	5	6	7
11. feel alert and energetic during the day	0	1	2	3	4	5	6	7
12. get too much sleep	0	1	2	3	4	5	6	7
13. get too little sleep	0	1	2	3	4	5	6	7
14. take a nap at a scheduled time	0	1	2	3	4	5	6	7
15. fall asleep at a unscheduled time	0	1	2	3	4	5	6	7

Appendix H



Consensus Sleep Diary-Core ID/Name:_____

Today's date	Sample 4/5/11						
1. What time did you get into bed?	10:15 p.m						
2. What time did you try to go to sleep?	11:30 p.m						
3. How long did it take you to fall asleep?	55 min.						
4. How many times did you wake up, not counting your final awakening?	3 times						
5. In total, how long did these awakenings last?	1 hour 10 min.						
6. What time was your final awakening?	6:35 a.m.						
7. What time did you get out of bed for the day?	7:20 a.m						
8. How would you rate the quality of your sleep?	☐ Very poor ☑ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good	☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Very good
9. Comments (if applicable)	I have a cold						

Figure 1 *(continued)*—Sleep Diary Instructions: Core

Appendix I

Perceived Stress Scale- 10 Item

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, please indicate with a check how often you felt or thought a certain way.

1. In the last month, how often have you been upset because of something that happened unexpectedly?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

2. In the last month, how often have you felt that you were unable to control the important things in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

3. In the last month, how often have you felt nervous and "stressed"?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

4. In the last month, how often have you felt confident about your ability to handle your personal problems?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

5. In the last month, how often have you felt that things were going your way?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

6. In the last month, how often have you found that you could not cope with all the things that you had to do?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

7. In the last month, how often have you been able to control irritations in your life?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

8. In the last month, how often have you felt that you were on top of things?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

9. In the last month, how often have you been angered because of things that were outside of your control?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

___0=never ___1=almost never ___2=sometimes ___3=fairly often ___4=very often

This scale can be found in:

Cohen, S., Kamarck, T., Mermelstein, R. (1983). A global measure of perceived stress. Journal of Health and Social Behavior, 24, 385-396. Link to full-text (pdf)

Appendix J

ID #_____ Date_____

Time _____a.m. _____p.m.

I am trying to find out about your level of energy before and after your night of sleep. There are 7 items I would like you to respond to. This should take less than 1 minute of your time. Thank you.

DIRECTIONS: You are asked to circle a number on each of the following lines to indicate how you are feeling RIGHT NOW.

For example, suppose you have not eaten since yesterday.
What number would you circle below?

not at all hungry 0 1 2 3 4 5 6 7 8 9 10 extremely hungry

You would probably circle a number closer to the "extremely hungry" end of the line.
This is where I put it:

not at all hungry 0 1 2 3 4 5 6 7 8 9 10 extremely hungry

NOW PLEASE COMPLETE THE FOLLOWING ITEMS:

1. not at all **tired** 0 1 2 3 4 5 6 7 8 9 10 extremely **tired**

2. not at all **sleepy** 0 1 2 3 4 5 6 7 8 9 10 extremely **sleepy**

3. not at all **drowsy** 0 1 2 3 4 5 6 7 8 9 10 extremely **drowsy**

4. not at all **fatigued** 0 1 2 3 4 5 6 7 8 9 10 extremely **fatigued**

5. not at all **worn out** 0 1 2 3 4 5 6 7 8 9 10 extremely **worn out**

15. **concentrating** is no effort at all 0 1 2 3 4 5 6 7 8 9 10 **concentrating** is a tremendous chore

18. I have absolutely **no desire to lie down** 0 1 2 3 4 5 6 7 8 9 10 I have a tremendous **desire to lie down**

Appendix K

SELF-EVALUATION QUESTIONNAIRE STAI Form Y-1

Please provide the following information:

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *right now*, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

Appendix L

Edinburgh Postnatal Depression Scale[1] (EPDS)

As you are pregnant or have recently had a baby, we would like to know how you are feeling. Please check the answer that comes closest to how you have felt **IN THE PAST 7 DAYS**, not just how you feel today.

Here is an example, already completed.

I have felt happy:
- ☐ Yes, all the time
- ☒ Yes, most of the time
- ☐ No, not very often
- ☐ No, not at all

This would mean: "I have felt happy most of the time" during the past week. Please complete the other questions in the same way.

In the past 7 days:

1. I have been able to laugh and see the funny side of things
   - ☐ As much as I always could
   - ☐ Not quite so much now
   - ☐ Definitely not so much now
   - ☐ Not at all

2. I have looked forward with enjoyment to things
   - ☐ As much as I ever did
   - ☐ Rather less than I used to
   - ☐ Definitely less than I used to
   - ☐ Hardly at all

*3. I have blamed myself unnecessarily when things went wrong
   - ☐ Yes, most of the time
   - ☐ Yes, some of the time
   - ☐ Not very often
   - ☐ No, never

4. I have been anxious or worried for no good reason
   - ☐ No, not at all
   - ☐ Hardly ever
   - ☐ Yes, sometimes
   - ☐ Yes, very often

*5 I have felt scared or panicky for no very good reason
   - ☐ Yes, quite a lot
   - ☐ Yes, sometimes
   - ☐ No, not much
   - ☐ No, not at all

*6. Things have been getting on top of me
   - ☐ Yes, most of the time I haven't been able to cope at all
   - ☐ Yes, sometimes I haven't been coping as well as usual
   - ☐ No, most of the time I have coped quite well
   - ☐ No, I have been coping as well as ever

*7 I have been so unhappy that I have had difficulty sleeping
   - ☐ Yes, most of the time
   - ☐ Yes, sometimes
   - ☐ Not very often
   - ☐ No, not at all

*8 I have felt sad or miserable
   - ☐ Yes, most of the time
   - ☐ Yes, quite often
   - ☐ Not very often
   - ☐ No, not at all

*9 I have been so unhappy that I have been crying
   - ☐ Yes, most of the time
   - ☐ Yes, quite often
   - ☐ Only occasionally
   - ☐ No, never

*10 The thought of harming myself has occurred to me
   - ☐ Yes, quite often
   - ☐ Sometimes
   - ☐ Hardly ever
   - ☐ Never

Administered/Reviewed by _____ Date _____

[1]Source: Cox, J.L., Holden, J.M., and Sagovsky, R. 1987. Detection of postnatal depression: Development of the 10-item Edinburgh Postnatal Depression Scale. *British Journal of Psychiatry* 150:782-786 .

[2]Source: K. L. Wisner, B. L. Parry, C. M. Piontek, Postpartum Depression N Engl J Med vol. 347, No 3, July 18, 2002, 194-199

Appendix M

NGHS IRB CONSENT: POSTPARTUM SLEEP

NORTHEAST GEORGIA HEALTH SYSTEM, INC/
GEORGIA STATE UNIVERSITY
Gainesville, Georgia/Atlanta, Georgia

Consent For Participation In Research

Study Title: Postpartum Sleep and Breastfeeding Outcomes Among First-Time Mothers of Full-term Newborns

Principal Investigator: Shih-Yu Lee, PhD, RN

Student Principal Investigator: Joanna Carrega, PhD candidate, RNC

I. Purpose and Background

The purpose of the study is to explore the impact of new mothers' sleep upon health outcomes. You are invited because you are a first-time mother who plans to give your baby breast milk only after birth. A total of 120 new mothers will be recruited for this study. Taking part in this study will take no more than two hours of your time during the the first month following birth.

II. Procedures

If you sign this form, you will take part in two phone calls. The first will take place at one week. The next will take place one month after the birth of your baby. You will also take part in a home visit by the student researcher at two weeks after birth.

1. When you sign this form, you will be asked to give asked to give some personal and medical data in a survey. This survey will take no more than 10 minutes to complete.
2. During the first phone call, you will provide data about your baby's birth and how you are feeding your baby. This phone call is to make sure you are still able to take part in the study and will take no more than 15 minutes of your time.
3. Before your home visit, you will be asked to fill out a sleep diary for three nights and record your sleep time and wake time. This should take no more than 5 minutes per day.

4. During the home visit:
    a. You will be asked to fill out six written surveys. You will provide some basic data about yourself, your sleep quality, degree of fatigue and stress, and current mood.
    b. Your baby will be weighed on an infant scale before and after one feeding session.
    c. You will be asked to weigh your baby for the next two feedings and record your baby's weights. This visit will take no more than one hour of your time.
5. The final phone call will take place at one month after birth. You will be asked how you are feeding your baby at that time. This phone call will take no more than 5 minutes.

III. Possible Risks Or Discomforts

In this study, you will not have any more risks than you would in a normal day of life.

IV. Possible Benefits

Taking part in this study may not benefit you. Overall, we hope to learn about how mothers' sleep patterns during the early postpartum period impacts health outcomes. Results will help to increase knowledge and improve nursing care for new mothers and infants.

V. Confidentiality

We will keep your records private to the extent allowed by law. Dr. Shih-Yu (Sylvia) Lee and Joanna Carrega will have access to the data you provide. Data may also be shared with those who make sure the study is done correctly. This includes Georgia State University's Institutional Review Board (IRB) and Office of Research Integrity (ORI) and Northeast Georgia Medical Center's IRB.

We will use a study number rather than your name on study records. A key that links your name to your study number will be kept in a safe location separate from all other data you provide. This key and records that have your name and other personal information will be destroyed after your last interview. Numbered data will be stored in firewall-protected computers, and kept for a period of five years. After five years, your records will be destroyed.

Your name and other facts that might point to you will not appear when we present this study or publish its results. Findings will be summed and reported in group forms. You will not be named.

VI. Financial Issues

There will be no cost to you taking part in this study.

VII. Questions

Contact Shih-Yu Lee at slee29@gsu.edu or Joanna Carrega at jcarrega1@student.gsu.edu or 706-867-3094 if you have questions about this study. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Georgia State University's Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu.

If you have questions about your rights or complaints you don't believe you can discuss with the researcher, call the NGHS IRB Coordinator at 770-538-7386 or Susan Vogtner, Georgia State University's Office of Research Integrity, at 404-413-3513.

VIII. Voluntary Participation

Taking part in this study is voluntary. If you choose to drop out, there will be no penalty to you. If you drop out of the study before your last interview, we will not use any of your data. However, we will destroy the key that links your name to your study number after our last interview. We won't be able to remove your data from the study after this because we won't have any record of which data are yours.

Your decision whether or not to take part will not affect current or future medical care provided to you by Northeast Georgia Health System, Inc. You are free to drop out at any time without any danger to your care.

NORTHEAST GEORGIA HEALTH SYSTEM, INC/
GEORGIA STATE UNIVERSITY
Gainesville, Georgia/Atlanta, Georgia

DOCUMENTATION OF AGREEMENT

I have read (or someone has read to me) the above information. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I agree to participate in this research. I have been given a copy of this form.
If the participant cannot consider consent because of a lack of ability to comprehend, a legally authorized person may consent on the participant's behalf. The participant should be involved to the extent possible

_____ _____
Date **Signature Of Participant**

_____
Printed Name Of Participant

_____ _____
Date **Signature Of Parent or Guardian**

_____
Printed Name Of Parent or Guardian

ASSURANCE OF INVESTIGATOR OR HIS/HER STAFF PERSON

I discussed this research with the participant and/or legally authorized guardian, and I have offered the opportunity for further explanation. In my judgement, the participant or the legally authorized guardian is giving both voluntary and informed consent and possesses the legal right and mental capacity to give that consent. I or my designee will make sure that significant new findings developed during the course of this research are communicated in a timely manner.

_____ _____
Date **Signature Of Person Obtaining Consent**

_____
Printed Name Of Person Obtaining Consent

GSU APPROVED
IRB NUMBER: H16421
IRB APPROVAL DATE: 09/12/2017
IRB EXPIRATION DATE: 09/11/2018