UCONN LIBRARY

University of Connecticut
OpenCommons@UConn

Doctoral Dissertations | University of Connecticut Graduate School

8-24-2016

The Impact of Infant Sleep on Maternal Health Behaviors

Megan M. Clarke
University of Connecticut, megan.clarke@uconn.edu

Follow this and additional works at: https://opencommons.uconn.edu/dissertations

Recommended Citation
Clarke, Megan M., "The Impact of Infant Sleep on Maternal Health Behaviors" (2016). *Doctoral Dissertations*. 1198.
https://opencommons.uconn.edu/dissertations/1198

The Impact of Infant Sleep on Maternal Health Behaviors

Megan Clarke

University of Connecticut, 2016

Obesity continues to impact the majority of American adults. Women are especially vulnerable during their childbearing years; while weight gain is appropriate during pregnancy, the postpartum period is a potential teachable moment to prevent excess weight retention long term. This study sought to explore the relationships between infant sleep training, maternal physical activity levels, and weight loss during the first postpartum year by comparing mothers who successfully sleep trained their infants with those who did not. Researchers sought to evaluate the presence of between group differences in 1) quality and quantity of maternal sleep, 2) quality and quantity of infant sleep, 3) maternal physical activity and weight loss, 4) psychosocial variables including postpartum depression and perceived social support and 5) mothers' preference for potential weight loss and infant sleep training interventions. To address these aims, mothers were recruited with study flyers both online and in the community. 150 mothers of 6-12 month old infants completed study questionnaires online. Data was analyzed using chi-square and independent t-tests. Results indicate that mothers who successfully sleep trained their infants reported higher quality and quantity of maternal sleep and infant sleep, as well as higher levels of perceived social support. While there were no other significant group differences on psychosocial variables, mothers in both groups reported a notably high prevalence of postpartum symptomatology that exceed prevalence estimates for postpartum depression. There were no significant between group differences in physical activity levels, but differences in weight retention approached significance, with mothers who successfully sleep trained indicating that they were closer to their prepregancy weight, perhaps due in part to improved

sleep. There were no significant between group differences in mothers' preference for potential weight loss interventions, with mothers endorsing the highest level of interest in online interventions. Non-Sleep Trainers were significantly more likely to express interest in potential sleep training interventions, with most expressing interest in an online format as well. These results suggest that potential future interventions targeting postpartum weight retention should take the mother-infant dyad into account in study design, with both barrier reduction and infant sleep modification presenting possible targets for intervention.

The Impact of Infant Sleep on Maternal Health Behaviors

Megan Clarke

B.S.L.A., Georgetown University, 2002

Ed.M., Harvard University, 2006

M.A., University of Connecticut, 2011

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

at the

University of Connecticut

2016

Copyright by

Megan Clarke

2016

APPROVAL PAGE

Doctor of Philosophy Dissertation

The Impact of Infant Sleep on Maternal Health Behaviors

Presented by

Megan Clarke, B.S.L.A., Ed.M., M.A.

Major Advisor _____

Amy Gorin, Ph.D.

Associate Advisor _____

Dean Cruess, Ph.D.

Associate Advisor _____

Jaci VanHeest, Ph.D.

University of Connecticut

2016

Acknowledgments

I would like to thank my advisor, Dr. Amy Groin, for her tireless support, patience, knowledge, and expertise, both in helping me to complete this dissertation and throughout each milestone during the past seven years of graduate school. I would also like to thank my dissertation committee (Dr. Dean Cruess, Dr. Jaci VanHeest, Dr. Marianne Barton, and Dr. Julianne Fenster,) for their help and their time, and also my research assistant, Jennifer Selensky, who provided me with considerable logistical assistance throughout this project. I had various sources of financial support that made this project possible, including the Farber Fellowship, the Center for Health, Intervention, and Prevention Graduate Student Seed Grant, and the Graduate School Doctoral Dissertation Fellowship. I would like to offer special thank you to all of the mothers who agreed to participate in this study, for their time and their contribution.

On a personal note, I would like to express my immense gratitude to my family and friends. In particular, I would like to thank my husband and partner, Michael Archambault, for his unwavering support of all sorts and his good humor throughout the last seven years. Without you, none of this would be possible. Lastly, thank you to my three muses, Lucy, Catherine and Grace; you inspire me every day.

TABLE OF CONTENTS

INTRODUCTION

Obesity is an ongoing and persistent public health issue in the United States, and it has a particularly damaging impact on vulnerable populations. Recent research indicates that nearly 70% of American adults are currently overweight or obese based on a body mass index (BMI) of 25 kg/m^2 or greater (Ogden, Carroll, Kit & Flegal, 2014). The negative impact of overweight and obesity varies at the individual level, but the deleterious health effects of excess weight are staggering when examined in the aggregate. Obesity is associated with numerous illnesses including, but not limited to, cardiovascular disease, hypercholesterolemia, hypertension, and polycystic ovarian syndrome, which can negatively impact female fertility (Finkelstein, Brown, Wrage, Allaire, & Hoerger, 2010). Moreover, metabolic syndrome, which consists of numerous pathologies including truncal obesity, hypertension, and insulin resistance among others, has an overall estimated prevalence of 35% and is also associated with overweight and obesity (Aguilar, Bhuket, Torres, Liu, & Wong, 2015). The number of symptoms of metabolic syndrome that one exhibits are directly and positively associated with an increased risk for heart disease, stroke, and type II diabetes. In addition to the considerable impact of excess weight on individuals, obesity is also estimated to be associated with $147 billion in direct medical costs, resulting in a widespread financial impact of the condition and its attendant comorbidities (Finkelstein, Trogdon, Cohen & Dietz, 2009). Preventing obesity through early intervention may reduce the prevalence of comorbid illnesses, reduce mortality rates, and save billions of dollars in medical costs.

While excessive calorie intake and inadequate levels of physical activity are the biggest contributors to overweight and obesity, there are also critical windows during

which individuals may be more vulnerable to significant weight gain. For females of childbearing age, both pregnancy and the postpartum period represent windows during which some weight gain is both appropriate and necessary for maternal and infant health for nearly all women. However, the most recent data indicate that 58.5% of women of childbearing age, defined as those between 20-39 years old, were classified as overweight or obese, and 15% had a BMI $\geq$ 35 kg/m^2 and were classified as having grade two or three obesity (Ogden, Carroll, Kit & Flegal, 2014). In 1990, the Institute of Medicine (IOM) made recommendations for appropriate weight gain during pregnancy, based primarily on findings that the lowest incidence of pregnancy complications such as low birth weight and perinatal death was associated with gaining approximately .9 – 1.0 pounds a week during the last 20 weeks of pregnancy. Since 1990 there have been considerable shifts within the population; prepregnancy BMI and excessive gestational weight gain have increased across all groups, and especially in minority populations that are already at considerable risk for poorer health outcomes for mothers and children (Yeh & Shelton, 2005; Kim, Dietz, England, Morrow, & Callaghan, 2007).

Women are not the only group placed at risk due to excessive gestational weight gain; excess gestational weight gain is also associated with the risk of the child being overweight at three years of age (Olson, Strawderman & Dennison, 2009). The impact of excess pregnancy weight on childhood overweight and obesity was greatest among women with a BMI > 25.0. In 2009, a second IOM committee convened in order to re-examine the weight guidelines based on the marked epidemiological changes in the American population (Rasmussen & Yaktine, 2009). Consequently, new recommendations were published that offered specific recommendations for weight gain

tailored to an individual's BMI category. Unlike the 1990 recommendations, the 2009 guidelines are based on the prevalence of the five pregnancy outcomes of greatest interest: (1) cesarean delivery, (2) postpartum weight retention, (3) preterm birth, (4) small- or large-for gestational age birth weight, and (5) childhood obesity. The 2009 IOM report also makes recommendations for optimizing gestational weight gain and pregnancy outcomes, including beginning pregnancy with a BMI in the normal weight category. The report goes so far as to recommend that individuals make an effort to time pregnancy with this particular goal in mind if at all possible. The updated recommendations in combination with widespread increases in BMI highlight the need for effective interventions for women of childbearing age before, during, and after pregnancy, especially when one considers that a minority of women fall within the normal BMI range (Ogden, Carroll, Kit & Flegal, 2014).

In spite of clear and recent recommendations, many women continue to gain excessive weight during pregnancy for several reasons, including increased consumption of high-calorie convenience foods, limited sleep, and limited physical activity (Olson, Strawderman, Hinton & Pearson, 2003; Sarwer, Allison, Gibbons, Markowitz & Nelson, 2006). A longitudinal study found that the women who were most likely to retain significant amounts of weight during the postpartum period were those who gained excess weight during pregnancy, rather than those who were overweight before becoming pregnant (Linné, Dye, Barkeling & Rössner, 2004). Up to 20% of women retain excessive weight following pregnancy, suggesting that gestation itself is an obesity risk factor for many women (Gunderson & Abrams, 2000). Furthermore, weight at 1-year postpartum was the single best predictor of overweight at 15-year follow-up, rather than

weight gained during gestation itself (Linné, Dye, Barkeling & Rössner, 2004). This finding has several implications; it highlights the importance of appropriate weight gain during pregnancy, but also suggests that those who do gain excess weight stand to benefit most from intervention, especially during the first year following childbirth. More specifically, it suggests that interventions targeting mothers of babies younger than one-year old could have considerable impact on long-term obesity in females, potentially reducing the overall prevalence of overweight and obesity and healthcare costs.

Postpartum weight retention has been surprisingly understudied, especially considering the lasting impact of excessive pregnancy weight gain on long-term weight classification. While several studies have examined the effects of nutrition and physical activity on lactation, only three completed studies in the United States have specifically focused on weight loss and physical activity during the postpartum period, and one internet-based study is currently in progress (Leermakers, Anglin & Wing, 1998; Østbye et al., 2009; Phelan et al., 2015; O'Toole, Sawicki & Artal, 2003). Another intervention, eMoms, examined the utility of and engagement with an online intervention for pregnant mothers, but results examining the impact of the same intervention on postpartum weight retention have not yet been published (Graham, Uesugi, Niederdeppe, Gay & Olson, 2014; Fernandez et al., 2015). Overall, postpartum interventions have varied considerably in their design and implementation, making them difficult to compare. However, the interventions that have been published are useful in formulating future research examining possible barriers to participation. First, each of the postpartum weight interventions suffered from high attrition rates, suggesting that women with young infants have numerous barriers to contend with when engaging in weight loss efforts

(Leermakers, Anglin & Wing, 1998; Østbye et al., 2009; O'Toole, Sawicki & Artal, 2003). This may be due to limited energy levels and motivation to lose weight, as well as the added barriers of the need for childcare and the demands of both family and, for some, work outside of the home. Furthermore, of the three completed postpartum weight studies that have been published, the most intensive intervention was arguably the least effective, while the correspondence-based study had the best outcomes for participants, suggesting that future studies should provide flexibility for interested new mothers, such as correspondence or online options (Østbye et al., 2008; Østbye et al., 2009). Phelan et al. (2015) have created a study protocol targeting postpartum weight retention in low-income mothers enrolled in the Women, Infants and Children supplemental nutrition program. By combining the use of the internet, text messaging, and monthly group meetings, the program seeks to capitalize on new intervention delivery methods which reduce barriers to participation, especially in a low-income sample, while also encouraging face-to-face peer support. Results from this promising intervention are not yet available, but could suggest new ways to target this at-risk group. Graham and colleagues (2015) have developed an online intervention targeting gestational weight gain that they plan to utilize in the postpartum period as well, but results from its application with this unique population are forthcoming.

The research to date has suggested that physical activity may be a more appropriate target of interventions than modifying diet; one study established that increasing physical activity had a greater impact on weight loss at 12 weeks and one year postpartum than reducing caloric intake (O'Toole, Sawicki & Artal, 2003). This finding may be especially important when one takes breastfeeding mothers' nutritional needs into

account. Physical activity during the postpartum period has the potential to lessen the impact of excess weight gained during gestation in the long-term as well, as nutritional needs change over time (Oken, Taveras, Popoola, Rich-Edwards & Gillman, 2007). While television viewing during early parenthood is associated with weight retention at one year postpartum, walking behavior is inversely associated with weight retention during the same period. Highlighting the need for regular moderate physical activity during this teachable moment has the potential to modify postpartum weight retention and possibly establish long-standing healthier habits.

To date, no completed research has addressed established barriers to success within study design. There are some established research findings that suggest appropriate targets for future interventions. For example, prior research has established that both limited sleep quantities and postpartum depression are associated with long-term weight retention, and that sleep deprivation exacerbates the impact of postpartum depressive symptoms (Gennaro & Fehder, 2000; Setse et al., 2008; Siega-Riz, 2009; Vernon, Young-Hyman & Looney, 2010). Previous findings suggest that potential interventions, such as those that this particular study might inform, should build on earlier research by focusing on physical activity levels, addressing barriers to success within study design, and should take advantage of alternative intervention delivery methods, such as online formats (Gennaro & Fehder, 2000; Phelan et al., 2015; Setse et al., 2008; Siega-Riz, 2009; Vernon, Young-Hyman & Looney, 2010). Phelan et al. (2015) have sought to design a more accessible intervention that takes barriers to participation into account, but results are forthcoming. The current study sought to take advantage of findings from previous and current informational and intervention studies by further evaluating the

relationships between infant sleep, physical activity levels, and postpartum weight loss. *This study seeks to establish whether mothers who engage in behaviorally-based infant sleep training are more likely to engage in regular physical activity and less likely to retain excessive weight postpartum than those who do not.*

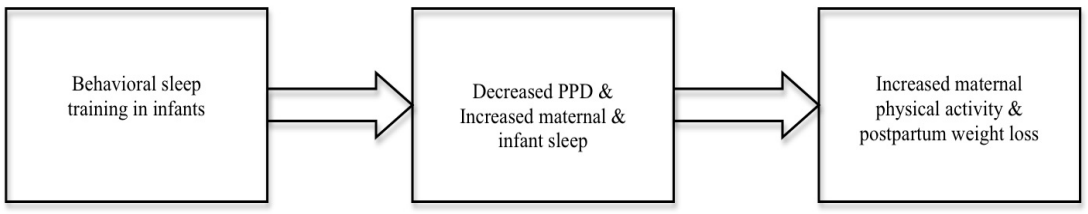
Sleep training can be effective in reducing short-term sleep problems and provides parents with an example of ideal authoritative parenting that includes both warmth and boundary-setting (Mindell et al., 2011; Ramchandani, Wiggs, Webb & Stores, 2000). The American Academy of Sleep Medicine (AASM) established practice parameters based on 52 scientific studies of the behavioral treatment of sleep problems in infants and young children (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006; Morgenthaler et al., 2006). Based on a comprehensive review of existing literature, the AASM posited that behavioral treatment of sleep problems in infants and young children are effective and recommended to reduce bedtime problems and night wakings, with 94% of the studies examined reporting clinically-significant improvements in pediatric sleep. Behavioral sleep training includes several treatment modalities including unmodified extinction, in which parents put the child to bed and return in the morning, returning only when issues of safety may arise; and graduated extinction, in which parents check on the child at either set or increasing intervals when they engage in unwanted behaviors like night wakings and crying. Other methods of behavioral sleep training include fading bedtimes to correspond with natural sleep onset, and scheduled awakenings, in which parents preemptively awaken their children in order to encourage sleeping through typical spontaneous awakenings. The AASM asserts that unmodified extinction and parent education to prevent sleep problems are the standards of treatment for sleep problems and

have the highest level of research support. However, the AASM also notes that unmodified extinction is frequently unpalatable for parents, who are oftentimes unable to utilize the approach consistently enough for it to be effective. As such, the AASM provides graduated extinction as a guideline for treatment as well, as it also has strong demonstrated research and clinical support and is oftentimes instituted more consistently. Mindell and colleagues (2006) note that "sleep training" in the popular literature typically refers to graduated extinction, as it is an effective treatment for problem sleep behaviors such as night wakings and parents are usually able to better tolerate it over unmodified extinction. Typically, most pediatricians endorse sleep training for healthy infants six months and older that are not yet sleeping through the night. The majority of infants who are six months old are developmentally and biologically capable of sleeping for extended periods without eating and self-soothing when they do awaken (Green & Palfrey, 2002.)

While there has been some debate in developmental literature about the safety of sleep-training and its long-term impact on child-parent bonding and attachment, recent research has found short- and medium-term benefits to parents, including improving parental sleep quantity and quality, better maternal mental health, less postpartum depression, and strong child-parent bonding, and that it has no long-term negative impacts on children (Hiscock, Bayer, Hampton, Ukoumunne & Wake, 2008; Price, Wake, Ukoumunne & Hiscock, 2012). Further, if a relationship between infant sleep training and postpartum physical activity and weight loss does exist, study investigators would have evidence for a novel approach to postpartum weight retention that has the

potential to address maternal needs, while concurrently taking barriers to success such as limited infant sleep into account during study design.

While previous postpartum weight studies have focused primarily on maternal eating and physical activity behaviors, none have directly addressed infant needs as well. The current study is innovative in that it brings barriers to postpartum weight loss to the forefront of study design by attempting to evaluate whether proactively addressing a lack of sleep and postpartum depression symptoms through infant sleep training is associated with increased physical activity levels in new mothers. These data may establish whether behavioral sleep training in infants can lead to increases in maternal physical activity. Furthermore, these data may also illuminate how these approaches could be structured and why they may be successful. The current study sought to evaluate whether mothers who successfully sleep trained their infants report 1) greater quantity and quality of maternal sleep, 2) greater quantity and quality of infant sleep, 3) higher levels of physical activity and less postpartum weight retention, and 4) lower levels of postpartum depression than mothers who did not successfully sleep train their child. Finally, the study sought to 5) evaluate mothers' interest in and preferences for both potential postpartum weight loss interventions and behavioral treatment interventions for infant sleep.



Proposed Mediator Model

METHODS

Participants

To be eligible for inclusion in the study, participants (n = 150) had to be adult women 18 years and older with healthy infants between 6- and 12-months of age. Infants had to be the result of a full-term singleton pregnancy (37-42 weeks gestation), as pre-term infants have an increased frequency of unique medical or developmental needs due to prematurity. Singleton pregnancies were included because infants that are multiples are typically on unique schedules at a very early age because of increased demands on parents. Participants were required to be proficient in English reading and writing. Study materials were completed online, and printed in English, so participants were expected to complete them independently.

Procedures

Potential participants were recruited either online or with printed study flyers posted in the community. Online recruitment methods included advertising in the Daily Digest at the University of Connecticut, as well as posts on Facebook groups appealing specifically to mothers, and with emails to local parenting forums and groups. Printed flyers with study information were posted in various places that parents are likely to frequent, including libraries, preschools, coffee shops, and other Connecticut businesses that cater to parents and children. Potential participants were provided with the study website address, which included the study information sheet, inclusion criteria, and all study measures. The study information sheet provided potential participants with information outlining study procedures, the potential risks and benefits of the study, information about participants' rights and how personal information would be protected,

and contact information for study investigators. No deception was used during the course of the study and participants were given the opportunity to complete online surveys anonymously. If participants were interested in receiving a $5 Amazon gift card as an appreciation of the time they had spent on study surveys, they had the option of providing an email address in a separate second survey. The investigation and all study procedures were approved by the Institutional Review Board at the University of Connecticut.

Study surveys collected data regarding mothers' utilization of sleep training methods, the quality and quantity of both infant and maternal sleep, and mothers' physical activity levels. In order to evaluate possible mediator variables, data was also collected on postpartum depression symptomatology, mother-to-infant bonding, breastfeeding, and social support. Finally, data was collected on the mother's preference for both sleep training interventions and physical activity interventions in order to evaluate the feasibility of future intervention studies. Mothers were asked to provide self-report data regarding their current height and weight, pre-pregnancy weight, and the amount of weight gained during pregnancy. Participating individuals completed survey data online between May and August of 2015. Questionnaires took approximately 20 minutes to 1 hour to complete.

Every effort was made to ensure confidentiality for study participants. Participant participation was anonymous, and due to the benign nature of the study, individuals were not required to sign a consent form. Participants were assigned a unique three-digit subject code. Surveys were administered using Qualtrics (www.qualtrics.com). Qualtrics goes to great measures to protect participants' data and information from unintended use. Their system maintains data behind a firewall. Qualtrics offers Transport Layer Security

(TLS) encryption (HTTPS) and survey security options like password protection and HTTP referrer checking. All data were accessed only by the researcher using a secure user identification code and a password. All pieces of data were keyed to that owner identification and cannot be accessed by anyone else. Although Qualtrics does include IP addresses with the data initially, this information was deleted by the researchers immediately upon retrieval of the data. Participants did not engage in a physical activity program so there were no identified risk factors to this study other than possible discomfort answering questions of a personal nature.

Questionnaires

Demographics. Basic demographic information including gender, age, marital status, household income, and education level was obtained via self-report online. Additional items assessed participants' reproductive history including how many times they had been pregnant, how many biological children they had, and the type of delivery they experienced with their 6- to 12- month old. Finally, participants' were asked whether they had a known history of depression, and whether they had even been treated for depression with psychotherapy and/or medication.

Weight/Height. Self-reported weight and height was collected because of the online nature of the study. Weight was reported in pounds and height was reported in feet and inches and subsequently converted into inches. The data were then used to calculate individuals' current body mass index. Self-reported height and weight, while less accurate than that collected by study investigators in a laboratory setting, is considered a reliable way to assess BMI and obesity status (Goodman, Hinden, & Khandelwal, 1999).

Physical Activity. Physical activity levels were assessed by self-report using item eight from the Paffenbarger Physical Activity Questionnaire. The Paffenbarger Physical Activity Questionnaire is a short, self- administered questionnaire designed to measure participation in leisure time physical activity among young and older adults (Paffenbarger, Blair, Lee, & Hyde, 1993). This study utilized item eight, which assesses the number of hours per day that an individual spends doing various levels of activity or inactivity. A typical weekday and weekend day were included.

Psychosocial variables. Symptoms of postpartum depression were measured using the Postpartum Depression Screening Scale (PDSS; Tatano Beck & Gable, 2002). The PDSS is a 35-item self-report measure that uses a 5-point Likert scale for scoring. The PDSS has demonstrated content validity and high levels of alpha internal consistency reliability (Beck & Gable, 2000). Additionally, the PDSS demonstrates higher sensitivity in identifying women with postpartum depression than traditional depression measures and another frequently used measure, the Edinburgh Postnatal Depression Scale (Beck & Gable, 2001).

Sleep. Study participants answered several questions pertaining to sleep quality and quantity. Subjects completed the Brief Infant Sleep Questionnaire (BISQ), a brief informational questionnaire that has demonstrated reliability, clinical validity, and applicability for screening sleep problems among infants and young children (Sadeh, 2004). It has shown strong efficacy distinguishing between control and clinical samples, and has demonstrated strong feasibility for completion online. Additionally, mothers were asked to estimate how long both they and their 6-12 month old infants slept between

the hours of 7 p.m. and 7 a.m., as well as how much their infant slept during daytime hours between 7 a.m. and 7 p.m.

Engagement with Sleep Training. Participants were asked several questions about whether they had successfully sleep-trained their 6-12 month old infant. Additionally, they completed a Sleep Training Questionnaire that assesses how frequently all participants utilized specific methods to sleep train their 6-12 month old child. This measure was created specifically for this study to capture various sleep training approaches and techniques, and as such there is no reliability or validity data available at this time.

Mother and Infant Bonding. In order to assess the quality of the relationship between mothers and infants, participants completed the Mother-to-Infant Bonding Scale (MIBS). The MIBS is an 8-item measure that uses a 4-point Likert scale for scoring. It has demonstrated strong internal reliability, and is unique as it is designed for use in the general population rather than a psychiatric sample (Taylor, Atkins, Kumar, Adams & Glover, 2005; Wittkowski, Wieck, & Mann, 2007).

Multidimensional Scale of Perceived Social Support. Participants completed the Multidimensional Scale of Perceived Social Support (MSPSS) in order to indicate how much they feel supported by important others in their day-to-day lives. The MSPSS is a 12-item measure that uses a 5-point Likert scale for scoring. It assesses how supported an individual feels by important others. The MSPSS has demonstrated good internal and test-retest reliability across various groups and strong factorial validity (Zimet, Dahlem, Zimet, & Farley, 1988; Zimet, Powell, Farley, Werkman, & Berkoff, 1990).

Infant Feeding Behavior. Participants were asked about how they were currently feeding their 6-12 month old infants, as well as how they had fed their infant in the past, and their potential plans moving forward. The questions asked were specific to this particular study, so no psychometric data is available for the questions assessing infants use of breastfeeding, bottle feeding, formula use, and consumption of solids.

Potential Interventions. Finally, participants were questioned about how interested they would be in specific types of interventions for postpartum weight loss and/or infant sleep training. While these data were collected, there is no psychometric information available since it is not a research measure. Rather, it was included based on the possibility that it could provide information about future interventions administered to new mothers.

Data Analysis Plan

Data were analyzed using Statistical Package for the Social Sciences (SPSS for Mac, version 23.0, IBM, Somers, NY, USA). Demographic data for all participants were evaluated. Subsequently, participants were divided into two groups; those who reported that they successfully sleep trained their 6-12 month old child (sleep trainers; ST), and those who indicated that they had not successfully sleep-trained their 6-12 month old child (non-sleep trainers; NST). Demographic differences between ST and NST were examined using chi-square or independent t-tests. Exploratory analyses identified factors that may contribute to increased physical activity levels in postpartum mothers. More specifically, groups were compared in various ways using both chi-squares and independent t-tests to assess for any group differences, including which sleep training methods group members endorsed, their engagement with physical activity, infant and

maternal sleep, mother/child bonding, and mothers' engagement with physical activity. Finally, the study sought to assess mothers' preferences for intervention, both for weight loss and infant sleep training.

RESULTS

Sample Demographics

Women (n = 150) completed the study assessment online; of those, three mother-infant dyads were removed from the dataset because their responses suggested that they did not meet the inclusion criteria for age of the infant. A fourth individual was excluded because they did not respond to the sleep training item. Finally, 21 mother-infant dyads were excluded from analyses due to inconsistent responses on the postpartum depression measure, which yielded invalid data based on the guidelines for the measure. There were no significant demographic differences between the dyad pairs that met inclusion criteria versus those that did not. Demographic characteristics for the final sample of mother-infant dyads (n=125) are available in Table 1. The majority of mothers reported their race as White (91.2%). The mean current BMI for the entire sample was 27.1 $\pm$ 6.2 kg/m^2. The mean age of participants was 32.2 $\pm$ 3.7 years and the mean age of the infants in the dyads was 8.6 $\pm$ 1.9 months. The overall sample had demonstrated high achievement in terms of education; 41.6% had attended graduate or professional school and 40.0% had a bachelor's degree. Most mothers were married (89.6%) and reported a household income of $75,000+ a year (72.0%).

The sample was subsequently divided into two groups; those that endorsed successfully sleep training their child ("Sleep Trainers," n = 50, 40% of the total sample) and those that did not endorse the same item ("Non-Sleep Trainers," n = 75). The groups

were not significantly different from one another on any demographic measures (Table 1). There were significant between-group differences in terms of two specific methods of sleep training that mothers endorsed; 92.0% of mothers who successfully sleep trained their infants had used extinction in the process, and 80.0% of them endorsed graduated extinction as a method as well vs. 58.7% of Non-Sleep Trainers who endorsed utilizing extinction, and 42.7% who utilized graduated extinction, $p < .01$.

Research Question 1: Quantity and Quality of Maternal Sleep

Results regarding the quality and quantity of maternal sleep are presented in Table 2. The two groups differed significantly in the quantity of their sleep, with Sleep Trainers sleeping 412.5 ($\pm$ 57.2) minutes per night on average, and Non-sleep Trainers reporting an average of 382.0 ($\pm$ 71.3) minutes per night, $p < .05$. Sleep Trainers also reported that their sleep was less likely to be interrupted; Sleep Trainers woke up 1.4 ($\pm$ 1.2) times per night on average, while Non-Sleep Trainers woke up an average of 2.4 ($\pm$ 1.7) times per night ($p < .01$).

Research Question 2: Quantity and Quality of Infant Sleep

Results regarding the quantity and quality of infant sleep are also presented in Table 2. The infants in the two groups demonstrated significant differences in several ways. First, infants whose mothers endorsed sleep training slept 624.2 ($\pm$ 81.7) minutes per night on average, whereas infants who were not sleep trained slept 577.4 ($\pm$ 99.5) minutes per night on average, $p < .01$. 28.0% of mothers who sleep trained their infants reported that their child's sleep was a problem, versus 54.7% of mothers who did not sleep train, with $p < .01$. Finally, 60.0% of sleep-trained infants fell asleep independently, compared to 22.7% of infants who were not sleep trained, with $p < .01$.

Infants who were sleep-trained were awake for less time overnight, averaging 30.7 (± 43.6) minutes awake overnight, versus 64.2 (± 70.9) minutes for infants who were not sleep-trained, $p < .01$. There were no significant differences between groups for infant sleep during daytime hours (7 a.m. to 7 p.m.), or how long bedtime routines lasted.

Research Question 3: Maternal Physical Activity and Weight

Maternal physical activity level is reported in Table 4. There were statistically significant differences between the two groups in relation to how many hours participants reported sleeping or reclining. On weekdays, Sleep Trainers spent an average of 8.0 (± 1.3) hours sleeping or reclining compared to Non-Sleep Trainers, who spent 7.0 (± 2.0) hours sleeping or reclining, $p < .05$. The difference approached significance on weekend days, with Sleep Trainers reporting an average of 8.1 (± 1.8) hours sleeping or reclining compared to Non-Sleep Trainers, who reported an average of 7.5 (± 2.0) hour sleeping or reclining on weekend days, with $p = .056$.

There were no significant differences in vigorous, moderate, light, or sedentary physical activity between the groups, as seen in Table 4. On average, both groups spent the most hours sleeping or reclining, followed by the time they spent engaging in light physical activity, sedentary activity, moderate physical activity, and lastly vigorous activity. This was true of both weekdays and weekend days.

Self-report data was also collected regarding mothers' prepregnancy BMI and how much weight they needed to lose in order to return to their prepregnancy weight. Both of these variables approached statistical significance between the groups, with mothers who sleep trained reporting a mean prepregnancy BMI of 27.5 (± 7.4) kg/m^2 versus 25.6 (± 5.3) for mothers who did not endorse sleep training, with $p = .10$. While

the data suggested that Sleep Trainers may have slightly higher BMIs overall, the group also had less remaining baby weight, reporting they had an additional 1.8 (± 14.4) lbs. to lose versus 5.5 (± 10.0) lbs. remaining for Non-Sleep Trainers, $p = .10$.

Research Question 4: Psychosocial variables

The study examined numerous psychosocial variables that could potentially have an impact on both sleep and physical activity levels. Results are included in table 3, and variables examined include maternal history of depression, prior treatment for depression, and postpartum depression symptomatology. 28.0% of the total sample reported a history of depression, and the same percentage of participants endorsed seeking treatment for depression in the past. In the past two weeks, 28.8% had clinically significant postpartum depression, and 32.0% met criteria for a major postpartum depressive episode. There were no significant differences between the sleep training groups with regard to a history of depression, treatment for depression, or postpartum depression of any kind. However, there were significant between-group differences in self-report of perceived social support, with Sleep Trainers reporting higher levels of social support than those individuals who did not endorse sleep training, $p < .05$.

Research Question 5: Preference for intervention

In addition to evaluating the relationship between infant sleep training and maternal health behavior, this study also sought to evaluate maternal interest in interventions addressing postpartum weight loss and infant sleep training. 43.2% of all participants indicated that they would be interested in attending a weight loss program specifically for mothers of infants. There were no differences between Sleep Trainers and Non-Sleep Trainers for general interest in weight loss programs. Participants were

most likely to be interested in on-line weight loss programs (56.0%), and least interested in weight loss programs delivered by phone (23.2%). There were no significant differences between the groups in preference for the type of weight loss intervention.

42.4% of participants indicated that they would be interested in baby sleep coaching classes in order to teach their infants to sleep independently. Mothers who had not sleep trained their infants were significantly more likely to indicate interest in sleep training programs than mothers who had previously sleep trained their babies (52.0% versus 28.6%, $p < .05$). There were also significant between group differences in preferences for the type of sleep training programs that mothers indicated they would be interested in; 38.7% of mothers who had not sleep trained their infants indicated that they would be interested in a phone-based program, while only 22.0% of mothers who had sleep-trained their babies expressed the same interest ($p < .05$). 62.7% of Non-Sleep Trainers indicated an interest in on-line sleep coaching, versus 44.0% of Sleep Trainers, with $p < .05$.

Discussion

To date, there have been few interventions targeting postpartum weight retention, which can impact weight classification in the long term (Leermakers, Anglin & Wing, 1998; Østbye et al., 2009; Phelan et al., 2015; O'Toole, Sawicki & Artal, 2003). Highlighting the impact of infant behaviors and their impact on postpartum weight loss and physical activity levels has the potential to illuminate novel approaches for future interventions, while also eliminating possible barriers to treatment. The current study explored which factors within the mother-infant dyad impact maternal health behaviors in the first postpartum year. Specifically, we evaluated whether infant sleep training was

positively associated with sleep quantity and quality in babies and their mothers as well as with maternal physical activity levels. We proposed that infant sleep training would result in lower postpartum weight retention. Furthermore, we examined the influence of sleep training on several psychosocial variables including mother-to-infant bonding and perceived social support. Finally, we sought to examine mothers' preferences regarding potential weight loss and sleep training interventions.

Prior research in Australia has established that infant sleep training is associated with improved quantity and quality of both infant and parental sleep (Price, Wake, Ukoumunne & Hiscock, 2012). This study sought to establish whether similar associations held true in an American study sample. In accordance with our hypothesis, participants reported that infants who had been successfully sleep-trained slept more minutes overnight, were awake for less time overnight, and were more likely to fall asleep independently than those infants who had not been successfully sleep-trained. Finally, mothers who successfully sleep-trained their infants were significantly less likely to report that their child's sleep was a problem. There were no significant between group differences in how long infants napped throughout the day, nor were any significant differences in the length of bedtime routines detected. These findings suggest that infant sleep training does in fact improve both the quality and quantity of infant sleep overnight, as well as parental perceptions of the child's sleep. Both groups endorsed using various sleep training methods at least some of the time, but Sleep Trainers were significantly more likely to endorse using unmodified Extinction or Graduated Extinction with their babies. This finding was interesting, especially since both groups endorsed other sleep training methods more or less equally. This finding may suggest that those who utilize

unmodified Extinction or Graduated Extinction with their 6-12 month old infant are more likely to successfully sleep train their infant, which is consistent with current recommendations from the AASM (Morgenthaler et al., 2006).

Infant sleep training was associated with improved maternal sleep as well as infant sleep in the current study. Infant sleep was significantly positively correlated with maternal sleep in the total sample, as well as in both groups, suggesting that when infants sleep more, their mothers sleep more as well. That said, it is not surprising that maternal sleep improves similarly to infant sleep following behavioral sleep training. In accordance with our hypothesis, mothers who sleep trained their infants reported sleeping significantly longer overnight than mothers who did not sleep train their infants. Furthermore, mothers who sleep trained their infants reported that they wake less frequently overnight, indicating that their sleep is less interrupted than that of Non-Sleep Trainers and may therefore be of higher quality overall. In combination with the findings regarding infant sleep, these data suggest that infant sleep training has a positive impact on the quantity and quality of infant sleep as well as the quality and quantity of maternal sleep. This is consistent with prior research, which has found that infant sleep training positively impacts both infant and maternal overnight sleep (Hiscock, Bayer, Hampton, Ukoumunne & Wake, 2008; Morgenthaler et al., 2006; Price, Wake, Ukoumunne & Hiscock, 2012).

Prior research has established two integral relationships; the impact of infant sleep training on postpartum depression levels and maternal and infant sleep, and also the positive impact of decreased PPD levels and increased infant and maternal sleep on both physical activity levels and postpartum weight loss (Gennaro & Fehder, 2000; Hiscock,

Bayer, Hampton, Ukoumunne & Wake, 2008; Price, Wake, Ukoumunne & Hiscock, 2012; Setse et al., 2008; Siega-Riz, 2009; Vernon, Young-Hyman & Looney, 2010 Hiscock, Bayer, Hampton, Ukoumunne & Wake, 2008; Price, Wake, Ukoumunne & Hiscock, 2012). There were no significant findings regarding the impact of infant sleep training on maternal physical activity levels in the current study. Contrary to our hypothesis that behavioral sleep training would increase maternal physical activity levels due to increasing maternal sleep, findings indicated that there were no differences between Sleep Trainers and Non-Sleep Trainers with regard to vigorous, moderate, light, or sedentary physical activity levels. The only significant difference regarding physical activity levels was related to the time that individuals spent sleeping or reclining, with Sleep Trainers again reporting significantly more sleep than those individuals who did not sleep train, reinforcing findings from a separate measure within the study. There could be several explanations for why we did not detect a significant relationship between infant sleep training and maternal physical activity levels. The first is that it is possible that no such relationship exists. However, this would be surprising considering research-established relationships between sleep training and maternal sleep as well as the relationship between maternal sleep and physical activity (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006; Siega-Riz et al., 2010). Another explanation is that the physical activity measure used was not sensitive or specific enough to capture a more nuanced difference between the two groups; question 8 on the Paffenbarger instructs participants to estimate the number of hours they spend engaging in each level of physical activity on the average weekday and the average weekend day, which may have under- or over-estimated physical activity levels for those individuals who did not exercise in one hour

increments. Another proposed explanation is that considering that the American Academy of Pediatrics does not suggest sleep training any infant younger than six months, the moment in time evaluated by recruiting mothers of infants 6-12 months old may have captured the impact of sleep training on sleep, but not any potential impact on other maternal health behaviors. Perhaps recruiting mothers of infants slightly older than 12-months would have provided a more appropriate window for detecting differences in physical activity levels following sleep training that typically occurs between 6- and 9-months. Future research may elucidate the relationship between infant sleep training and physical activity more effectively, especially if these possible explanations are taken into consideration.

Despite the lack of significant findings regarding the relationship between infant sleep training and physical activity levels, there were weight-related differences that were notable. The relationship between sleep training and postpartum weight retention approached significance, with mothers who endorsed sleep training retaining less weight than those mothers who did not successfully sleep train their children. This finding is interesting especially when one considers recent research highlighting the relationships between sleep, appetite, and weight outcomes, which suggests that sleep deprivation can lead to overeating and attendant weight gain (Markwald et al., 2013). However, both groups reported mean prepregnancy BMIs in the overweight range, with Sleep Trainers reporting slightly higher BMIs. Even with better postpartum weight loss results, Sleep Trainers are still carrying excess weight, highlighting the need for interventions tailored to new mothers.

While several studies have established the significant relationship between lack of sleep and postpartum depression symptomatology, this study found no between group differences with regard to the prevalence of a history of depression, or current clinically significant or major postpartum depression (Gennaro & Fehder, 2000; Setse et al., 2008; Siega-Riz, 2009; Vernon, Young-Hyman & Looney, 2010). The results did not support our study hypothesis that mothers who sleep trained their infants would report less postpartum depression. However, the data indicated a shockingly high prevalence of postpartum depression in our study sample, with 32.0% meeting criteria for a major postpartum depression. Recent prevalence estimates suggest that approximately 21.9% of women experience postpartum depression (Alvarado et al., 2014; Wisner et al., 2013). While it is possible that this study overestimated the prevalence of postpartum depression in the first year, it is also possible that established screening recommendations result in a high proportion of undetected PPD. The American College of Obstetricians and Gynecologists currently suggests screening for postpartum depression once during the postpartum period using a standardized and validated tool, but does not specify when that screening should occur (American College of Obstetricians and Gynecologists, 2015). However, the majority of women are screened around 6-8 weeks following delivery at their postpartum check-up. Postpartum depression can occur anytime between two weeks and one year postpartum and, as the present study suggests, impacts almost 1/3 of women 6-12 months postpartum. Recent recommendations suggest screening women for depression during pregnancy, the postpartum period, and throughout general adulthood in order to increase the likelihood of remission and treatment response (O'Connor et al., 2016).

While there were no significant differences in postpartum depression symptoms between the two groups, there were differences in perceived social support, with Sleep Trainers reporting greater perceived social support than Non-Sleep Trainers. This finding is interesting, as prior research has established that social support is inversely related to postpartum depression rates (Ege, Timur, Zincir, Geckil, & Sunar-Reeder, 2008). Considering the lack of other significant differences in psychosocial variables, this finding may suggest that those mothers who report having greater perceived social support are more likely to utilize behavioral sleep training methods. Social support can take many forms, including emotional, logistical, and informational; mothers with greater social support may have greater access to individuals who are knowledgeable about sleep training, greater support when they undertake behavioral changes, and more emotional support if the process gets challenging. This finding suggests an interesting possibility for future research exploring whether a causal relationship between perceived social support and engagement with behavioral infant sleep training exists.

Our final research questioned examined participants' interest in both weight loss and sleep training interventions. 43.2% of the total sample expressed interest in weight loss interventions in general, and 42.4% indicated an interest in sleep training programs. With regard to weight loss programs, results suggest that the two groups reported similar interest in general, and both groups indicating that they would be the most interested in interventions provided with an online delivery format. This was not surprising; prior research regarding interventions designed specifically with new mothers in mind suggest that online formats provide the highest level of convenience and accessibility for new mothers with numerous demands on their time (Østbye et al., 2008; Østbye et al., 2009).

Surprisingly, there were significant between group differences regarding interest in potential sleep training interventions. A majority of mothers who had *not* sleep trained their infants indicated interest in sleep training in general. This finding suggests that while some mothers had not yet sleep trained their infants at the time of data collection, this may not have been due to a lack of interest in behavioral modification, but rather suggests that perhaps these individuals had a lack of knowledge regarding sleep training approaches or a lack of informational or social support. Mothers who had not successfully sleep trained their infants expressed that they were most interested in sleep training programs delivered online. This finding again suggests that mothers are most interested in interventions that are readily and conveniently available with flexible delivery methods. Future research should consider these findings as well as forthcoming results from Phelan et al. (2015) whenever potential interventions are considered and designed.

Conclusions & Future Directions

The current study sought to explore the impact of infant sleep training on maternal health behaviors, and in particular physical activity levels, postpartum depression, and postpartum weight loss. The study found that behavioral sleep training is associated with improved maternal and infant sleep quantity and quality, higher levels of perceived social support, and a trend towards decreases in postpartum weight retention. The data did not support the hypotheses that infant sleep training would be associated with less postpartum depression or higher levels of maternal physical activity. While not all study hypotheses were supported, the findings suggest several areas of interest that

lend themselves to future research, and highlight study limitations, including the limited diversity within the study sample.

First, a more in-depth exploration of the role of perceived social support in new mothers and their use of infant sleep training may shed light on other group differences and potentially predict group membership. While there were no significant between group differences in physical activity levels, future studies may consider using more objective measures of physical activity levels, such as personal pedometers or accelerometers. More precise data could potentially capture nuanced group differences in exercise participation to explain the trend towards improved postpartum weight loss that may not be fully accounted for by improved maternal sleep. Current recommendations suggest the behavioral sleep training is safe and effective beginning when infants are around six months of age. It is possible that mothers who sleep train their infants do in fact engage in greater physical activity levels eventually once their own sleep improves, but that we were unable to capture group differences in our sample of mothers of 6-12 month olds. Future studies should also consider recruiting a more diverse group of mothers of slightly older infants in order to better understand the relationship between infant sleep and maternal health behaviors in a more representative group in order to better capture the impact of infant sleep training on maternal health behaviors.

The current study included very high percentages of mothers in both groups reporting both moderate and major postpartum depression, which can have a considerable impact on both mothers and children. This finding highlights the need for increased screening for depression in women beyond the first postpartum check-up. Postpartum depression can occur anytime in the first postpartum year, and it may be advisable to

explore optimal windows for assessing depression symptomatology as well its impact on a mother's ability to engage in other health behaviors.

Finally, this study was unique in its efforts to explore the impact of the unique and oftentimes symbiotic nature of the mother-infant dyad on maternal health behaviors. While day-to-day life provides considerable challenges to new parents including limited sleep, the demands of childcare, work both inside and oftentimes outside of the home, and myriad other stressors, new technologies have the potential to provide creative solutions to overcome barriers to improved health behaviors. Potential interventions tailored to new mothers should consider the needs and behaviors of both mothers and their children, seek to maximize flexibility and accessibility, while also aiming to increase social support in intervention design. Finally, potential interventions should consider screening for postpartum depression symptomatology and also providing psychoeducation regarding the nature and potential impact of postpartum depression. While the postpartum period is rife with challenges, its potential to serve as a teachable moment for behavior change to improve the lives of both mothers and infants should not be overlooked.

REFERENCES

American College of Obstetricians and Gynecologists (2015). Screening for perinatal depression. Committee Opinion No. 630. *Obstetrics and Gynecology, 125,* 1268-71.

Aguilar, M., Bhuket, T., Torres, S., Liu, B., & Wong, R.J. (2015). Prevalence of the Metabolic Syndrome in the United States, 2003-2012. *Journal of the American Medical Association, 313*(19), 1973-4.

Alvarado R, Jadresic E, Guajardo V, & Rojas, G. (2015). First validation of a Spanish-translated version of the Edinburgh postnatal depression scale (EPDS) for use in pregnant women: A Chilean study. *Archive of Womens' Mental Health, 18*(4), 607-612.

Ege, E., Timur, S., Zincir, H., Geckil, E. & Sunar-Reeder, B. (2008). Social support and symptoms of postpartum depression among new mothers in Eastern Turkey. *Journal of Obstetrics and Gynaecology Research, 34*(4), 585-593.

Fernandez, I.D., Groth, S.W., Reschke, J.E., Graham, M.L., Strawderman, M., & Olson, C.M. (2015). eMoms: Electronically-mediated weight interventions for pregnant and postpartum women. Study design and baseline characteristics. *Contemporary Clinical Trials, 43,* 63-74.

Finkelstein, E., Brown, D., Wrage, L., Allaire, B., & Hoerger, T. (2010). Individual and aggregate years-of-life-lost associated with overweight and obesity. *Obesity, 18*(2), 333-39.

Finkelstein, E.A., Trogdon, J.G., Cohen, J.W., & Dietz, W. (2009) Annual medical spending attributable to obesity: payer-and service-specific estimates. *Health Affairs, 28*(5), 822-831.

Gennaro, S., & Fehder, W. (2000). Health behaviors in postpartum women. *Family & Community Health, 24,* 16-26.

Graham, M.L., Uesugi, K.H., Niederdeppe, J., Gay, G.K., & Olson, C.M. (2015). The theory, development, and implementation of an e-intervention to prevent excessive gestational weight gain: e-Moms Roc. *Telemedicine and e-Health, 20*(12), 1135-42.

Green M. & Palfrey J.S. (Eds.). (2002). *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents (2nd ed., rev.).* Arlington, VA: National Center for Education in Maternal and Child Health.

Gunderson, E.P. & Abrams, B. (2000). Epidemiology of gestational weight gain and body weight changes after pregnancy. *Epidemiologic Reviews, 22*(2), 261-74.

Hiscock, H., Bayer, J.K., Hampton, A., Ukoumunne, O.C., & Wake, M. (2008). Long-term mother and child mental health effects of a population-based infant sleep intervention: Cluster-randomized, controlled trial. *Pediatrics,122*(3), 621-627.

Institute of Medicine (1990). *Nutrition during pregnancy. Part I, Weight gain.* Washington, D.C.; National Academy Press.

Kim, S.Y., Dietz, P.M., England, L., Morrow, B., & Callaghan, W.M. (2007). Trends in prepregnancy obesity in nine states, 1993-2003. *Obesity, 15*(4), 986-93.

Leermakers, E.A., Anglin, K., & Wing, R.R. (1998). Reducing postpartum weight retention through a correspondence intervention. *International Journal of Obesity, 22*(11), 1103-09.

Linné, Y., Dye, L., Barkeling, B., & Rössner, S. (2004). Long-term weight development in women: A 15-year follow-up of the effects of pregnancy. *Obesity Research, 12*(7), 1166-78.

Markwald, R.R., Melanson, E.L., Smith, M.R., Higgins, J., Perrault, L., Eckel, R.H., & Wright, Jr., K.P. (2013). Impact of insufficient sleep on total daily energy expenditure, food intake, and weight gain. *Proceedings of the National Academy of Sciences of the United States of America, 110*(14), 5695-5700.

Mindell, J.A., Du Mond, C.E., Sadeh, A., Telofski, L.S., Kulkami, N., & Gunn, E. (2011). Efficacy of an Internet-Based Intervention for Infant and Toddler Sleep Disturbances. *Sleep, 34*(4), 451-458.

Mindell J.A., Kuhn B., Lewin D.S., Meltzer L.J., Sadeh A. (2006). Behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep, 29*(10),1263–1276.

Morgenthaler, T.I., Owens, J., Alessi, C., Boehlecke, B., Brown, T.M., Coleman, J., Friedman, L., Kapur, V.K., Lee-Chiong, T., Pancer, J., & Swick, T.J. (2006). Practice parameters for behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep, 29*(10), 1277-1281.

O'Connor, E., Rossom, R.C., Henninger, M., Groom, H.C., Burda, B.U., Henderson, J.T., Bigler, K.D., & Whitlock, E.P. (2016). Screening for depression in adults: An

updated systematic evidence review for the U.S. Preventive Services Task Force. Evidence Synthesis No. 128. *AHRQ Publication No. 14-05208-EF-1*.

Ogden, C.L., Carroll, M.D., Kit, B.K., & Flegal, K.M. (2014). Prevalence of overweight and obesity in the United States, 2011-2012. *Journal of the American Medical Association 311*(8), 806-14.

Oken, E., Taveras, E.M., Popoola, F.A., Rich-Edwards, J.W., & Gillman, M.W. (2007). Television, walking, and diet: Associations with postpartum weight retention. *American Journal of Preventive Medicine, 32*(4), 305-311.

Olson, C.M., Strawderman, M.S. & Dennison, B.A. (2009). Maternal weight gain during pregnancy and child weight at age 3 years. *Maternal Child Health Journal, 13,* 839-846.

Olson, C.M., Strawderman, M.S., Hinton, P.S., & Pearson, T.A. (2003). Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 year postpartum. *International Journal of Obesity, 27,* 117-127.

Østbye, T., Krause, K.M., Brouwer, R.J.N., Lovelady, C.A., Morey, M.C., Bastian, L.A., Peterson, B.L., Swamy, G.K., Chowdhary, J., & McBride, C.M. (2008). Active mothers postpartum (AMP): Rationale, design, and baseline characteristics. *Journal of Women's Health, 17*(10), 1567-75.

Østbye, T., Krause, K.M., Brouwer, R.J.N., Lovelady, C.A., Morey, M.C., Bastian, L.A., Peterson, B.L., Swamy, G.K., Brouwer, R.J.N., & McBride, C.M. (2009). Active mothers postpartum: A randomized controlled weight-loss intervention trial. *American Journal of Preventive Medicine, 37*(3), 173-80.

O'Toole, M.L., Sawicki, M.A., & Artal, R. (2003). Structured diet and physical activity prevent postpartum weight retention. *Journal of Women's Health, 12*(10), 991-998.

Phelan, S., Brannen, A., Erickson, K., Diamond, M., Schaffner, A., Munoz-Christian, K., Stewart, A., Sanchez, T., Rodriguez, V.C., Ramos, D.I., McClure, L., Stinson, C., & Tate, D.F. (2015). 'Fit Moms/Mamas Activas' internet-based weight control program with group support to reduce postpartum weight retention in low-income women: Study protocol for randomized control trial. *Trials, 16*(4), 59-75.

Price, A.M.H., Wake, M., Ukoumunne, O.C., & Hiscock, H. (2012). Five-year follow-up of harms and benefits of behavioral infant sleep intervention: Randomized trial. *Pediatrics 130*(4), 643-651.

Ramchandani P, Wiggs L, Webb V, Stores G. (2000). A systematic review of treatments for settling problems and night waking in young children. *British Medical Journal, 320,* 209-213.

Rasmussen, K.M. & Yaktine, A.L. (Eds.). (2009). *Weight gain during pregnancy: Reexamining the guidelines.* Washington, D.C.: The National Academies Press.

Sarwer, D.B., Allison, K.C., Gibbons, L.M., Markowitz, J.T., & Nelson, D.B. (2006). Pregnancy and obesity: A review and agenda for future research. *Journal of Women's Health, 15,* 720-733.

Setse, R., Grogan, R., Cooper, L. A., Strobino, D., Powe, N. R., & Nicholson, W. (2008). Weight loss programs for urban-based, postpartum African-American women: Perceived barriers and preferred components. *Maternal and Child Health Journal, 12*(1), 119-127.

Siega-Riz, A.M., Herring, A.H., Carrier, K., Evenson, K.R., Dole, N., & Deierlein, A. (2009). Sociodemographic, perinatal, behavioral, and psychosocial predictors of weight retention at 3 and 12 months postpartum. *Obesity, 18,* 1996-2003.

Vernon, M.M., Young-Hyman, D., & Looney, S.W. (2010). Maternal stress, physical activity, and body mass index during new mothers' first year postpartum. *Women & Health, 50*(6), 544-562.

Yeh, J., & Shelton, J.A. (2005). Increasing prepregnancy body mass index: Analysis of trends and contributing variables. *American Journal of Obstetrics and Gynecology 193*(6): 1994-98.

Zimet, G.D., Dahlem, N.W., Zimet, S.G., & Farley, G.K. (1988). The Multidimensional Scale of Perceived Social Support. *Journal of Personality Assessment, 52,* 30-41.

Zimet, G.D., Powell, S.S., Farley, G.K., Werkman, S., & Berkoff, K.A. (1990). Psychometric characteristics of the Multidimensional Scale of Perceived Social Support. *Journal of Personality Assessment, 55*(3 & 4), 610-617.

Table 1
Baseline Characteristics of Groups

	Total Sample Participants (n = 125)		Groups Participants (n = 125)			
			Sleep Trainers (n = 50)		Non-Sleep Trainers (n = 75)	
	n (%)	M *(SD)*	n (%)	M *(SD)*	n (%)	M *(SD)*
Demographics						
White, Non-Hispanic	114 (91.2%)	-	46 (92.0%)	-	68 (90.7%)	-
Black or African-American	2 (1.6%)	-	0 (0%)	-	2 (2.7%)	-
Asian	6 (4.8%)	-	3 (6.0%)	-	3 (4.0%)	-
Native Hawaiian or Other Pacific Islander	0 (0.0%)	-	0 (0%)	-	0 (0.0%)	-
Latino/Hispanic	8 (6.4%)	-	2 (4.0%)	-	6 (8.0%)	-
Other Race	3 (2.4%)		1 (2.0%)	-	2 (2.7%)	-
Infant Age (Months)	-	8.58 *(1.86)*	-	8.72 *(1.83)*	-	8.48 *(1.90)*
Infant Birth Weight (Pounds)	-	7.67 *(1.39)*	-	7.72 *(1.26)*	-	7.64 *(1.47)*
Maternal Age (Years)	-	32.24 *(3.70)*	-	32.32 *(3.70)*	-	32.19 *(3.72)*
Current Maternal BMI	-	27.07 *(6.21)*	-	28.04 *(7.37)*	-	26.42 *(5.26)*
Vaginal Delivery	76 (60.8%)	-	27 (54.0%)		49 (64.5%)	
Education Level						
High School Diploma or less	4 (3.2%)	-	1 (2.0%)	-	3 (4.0%)	-
Some College, Associate's Degree or Technical School	19 (15.2%)	-	10 (20.0%)	-	9 (12.0%)	-
Bachelor's Degree	50 (40.0%)	-	17 (34.0%)	-	33 (44.0%)	-
Graduate or Professional School	52 (41.6%)	-	22 (44.0%)	-	30 (40.0%)	-
Marital Status						
Married	112 (89.6%)	-	46 (92.0%)	-	66 (88.0%)	-
Widowed	1 (0.8%)	-	1 (2.0%)	-	0 (0.0%)	-
Separated	1 (0.8%)	-	0 (0.0%)	-	1 (1.3%)	-
Never married	5 (4.0%)	-	0 (0.0%)	-	5 (6.7%)	-
A member of an unmarried couple	6 (4.8%)	-	3 (6.0%)	-	3 (4.0%)	-
Household Income						
20,000-24,999	1 (0.8%)	-	0 (0.0%)	-	1 (1.3%)	-
25,000-34,999	5 (4.0%)	-	3 (6.1%)	-	2 (2.7%)	-
35,000-49,999	8 (6.4%)	-	0 (0.0%)	-	8 (10.7%)	-
50,000-74,999	20 (16.0%)	-	7 (14.3%)	-	13 (17.3%)	-
75,000+	90 (72.0%)	-	39 (79.6%)	-	51 (68.0%)	-

Table 2:
Sleep Variables

	Total Sample Participants (n = 125)		Groups Participants (n = 125)			
			Sleep Trainers (n = 50)		Non-Sleep Trainers (n = 75)	
	n (%)	M *(SD)*	n (%)	M *(SD)*	n (%)	M *(SD)*
Maternal Overnight Sleep (Minutes)	-	394.19 *(67.44)*	-	412.52 *(57.16)*[b]	-	381.97 *(71.27)*[b]
Maternal Night Wakings (# per night)	-	1.99 *(1.55)*	-	1.44 *(1.17)*[a]	-	2.36 *(1.67)*[a]
Infant Overnight Sleep (Minutes)	-	596.36 *(95.19)*	-	624.18 *(81.70)*[a]	-	577.43 *(99.52)*[a]
Infant Daytime Sleep (Minutes)	-	195.32 *(72.58)*	-	198.30 *(71.28)*	-	193.31 *(73.85)*
Infant Overnight Awake (Minutes)	-	50.79 *(63.42)*	-	30.66 *(43.59)*[a]	-	64.21 *(70.89)*[a]
Bedtime Routine Length (Minutes)	-	44.44 *(160.82)*	-	22.7 *(21.19)*	-	59.12 *(206.72)*
Infant Falls Asleep Independently	47 (37.6%)	-	30 (60.0%)[a]	-	17 (22.7%)[a]	-
Problem Infant Sleep	55 (44.0%)	-	14 (28.0%)[a]	-	41 (54.7%)[a]	
Endorsed Sleep Training Methods						
Extinction	90 (72.0%)	-	46 (92.0%)[a]	-	44 (58.7%)[a]	-
Graduated Extinction	72 (57.6%)	-	40 (80.0%)[a]	-	32 (42.7%)[a]	-
Positive Routines	119 (95.2%)	-	48 (96.0%)	-	71 (94.7%)	-
Faded Bedtime with Response Cost	81 (64.8%)	-	34 (68.0%)	-	47 (62.7%)	-
Scheduled Awakenings	14 (11.2%)	-	6 (12.0%)	-	8 (10.7%)	-
Camping Out	65 (52.0%)	-	25 (50.0%)	-	40 (53.3%)	-
Successful Sleep Training Method						
Extinction	-	-	6 (12.0%)	-	-	-
Graduated Extinction	-	-	12 (24.0%)	-	-	-
Positive Routines	-	-	28 (56.0%)	-	-	-
Faded Bedtime with Response Cost	-	-	3 (6.0%)	-	-	-
Scheduled Awakenings	-	-	0 (0.0%)	-	-	-
Camping Out	-	-	1 (2.0%)	-	-	-

[a] $p < .01$
[b] $p < .05$

Table 3
Psychosocial Variables

	Total Sample Participants (n = 125)		Groups Participants (n = 125)			
			Sleep Trainers (n = 50)		Non-Sleep Trainers (n = 75)	
	n (%)	M *(SD)*	n (%)	M *(SD)*	n (%)	M *(SD)*
Maternal History of Depression	35 (28.0%)	-	16 (32.0%)	-	19 (25.3%)	-
Previous Treatment for Depression	35 (28.0%)	-	15 (30.0%)	-	20 (26.7%)	-
Clinically-significant Postpartum Depression	36 (28.8%)	-	11 (22.0%)	-	25 (33.3%)	-
Major Postpartum Depression	40 (32.0%)	-	15 (30.0%)	-	25 (33.3%)	-
Perceived Social Support	-	49.82 *(8.01)*	-	51.56 *(6.96)*[b]	-	48.65 *(8.49)*[b]
Postpartum Depression Scale	-	71.44 *(24.76)*	-	68.18 *(24.75)*	-	73.61 *(24.70)*
Mother-to-Infant Bonding Scale	-	2.80 *(3.46)*	-	3.28 *(3.94)*	-	2.48 *(3.09)*

[b] $p < .05$

Table 4
Physical Activity and Weight Variables

	Total Sample Participants (n = 125)	Groups Participants (n = 125)	
		Sleep Trainers (n = 50)	Non-Sleep Trainers (n = 75)
	M *(SD)*	M *(SD)*	M *(SD)*
Weekday Physical Activity			
Vigorous Physical Activity (hours)	1.07 *(1.91)*	0.83 *(1.12)*	1.23 *(2.29)*
Moderate Physical Activity (hours)	3.35 *(2.47)*	3.26 *(2.21)*	3.41 *(2.64)*
Light Physical Activity (hours)	6.26 *(2.82)*	6.18 *(2.94)*	6.32 *(2.75)*
Sedentary Physical Activity (hours)	5.92 *(2.86)*	5.78 *(2.83)*	6.02 *(2.89)*
Sleeping or Reclining (hours)	7.39 *(1.83)*	7.96 *(1.33)*[a]	7.02 *(2.03)*[a]
Weekend Day Physical Activity			
Vigorous Physical Activity (hours)	1.36 *(1.75)*	1.30 *(1.43)*	1.41 *(1.94)*
Moderate Physical Activity (hours)	4.10 *(2.70)*	3.75 *(2.04)*	4.33 *(3.06)*
Light Physical Activity (hours)	5.52 *(2.64)*	5.42 *(2.71)*	5.58 *(2.61)*
Sedentary Physical Activity (hours)	5.32 *(2.69)*	5.43 *(2.94)*	5.24 *(2.53)*
Sleeping or Reclining (hours)	7.71 *(1.92)*	8.11 *(1.81)*[c]	7.45 *(1.95)*[c]
Maternal Weight Variables			
Prepregnancy BMI	26.37 *(6.26)*	27.50 *(7.40)*[d]	25.62 *(5.31)*[d]
Remaining Baby Weight	4.06 *(12.01)*	1.83 *(14.37)*[d]	5.5.4 *(9.99)*[d]

[a] $p < .01$
[c] $p = .056$
[d] $p = .10$

Table 5
Preference for Intervention

	Total Sample Participants (n = 125)	Groups Participants (n = 125)	
		Sleep Trainers (n = 50)	Non-Sleep Trainers (n = 75)
	n (%)	n (%)	n (%)
Weight Loss (WL) Interest			
Interested in WL Programs	54 (43.2%)	20 (40.0%)	34 (45.3%)
Interested in WL Program In-Person	47 (37.6%)	17 (34.0%)	30 (40.0%)
Interested in WL Program By Phone	29 (23.2%)	10 (20.0%)	19 (25.7%)
Interested in WL Program On-Line	70 (56.0%)	25 (50.0%)	45 (60.0%)
Sleep Training (ST) Interest			
Interested in ST Programs	53 (42.4%)	14 (28.6%)[b]	39 (52.0%)[b]
Interested in ST Program In-Person	42 (33.6%)	12 (24.0%)	30 (40.0%)
Interested in ST Program By Phone	40 (32.0%)	11 (22.0%)[b]	29 (38.7%)[b]
Interested in ST Program On-Line	69 (55.2%)	22 (44.0%)[b]	47 (62.7%)[b]

[b] $p < .05$