Descriptive sleep quality and quantity in first-time parents of healthy infants between 4-12 months of age

Gracela Gregorio

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UNITEC Institute of Technology
Declaration

Name of candidate: Gracela Gregorio

This Thesis/Research Project entitled “Sleep in the Family: Sleep Patterns of Parents and First-Born Infants from 4 – 12 Months of Age” “Descriptive sleep quality and quantity in first-time parents of healthy infants between 4-12 months of age” is submitted in partial fulfillment for the requirement for the Unitec degree of Master of Osteopathy.

Candidate’s Declaration

I confirm that:

- This Thesis/Dissertation/Research Project represents my own work;
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.

Research Ethics Committee Approval Number: 2012-1074

Candidate Signature: ..................................................Date: .....................

Student number: 1347219
Abstract

**Aims:** The aims of this study were to describe the sleep quality and quantity of new biological parents of healthy infants single, first born between 4 and 12 months of age and to establish correlates of depression and sleep.

**Methods:** Sixty new parents completed 7-day sleep diaries 3 times over consecutive months. In addition, the General Sleep Disturbance, Edinburgh Postnatal Depression Scale (EPDS) and Brief Infant Sleep Disturbance Questionnaire (BISQ), were completed upon commencement and completion of the study.

**Results:** Primary (usually maternal), compared with secondary (paternal), caregivers of infants regarded as having problematic sleep were found to have lower sleep duration ($p < 0.001$) and sleep quality ratings ($p = 0.03$), longer sleep latency ($p = 0.03$), greater depression ($p = 0.01$), more weekly night feeding duties ($p < 0.001$) and weekly night wakes ($p < 0.001$), but higher levels of accumulated sleep ($p = 0.04$) and lower caffeine intake ($p = 0.045$).

Primary caregivers of problematic sleepers compared with primary caregivers of non-problematic sleepers had higher EPDS scores ($p = 0.03$). No differences were reported for secondary caregivers.

A moderately strong correlation was found between EPDS scores and the sleep quality rating of primary caregivers ($\rho = -0.48, p < 0.001$), whereas secondary caregiver scores were strongly correlated with sleep duration ($\rho = -0.51, p < 0.001$).

**Conclusions:** Results of this study indicate that mothers experience more fragmented sleep but maintain greater amounts of accumulated sleep than fathers. Although both parents can experience symptoms of depression, mothers’ symptoms are more strongly related to subjective sleep quality whereas fathers’ symptoms are related to sleep duration. Sleep interventions that address parent sleep must acknowledge the specific needs of each parent and be tailored accordingly.
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Abbreviations

ACT – Actigraph
BMI – Body Mass Index
EEG – Electroencephalogram
EOG – Electrooculography
ESS – Epworth Sleep Scale
GER – Gastroesophageal Reflux
GST – Global Sleep Time
ISD – Infant Sleep Disturbance
LSP – Longest Sustained Sleep Period
LSRP – Longest Self-Regulated Sleep Period
NREM – Non-rapid Eye Movement
OSA – Obstructive Sleep Apnoea
PPD – Postpartum Depression
REM – Rapid Eye Movement
SCN – Suprachiasmic Nuclei
SD – Standard Deviation
SE – Sleep Efficiency
SSS – Stanford Sleepiness Scale
SWS – Slow Wave Sleep
TST – Total Sleep Time
WASO - Wake After Sleep Onset
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Introduction to Thesis

The birth of an infant is often accompanied by changes in sleep patterns encountered by the mother and father that may impact other aspects of their lives (Gay, Lee, & Lee, 2004; Goyal, Gay, & Lee, 2009; Lee, Zaffke, & McEnany, 2000). The sleep patterns of the mother, who are usually the primary caregivers, have been investigated extensively at varying periods throughout the pregnancy and postpartum periods (Horiuchi & Nishihara, 1999; Kang, Matsumoto, Shinkoda, Mishima, & Seo, 2002) often characterizing sleep as being fragmented and associated with high levels of depression (Goyal et al., 2009). Despite this, the research that has been conducted during the postpartum period has focused on early infancy and less so on older infants.

Although literature pertaining to the fathers’ sleep is less comprehensive, research suggests that fathers, who are usually the secondary caregivers, also experience sleep disturbances similar to mothers (Watson, Watson, Wetzel, Bader, & Talbot, 1995). Early literature has focused on changes in fatigue (Elek, Hudson, & Fleck, 1997, 2002) and sleep (Gay et al., 2004) in the early postpartum period and again less on the older infants. In addition, fathers have been reported to suffer from postpartum depression (Matthey, Barnett, Ungerer, & Waters, 2000) that can at times be overlooked by maternal depression.

The lack of understanding related to the sleep of parents with older infants and the limited research surrounding paternal sleep have thus lead to this study. The study as outlined in this thesis aims to describe the sleep quality and quantity of new parents of healthy infants.

This thesis is organized in three main sections:

Section 1 is a literature review outlining the normal physiology of sleep in adults, the rhythmicity of sleep-wake cycles, the impact of sleep on health, and current findings in adult sleep research pertaining to factors affecting sleep. Additionally, infant sleep and the changes in sleep patterns of mothers and fathers pre- and postpartum are explored alongside the consequences of these changes. Section 2 contains a manuscript formatted for submission to the Journal of Sleep Research. Section 3 comprises appendices and all other pertinent information in support of this thesis. This thesis is a sub-study of a parent study entitled “Sleep in the family: sleep patterns of parents and first-born infants from 4–12 months of age”. The aim of the current study outlined in the manuscript is to describe the sleep patterns of first-time mothers and fathers of healthy infants 4 to 12 months of age.
Section One

Literature Review
1.0 Introduction
Analyses of historical and current sleep research have generally reported that, in recent times, there has been a decreasing trend in the amount of sleep that the average adult receives (Alvarez & Ayas, 2004). Over the past 50 years, American adolescents and adults reported a decline in sleep duration from 1.5 – 2 hours (Bin, Marshall, & Glozier, 2012). In 1960 the American Cancer Society found modal sleep duration to be between 8 – 8.9 hours, but by 1995 this dropped to 7 hours as reported by the National Sleep Foundation (Cauter, Spiegel, Tasali, & Leproult, 2008). In Finland, a small decrease in self-reported sleep of 18 minutes was recorded over a period of 33 years between 1972 - 2005, with an increase of sleepers reporting 7 hours of sleep and a decrease in those reporting 8 hours (Knutson, Spiegel, Penev, & Cauter, 2007). Despite these studies, a recent review comparing sleep in 12 countries reported mixed findings (Kronholm et al., 2008). Seven of the 12 countries were reported to show increased sleep duration over the past 40 years, 6 countries were found to have less sleep duration and 2 countries reporting inconsistent findings. Notwithstanding the mixed results, the tendency to short sleep duration has been strongly associated with mortality and morbidity (Bin et al., 2012).

Compromised sleep can have many adverse effects. It has been shown to affect carbohydrate and glucose metabolism, and the associated endocrine function (Bixler, 2009). Additionally, it increases levels of C-reactive protein promoting development of atherosclerotic lesions and increasing the risk of coronary artery disease (Spiegel, Leproult, & Cauter, 1999, 2007), causes altered hormonal function in appetite regulation leading to obesity and increased risk of diabetes (Meier-Ewert et al., 2004), and decreases cognitive function in children and adults (Taheri, Ling, Young, & Mignot, 2004). In some instances, lack of sleep may be self-inflicted in the form of longer hours socializing, late night internet interests and watching television. In other cases it is a necessity owing to careers that involve night shifts, long hours at work or as a caregiver for family or extended family, and in still other cases it is a result of sleep disorders (R. Dahl, 1996; Drummond & Brown, 2001).

Parents of newborn infants often report less and disturbed sleep during the transition into early parenthood (Alvarez & Ayas, 2004). Fragmented sleep is the result of accommodating a change in lifestyle that revolves around the infant’s physiological development. Early research has focused primarily on the sleep patterns of the mother during pregnancy and post-childbirth (Gay et al., 2004; Lee et al., 2000). Only recently has there been any interest or research on the impact on the father’s sleep pattern (Horiuchi & Nishihara, 1999; Kang et al., 2002). Furthermore, the aforementioned studies report parent sleep patterns during late pregnancy and early infancy and focus less on sleep
patterns of parents with older infants. This review will briefly outline the normal physiology of adult sleep and how this sleep changes for parents during the transition into and immediately beyond childbirth.

2.0 Circadian Rythmicity of Sleep-Wake Cycles

The mutual inhibition between the sleep and wake processes are intricately associated with anatomical structures within the brain. In addition, the regulation of the timing and consolidation of sleep and wake are influenced by internal biological processes and external factors, namely circadian rhythm, endogenous factors and environmental influences.

Circadian rhythms such as sleep-wake, core body temperature or hormonal levels are generated by the suprachiasmatic nuclei (SCN) in the anterior hypothalamus, located dorsal to the optic chiasm (Dijk & Archer, 2009; Lee-Chiong, 2008). The SCN operates as the master neural pacemaker of circadian rhythms and oscillates independently of the environment, synchronizing the timing of the “slave oscillators” found in other areas of the brain such as the cortex and in peripheral organs like the kidney and liver. Oscillations of 24-hour durations can be sustained for a few days without input from the SCN (Dijk & Archer, 2009; Lee-Chiong, 2008; Turek, Dugovic, & Laposky, 2011). This in turn can regulate local physical and behavioural rhythms.

Sleep-wake is timed to occur at specific phases relative to the internal rhythms such as the pineal melatonin rhythm and the rhythm of responsiveness of the circadian pacemaker (Reppert & Weaver, 2002). Without any environmental cues circadian rhythms “free-run” at their genetically determined frequency. The process of entrainment synchronizes the intrinsic circadian cycle. External time cues such as light or darkness, meals, ambient temperature, physical exercise, and social activities, can entrain the phase of the intrinsic circadian rhythm resulting in the sleep-wake cycle to be brought forward in the evening or backward in morning (Dijk & Lockley, 2002). For example, physical exercise in the evening can delay rhythms while exercise in the morning can cause a phase advance of rhythms.

2.1 Normal Sleep Patterns in Adults and Their Central Nervous System Regulation

Normal adult sleep architecture comprises two types of sleep, namely non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep (Feinberg & Floyd, 1979). A normal pattern of sleep in adults with regular sleep schedules begins with a short period of NREM before achieving REM sleep (Carskadon & Dement, 2011; Walker, 2009). Individuals alternate in cycles between
NREM and REM throughout the evening with 75 – 80% of the night spent in NREM sleep and 20 – 25% spent in REM sleep (Carskadon & Dement, 2011; Colten & Altevogt, 2006). The average length of the first NREM to REM sleep cycle is approximately 70 to 100 minutes with the second one lasting longer at 90 to 120 minutes (Colten & Altevogt, 2006). The number of sleep cycles achieved per night can determine the quality of an individuals’ sleep.

NREM sleep comprises four distinct stages in terms of their electroencephalogram (EEG) characteristics, which have been well documented and described (Colten & Altevogt, 2006). Generally, Stage 1 sleep is considered to have a transitional role (Carskadon & Dement, 2011; Colten & Altevogt, 2006; Kryger, Roth, & Dement, 2011; Lee-Chiong, 2008; Walker, 2009) that usually lasts 1 – 7 minutes, comprising only 5% of total sleep and is a period during sleep where the individual is easily interrupted with disruptive noise (Colten & Altevogt, 2006). Stage 2 usually lasts 10 – 25 minutes in the initial cycles and becomes longer in subsequent cycles. This stage comprises 45 – 55% of total sleep with the individual requiring greater stimuli to wake from this stage than from Stage 1 (Colten & Altevogt, 2006). Stages 3 and 4, the slow wave sleep (SWS) stages, usually occur in the first third of the night with Stage 3 lasting only a few minutes and comprising 3 – 8% of sleep and Stage 4 approximately 20 – 40 minutes in duration for the first cycle and comprising 10 – 15% of total sleep. Arousal threshold is highest during NREM stages 3 and 4 and lowest in Stage 1. While stages 3 and 4 dominate early in the night, Stage 2 and REM sleep increase in duration in the latter half of the night. The proportion of NREM stages 3 and 4 is related to the length of prior wakefulness whereas REM sleep is linked to the circadian rhythms of body temperature (Colten & Altevogt, 2006; Lee-Chiong, 2008). It is believed that Stages 3 and 4 sleep are necessary for restoration of physiological functions of the body whereas REM sleep is for enhanced brain function (Carskadon & Dement, 2011; Lee-Chiong, 2008).

### 2.2 Impact of Sleep on Health

The ideal amount of sleep that an individual should get appears to vary among researchers. Bixler (2009) believes that the optimal amount of sleep that is associated with maintenance of good health is 7 to 8 hours. Cauter et al. (2007) reported that sleep varies between individuals and is influenced by age; others believe that the amount of sleep that an individual gets should be sufficient for them to perform at satisfactorily levels and feel refreshed Cauter et al. (2007). Ohlmann & O’Sullivan (2009) is more specific, recommending 7 to 8 hours of sleep per night or 1 hour of sleep for every 2 hours awake. It would appear however, that there is a fine line between getting too much sleep and not getting enough. Although ill-health has been associated with regular short sleep duration, it has
been observed that long sleep duration can have the same complications (Ohlmann & O'Sullivan, 2009).

Earlier reports by Oswald (1980) and Adam (1980) outline the restorative nature of sleep not only for the brain but for the body as a whole. According to the authors, during wakefulness catabolic processes dominate due to the greater energy demands of heightened cellular activity (Oswald, 1980). Conversely, it is during sleep, when cellular work is at its lowest, that adenosine triphosphate (ATP) is restored and anabolic functions dominate. Both authors believe that REM sleep is for repair and synthesis for the brain whereas NREM, is of particular importance for growth and tissue repair. It is during SWS that an increase of human growth hormone occurs which stimulates amino acid uptake into tissues, promotes protein and RNA synthesis, stimulates red blood cell formation and raises blood-free fatty acids (Oswald, 1980). All of these processes lead to enhanced protein synthesis. When the amount of sleep that an individual gets is consistently insufficient, the restorative benefits of sleep are compromised.

2.3 Adult Sleep Research
Although, there is a general assumption that people are getting less sleep than in the past, a recent review of the trends in the duration of adult sleep does not support this view (Bin et al., 2012). A total of 12 studies were reviewed, which described data from fifteen countries between the 1960’s and 2000’s. During this period sleep duration had increased in seven countries (range: 0.1 – 1.7 min per night each year), decreased in six countries (range: 0.1 — 0.6 min per night/year) and showed inconclusive findings in two countries. It is difficult to generalize the results of these studies due to numerous factors. Firstly, the populations of these studies were not all representative of the country where the surveys were conducted. The Swedish population was confined to middle-aged women and the Russian population was made up of rural workers in Siberian Russia. Secondly, the two indicators of sleep duration that were used in the studies were not consistent, with five studies using habitual sleep duration (reflecting perceived sleep sufficiency and introducing potential biases) and the remainder utilizing a time use estimate of sleep which may overestimate sleep duration if time awake while in bed and daytime sleep are considered. Finally, not all of the studies identified the type of day (i.e. weekend or weekday) or the season of the survey. It is possible that there are several differences in sleep as well as different sleep patterns from weekend to weekday. Overall, it is still unclear what longitudinal changes in sleep patterns have occurred on a global level.
Research in adult sleep is broad and difficult to review as a whole due to the vast range of issues addressed in each study. Research has encompassed the sleep of various age groups, addressing sleep in the context of ill-health (Bin et al., 2012), disordered sleep (Knutson et al., 2007) and comparison between genders (Crowley, 2011). Other studies have identified many factors affecting sleep patterns, such as anxiety (Staner, 2003), depression (Franzen & Buysse, 2008), child/family care (Gay et al., 2004), marital status, educational background and socioeconomic status (Hale, 2005), environmental factors as in noise pollution (Hume, Van, & Watson, 1998) and demographics, family structures, health behaviour and health status (Krueger & Friedman, 2009). Differences in methodology of the various studies, for example differing measurement tools used, population size and sampling and different sleep parameters of interest also make it difficult to generalize findings.

Measurement of sleep parameters has been accomplished using objective and subjective measures. These include polysomnography, actigraphy, use of diaries and global questionnaires. Polysomnography is the gold standard methodology when studying sleep physiology (Krystal & Edinger, 2008), however actigraphy (ACT), also known as actimetry, has been reported to have reasonable validity and reliability when assessing sleep-wake patterns in normal individuals with relatively good sleep quality (Sadeh, 2011). Sleep diaries have been used successfully with good correlation in measuring sleep time and duration (Lockley, Skene, & Arendt, 1999). Questionnaires such as the Epworth Sleep Scale have also been used to assess the level of daytime sleepiness.

2.3.1 Factors Affecting Sleeplessness

The following population-based studies assessed levels of sleeplessness and the possible factors affecting them. Research by Anderson and Horne (2008) studied 10,810 people aged 20 — 65 years, Broman et al. (1996) studied 600 people aged 20 — 64 years, and Hublin et al. (2001) studied 12,423 twins aged 33 – 60 years. In Anderson and Horne (2008) the variables studied were sleep period time, sleep deficit and subjective daytime sleepiness using the Epworth Sleepiness Scale. Broman et al. (1996) utilized a revised Uppsala Sleep Inventory to determine the degree of the respondents’ lack of sleep, and in Hublin et al. (2001) the objective multiple sleep latency test was used to assess individual daytime sleepiness. In addition, Hublin et al. (2001) analyzed whether other variables such as gender, education level, lifestyle, work status, and diurnal type, affected sleep.

In Anderson and Horne (2008) 10,810 participants completed questionnaires that provided information on sleep length, daytime sleepiness, desired sleep length, stressful lifestyle and choice of alternative daytime activities in a “free” hour. Regarding sleep deficit, 46.7% of men and 44% of women reported wanting the same or less sleep than actually achieved, with significant sex effect (p
but not age. Across the 20 – 65 year group, 19.8% of men and 19.9% of women reported excessive daytime sleepiness with significant age ($p < 0.0005$) and sex effect ($p < 0.001$) but with small effect sizes. The younger group had significantly lower levels of daytime sleepiness compared with the two older groups. A determining factor in individuals considering themselves as a problem sleeper is the sleep period time (mean: 7.32 h vs 6.55 h, $p=0.0005$), which is the time between falling sleep at night and waking up in the morning. Women slept better than men averaging 8.0 compared with 7.37 hours. The risk factors for sleep deficit were “reporting problem sleep” (1.82 increased risk, CI 1.67 – 1.99) and “always stressed” (1.62. CI 1.42 –1.85). For those indicating a sleep deficit, and regardless of the severity of this deficit, only a minority (19% of men and 23.4% of women) chose “sleep” if they had an extra hour of free time.

In the questionnaire study by Broman et al. (1996), women reported a greater need for sleep ($p = <0.001$) and younger participants needed more sleep than older ($p = <0.001$). Women also reported less sleep sufficiency index (ratio of amount of habitual sleep to the amount of estimated need for sleep) than men (mean sleep sufficiency index SD 88.1 ± 13% versus 91.7 ± 14%, respectively; $p < 0.01$). Deemed causes of insufficient sleep were age-specific, with leisure activities and watching television identified by the younger age group, infant sleeping patterns identified by the middle aged group and personal illness identified by the older group as being the primary cause. The most common cause of sleep insufficiency was having sleeping difficulties (ie. falling asleep, night time awakenings or premature morning awakenings) which was reported by 15.3% of the population with no differences between age and sex and by 49% of those identified as having persistent insufficient sleep.

The twin study by Hublin et al. (2001), helped to determine the prevalence of insufficient sleep, the factors associated with it, and whether it was subject to genetic influence. In terms of prevalence, 79.6% reported that the length of sleep differed less than 1 hour from their sleep need, with the remaining 20.4% reporting at least 1 hour difference meeting the criterion for having insufficient sleep. Significant gender differences existed (with 16.2% of men and 23.9% of women having insufficient sleep, $p<0.001$). A total of 10.8% reported insufficient sleep in 1981 but did not report it in 1990 and 12.1% who had insufficient sleep in 1981 continued to experience it in 1990. Insufficient sleep was found to be a long-standing condition for some with 8.5% experiencing it at both measure points. Spearman correlation for persistence between 1981 and 1990 was 0.334. A significant age effect was shown for insufficient sleep in both genders ($p=0.001$) with 20% of men aged 33 – 39 and 12.8% of men aged 50 – 60 experiencing insufficient sleep compared with 27.6% and 19.3% in
women, respectively. Many variables were identified to be strongly and positively correlated with insufficient sleep. For example, heavy alcohol use was positively associated in both genders (p<0.05), education was significantly and positively associated but only in men having primary level education in men (p = 0.05), more weekly working hours was positively associated in women (p = 0.05), and finally stress of daily activities, life satisfaction and depression were each significantly and positively associated (p = 0.05). Approximately 1/3 of inter-individual variability in the liability to insufficient sleep was due to gene tic factors.

All three studies agree that one of the many variables that are associated with insufficient sleep is having sleeping difficulties. Difficulties with falling asleep, night time awakenings, inability to sleep without sleep disturbances, and stressful lifestyle each contributed to insufficient sleep. Although the three studies concur that there are gender differences in levels of insufficient sleep, they differ in their findings between men and women. According to Anderson and Horne (2008), women were found to have slept longer than men indicated by the amount of sleep they achieved whereas in the Broman et al. (1996) study, women had less sleep sufficiency than men and in Hublin et al. (2001) 23.9% women and only 16.2% men (p = <0.001) had sleep length at least 1 hour less than sleep need. It is difficult however to make a direct comparison as in Anderson and Horne’s study the total hours slept are reported whereas the sleep sufficiency index in Broman’s study is a ratio between the amount of habitual sleep and the amount of estimated need for sleep. The outcome based on the different methods of reporting might imply that although women sleep longer than men, they are less likely to get the amount of sleep that they desire.

Generalizability from these population-based studies may be in question. Anderson and Horne (2008) recruited their population as part of a BBC TV program and used a sleep questionnaire via an interactive website to generate their data. Results of these studies are limited to those individuals who happened to be watching the program and are further limited to those who have access to a computer and to the internet. The Broman population was recruited from a Swedish population who are subject to the extreme light changes experienced in Scandinavia due to its latitude which have been shown to affect sleep (Nilssen et al., 1997). The population in Hublin et al. (2001) was made up of sets of twins, and as such, may not have been representative of the general public.

Although these population studies investigated the insufficiency of sleep in adults, other characteristics of sleep have been studied. Elements of sleep architecture that have been thoroughly researched include sleep duration, timing and quality, along with behaviours associated
with sleepiness such as vulnerability to sleep loss, the relationship between wakefulness and sleep, and various sleep disorders (Van Dongen, Vitellaro, & Dinges, 2005).

### 2.3.2 Gender Differences in Sleep

Some studies have identified gender differences over a wide range of ages, although these differences are not consistent across ages. In one study of neonates, for example, boys displayed less total sleep time (TST) of 106 ± 44 minutes and global sleep time (GST) of 111 ± 44 minutes compared with the girls who had longer TST and GST times of 113 ± 36 and 126 ± 35 respectively (Bach, Telliez, Leke, & Libert, 2000). In contrast, other studies have reported no significant gender differences in sleep quality and quantity in school-aged children (Bach et al., 2000) nor differences in TST, sleep onset latency and the number of awakenings during sleep in adolescents (Meijer, Habekotth, & Van Den Wittenboer, 2000). Studies in adults show varying results, with some showing more favourable sleep parameters in females (Lee, McEnany, & Weekes, 1999), some in males (Geol, Kim, & Lao, 2005; Kobayashi et al., 1998; Reyner & Horne, 1995; Silva et al., 2008) and some showing no significant gender differences (Hume et al., 1998; Sakakibara et al., 1998; Voderholzer et al., 2003).

Various studies have reported that women have more positive sleep patterns than men and report poorer sleep quality. Kobayashi et al. (1998) support this view however, Sakikabara et al. (1998) and Volderholzer et al. (2003) oppose this view reporting that males have more positive sleep patterns. It is notable that the findings of the aforementioned research are inconsistent and may be due to the various measurement methods applied in the studies.

### 2.3.3 Better Sleep Quality In Women Compared with Men

#### 2.3.3.1 Objective Measures Only

Kobayashi et al. (1998) studied 18 subjects over the age of 60 (8 males, 60.6 ± 6.7 years; 10 females 61.7 ± 6.8 years) using 2 consecutive 36-hour sleep wake polygraph recordings and reported that males spent less time asleep with a lower sleep efficiency index (75.1% vs 87.7%), experienced more Stage 1 sleep (p not reported), significantly less stages 3 and 4 sleep (p < 0.001) and napped more than females (p not reported). The population used in this study was a small Japanese sample, over 60 years of age, therefore cultural differences in sleep habits may disallow direct generalizability of these results. In addition, the polygraphic recordings were conducted from
Saturday evening to Monday morning covering the weekend period only and did not consider the differences between weekday and weekend activities.

### 2.3.3.2 Subjective and Objective Measures

Geol et al. (2005) studied 31 young adults (16 males; 15 females), 18 – 30 years of age, mean ± SD, 20.5 ± 2.4 yr using polysomnographic recording over 3 nights and the Stanford Sleepiness Scale (SSS). This study showed women as objectively having significantly longer TST, better sleep efficiency, less total wake time and shorter sleep onset latency than men. Correspondingly, men scored higher on the SSS revealing that men subjectively reported more sleepiness than women.

The effect sizes for all the difference in sleep characteristics ranged from $d = 0.98$ to 1.12, although the amount of variability within each gender was not reported. Generalizability of this result to a wider population may be limited by recruiting methods, namely local newspaper advertisements and university campus postings. Campus recruiting might have introduced a higher representation of young adults with a higher level of education and affluence than a more broadly sampled survey.

Reyner and Horne (1995), compared the sleep patterns between genders of 400 adults (211 females, 189 males) in three groups aged 20 – 34 (n = 148), 35 – 49 (n = 135) and 50 – 70 (n = 117) years, using wrist actimetry and morning logs measured in the home environment. Sleep log results for time of sleep onset, revealed significant gender ($p < 0.038$) and age ($p < 0.016$) effects but no interaction, with younger men experiencing earlier sleep onset than middle aged and older groups. Similar findings were revealed for total sleep period measured via actimetry, with significant effects of gender ($p < 0.006$) and age ($p < 0.033$) but no interaction shown. Women were reported to fall asleep 7 minutes faster than men and sleep onset time became later with advancing age. Despite the more favourable objective sleep patterns, women showed a non-significant tendency to rate their sleep quality more poorly and felt significantly more tired and less refreshed after 15 minutes of being awake in the morning than men.

Silva et. al. (2008) undertook polysomnography, the Epworth Sleep Scale (ESS), and pre-study sleep questionnaires with 2,365 patients of a sleep laboratory (1,550 men; 815 women) to determine the differences in sleep patterns between genders in six age groups for adults undergoing investigation for sleep complaints. Subjectively, women complained more frequently of somnolence in their pre-sleep questionnaire, however, results from the ESS did not corroborate this, instead showing that men actually scored higher than women ($10.8 \pm 5.3$ versus $9.5 \pm 6.0$). A score above 10 is suggestive of more daytime sleepiness. In addition, women spent more time in Stages 3 and 4 ($p < 0.0001$) of
NREM sleep than men who spent more time in Stages 1 \((p < 0.001)\) and 2 \((p < 0.0001)\). Sleep disturbances such as sleep apnea/hypopnea were also significantly higher in men than in women. Polysomnographic recordings reported sleep efficiency \(SE\) being the total sleep time or time spent in bed, as being generally similar between males and females. Decreased sleep onset latency significantly occurred more frequently in males, who, in contrast to those in the Reyner and Horne (1995) study took much less time to fall asleep than females.

### 2.3.4 Better Sleep Quality In Men Compared with Women – Subjective and Objective Measures

In contrast to the studies above that support the concept that females have more positive sleep patterns than males, the following studies oppose this trend by suggesting that males have more positive sleep patterns, as in Sakakibara et al. (1998) and Voderholzer et al. (2003).

Sakakibara et al. (1998) recruited 20 subjects (9 males; 11 females), 50 – 76 years of age and utilized polysomnographic recording over 5 nights, wrist actigraphy and the obstructive sleep apnoea (OSA) sleep inventory for subjective sleep measures. The study indicated no differences in subjective measures between genders in sleep quality although night time movement index of men tended to be higher than in women suggesting better sleep in men. Transitions between sleep cycles has been associated with a high number of body movements (Hoque, Dickerson, & Stankovic, 2010).

Voderholzer et al. (2003) reported, via sleep logs and polysomnographic recordings from 86 patients suffering from insomnia and 86 healthy controls, that while no gender differences existed in subjective sleep parameters there were differences in objective measures. Gender by group interactions were significant for REM latency measures \((p = 0.002)\), which were 30% longer in female compared to male patients, but 16% shorter in female compared to male healthy controls. No gender differences in sleep continuity or sleep architecture were shown in the healthy-sleeping group, although females tended to have slightly better subjective sleep quality than healthy males \((p = 0.159)\).

### 2.3.5 No Gender Difference in Sleep Quality – Objective Measure Only

Hume et al. (1998) studied 52 volunteers (23 males; 29 females) and attempted to describe the sleep patterns of 20 – 70 year olds in their own homes. The population was categorized into groups by age (20 – 34, 35 – 49 and 50 – 70 years). Greater differences in sleep variables were found across age groups than between gender. Stage 1 sleep was greater in males than in females as age increased and men had less deep sleep and more Stage 1 sleep than females.
Although Reyner and Horne (1995) reported that women show more positive sleep characteristics than men, some sampling factors inherent in the study should be considered. The original population used in this study was recruited to assess the impact of aircraft noise on sleep. The population lived in close proximity to 4 major airports in the United Kingdom where noise generated during the evening could possibly affect the sleep patterns of the population. This could also have influenced the demographic or socio-economic characteristics of these areas. In addition, 45% of these households had 1 or more children less than 16 years of age. The proportion of those with young infants is not known and may have affected the statistics generated for the middle aged males and females of the group. In Hume et al.’s (1998) study, the 103 females were slightly older than the 87 males (44 compared to 39; respectively; \( p < 0.05 \)). Age variability data was not reported. As with Reyner and Horne (1995) The population was also gathered from a group of people living within close proximity to an airport having the same sampling issues influencing generalizability to the broader population.

Sakikabara et al. (1998) and Volderholzer et al. (2003) have generated a slightly opposing standpoint from the other research outlined above, however, some issues should be considered regarding methodology when comparing the results. In the case of Sakakibara’s study, mean and standard deviation of the age of the sample group was not disclosed making it difficult to tell whether age variability amongst the sample could have affected the results. In addition, although no significant gender difference was found with regard to sleep quality, the subjects of this study ranged between 50 – 76 years of age. Results, therefore, cannot be generalized outside of this age group. In Voderholzer’s study there was a tendency for the male patients suffering from insomnia to overestimate sleep onset latency and underestimate sleep duration. Due to missing data, it was not possible to compare subjective to objective sleep data for the entire population. Sleep objective and subjective sleep parameters were therefore evaluated in the identical sub-population matched for age and gender. A total of 70 patients suffering from insomnia but only 54 healthy controls were available for analysis. The characteristics of participants with missing data were not reported. Additionally, it was also not revealed whether the data was lost or whether participants withdrew from the study. If participants in fact withdrew from the study, a bias for certain characteristics may have had affected on the results. It is difficult to evaluate this likelihood without knowing the details of the missing data.

Silva et al. (2008) (n=2365) and Reyner and Horne (1995) (n=400) are relatively larger studies compared with others reviewed and concurred that women have better sleep quality than men.
Two important points of difference exist between the studies. The main point of difference being that the Silva study recruited current patients of a sleep laboratory and cannot be generalized to the wider population. Secondly, males in the Silva study had a higher BMI than the females \(28.5 \pm 4.8\) vs \(27.7 \pm 6.35\) \text{kg/m}^2; p = 0.001. Body mass index in Reyner and Horne study, was not reported, however, a correlation has been made between short sleep duration and raised BMI (Taheri et al., 2004) which might explain the shorter sleep onset latency found by Reyner and Horne.

The finding that women have positive objectively measured sleep patterns yet subjectively report poor sleep, could be ascribed to a few factors. In the case of Reyner and Horne (1995) for instance, it was not known how many of these women were responsible for night-time care of young infants which has been known to contribute to fragmented sleep (Campbell, 1986). The number of times that a mother attends to the night time needs of the infant has been correlated with poor sleep quality (Elek et al., 1997; Quilllin, 1997). Another factor contributing to this trend is the woman’s menstrual cycle. Circadian physiology could be altered due to the change in hormone profile associated with the different menstrual phases (Hunter, Rychnovsky, & Yount, 2009). Reyner and Horne’s study reported that women subjectively experienced greater disturbed sleep during the luteal and premenstrual phases yet polysomnographic estimates do not support this claim. Further, premenstrual syndrome where symptoms and mood changes appear regularly in the luteal phase and diminish soon after the onset of menstruation, may have a negative impact on the woman’s daily function and possibly affect their ability to perform duties at home and in the workplace (Shechter & Boivin, 2010). Women often report increased fatigue and sleep-related problems during this period (Shechter & Boivin, 2010). In addition to these factors, women may report their sleep problems more readily than men (Voderholzer et al., 2003).

### 2.4 Consequences of Sleeplessness

Prolonged periods without sleep have been observed to lead to disturbances in cognition and memory (Capellini, McNamara, Preston, Nunn, & Barton, 2009; Drummond, Brown, Salamat, & Gillin, 2004; Harrison & Horne, 2000; Neubauer, 2009), change in metabolism, weight and increased risk of diabetes (Knutson et al., 2007; Nagai, Hoshide, & Kario, 2010; Taheri et al., 2004), increased risk of hypertension and cardiovascular complications (Gangwisch et al., 2006) and general negative changes to quality of life (Herrick, 2010; Lo & Lee, 2012).

The relationships of habitual short sleep duration with obesity and type II diabetes has been recently under review as obesity and type II diabetes are increasing worldwide. Links have been made
between short sleep duration and an increase in ghrelin and decreased leptin plasma levels (Taheri et al., 2004). Ghrelin and leptin are opposing hormones that regulate hunger and appetite. Ghrelin, primarily released by the stomach, stimulates appetite whereas leptin, primarily secreted by adipose tissue, induces satiety in normal-weight people (Gangwisch et al., 2006). Under normal conditions in a 24-hour period, plasma levels of leptin rise during the evening, depending partly on meal intake. Plasma levels of ghrelin also show a nocturnal rise post-digestion, then decrease in the second half of the sleep period. It is unclear how short sleep duration leads to the changes in plasma levels of leptin and ghrelin or in body weight but these changes are believed to contribute to changes in metabolism leading to obesity and greater incidences of type II diabetes (Littman et al., 2007; Taheri et al., 2004).

The correlation between short sleep duration and changes in leptin and ghrelin is supported by a population-based longitudinal study conducted by Taheri et al. (2004). In this study, 1024 volunteers from the Wisconsin Sleep Cohort Study, aged 30 – 60 years of age, responded to surveys on sleep habits which were repeated over 5 year intervals. A random sample of this group undertook overnight polysomnography and collection of a blood sample the following day shortly after waking. Follow-up studies of this group were conducted at 4-year intervals. Results showed, independently of BMI, age and sex, a significant increase in leptin ($p = 0.01$) with an increase in average nightly sleep and that a decrease in sleep from 8 to 5 hours was associated with a decrease in leptin by 15.5%. Moreover, there was a significant decrease in ghrelin with increased total sleep time ($p = 0.008$). A decrease in sleep from 8 to 5 hours was associated with an increase of ghrelin by 14.9%. Overall, sleep that was consistently less than 7.7 hours was associated with increased BMI.

In this randomized trial, 173 post-menopausal sedentary overweight women, aged 50 – 75 years of age, were given a moderate-intensity exercise regime to follow over a period of one year. The first 3 months involved a combination of supervised and self-administered exercises 5 days of the week, with the majority of the workouts being done independently by months 4 to 12. A control group was only required to attend a 45-minute stretching session once per week for 1 year. Sleep questionnaires were completed at baseline, 3 and 12 months. Results showed that regardless of whether there was an improvement or deterioration in sleep, these changes were not significantly associated with the changes in levels of weight, leptin or ghrelin. It would be difficult to generalize the findings of this study due to the particular demographic of the sample population.
2.5 Maternal Sleep

There is an abundance of literature relating to maternal sleep at different phases from pre-pregnancy to postpartum (Driver & Shapiro, 1992; Elek et al., 1997, 2002; Gay et al., 2004; Lee et al., 2000; Nishihara & Horiuchi, 1998). The majority of these studies reported on the changes in maternal sleep over these periods, paying particular attention to total sleep time, sleep latency, sleep efficiency, and changes in the percentages of time in the various stages of sleep.

A general trend observed is that the quality and the quantity of maternal sleep declines from pregnancy to the postpartum period (Karcan et al., 1968; Matsumoto, Shinkoda, Kang, & Seo, 2003; Quillin, 1997); however, some studies have reported inconsistent results. Lee et al. (2000) utilized polysomnography in the participants home for 2 consecutive nights. Matsumoto et al. (2003) conducted their study in the hospital or in the participant’s home using actigraphs and daily sleep logs from 34 weeks gestation to 16 weeks postpartum. In Nishihara and Horiuchi (1998), polysomnograms were used in the participant’s home for one night in each of the first, third and sixth postpartum weeks. In Karcan et al. (1968) participants were wired for electroencephalogram (EEG) and electrooculography (EOG) and were recorded for 3 consecutive nights in the last month gestation and for the same duration immediately following delivery. These studies report that maternal sleep was poorly affected after delivery. However, Karcan et al. (1968) reported that the changes were not long lasting and that maternal sleep resumed to almost normal conditions within 2 weeks of birth. The difference identified by Karcan et al. (1968) may be due to the fact that the mothers were not responsible for the 2 a.m. feed for the duration of the study; the infants were kept in a nursery between 10 p.m. to 6 a.m. in order to avoid disrupting the mother’s sleep.

Furthermore, feeding styles have changed over the past few years with more and more mothers choosing to breastfeed. For instance, more than 2/3 of mothers in the early 1900’s initiated breastfeeding in the United States (Hirschman & Mutler, 1981) and despite a decline in 1946 – 1950 (Hirschman & Mutler, 1981) a resurgence was experienced with breastfeeding rates remaining relatively static from early 1980’s to 1995 (Ryan, 1997). The withdrawal of the 2 a.m. feed in the study of Karcan et al. (1968) may have greatly impacted the mothers night time sleep.

Changes in sleep patterns prior to delivery were attributed to discomfort associated with a growing fetus and changes experienced by the mother due to a growing abdomen in addition to hormonal changes before pregnancy (Karcan et al., 1968). Fragmented sleep after delivery contributed to a decrease in total sleep time due to feeding requirements of the infant, regardless of feeding type (Driver & Shapiro, 1992).
2.5.1 Postpartum Depression
Many women experience sleep deprivation during the transition into motherhood which can be a prelude to postpartum depression (PPD) (Hunter et al., 2009). Maternal fragmented sleep may be linked to infant growth and development or temperament (Dorheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009), implying a stronger causal link between mothers’ sleep and PPD, than infant factors in the development of PPD. Others support an opposing view, that an unsettled infant can lead to PPD (Goyal et al., 2009). The implication of sleeplessness on PPD is problematic mainly because there are many factors that contribute to PPD. In addition to sleep disturbances directly related to infant care being a contributor to PPD, hormonal changes immediately after childbirth have also been hypothesized to contribute to PPD. Declines in levels of progesterone, that occur immediately postpartum, are noted to have sedative properties, and sleep patterns are often affected during that time (Hunter et al., 2009). In addition, a recent theory has been introduced that suggests inflammation plays a role in depression with physical and/or psychological stress being the trigger (Kendall-Tackett, 2010). A moderate increase of pro-inflammatory cytokines in the third trimester is normal, but when stress is added there is an increased potential for depression. Sleep disturbances and fatigue increase cytokine levels and when these levels are high, fatigue increases (Kendall-Tackett, 2010).

PPD has been known to commonly affect mothers but occurrence of paternal PPD has recently also been recognized (McMahn, Barnett, Kowalenko, Tennant, & Don, 2001). The reported incidence of maternal and paternal postpartum depression varies within the literature: from 8% to 28% of mothers and 5% to 13% of fathers (Edmondson, Psychogiou, Vlachos, Netsi, & Ramchandani, 2010). However, paternal PPD incidence can increase to almost 25% if the mother is also suffering from PPD (Matthey et al., 2000). The detrimental ramifications of PPD may affect either parent individually or both as a couple, the couple together with their infant as well as the enlarged family unit.

In the context of the new family, PPD has been reported to negatively impact upon the entire family unit. Maternal mental health and well-being suffer for prolonged periods which, if untreated, can hamper the growth of family relationships and infant development. Research pertaining to paternal postnatal depression has enriched the general understanding of paternal experiences during pregnancy and early infancy. The relationship between PPD and sleeplessness is difficult to define due to the numerous contributing factors, however, it is noteworthy that family care specialists recognize that this is indeed a family problem and should be dealt with accordingly.
3.0 Changes in Parent Sleep Patterns Pre- and Post-birth

3.1 Infant Sleep

The birth of an infant has been associated with changes in maternal and paternal sleep patterns well before delivery (Driver & Shapiro, 1992; Kang et al., 2002; Karcan et al., 1968). New infant responsibilities can cause parent sleep to become fragmented, requiring naps during the day. These naps are essentially working against the natural circadian rhythms that promote sleep and wake at particular times throughout the 24 hour period. Parent sleep is often subject to the feeding requirements of their infant but is also dependent on the maturation of their infant’s sleep/wake system.

3.1.1 Sleep Consolidation

Three aspects of sleep and sleep self-regulation have been identified in the infants first year; i) the longest sustained sleep period (LSP), marking a period of unbroken sleep; ii) the longest self-regulated sleep period (LSRSP), that involves the infants ability to self-soothe after a night awakening; and iii) sleeping through the night, when the infant experiences unbroken sleep ideally corresponding to the sleep patterns of other family members (Henderson, France, & Blampied, 2011).

The review by Henderson et al. (2011) outlined that the greatest rate of change in LSP occurred within the first 3 months but particularly between 1 and 2 months of age when the average LSP went from $3.57 \pm 1.21$ hours to $5.16 \pm 1.58$ hours. Minimal increases continued to $5.74 \pm 1.98$ hours by 12 months. With respect to LSRSP, the first and most prominent trend occurred between 1 and 4 months with average LSRSP $6.98 \pm 1.96$ and $9.10 \pm 2.07$ respectively, representing an increase in reported length of 3 to 5 hours. A plateau in rate of change occurred between 4 and 8 months with steady increases occurring between 9 to 12 months, $9.78 \pm 2.16$ hours to $10.25 \pm 1.90$, suggesting that many infants can experience self-regulated sleep for up to 9 hours by the end of their first year. By 1 month of age, 10 to 19% of infants were considered sleeping through the night if they slept between 12:00 a.m. and 5:00 a.m.. At 2 months the rates of change in sleeping continue, ranging from 31 to 58%, and by 3 months 57 to 71% were considered to be sleeping through the night.

3.1.2 Sleep Disturbance

Sleep disturbance (Minde et al., 1993), sleep problems (Byars, Yolton, Rausch, Lanphear, & Beebe, 2012), and infant sleep disturbance (ISD) (France, Blampied, & Henderson, 2003) are terms used interchangeably by parents and researchers to describe behaviours such as frequent night
awakenings, sleep onset delay, co-sleeping not desired by the parents, short sleep duration, difficulty falling asleep and difficulty staying asleep (France et al., 2003). Some parents eventually seek professional assistance to address this issue.

The literature is generally consistent showing the prevalence of sleep disturbances ranging from 20 to 30% in infants under 3 years of age (France et al., 2003; Gibson, Gander, & Elder, 2012; Sadeh & Anders, 1993; Teng, Bartle, Sadeh, & Mindell, 2012). The first 3 years of life are characterized by cycles of wakefulness and settled periods in infant sleep. A study conducted by (Moore & Ucko, 1957) revealed that 70% of 160 infants settled into non-wakeful night sleep by 3 months of age and 83% by 6 months of age, with 10% never settling in the first year of life. However, of those that settled, 50% had relapses of night waking lasting more than four weeks between 5 to 9 months of age. In a study by Byars et al. (2012) 10% of the 359 mother/infant dyads were reported as having sleep problems from 3 months to 36 months of age.

Children who suffer from short sleep duration respond with irritability and have a low-frustration tolerance (R. Dahl, 1996). Lack of sleep in the infant and toddler has negative consequences in terms of increased risk of accidental falls, mental and emotional wellbeing (R. E. Dahl, 1996). Spruyt et al. (2008) studied 20 healthy term infants to assess their sleep patterns at varying points throughout the first year and assessed temperament and mental, motor and behavioral development during these times. Subjective and objective methods of measurement were utilized and revealed that a correlation existed between increased sleep and positive behaviours such as ease of approachability \( r = 0.62 \), adaptability \( r = 0.67 \) and low distractibility \( r = 0.52 \). This research suggests positive correlations between increased sleep and the infant’s development.

3.1.3 Theories on the Etiology of Sleep Disturbances in Infants

The newborn is changing and adapting daily as their systems mature and as a result it is difficult for the infant to establish predictable sleep patterns. There are many variables that must be considered in understanding the development of sleep disturbances in infants as sleep is the result of biological developmental phases but equally influential is the environment acting upon the infant, in particular the parent(s) (Bax, 1980; France & Blampied, 1999).

Gastro-esophageal reflux (GER) and cow’s milk intolerance have been associated with sleep disturbances in infants (Ammari et al., 2012; Kahn, Mozin, Rebuffat, Sottiaux, & Muller, 1989). Gastro-esophageal (GER) is a common physiological process experienced by preterm and term neonates usually manifesting as vomiting (Ammari et al., 2012). Cow’s milk intolerance has been
associated with symptoms such as continual waking and crying during sleep hours (Wessel, Cobb, & Jackson, 1954). Kahn et al. (1989) established a correlation between cow’s milk and median sleep time after removing and re-introducing cow’s milk into infants’ diets.

The impact of GER on sleep in neonates was determined by Ammari et al. (2012) where 25 neonates were hospitalized with a suspicion of GER. This group was further subdivided into two groups according to whether the infants showed GER with esophageal pH <4 (GER group n = 18) or not (control n = 7). There was a positive correlation with the frequency of GER and the frequency of sleep stage change \( r = 0.60, p = 0.007 \). The number of GER episodes influenced continuity of sleep showing that there is greater sleep instability when the number of episodes increases.

4.0 Parent Sleep

4.1 Mothers Sleep

The most commonly studied sleep parameters are total sleep time (TST), sleep time or time in bed otherwise known as sleep efficiency (SE), wake after sleep onset (WASO), sleep latency (the amount of time it takes for an individual to fall asleep) and the number of night awakenings (sleep disturbances) experienced by the mother. The results outlined below give an indication of the variability of the mother’s sleep patterns before and after pregnancy.

4.2 Total Sleep Time and Sleep Efficiency

In terms of TST, some of the studies reviewed reported no change detected from late pregnancy to the first month postpartum (Gay et al., 2004) and up to the 6th week postpartum (Nishihara & Horiuchi, 1998), whereas it was found to be shorter postpartum and significantly shortened and decreased each week after delivery up to 12 weeks postpartum (Kang et al., 2002). Kang et al. (2002) reported a decrease in SE among postpartum mothers and also suggested that SE approached normal values at different weeks postpartum.

A comprehensive study by Lee et al. (2000) followed 33 first time mothers and multiparous women those who had given birth more than twice, (25 –39 years of age) through various stages of pre-pregnancy to the first year postpartum and used polysomnography to understand the longitudinal changes in sleep patterns experienced by mothers. Changes found in their sleep patterns were identified as early as 11 to 12 weeks gestation. This study reported a significant change in TST in the study period \( p = .016 \) where sleep in the first trimester (446 minutes) was significantly higher than
in the third (372 minutes). A decrease in SE was also reported in the first month post-partum especially in new mothers, owing to more awakenings in the evening. Rapid eye movement sleep did not change however SWS increased significantly in the first month postpartum suggesting that mothers can get into deep sleep quickly after night awakenings, thus providing some adaptation to counteract potential sleep deprivation (Lee et al., 2000).

In the study by Kang et al. (2002), the sleep patterns of 10 multiparous women, and primigravida, women in their first pregnancy, 29.5 ± 2.2 (mean ± SD) years of age, were recorded with actigraph and sleep logs between the fifth week gestation to fifteen weeks post-partum. Both actigraph and sleep log recordings reported that TST decreased from 425 to 300 minutes between the last month gestation to the first week postpartum. Sleep efficiency decreased from 87% to 70% in the same period. Both TST and SE decreased for each week from delivery up to week 12. The reduction in SE calculated from actigraph recordings was greater than that of sleep-log-calculated SE. Data from this study also suggests that between week 12 and 13 after delivery there is a turning point where maternal sleep-wake rythms become similar to that during late pregnancy. Lee et al. (2000) support the change in patterns occurring 3 months postpartum.

Challenging the decrease in TST reported in the studies above, is a study that also used polysomnography in 5 primiparous women (18 – 29 years of age), and reported no significant difference in the total time recorded (from sleep onset to cessation of recording and included any awakening) from 8 – 39 weeks gestation and 1 month postpartum overall weighted mean of (± SD) of 13.1 ± 3.5 between pre- and post- pregnancy recordings) (Driver & Shapiro, 1992). The study also reported that REM sleep was not different during pregnancy, compared to before, but was decreased postpartum. However, as in Lee et al. (2000), Stage 4 sleep, was higher at weeks 17 – 27 and 28 – 30 compared to 8 – 16 weeks gestation. Postpartum sleep cycles showed similar lengths for the first cycle but significantly longer for the second and third cycles due to infant feeding times indicating longer NREM sleep as the night progressed. In one instance, one of the babies did not wake for a feeding, however, the mother showed a longer second cycle, suggesting that the lengthened cycles become entrained (Driver & Shapiro, 1992). In support of the finding by Driver & Shapiro (1992) that there were no changes in TST from pregnancy to postpartum, is the study by Gay et al. (2004). This study reported the findings from 72 couples with first born children from actigraph and sleep logs in the last month of pregnancy and the first month postpartum. Although no change in TST was reported, the composition of the sleep period had changed between time points. In this sample, mothers lost an average of 41.2 minutes of nighttime sleep (p = 0.001),
however, their daytime sleep increased by 30.8 minutes in the first month postpartum ($p < 0.01$). There was no report on SE in this study.

In a study by Nishihara and Horiuchi (1998) of 10 young Japanese mothers from 36 weeks gestation to the sixth week postpartum, mothers’ TST decreased by 24.7 minutes and SE also decreased by 9.5% between the first and last time points. Unlike Lee et al. (2000) and Driver and Shapiro (1992), the percentage and amount of REM and SWS did not change across the four time points but Stage 2 NREM sleep decreased from $210 \pm 55.7$ minutes to $153 \pm 30.2$ minutes between the first (pre-natal) and last (post-natal) time points.

It is difficult to conclude that any definite trends in TST and SE have been established from the studies reviewed due to the variations between studies. In the first instance, Nishihara et al. (1998) conducted their study with Japanese women, introducing the possibility of different cultural beliefs regarding infant sleep habits, such as co-sleeping which is regarded as acceptable in Asian cultures (Nishihara & Horiuchi, 1998). It is therefore difficult to generalize the findings from this study. Secondly, the age differences of the mothers used in the studies differ with 23 – 31 years ($M = 26.8$, SD not reported) (Nishihara & Horiuchi, 1998), 20 – 43 years ($M = 32.1 \pm 5.1$ years) (Gay et al., 2004), 25 – 39 years (with nulliparous $M = 30.5 \pm 3.7$) (Lee et al., 2000), $M = 29.5 \pm 2.2$ years (Matsumoto et al., 2003), and 18 – 29 years (M and SD not reported) (Driver & Shapiro, 1992). Younger mothers have been reported to have more difficulty with the maternal role than older women (Secco, Ateah, Woodgate, & Moffatt, 2002), which may be reflected in their perceptions and management of their sleep and their infant’s sleep. In addition sleep characteristics were not categorized according to feeding style except by Gay et al. (2004), which was also the only study to categorize work status of the mother. In general, it is difficult to conclude with specificity that the sleep patterns of mothers follow a straightforward path during pregnancy and after delivery however similarities between studies, in particular the decrease in TST and increase in Stage 3 and 4 of sleep do exist.

4.3 Wake After Sleep Onset (WASO) and Nighttime Awakenings
It is generally agreed that the length and number of WASO increases significantly from the late pregnancy to the early postpartum period. Some studies reported increases in actigraph measurements from the postpartum weeks 1 to 10 gradually decreasing from weeks 5 to 12 postpartum (Horiuchi & Nishihara, 1999) but not significantly from weeks 11 to 15 postpartum (Matsumoto et al., 2003) and affecting mothers more than fathers in both the last month of pregnancy and the first month postpartum (Gay et al., 2004).
Nighttime awakenings are commonly experienced by mothers in response to the feeding and care demands of their young infants. Campbell (1986), studied 9 first time mothers at the time of birth and weekly during the first 3 weeks after delivery with non-directive interviews and the Nursing Child Assessment Sleep Activity Record. Infants slept between 58 and 99% of the mother’s normal sleep time. Awakenings averaged 1.57 – 3.00 per night in the study period but by the fourth week the mean number of awakenings was decreased in 8 of the 9 infants.

Nishihara and Horiuchi (1998) studied the relationship between the sleep patterns of 10 primiparae women and their infants movements at night between the 36 weeks of pregnancy to 6 weeks postpartum. All mother-infant dyads slept in the same room and in the same bed. Of these women, 8 breastfed and 2 were formula fed. Mother’s wakefulness was strongly influenced by her infant’s movements postpartum. The frequency and duration of awakenings increased significantly postpartum.

Another factor to be considered in the maternal nighttime awakenings is the maturity of the infant’s circadian sleep-wake rhythms. Nishihara and Horiuchi (2000) studied 7 primiparae mothers and their infants at weeks 3, 6, 9 and 12 postpartum. Mother’s movements at night significantly decreased from week 3 to week 12. Autocorrelogram of activity-non-activity for infants revealed that there was a 24-hour peak by week 6 which the researchers attributed to the infants’ circadian rhythms. All infants showed peaks in their autocorrelograms by week 12 whereas none showed them at week 3. Most (80%) infants showed prominent circadian components by weeks 8 to 12. In the study of Matsumoto et al. (2003), 5 primiparae mothers were studied over 4 periods from 39 – 41 weeks gestation to weeks 1, 5, 6 - 10 and 11 - 15 postpartum. Maternal nocturnal activity during the first 2 weeks postpartum had increased but by the third week onward it had decreased. Wake after sleep onset increased in all postpartum periods except for the last. Mean amplitudes of circadian rhythms decreased markedly in the first postpartum days (up to day 23) and gradually increased after that time so that they were significantly higher by days 71– 93. Although nocturnal sleep patterns had not returned to normal or pregnancy values even by week 11, WASO and the decrease in daytime naps suggested that these mothers showed circadian amplitude returning to normal by week 10.

Horiuchi and Nishihara (1999) and Matsumoto et al. (2003) both identified “turning points” in maternal sleep from interrupted to uninterrupted sleep. This occurred between 1 and 6 weeks postpartum in the study by Matsumoto et al. (2003), and after 9 weeks in the study by Horiuchi and...
Nishihara (1999). In addition, a transition between 9 and 12 weeks postpartum was reported with the main factor serving to initiate this change being the infant’s development of circadian sleep-wake rhythms (Nishihara et al., 2000).

4.4  Sleep Fragmentation - Quantity vs. Quality
When considering the various sleep parameters that contribute to a good night’s rest, it would be logical to assume that the more sleep an individual gets during the nighttime period, the more restorative processes can occur and the more rejuvenated an individual will feel the next day. On the contrary, many studies indicate the importance of receiving greater amounts of 90 minute sleep cycles which leads to more refreshed feeling (Elek et al., 1997, 2002; Gress et al., 2010; Quilllin, 1997). Troy (1999), however, maintains that overall quality of sleep is related to the duration of a mother’s sleep. This perspective taken by Troy may be due to the fact that the majority of the population were considered somewhat depressed and were significantly correlated with having high levels of morning fatigue.

Gress et al. (2010) studied 94 women in their last week of pregnancy and 10 weeks postpartum, 46% of whom were primiparae. The researchers studied the mother’s subjective sleep and its correlation to infant caretaking at night. On average, the mothers woke 2.2 times per night and spent an average of 47.3 minutes awake to attend to their infant. A significant predictor of a mother’s perceived quality of sleep was the number of times her sleep was disturbed by attending to her infant and not the duration of time tending to the infant.

5.0  Father’s Sleep
Numerous studies have been conducted that focus on the sleep patterns of mothers and how they change throughout the various stages from pregnancy and postpartum. Very few studies have focused on the sleep pattern of the father (or secondary parent in single-sex partnerships). Only recently has there been recognition that the birth of an infant has any bearing, positive or negative, on the lifestyle, level of stress, physical and emotional health and sleep patterns of the father. While the mother and father become parents at the same time, they do not become parents in the same way (Watson et al., 1995). Nonetheless, the father is subject to the same adaptations as the mother experiences and as such is subject to repercussions of fatigue and sleeplessness however, these are not elucidated to the same extent as the mothers’ plight.
5.1 Fatigue
There is insufficient literature that focuses exclusively on fathers’ experiences. There are however preliminary data that compare the fatigue levels and sleep patterns of the father with that of the mother during the same timeframe (Elek et al., 1997, 2002; Gay et al., 2004). Both Elek studies focused on the fatigue levels and less so of the sleep patterns of first-time parents from the ninth month of pregnancy to the fourth month postpartum. The studies reported that mothers’ fatigue levels were significantly and negatively correlated with the number of undisturbed sleep cycles obtained the previous night at the 12-week data period. In the study by Elek et al. (2002), only a non-significant trend existed between mothers reporting fewer undisturbed 90 minute sleep cycles than the fathers during data collection period.

Gay et al. (2004) observed sleep and fatigue of both parents from nine months gestation to the first month postpartum. Fathers were reported to have a greater increase in fatigue from the 9th month pregnancy to the 4th week postpartum. Both mothers and fathers always reported less morning fatigue than nighttime fatigue although still at mild to moderate levels. The differences between the mother’s morning and evening fatigue, however, lessened as pregnancy progressed whereas the fathers were consistent throughout the third trimester. These levels were significantly associated with other variables such as marital satisfaction, parental leave and age of father.

5.2 Sleep
In Elek et al. (2002) sleep patterns were also noted to have changed during the study period of the last trimester of pregnancy in that mothers’ reports of undisturbed 90-minute sleep cycles increased from the 7th to the 8th month then decreased in the 9th month. Fathers on the other hand reported an increase in 90-minute sleep cycles from the 7th to the 8th month and again in the 9th (Elek et al., 2002). Over the four data collection periods, 50%, 70%, 48% and 39% of mothers and 14%, 64%, 50%, 30% and 25% of fathers reported receiving less than four nighttime sleep cycles or 90 minute sleep cycles of uninterrupted sleep. The aim of most people is to get 7 - 8 hours of sleep each evening whereas parents in this study were getting less than 7 hours.

In the study by Gay et al. (2004), mothers and fathers received approximately the same amounts of sleep in the last month of pregnancy. The mother’s nighttime sleep however, changed significantly during the transition from pregnancy to postpartum losing an average of 41.2 minutes of sleep whereas the father only lost 15.8 minutes. Both parents experienced significantly more disturbed
sleep as WASO time increased from pregnancy to postpartum, with mothers being affected more than fathers during pregnancy and postpartum.

Despite infant care and feeding responsibilities normally falling onto the mother’s shoulders, it is interesting to note that in Gay et al. (2004), fathers actually slept less than mothers during both the pregnancy and postpartum period and TST did not change for the mother in either time. The number of naps taken by the mother may have contributed to the TST since fathers who returned to employment did not have the opportunity to nap.

In terms of fatigue, and similar to Elek et al. (1997, 2002), there was no difference in morning and evening fatigue experienced by mother and father during pregnancy and postpartum. Mothers and fathers had similar levels of morning and evening fatigue which were generally higher postpartum than in pregnancy (Gay et al., 2004).

6.0 Conclusion
Adults have been reported to be gradually sleeping less in recent years which has been associated with harmful health-related issues. Although findings of some studies have identified gender differences in quality and quantity of sleep, literature is generally inconsistent owing to various factors associated with sleep. The transition into parenthood introduces yet another factor that contributes to changes in adult sleep quality and quantity. The sleep patterns of both the mother and father are affected well before the birth of their baby. In the mothers’ case this may be due to the endocrine and physiological changes in addition to the discomforts of their increasing mass which may in turn affect the father’s sleep. The changes of the mother’s sleep before and after delivery are well documented and identify a general trend to decreased quality and quantity over the course of this time, particularly after delivery. Although literature is limited regarding the father’s sleep patterns, it appears that the father’s sleep patterns are also in flux during the same period but appear to maintain an element of stability compared with the mother’s sleep. A great deal of the research that addresses the changes in sleep patterns of new parents focuses on their patterns during early infancy and less so in older infancy. In addition, some parents experience difficulty in adjusting to these changes whereas others do not. Factors contributing to either experience are associated with both parent and infant variables that must be considered in order to have a better understanding of the nuances surrounding family sleep. It is worthwhile therefore to develop an understanding of the normal sleep patterns of parents of older infants and factors
associated with these patterns in order for health care professionals and sleep specialists to be aware of the specific needs of the family.
References


Silva, A., Andersen, M., De Mello, M., Bittencourt, L., Peruzzo, D., & Tufik, S. (2008). Gender and age differences in polysomnography findings and sleep complaints of patients referred to a sleep laboratory. *Brazilian Journal of Medical and Biological Research* (41), 1067-1061-1075.


Section Two

Manuscript

Note:

This manuscript has been prepared in accordance with instructions for authors from the *Journal of Sleep Research*. Line spacing is set at 1.5 and APA Referencing has been used in line with Unitec presentation guidelines. For the purposes of completing this thesis some of the guidelines of the *Journal of Sleep Research* have not been followed (for example word and reference limitations).
SUMMARY

Background: Data characterizing the sleep patterns of parents of infants is lacking, particularly for fathers.

Aims: The aims of this study were to explore the sleep quality and quantity of new parents of healthy infants, including those described as problematic, aged 4 to 12 months and to establish whether sleep and depression are correlated.

Methods: Sixty new parents completed 7-day sleep diaries, 3 times over consecutive months. In addition, the General Sleep Disturbance, Edinburgh Postnatal Depression Scale (EPDS) and Brief Infant Sleep Disturbance Questionnaire (BISQ), were administered upon commencement and completion of the study.

Results: Primary (usually maternal), compared with secondary (often paternal), caregivers of infants regarded as having problematic sleep were found to have lower sleep duration ($p < 0.001$) and sleep quality ratings ($p = 0.03$), longer sleep latency ($p = 0.03$), greater depression ($p = 0.01$), more weekly night feeding duties ($p < 0.001$) and weekly night wakes ($p < 0.001$), but higher levels of accumulated sleep ($p = 0.04$) and lower caffeine intake ($p = 0.045$).

Primary caregivers of problematic sleepers compared with primary caregivers of non-problematic sleepers had higher EPDS scores ($p = 0.03$). No differences were reported for secondary caregivers.

A moderately strong correlation was found between EPDS scores and the sleep quality rating of primary caregivers ($\rho = -0.48$, $p < 0.001$), whereas secondary caregiver scores were strongly correlated with sleep duration ($\rho = -0.51$, $p < 0.001$).

Conclusions: Results of this study indicate that mothers experience more fragmented sleep but maintain greater amounts of accumulated sleep than fathers. Although both parents can experience symptoms of depression, mothers’ symptoms are more strongly related to subjective sleep quality whereas fathers’ symptoms are related to sleep duration. Sleep interventions that address parent sleep must acknowledge the specific needs of each parent and be tailored accordingly.
Introduction
Lack of sleep appears to be becoming more prevalent for both genders, across ages and cultures (Alvarez & Ayas, 2004; Bin, Marshall, & Glozier, 2012; Cauter, Spiegel, Tasali, & Leproult, 2008; Kronholm et al., 2008). Adult and adolescent sleep duration has declined by 1.5 – 2 hours in America (Cauter et al., 2008) with night sleep for adults gradually declining over a 35-year period to around 7 hours from 8 (Knutson, Spiegel, Penev, & Cauter, 2007). Similar trends have been reported in Finland over a 33-year period (Kronholm et al., 2008). Longer hours at work, more time spent watching television or on the computer and social activities are thought to contribute to the decrease in sleep duration (Anderson & Horne, 2008; Bixler, 2009; Broman, Lundh, & Hetta, 1996). The consequences of lack of sleep to one’s health are widely researched and studies reveal adverse effects on carbohydrate and glucose metabolism and associated endocrine function (Spiegel, Leproult, & Cauter, 1999, 2007), increased levels of C-reactive protein promoting development of atherosclerotic lesions and increasing risk of coronary artery disease (Meier-Ewert et al., 2004), altered hormonal function in appetite regulation leading to obesity and increased risk of diabetes (Taheri, Ling, Young, & Mignot, 2004), and decreased cognitive function in children and adults (Dahl, 1996; Drummond & Brown, 2001).

The transition into early parenthood, particularly for new parents, is marked by less and fragmented sleep due to the changes inherent in caring for the infant (Gay, Lee, & Lee, 2004; Lee, Zaffke, & McEnany, 2000). Parents’ sleep may also be affected by sleep disturbances experienced by their infant. Although the clinical relevance of infant sleep disturbance remains unclear, the term describes behaviours such as frequent night awakenings, sleep onset delay, co-sleeping not desired by the parents, short sleep duration, difficulty falling asleep and difficulty staying asleep (France, Blampied, & Henderson, 2003). Between 20% - 30% of infants under 3 years of age are reported to suffer from sleep disturbances (France et al., 2003; Gibson, Gander, & Elder, 2012; Sadeh & Anders, 1993). Although the majority of infants can settle by 3 months of age, at least 10% do not settle in the first year of life (Byars, Yolton, Rausch, Lanphear, & Beebe, 2012; Moore & Ucko, 1957). As a result, parents may become vulnerable to the adverse effects of lack of sleep and can suffer postpartum depression that in some cases is attributed to lack of sleep (Matthey, Barnett, Ungerer, & Waters, 2000). Usually the maternal and paternal parents are the caregivers, with the mother being the primary and father the secondary caregiver.

The majority of the research conducted on parental sleep focuses primarily on sleep patterns of the mother, usually the primary caregiver, and the changes encountered prior to and after delivery.
(Horiuchi & Nishihara, 1999; Kang, Matsumoto, Shinkoda, Mishima, & Seo, 2002). Many of these changes can be attributed to physiological changes that take place during the gestation stage and continue after delivery (Driver & Shapiro, 1992; Kendall-Tackett, 2010). The mothers’ experiences, however, are not limited to physiological factors since broad lifestyle adaptations are often also required. Infant care duties, particularly during the evening hours, often cause continuing compromise to mothers’ sleep (Hunter, Rychnovsky, & Yount, 2009; Nishihara & Horiuchi, 1998). New responsibilities can introduce an element of stress into relationships with the new infant, especially if the infant is unsettled (McMahn, Barnett, Kowalenko, Tennant, & Don, 2001), and on family relationships, that can sometimes lead to emotional concerns and postpartum depression (Dorheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009).

The variability of sleep experienced by the mother throughout the gestation and postpartum period has been the subject of various studies. Sleep research has focused on total sleep time (TST), sleep efficiency (SE), wake after sleep onset (WASO) and nighttime awakenings (Campbell, 1986; Gay et al., 2004; Kang et al., 2002; Karcan et al., 1968; Matsumoto, Shinkoda, Kang, & Seo, 2003; Montgomery-Downs, Insana, Clegg-Kraynok, & Mancini, 2010; Nishihara & Horiuchi, 1998; Nishihara, Horiuchi, Eto, & Uchida, 2000). It is unclear from the literature whether reduced sleep quality or sleep quantity is more detrimental to the subjective sleep ratings or depressive symptoms of the mother.

The father’s, or secondary caregiver’s, sleep patterns are less well understood despite early research that reveals experiences similar to those of the mother (Watson, Watson, Wetzel, Bader, & Talbot, 1995). Fathers are subject to the same lifestyle adjustments as the mother however they may affect their sleep differently. Preliminary research has examined paternal levels of fatigue (Elek, Hudson, & Fleck, 1997, 2002) and sleep (Gay et al., 2004), however the majority of the research was conducted within the first 6 months of the infants’ life (Flaherty & Damato, 2009; Henderson & Brouse, 1991; Likotzky, Sadeh, & Glickman-Gavrieli, 2011) and less is known about how older infants affect fathers’ sleep.

In light of the lack of research pertaining to the fathers’ sleep, and as not all parents experience difficulty with lack of sleep, it is worthwhile to further understand the range of sleep patterns experienced by both parents and whether these patterns may differ according to perceived sleep problems in the infant. The aims of this study were, firstly, to describe the sleep quality and quantity of first-time parents of healthy infants between 4 – 12 months of age and secondly, to establish
correlates of the validated global indices of the General Sleep Disturbance Scale (GSDS), Edinburgh Postnatal Depression Scale (EPDS) and Brief Infant Sleep Questionnaire (BISQ).
METHODS

Data reported in this descriptive, non-experimental study were collected as part of a larger study entitled “Sleep in the family: sleep patterns of parents and first-born infants from 4 to 12 months of age”. All participants gave informed consent, and ethical approval for the overarching study was granted by the Unitec Research Committee (22 August 2012, #2012-1074).

Participants

Participants were recruited for the main study from online advertisements in five major infant-orientated websites in New Zealand and a research advertising website www.researchstudies.co.nz. This study included first time parents of healthy infants 4 – 9 months of age living in New Zealand. Families were excluded if the infant was adopted, born prematurely or suffered from any medical condition (i.e. asthma, sleep apnoea, allergies), if they contained additional live-in caregivers, parents were single, or if at least one parent worked shifts.

Prospective participants were sent an information package containing study information, consent forms, and materials [Appendices A – G]. Those interested in participating were contacted to confirm their interest and to address any of their questions and concerns.

Measures

Demographic and descriptive information was collected, including sex, birth date, education and occupational status, marital status, birthing details, feeding style and whether the participant was the primary or secondary caregiver.

Daily sleep diaries

A sleep diary was utilized that captured parental activities related to bed and wake times, caffeine, alcohol and food consumption, toilet use, infant feed and care, and daily sleep quality ratings. Daily entries commenced at 7:00 am for a 24-hour period with entries being made hourly. Actual times were entered by the individual in cases when activities did not finish at the top of the hour or when only a portion of the hour was spent on activities.

Sleep-related variables extracted from the sleep diaries were average Sleep Quality Rating (the participant’s subjective perception of their quality of sleep for the previous night, measured on a scale from 1 to 10 with 1 representing poor quality sleep and 10 representing a high quality sleep), Latency (the subjective length of time in minutes that the participant required to fall asleep), Sleep
Duration (a sleep period of uninterrupted sleep) and Accumulated Sleep (the average amount of sleep in hours, over 3 weeks, including daily naps and night time sleep).

Night waking was also quantified as weekly averages and 3 defined variables included Night Wakes - Feeds, Night Wakes - Care (any instance where the participant was awakened to feed or care for the infant during the night) and Night Wakes – Anything (any instance where the participant was awakened for any reason, including infant feed/care, toilet use or any unspecified wakes).

**General sleep disturbance scale**
The General Sleep Disturbance Scale (GSDS) is a 21-item scale used to assess the nature of sleep disturbances in each participant. Possible total scores range from 0 to 147. Totals between 20 to 40 are indicative of good sleepers. The questionnaire has been validated in a sample of new parents aged 33 ± 5 years and has reliability (chronbach alpha) > 0.75; 0.77 for new mothers and 0.85 for new fathers (K. Lee, personal communication, 29 May 2012).

**Edinburgh postnatal depression scale**
The Edinburgh Postnatal Depression Scale (EPDS), was administered to both mothers and fathers. The 10-item questionnaire was originally validated for young mothers (mean 26 years of age) of 3 month old babies, has satisfactory validity, internal consistency (split-half reliability $\alpha = 0.88$) and is sensitive to changes in the severity of depression over time (J. Cox & Holden, 2003). A maximum score of 30 is possible with scores of 10 or greater indicating the possibility of depression. The questionnaire has been used extensively in both English and non-English speaking communities and has recently been validated for use in men (Matthey, Barnett, Kavanagh, & Howie, 2001), with internal consistency for men of $\alpha = 0.81$ (JL. Cox, Holden, & Sagovsky, 1987).

**Brief infant sleep questionnaire**
The Brief Infant Sleep Questionnaire (BISQ) was used by parents to rate their infants sleep problem as not a problem, a small problem, or a very serious problem. Other items pertain to duration of night time sleep, frequency of night time sleep and awakenings, duration and frequency of daytime naps and preferred sleep position and sleep location of the infant.

The BISQ is reliable in terms of variables such as sleep onset, number of awakenings and nocturnal sleep duration; clinical validity and applicability for screening sleep problems in infants and children and has been validated against actigraph and daily sleep measures (Sadeh, 2004).
**Data analysis**

Data from the BISQ, the GDS, the EPDS and the daily sleep diaries were collected manually, and entered into an Excel 2010™ spreadsheet with various checks for accuracy and identification of missing data. Statistical analyses of these data were conducted using IBM SPSS Statistics™ Version 21.

Stability and reliability of sleep-related diary variables was assessed by calculating intra-class correlation coefficients (ICC: Model, Form 2,1 for the first two chronologically adjacent daily measurements and 2,1 for all 21 daily measurements). Intra-class correlation coefficient 2,7 with adjustments of ICC for weekly averages was applied for night waking variables. Systematic changes were assessed using Friedman’s ANOVA.

Differences in measurement indices between parents of infants perceived by either or both caregivers as being problematic or non-problematic sleepers were assessed using independent sample t-tests in the case of variables that met the assumptions of normality required for parametric tests, and non-parametric Mann-Whitney U tests in the case of variables that did not. Differences between primary and secondary caregivers were conducted using paired t-tests in the case of parametric variables or Wilcoxon rank test in the case of non-parametric variables.

Spearman’s rank correlation coefficient was conducted to determined factors affecting GDS, EPDS, and BISQ for primary and secondary parents separately and combined.
RESULTS

A total of 133 families were assessed for eligibility. Seventy declined from participating or did not meet eligibility criteria leaving 63 new parent dyads who entered the study. Of these, 60 dyads (120 individuals) provided sleep data for at least 1 of the 3 weeks of data collection and completed at least 1 set of questionnaires, but data from a further 14 individuals (7 dyads) were illegible or largely incomplete and were therefore eliminated from all analyses. Of the remaining 56 dyads, one couple were removed from paired analyses comparing primary and secondary caregivers as both indicated that they were the primary caregiver. Comparisons conducted between parents of infants perceived as problematic sleepers (n = 42) and parents of infants perceived as non-problematic sleepers (n = 50) had a reduced sample size because for 10 dyads neither parent completed the portion on the BISQ that categorized their infant’s sleep as problematic or non-problematic.

The distribution of measurement indices, sleep quality ratings, scores on GSDS, EPDS, weekly caffeine consumption, accumulated sleep, sleep latency, nightly infant care and awakenings did not meet the assumption of normality, thus non-parametric analyses were applied for the majority of the variables (Table 2).

Participant demographics
The 56 dyads comprised 57 females and 55 males, one couple being a same-sex dyad. Median interquartile range (IQR) infant age was 28 (17.4 – 36.5) weeks. A total of 62% of primary caregivers were either on maternity leave or identified themselves as homemakers. Of the secondary caregivers, 71% were employed for wages, 20% were self-employed, and the remaining identified themselves as unemployed, student or homemaker. Other characteristics of the study cohort are shown in Table 1.

Measurement stability
The ICC for the four diary sleep measures ranged from 0.36 – 0.51 for the first two days of measurement and 0.26 – 0.47 across all days from each of the three weeks of measurement. Intra-class correlation coefficient for sleep quality rating, latency and accumulated sleep (but not sleep duration) were higher for parents of problematic sleepers (range 0.31 – 0.47) compared to non-problematic (0.13 – 0.34). The same three variables showed statistically significant changes over time (p = 0.01 for all), but these did not represent consistent improvement or deterioration over
time. ICC for weekly averages for the three night-waking variables ranged from 0.68 – 0.86 for the first two weeks and 0.76 – 0.88 for all three weeks. Night wakings - care, and night wakes - anything reduced over the course of the three data collection periods, with median (IQR) 1.0 (0.0 – 4.0) and 0.0 (0.0 – 3.0) for night wakings - care in Weeks 1 and 3 respectively (p = 0.049 for ANOVA) and 5.0 (1.0 – 13.0) Week 1 and 1.0 (0.0 – 8.0) Week 3 for Night Wakes (p < 0.001). The third night-waking variable, night wakes - feeds did not change significantly throughout the study period.

**Comparison of primary with secondary caregivers**

When averaged for the entire data collection period, primary caregivers of problematic sleepers, were found to have longer sleep latency (p=0.03), lower sleep quality ratings (p = 0.03) and lower caffeine intake (p = 0.045) compared with their secondary caregiver counterparts (Table 2). They also had higher EPDS scores (p = 0.01), lower average sleep duration (<0.0001), higher levels of accumulated sleep (p = 0.04), and had higher weekly night wakings - feeds (p < 0.001) and weekly night wakings – anything (p < 0.001) than the secondary caregiver.

For parents of infants without perceived sleeping problems, primary caregivers revealed higher levels of weekly night wakings - feeds (p=0.001), weekly night wakings - care (p=0.012) and weekly night wakings - anything (p=0.006) compared with secondary caregivers.

**Comparison of sleep patterns between problematic vs. non-problematic sleepers**

Primary caregivers of perceived problematic infant sleepers were found to have higher EPDS scores (p = 0.03) compared to primary caregivers of non-problematic sleepers (Table 2). No significant differences between secondary caregivers of problematic and non-problematic sleepers were noted for any of the main variables.

**Correlations between sleep diary variables and sleep & depression questionnaire score**

Primary caregiver’s perceptions of their infant’s sleep, as shown by the BISQ, were moderately correlated with sleep quality rating (rho=-0.39, p=0.009), sleep duration (rho=-0.39, p=0.008), infant age (rho = 0.43, p = 0.003), night wakings - feeds (rho = 0.38, p = 0.008), night wakings – anything (rho = 0.44, p=0.002) and weekly caffeine intake (rho = -0.31, p = 0.35). No significant correlations were found with BISQ score for the secondary caregivers (Table 3).
Edinburgh Postnatal Depression Scale scores and sleep quality rating were significantly correlated for primary \((\rho=0.48, p<0.001)\) and secondary \((\rho=-0.32, p=0.03)\) caregivers. Primary caregiver EPDS scores were moderately correlated with sleep latency \((\rho=0.32, p=0.02)\). In addition, for secondary caregivers EPDS was moderately correlated with sleep duration \((\rho=-0.51, p<0.001)\) and total night wakes \((\rho=0.32, p=0.006)\).

General Sleep Disturbance scale scores were significantly correlated with sleep rating in both the primary \((\rho=-0.39, p=0.01)\) and secondary \((\rho=-0.48, p=0.001)\) caregivers.

<table>
<thead>
<tr>
<th>Table 1. Caregiver Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size (n)</td>
</tr>
<tr>
<td>Female/Male</td>
</tr>
<tr>
<td>Age Years (SD)</td>
</tr>
<tr>
<td>Marital status (%)</td>
</tr>
<tr>
<td>NZ European</td>
</tr>
<tr>
<td>European</td>
</tr>
<tr>
<td>Maori</td>
</tr>
<tr>
<td>Other</td>
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</table>
Table 2. Sleep parameters for primary and secondary caregivers of infants perceived as problematic or non-problematic sleepers

<table>
<thead>
<tr>
<th></th>
<th>Problematic (n=42)</th>
<th>Non-Problematic (n=50)</th>
<th>Difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep quality rating</td>
<td>5.86 (4.73-6.49)</td>
<td>6.57 (5.21-7.17)</td>
<td>-0.071 (0.1)</td>
</tr>
<tr>
<td>GS0DS</td>
<td>48.17 (12.37)</td>
<td>39.50 (30.50-51.75)</td>
<td>8.67 (0.1)</td>
</tr>
<tr>
<td>EPDS</td>
<td>8.00 (5.25-12.25)</td>
<td>5 (3.25-7.75)</td>
<td>3. (0.03)**</td>
</tr>
<tr>
<td>Weekly caffeine servings</td>
<td>2.42 (0.46-9.17)</td>
<td>8.50 (0.13-15.25)</td>
<td>-6 (0.5)</td>
</tr>
<tr>
<td>Accumulated sleep (hrs)</td>
<td>8.27 (0.64)</td>
<td>7.97 (0.78)</td>
<td>0.30 (0.2)</td>
</tr>
<tr>
<td>Average sleep duration (hrs)</td>
<td>3.81 (1.32)</td>
<td>4.77 (1.88)</td>
<td>3.13 (0.08)</td>
</tr>
<tr>
<td>Latency (mins)†</td>
<td>24.82 (12.72-38.53)</td>
<td>17.23 (12.47-37.28)</td>
<td>7.59 (0.6)</td>
</tr>
<tr>
<td>Weekly night feeds†</td>
<td>5.58 (1.83-8.50)</td>
<td>1.42 (0.08-5.50)</td>
<td>4.16 (0.08)**</td>
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<tr>
<td>Weekly night care†</td>
<td>2.00 (1.00-4.17)</td>
<td>1.67 (0.00-4.50)</td>
<td>0.33 (0.5)</td>
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<tr>
<td>Weekly night wakes†</td>
<td>14.00 (7.38-18.67)</td>
<td>5.67 (3.00-13.00)</td>
<td>8.33 (0.2)</td>
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<tr>
<td><strong>Secondary</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep quality rating</td>
<td>6.71 (5.02-7.29)</td>
<td>6.86 (5.83-7.45)</td>
<td>-0.15 (1.0)</td>
</tr>
<tr>
<td>GS0DS</td>
<td>43 (12.27)</td>
<td>40 (14.22)</td>
<td>2.95 (0.34)</td>
</tr>
<tr>
<td>EPDS</td>
<td>3 (1.75-7.00)</td>
<td>3 (1.00-4.00)</td>
<td>0 (0.7)</td>
</tr>
<tr>
<td>Weekly caffeine servings</td>
<td>8.17 (2.75-13.17)</td>
<td>12.08 (1.83-18.13)</td>
<td>-3.91 (0.2)</td>
</tr>
<tr>
<td>Accumulated sleep (hrs)</td>
<td>7.91 (0.69)</td>
<td>7.70 (0.82)</td>
<td>0.21 (0.5)</td>
</tr>
<tr>
<td>Average sleep duration (hrs)</td>
<td>5.89 (1.67)</td>
<td>6.26 (1.54)</td>
<td>0.37 (0.44)</td>
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<tr>
<td>Latency (mins)†</td>
<td>15.51 (9.68-32.24)</td>
<td>16.81 (11.51-21.55)</td>
<td>-1.3 (0.7)</td>
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<td>Weekly night feeds†</td>
<td>0 (0-0.33)</td>
<td>Nil</td>
<td>0 (0.5)</td>
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<tr>
<td>Weekly night care†</td>
<td>1.00 (0-2.50)</td>
<td>0 (0.00-0.92)</td>
<td>1.00 (0.2)</td>
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<td>3.83 (1.08-7.00)</td>
<td>1.75 (0.17-4.50)</td>
<td>2.08 (0.3)</td>
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<tr>
<td><strong>Parent (paired) difference</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sleep quality rating</td>
<td>-0.85 (0.03)*</td>
<td>-0.29 (0.7)</td>
<td>-</td>
</tr>
<tr>
<td>GS0DS</td>
<td>5.17 (0.7)</td>
<td>-0.55 (0.5)</td>
<td>-</td>
</tr>
<tr>
<td>EPDS</td>
<td>5(0.010)*</td>
<td>2 (0.1)</td>
<td>-</td>
</tr>
<tr>
<td>Weekly caffeine servings</td>
<td>-3.87 (0.045)*</td>
<td>-3.00 (0.3)</td>
<td>-</td>
</tr>
<tr>
<td>Accumulated sleep (hrs)</td>
<td>0.36 (0.038)*</td>
<td>0.27 (0.4)</td>
<td>-</td>
</tr>
<tr>
<td>Average sleep duration (hrs)</td>
<td>-2.06 (-0.001)***</td>
<td>-1.50 (0.005)</td>
<td>-</td>
</tr>
<tr>
<td>Latency (mins)†</td>
<td>10.27 (0.03)</td>
<td>5.91 (0.2)</td>
<td>-</td>
</tr>
<tr>
<td>Weekly night feeds‡</td>
<td>5.58 (&lt;-0.001)***</td>
<td>1.42 (0.001)***</td>
<td>-</td>
</tr>
<tr>
<td>Weekly night care‡</td>
<td>1.00 (0.1)</td>
<td>1.67 (0.012)*</td>
<td>-</td>
</tr>
<tr>
<td>Weekly night wakes‡</td>
<td>10.17 (&lt;-0.001)***</td>
<td>3.92 (0.006)*</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:
Data are mean (SD) and analyzed via paired t-tests (parent differences) or independent t-tests (problematic non-problematic difference) unless non-parametric test indicated
* Denotes non-parametric data showing median (IQR) that were analyzed using Mann-Whitney U-Test
** Denotes non-parametric data showing median (IQR) that were analyzed using the related-samples Wilcoxon Signed Rank Test
* p<0.05, ** p<0.01, ***p<0.001
# Difference between problematic and non-problematic groups
GSDS = General Sleep Disturbance Scale
EPDS = Edinburgh Postnatal Depression Scale
| Table 3. Primary and Secondary Caregiver Variables correlated to GSDS, EPDS, BISQ |
|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
|                                | GSDS                            | EPDS                           | BISQ                            |
|                                | Primary (n=51)                  | Secondary (n=46)                | Primary (n=52)                  | Secondary (n=48)                | Primary (n=46)                  | Secondary (n=42)                |
| Accumulated sleep              | 0.12 (0.4)                      | 0.030 (0.8)                    | -0.12 (0.4)                     | -0.26 (0.1)                     | 0.14 (0.4)                      | 0.14 (0.4)                      |
| Sleep quality rating           | -0.391 (0.01)**                 | -0.48 (0.001)**                | -0.48 (<0.001)**                | -0.32 (0.03)*                   | -0.39 (0.009)**                 | -0.14 (0.4)                     |
| Average Sleep duration         | -0.22 (0.1)                     | -0.16 (0.3)                    | -0.18 (0.2)                     | -0.51 (<0.001)**                | -0.39 (0.008)**                 | -0.1 (0.4)                      |
| Latency                        | 0.23 (0.1)                      | 0.22 (0.2)                     | 0.32 (0.02)*                    | 0.09 (0.6)                      | 0.14 (0.4)                      | 0.02 (0.9)                      |
| Infant age                     | 0.10 (0.5)                      | -0.16 (0.3)                    | 0.10 (0.5)                      | -0.02 (0.9)                     | 0.43 (0.003)**                  | 0.20 (0.2)                      |
| Night wakes – care             | 0.19 (0.2)                      | 0.03 (0.8)                     | 0.26 (0.1)                      | 0.20 (0.2)                      | 0.22 (0.2)                      | 0.12 (0.4)                      |
| Night wakes – feeds            | 0.13 (0.2)                      | -0.06 (0.7)                    | 0.21 (0.2)                      | 0.07 (0.7)                      | 0.38 (0.008)**                  | -0.12 (0.5)                     |
| Night wakes – anything         | 0.23 (0.1)                      | 0.13 (0.4)                     | 0.21 (0.2)                      | 0.3 (0.006)**                   | 0.44 (0.002)**                  | 0.17 (0.3)                      |
| Caffeine                       | 0.10 (0.5)                      | -0.13 (0.4)                    | -0.09 (0.5)                     | -0.02 (0.9)                     | -0.31 (0.35)*                   | -0.14 (0.4)                     |

Correlation coefficients reported as Spearman’s rho (p-value).
DISCUSSION

The primary aim of this study was to describe the sleep patterns of first-time mothers and fathers with healthy infants 4 to 12 months of age. Data from this study revealed that mothers (usually the primary caregiver), compared to fathers, report more frequent night time awakenings and poorer sleep quality despite more accumulated sleep.

The observation that mothers get more accumulated sleep than fathers is supported by past research (Gay et al., 2004). The researchers investigated 72 new parent dyads using actigraph and the GSDS to describe sleep patterns in the last month of gestation and the first month postpartum. Total sleep time consisted of less night time sleep but more daytime naps. Mothers in the current study experienced more sleep disturbances but more total sleep time than fathers which may be due to the fact that working fathers do not have the opportunity to supplement their night time sleep with daytime naps. Another possible reason for mothers having greater accumulated sleep despite reduced perceived sleep quality, may be that mothers who breastfeed have a higher energy expenditure when breastfeeding in order to support milk synthesis and as a result may require more sleep (Butte, Hopkinson, Mehta, Noon, & O’Brian Smith, 1999).

Both subjective sleep quality and levels of depressive symptoms appear to deteriorate due to frequent night awakenings. A series of three to six 90-minute sleep cycles is necessary for optimal brain and bodily function (Carskadon & Dement, 2011; Damato & Burant, 2008). Frequent night awakenings, perhaps due to the nutritional needs of the infant, can dictate the mother’s sleep patterns and may lead to a perceived lower quality of sleep (Sievers, Oldigs, Santer, & Schaub, 2002; Thomas & Foreman, 2005). In addition, these awakenings can fragment sleep leading to a decrease in the number of sleep cycles per evening that might preclude mothers from getting sufficiently long periods of sleep to offset fatigue (Elek et al., 2002).

This study’s finding that fragmented sleep is associated with poor quality sleep, depression and fatigue is in common with and supported by previous research (Gress et al., 2010; Thomas & Foreman, 2005). In Gress et al. (2010) the researchers utilized sleep logs for 4 nights and studied 91 mothers of 10-week old infants and found that maternal subjective sleep quality was inversely correlated with the frequency that the mother tended to their infant rather than the total amount of time tending to the infant. The study by Thomas and Foreman (2005), used sleep-activity diaries with 37 mothers and their 4 to 10 week old infants and revealed that mothers were getting less sleep per night 7.18 hours (SD 1.51), compared to 8.27 hours (SD 0.64) found in the current study.
The authors noted that the timing of their sleep was highly dependent on the feed and sleep-wake pattern of their infant, once again outlining the ramifications of fragmented sleep.

Other factors that can also affect sleep quality and quantity are co-sleeping, parity and work status. Of the total population studied by Thomas and Foreman (2005), 81.1% of the infants slept in their mothers’ room and 51.4% slept in the mothers’ bed. Co-sleeping has been reported to promote infant arousals (Mosko, Richard, & McKenna, 1997; Richard & Mosko, 2004), which may have been responsible for the reduced sleep noted in that study compared to the current one. The population in Gress et al. (2010) was composed of mothers with mixed parity (46% being primiparous) whereas the current study included only primiparous mothers which may have contributed to the higher frequency of night time awakenings. Parity has been reported to affect mothers’ sleep differently depending on the stage of pregnancy and postpartum (Signal et al., 2007). With regard to work status, a total of 62% of the mothers in the current study were on maternity leave. Many women of child-bearing years either work on a full-time or part-time basis as well as continue to bear the primary responsibility of housework and caring work. Sleep has been reported to be influenced by both work in the public domain and the additional work in the home environment (Hislop & Arber, 2003; Maume & Sebastian, 2009).

Another finding of the current study, that high levels of night time awakenings are associated with higher depression scores, is also supported by research (Armstrong, Van Haeringen, Dadds, & Cash, 1998; Goyal, Gay, & Lee, 2009; Karraker & Young, 2007). More specifically Armstrong et al. (1998) and Goyal et al. (2009) both utilized behavioural intervention to establish the association. Evidence for a longitudinal relationship between fragmented sleep and depression is further strengthened with data from Armstrong et al. (1998) who studied 70 new families with infants of mean age 19.1 months. In Armstrong et al. (1998) the frequency of night time awakenings was associated with higher EPDS scores ($p<0.001$), with both frequency of awakenings and EPDS scores decreasing after an intervention ($p<0.001$).

In the study by Goyal et al. (2009), besides fragmented sleep, infant temperament was found to be linked to postnatal depression. This study utilized 112 new parents, subjective and objective measures and behaviour modification strategies to improve their postpartum sleep. Regardless of the objective measures, mothers had higher depressive symptoms when they felt that they were not getting adequate sleep. Furthermore, the study specified that spending 2 hours awake or having sleep duration of less than 4 hours between 12 am and 6 am, and day time naps of less than 1 hour were associated with higher depressive symptoms at 3 months postpartum. It was not clear however, whether the 2 hours was a sum of all night time awakenings or a continuous 2 hours and
whether sleep duration was a continuous 4 hours or not. Without this knowledge, it is difficult to make direct comparisons with the current study. In Karraker and Young (2007) mothers of 1274 infants 6 months of age were asked about their infants’ waking behaviours and their own level of depression using interviewer developed questions and the Centre for Epidemiological Studies Depression Scale. The researchers reported that high frequency of night waking, longer wake times and total time awake were significantly correlated with maternal depression scores. Between 1 and 6 months, 865 mothers remained in the depressed category, 91 improved from the depressed to non-depressed category and 187 declined from the non-depressed to the depressed category. Of the 187 that became depressed, clinically significant depression scores were common in children of chronic wakers (18%).

The present study revealed that fathers are not as negatively affected by fragmented sleep due to night time infant care as the mothers. For instance, the difference in weekly night feeds tended to be mothers compared with fathers of problematic sleepers was 5.58 times (p=<0.001). Despite this, fathers did report symptoms consistent with postpartum depression that may often go undetected. Fathers’ depression scores were revealed to have a negative correlation with sleep duration and sleep quality rating and a positive correlation with night time awakenings unrelated to infant care duties. The night time awakenings experienced by the fathers may be due to the fragmented nature of the mother’s sleeps. Each maternal awakening may be disruptive to the father’s sleep although he is not responsible for night time infant care duties.

A potential source of bias in this study may have resulted from the sampling method used in the study. Facebook, online advertising from five major parent-orientated websites, and online research advertising websites were utilized which may have precluded members of the population a from a wider socio-economic or non-European ethnic groups from participating.

Although the main aim of this study was to describe the sleep patterns of new parents, a key limitation was that only the traditional nuclear family was studied. Parental sleep problems have no boundaries. While beyond the scope of this current study, future research in this field should include other family structures such as single parents, teen families, older first time parents and so on that are as likely to experience sleep difficulties in order to yield greater depth of knowledge.

In addition to extending research beyond the nuclear family, other significant factors to consider that could affect parental sleep patterns are co-sleeping and feeding style. These variables are sometimes associated with cultural beliefs that again expand the scope of research allowing for a deeper understanding of family sleep.
Overall, the results of this study outline the differences in sleep quality and quantity between new mothers and fathers who perceive their infants sleep to be problematic and those who do not. Regardless of their perception of infant sleep, fathers reported more positive sleep quality than mothers who in turn experience more sleep. This study highlights the disruptive nature of sleep in both parents during the transition into parenthood and established a relationship between sleep disturbances and poor mental health. An understanding that both parents can experience postpartum depression is a significant step in developing solutions to parental mental health. In particular it is noteworthy that the causes and expression of postpartum depression in the caregivers are dissimilar, where the mothers’ depression is associated with their sleep quality rating while the fathers’ is associated with their sleep duration. Understanding the intricacies of sleep difficulties and poor mental health can be utilized by physicians, midwives, sleep specialists and other health care professionals to guide the direction of their treatment of postpartum depression by addressing the specific needs of each parent and avoid generalizing the course of action.
REFERENCES


Section Three

Appendices
Appendix

Subject Information Sheet ........................................................................................................... A
Participant Consent Form ........................................................................................................... B
Demographic Information Sheet ................................................................................................ C
Brief Infant Sleep Questionnaire ............................................................................................... D
General Sleep Disturbance Scale ............................................................................................. E
Edinburgh Postnatal Depression Scale ...................................................................................... F
Sleep Diary ............................................................................................................................... G
Thank you for your interest in this research project. You, your partner and your infant are invited to participate in a study, which aims to quantify problematic infant sleep patterns by measuring them through actigraph monitoring and parental sleep diary for 7 days (one week) per month for no longer than 3 months and no less than 2 months.

**Purpose of Study**

Sleep is integral to the optimal growth and development of infants, having long-term impacts on individual infants’ development and wider familial dynamics. Infant Sleep Disturbance (ISD) is a condition that affects approximately 30% of infants from 6 months to 2 years old. It is characterised by frequent night waking, difficulty getting to sleep, persistent infant irritability and co-sleeping that is unwanted by parents. There is currently no information regarding ISD sleep-wake patterns. These patterns are normally measured by actigraphs and sleep diaries.

**Actigraph (ACT)**

Due to resource limitations, some of the participant families living the city of Auckland in will be required to wear ACT. The ACT is an accelerometer (similar to a pedometer) which measures movement of the lower limb, and is interpreted into sleep-wake patterns. The ACT is approximately 2cm square in size (similar to a watch face) and is attached to the infant via a tubular band to provide minimal disruption to the infant. In the adult, it must be worn on your non-dominant hand. It would be required to be worn by the infant for 24 hours per day over the designated time period. The ACT is not water proof so must be removed for bathing, but is water resistant so if soiled can be wiped clean and continued to be used.

**Sleep Diary**

You will also be required to complete daily sleep diaries that will help us observe the sleep patterns of you, your partner and your infant for the period stated above. At the end of each week, you must return your completed diary to the researchers for analysis and new diaries will be mailed to you before the beginning of each month.

The data collected from the ACT and sleep diaries will be downloaded at the New Zealand Sleep and Respiratory Institute, and used for further interpretation by the researchers.
Procedures

If you consent to you and your infant being involved in the study, the following will be required:

- Demographic information will be collected from both caregivers.
- Questionnaires regarding infants and caregivers sleep as well as caregivers frame of mind will be required to be completed.
- The infant will be required to wear an ACT on their ankle for 7 days (one week) per month, for up to 3 months.
- The caregiver will be required to wear an ACT on their non-dominant hand for 7 days (one week) per month, for up to 3 months.
- The caregivers will be required to fill out a sleep diary for the infant as well as for themselves for the 7 day (one week) period that the ACT is worn per month, for up to 3 months.

Risks, Discomforts and Benefits

It is not anticipated that there is any risk involved to your infant by wearing the ACT monitor. This method of monitoring sleep has been used internationally, and the Principle Researchers have not found any adverse effects to date. The tubular bandage that holds the ACT is specially designed for use with infants, to minimize any discomfort from wearing the device. If the infant is distressed or seems uncomfortable from the device, then the ability to withdrawal from the study is available.

If you and your infant do take part in this study, you will be able to accurately monitor your infants sleep patterns and development. This information will contribute to understanding the relationships, of sleep amongst mothers, fathers and their first-born infants. The results from this study will be very helpful in determining the variation of sleep-wake patterns in problematic sleepers, the frequency of ISD and the effectiveness of any future intervention.

Reimbursements

All participating families will go into the draw to win gift vouchers (Petrol, Baby Factory, Gift Card) throughout the data collection period. These prizes will be drawn on a monthly basis for each month that data is collected from a family. Families will receive one entry into the draw for completion of the sleep diaries and one entry for data collected from the ACT. A grand prize draw will be done upon completion of total data collection.

Confidentiality

The information provided in this study will be kept strictly confidential. You and your infant will be allocated an identification code at the commencement of the study, and that will remain confidential to the researchers, Leeann Jefferies and Gracela Gregorio, and study supervisors Catherine Bacon, Clive Standen and Jamie Manion. The data points downloaded at the NZRSI will be under the identification codes, and will be kept securely. All data will be kept securely in the Unitec database, and any data collection sheets will be stored in a locked filing cabinet.
The results of this study will be reported but it will not be possible to identify any individual participants.

Request for more information

You are encouraged to discuss any concerns regarding this study with the Principle Investigator or Supervisors at any time and ask any questions that you may have. If you would like a copy of the study conclusions, please ask and these can be provided at completion.

Refusal or withdrawal

You do not have to agree to participate in this study. If you do consent to participate, you may withdraw at any time during data collection without fear of prejudice. It is preferable that participant families are involved for a minimum of 3 months up to a maximum of 6 months. If you do decide to withdraw, please contact the Principal Researchers at the earliest opportunity.

Contact Information

If you have any questions or queries now or later, please direct them in the first instance to:

Principle Researchers

LeeAnn Jefferies (Principal Researcher)
Email: leeann.jefferies@gmail.com, Phone: 0274606877
Gracela Gregorio (Principal Researcher)
Email: gracela_graeme@hotmail.com, Phone: 021875809

Alternatively, to Research Supervisors

Catherine Bacon, Ph.D, Department of Osteopathy, Auckland
Email: cbacon@unitec.ac.nz

Jamie Mannion, Research Supervisor
Email: Jamie.Mannion@getparticipants.com

Associate Professor Clive Standen
Email: cstanden@unitec.ac.nz, Phone: 09-815 4321 ext 8475

This study has been reviewed and approved by the Unitec Research Ethics Committee, to ensure that all participants are protected from harm. If you have any further queries please contact ethics@unitec.ac.nz.
Participant Consent Form

Sleep patterns of parents and first-born infants from 4–12 months of age

Name of Participant: ______________________________________________________________

I have seen and read the information sheet for subjects taking part in the project titled “Sleep patterns of parents and first-born infants from 4–12 months of age” and have had the opportunity to discuss the project with Leeann Jefferies or Gracela Gregorio.

I understand that I am volunteering to partake in this study of my own accord, and I may withdraw at any time.

I understand that my participation in this project is confidential and that no material that could personally identify me will be used in any reports on this project.

I understand I can review the finished research document.

I have had enough time to consider whether I want to take part and acknowledge that any information collected during the study will be stored securely so that only the researchers may access them.

I understand that I may withdraw from this study at any time during data collection with no prejudice. If so, I undertake to contact the principal researchers at their earliest opportunity.

The principal researchers for this project are Leeann Jefferies and Gracela Gregorio, principal supervisors are Catherine Bacon and Jamie Mannion.

Contact details:
Leeann Jefferies email: leeann@gmail.com Mobile: 027 460 6877
Gracela Gregorio email: gracela_graeme@hotmail.com Mobile: 021 875 809

Participant Signature: ____________________________ Date: __________________

Participant Contact Information

Caregiver 1:
Caregiver 2:
Infant:

Address:
Home Phone #: _________________________ Cellular Phone: _______________________

Email address: _______________________________________________________________________

Preferred method of contact: _____________________________________________________________

Preferred time of contact: ___ Morning ___ Afternoon ___ Evening
(C) Demographic Information Sheet

1. What is your gender?
   - [ ] Male
   - [ ] Female

2. What year were you born?

3. What is the highest grade of Education you have completed?
   - [ ] High School (School Cert, Sixth Form Cert, Bursary, NCEA Levels 1-3)
   - [ ] University Degree (Bachelors, Masters, Ph.D)
   - [ ] Trade Qualification (Builder, Electrician, Plumber, Mechanic etc)
   - [ ] Did not complete

4. What form of employment are you in at the moment?
   - [ ] Self Employed
   - [ ] Employed for wages
   - [ ] Unemployed but looking for work
   - [ ] Unemployed but not looking for work
   - [ ] Homemaker
   - [ ] Student
   - [ ] Unable to work

5. What is your current wage bracket at the moment?
   - [ ] Less than $14,999
   - [ ] $15,000 - $29,999
   - [ ] $30,000 - $44,999
   - [ ] $45,000 - $59,999
   - [ ] $60,000 - $74,999
   - [ ] $75,000 - $99,999
   - [ ] More than $100,000
6. What ethnicity do you belong to?
   □ NZ European
   □ NZ Maori
   □ Pacific Island
   □ Indian
   □ Chinese
   □ European
   □ Other (please specify)

7. What is your marital status?
   □ Defacto Couple
   □ Married
   □ Divorced

8. How far away is your extended family (travel time)?
   □ < 1 hour
   □ 1-2 hours
   □ 2-3 hours
   □ > 4 hours
   □ N/A

9. How often would you see them?
   □ Daily
   □ Weekly
   □ Monthly
   □ 3-4 times per year
   □ 1-2 times per year
   □ Every few years
   □ Don’t see them
Pregnancy and Labour Information

1. Did you smoke during your pregnancy?
   - □ No
   - □ Yes - How many cigarettes (approx) per day?

2. Did you drink alcohol during your pregnancy?
   - □ No
   - □ Yes – How many drinks (approx) per week?

3. Did you take drugs during your pregnancy?
   - □ No
   - □ Yes – Please specify what type and how often

4. Did you have any complications during your pregnancy?
   - □ No
   - □ Yes – Please indicate what complications:
     - □ Ectopic Pregnancy
     - □ Gestational Diabetes
     - □ Hyperemesis Gravidarum (excessive nausea and vomiting)
     - □ Incompetent Cervix (incomplete closure of cervix)
     - □ Anaemia
     - □ ABO incompatibility
     - □ Placenta Praevia (placenta covers part or all of cervix)
     - □ Premature Labour
     - □ Elevated Blood Pressure
     - □ Rhesus Disease
5. How far along into your pregnancy when labour started?
   - □ <38 weeks
   - □ 38 weeks
   - □ 39 weeks
   - □ 40 weeks
   - □ 41 weeks
   - □ 42 weeks
   - □ Don’t know

6. How was your baby delivered?
   - □ Caesarean
   - □ Vaginal – unaided
   - □ Vaginal – forceps
   - □ Vaginal – ventouse

7. Were there any complications with the labour/birth?
   - □ No
   - □ Yes – Please provide more details

8. What was your baby’s APGAR scores at birth?

9. How do you feed your baby?
   - □ Breast
   - □ Bottle
   - □ Solids
□ Combination of breast and bottle
□ Combination of breast, bottle and solids

10. Does your baby have a history of colic?

□ No
□ Yes
(D)  Brief Infant Sleep Questionnaire

Name of Responder: _________________________________  Date: ________________

Role of Responder:  □ Father  □ Mother  □ Grandparent  □ Other,

Specify: ____________________

Name of the child: _____________________  Date of Birth: Month ___ Day ___ Year ______

Sex: □ Male  □ Female  

Birth order of the child: □ Oldest  □ Middle  □ Youngest

Sleeping arrangement:

□ Infant crib in a separate room  □ Infant crib in parents’ room

□ In parents’ bed  □ Infant crib in room with sibling

□ Other, Specify: _______________________________

In what position does your child sleep most of the time?

□ On his/her belly  □ On his/her side  □ On his/her back

How much time does your child spend in sleep during the NIGHT (between 7 in the evening and 7 in the morning)?  Hours: ____________  Minutes: ____________

How much time does your child spend in sleep during the DAY (between 7 in the morning and 7 in the evening)?  Hours: ____________  Minutes: ____________

Average number of night wakings per night: _________________

How much time during the night does your child spend in wakefulness (from 10 in the evening to 6 in the morning?)  Hours: ____________  Minutes: ____________

How long does it take to put your baby to sleep in the evening?

Hours: ____________  Minutes: ____________

How does your baby fall asleep?

□ While feeding  □ Being rocked  □ Being held  □ In bed alone  □ In bed near parent

When does your baby usually fall asleep for the night?

Hours: ____________  Minutes: ____________

Do you consider your child’s sleep as a problem?

□ A very serious problem  □ A small problem  □ Not a problem at all
## General Sleep Disturbance Scale

How often in the past week did you:

<table>
<thead>
<tr>
<th>DAY</th>
<th>NO</th>
<th>EVERYDAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>have difficulty getting to sleep</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>2.</td>
<td>wake up during your sleep period</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>3.</td>
<td>wake up too early at the end of a sleep period</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>4.</td>
<td>feel rested upon awakening at the end of a sleep period</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>5.</td>
<td>sleep poorly</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>6.</td>
<td>feel sleepy during the day</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>7.</td>
<td>struggle to stay awake during the day</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>8.</td>
<td>feel irritable during the day</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>9.</td>
<td>feel tired or fatigued during the day</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>10.</td>
<td>feel satisfied with the quality of your sleep</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>11.</td>
<td>feel alert and energetic during the day</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>12.</td>
<td>get too much sleep</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>13.</td>
<td>get too little sleep</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>14.</td>
<td>take a nap at a scheduled time</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>15.</td>
<td>fall asleep at an unscheduled time</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>16.</td>
<td>drink an alcoholic beverage to help you get to sleep</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>17.</td>
<td>use tobacco to help you get to sleep</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>18.</td>
<td>use herbal product to help you get to sleep</td>
<td>0 1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>
19. use an over-the-counter sleeping pill to help you get to sleep
0 1 2 3 4 5 6 7
20. use a prescription sleeping pill to help you get to sleep
0 1 2 3 4 5 6 7
21. use aspirin or other pain medication to help you get to sleep
0 1 2 3 4 5 6 7

K. Lee (GSDS, Sleep, 1992)
(F) Edinburgh Postnatal Depression Scale

Name: _______________________________ Address: _________________________________

Your Date of Birth: _____________________

Baby’s Date of Birth: ___________________ Phone: _________________________________

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 - This would mean: “I have felt happy most of the time” during the past week.

□ No, not very often Please complete the other questions in the same way.

□ No, not at all

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 ____________________

### (G)Sleep Diary

**Example Graph:**
- **B** = Time went to bed
- **W** = Time woke up
- **F** = food
- **C** = caffeine
- **A** = alcohol
- **N** = nap
- **x** = sudden sleep attack
- **AL** = alarm
- **S** = natural wake
- **T** = toilet
- **IC** = Infant Care
- **IF** = Infant Feeding

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date | 20/10/08 | WC F |   | F 2.30 |    | T | B 10.50 |    |    |    |    |    |    |    | W | AL | 5.00 | AM | Noon | PM | AM |

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** 10.55pm
- **Time went to sleep:** 11pm
- **Time woke up:** 6:00 am

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** ...........................
- **Time went to sleep:** ...........................
- **Time woke up:** ...............................
- **Rating of Sleep:** ...............................

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** ...........................
- **Time went to sleep:** ...........................
- **Time woke up:** ...............................
- **Rating of Sleep:** ...............................

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** ...........................
- **Time went to sleep:** ...........................
- **Time woke up:** ...............................
- **Rating of Sleep:** ...............................

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** ...........................
- **Time went to sleep:** ...........................
- **Time woke up:** ...............................
- **Rating of Sleep:** ...............................

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** ...........................
- **Time went to sleep:** ...........................
- **Time woke up:** ...............................
- **Rating of Sleep:** ...............................

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** ...........................
- **Time went to sleep:** ...........................
- **Time woke up:** ...............................
- **Rating of Sleep:** ...............................

| Time | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 |
|------|---|---|---|----|----|----|---|---|---|---|---|---|---|---|----|----|----|---|---|---|---|---|---|---|---|
| Day  |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |
| Date |   |   |   |    |    |    |   |   |   |   |   |   |   |   |    |    |    |   |   |   |   |   |   |   |   |

- **Time lights out:** ...........................
- **Time went to sleep:** ...........................
- **Time woke up:** ...............................
- **Rating of Sleep:** ...............................

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* Rating of Sleep – Please rate your sleep from 1 to 10 with 1 feeling non-refreshed and 10 feeling very refreshed

COMMENTS:

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