Perinatal anxiety and sleep

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ABSTRACT

Introduction

Anxiety symptoms and sleep health issues are common during the perinatal period. Few studies have investigated differences in prevalence of these issues for Māori and non-Māori women and considered the relationships between anxiety and sleep across this timeframe.

Objective

This study investigated the prevalence of anxiety symptoms in a large community sample of Māori and non-Māori women, and the cross-sectional and longitudinal relationships between anxiety and sleep from late pregnancy through to 3 months postpartum.

Methods

The longitudinal *Moe Kura* cohort study collected self-report data from 1144 women (406 Māori and 738 non-Māori) at several time points (prior to pregnancy, late pregnancy, 4-6 weeks postpartum and 12 weeks postpartum). Pearson's chi-square tests and univariate analyses were calculated to understand the sample and binary logistic regression models were used to investigate cross-sectional and longitudinal relationships.

Results

Results indicated bi-directional relationships between anxiety and sleep health at several time points across the perinatal period. Women with long sleep latencies were more than twice as likely to experience high anxiety symptoms (OR=2.11 at T2 and 2.71 at T4) and vice versa (OR=2.11 at T2 and 2.66 at T4). In late pregnancy, short sleep, daytime sleepiness and leg twitching/jerking, had a bi-directional relationship with high anxiety symptoms but this was not seen at other time points. Longitudinal analyses showed that high anxiety symptoms in late pregnancy were predictive of high anxiety symptoms postpartum.

Conclusion

The bi-directional nature of the relationship between long sleep latency and high anxiety symptoms could be used to develop questions to ask women so these issues can be identified and followed up. This is critical, as the most consistent predictor of high anxiety symptoms postpartum was high anxiety symptoms in late pregnancy. This study also highlights the high prevalence of anxiety and sleep health issues in pregnancy and the importance of ensuring identification, treatment and support of women across the perinatal period. The Kaupapa Māori principles incorporated in the design and implementation of the *Moe Kura* cohort study enables valuable insights into the experiences of Māori and non-Māori women and the differences between them.

Keywords: anxiety, sleep, sleep health, EPDS anxiety subscale, perinatal mental health, maternal mental health.

Māori whakatauki (proverb)

Ma te oro o te tamaiti mama hoki, hei arataki raraunga iho putanga.

Allow the voice of the child and mother, to drive the outcomes.

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TERMS AND ABBREVIATIONS

Amygdala	The part of the brain that is involved in processing fearful and threatening stimuli
DSM	The Diagnostic and Statistical Manual of Mental Disorders published by the American Psychiatric Association (APA). DSM-IV was the fourth edition published in 1994 and DSM-5 is the latest edition, published in 2013.
EPDS	Edinburgh Postnatal Depression Scale
ESS	Epworth Sleepiness Scale
GAD	Generalised anxiety disorder
Gestation	The time between conception and birth
GSDS	General Sleep Disturbance Scale
Kaupapa	Kaupapa means principles and ideas which act as a base or foundation for action. A kaupapa is a set of values, principles and plans which people have agreed on as a foundation for their actions.
LMC	Lead maternity carer
Moe Kura	Mother and Child, Sleep and Wellbeing in Aotearoa/New Zealand study
MoH	Manatū Hauora / Ministry of Health of NZ
NREM	Non-rapid eye movement
NZ	Aotearoa/New Zealand
NZDep13	New Zealand Index of Deprivation 2013
OCD-11	Eleventh Revision of the International Classification of Diseases published by the World Health Organization in 2022
OR	Odds ratio
Perinatal	The period before birth and after birth
PMMRC	Perinatal and Maternal Mortality Review Committee
Postpartum	After childbirth

Prenatal	Before birth
PTSD	Post-traumatic stress disorder
REM	Rapid eye movement
SEP	Socioeconomic position
SWS	Slow wave sleep
Te Aka Whai Ora	Māori Health Authority
Te Tiriti o Waitangi	The Treaty of Waitangi. A group of nine documents: seven on paper and two on parchment. Together they represent an agreement drawn up between representatives of the British Crown and representatives of Māori iwi and hapū.
Te Whatu Ora	Health New Zealand
TST	Total sleep time
Whānau	Whānau is generally described as a collective of people connected through a common ancestor (whakapapa) or as the result of a common purpose (kaupapa).
Women and mothers	The terms 'women' and 'mothers' are used throughout this thesis as the data analysed in this study was captured and recorded in that context, but it is acknowledged that not all birthing parents will identify with these gendered terms. The findings of this study are relevant to all birthing parents.

CHAPTER 1 INTRODUCTION

This thesis examines maternal anxiety, sleep, and the relationships between them in the perinatal period for women living in Aotearoa, New Zealand (NZ). It uses data gathered in the *Moe Kura: Maternal Sleep and Health (Moe Kura)* study of maternal and child sleep and health, which builds upon the *E Moe, Māmā: Maternal Sleep and Health in Aotearoa/New Zealand (E Moe, Māmā)* study of perinatal sleep and health in NZ (Signal et al., 2022). Using data collected, this work is focused on the cross-sectional and longitudinal relationship between perinatal anxiety and sleep for Māori and non-Māori women.

1.1 Overview

In many cultures, mothers are protected and nurtured from pregnancy through to the weeks and months after birth (Walker, 2022). Having a baby is often a time of huge change and adjustment and can trigger a whole range of emotional reactions from joy and excitement to apprehension and stress. For many women, feelings of anxiety and worry are a normal part of adjusting to parenthood but for some women, these feelings become unmanageable and can have a negative impact on their mental health throughout the perinatal period (defined here from pregnancy to one year after birth).

Mental health issues during pregnancy and following childbirth are common in all parts of the world and adversely impact on maternal morbidity, mortality and ultimately the survival and development of children (World Health Organization, 2022b). The impact of mental illness at this critical time can be far reaching, affecting not only the mother but also her baby, family and the community (Foreman, 1998; Stewart et al., 2003). Depression and anxiety disorders (including panic disorders and obsessive compulsive disorder (OCD)) in the perinatal period are the most common maternal mental health issues experienced. Post-traumatic stress disorder (PTSD) and postpartum psychosis are rarer but more serious

conditions that can also develop in this period. Diagnostically, these disorders are not distinct from disorders in the general adult population but are defined by onset occurring within the perinatal period e.g., 'major depressive disorder, with peripartum onset' (Segre & Davis 2013).

Women are more at risk of developing mental illness during the perinatal period than any other period of their lives. Shear & Mammen (1995) described the postpartum period as a period of "increased risk for onset or worsening of anxiety disorders" (p. 693) and an estimated 15-25 percent of women in NZ will experience symptoms of depression or anxiety during this time (Signal et al., 2017). Of these, Māori women are disproportionally affected with one study finding 25% of Māori women experience clinically significant anxiety symptoms compared to 20% of non-Māori women in late pregnancy (Signal et al., 2017). Despite this high prevalence in NZ and internationally, it is estimated that less than 50% of women will seek help and of those who do, only 10-15% will receive effective treatment (Bauer et al., 2016; Howard et al., 2014; Vesga-López et al., 2008).

The relationship between sleep and anxiety is complex as it is commonly recognised that one of the symptoms of anxiety is sleep disruption. This is further complicated by the perinatal period being a time where hormonal and body changes impact sleep and postnatally, caring for an infant is hugely disruptive to sleep. Normal sleep during this period is hard to define and the impact of sleep on anxiety or vice versa is even harder to tease out.

By looking at sleep patterns prior to pregnancy, during late pregnancy, 4-6 weeks after birth and then again at 12 weeks after birth, this study aims to understand the relationship between anxiety and sleep during the perinatal period. Recognising anxiety and sleep issues earlier could lead to earlier intervention and support for women with these concerns during this period. Improvements in sleep during pregnancy may have a positive effect on mental state and reduce anxiety. This study looks to understand this complex relationship and

explore how recognising issues earlier could make a difference for women through the perinatal period.

In this study, data collected in the *Moe Kura* study were analysed to answer the following questions:

- What is the prevalence of symptoms of anxiety across the perinatal period for Māori and non-Māori women?
- What is the relationship between symptoms of prenatal anxiety and postnatal anxiety for Māori and non-Māori women?
- What is the cross-sectional relationship between symptoms of anxiety and sleep health in pregnancy, at 4-6 weeks postpartum and at 12 weeks postpartum for Māori and non-Māori women? Is this relationship bi-directional?
- What is the relationship between anxiety and sleep across the perinatal period for Māori and non-Māori women? Is this relationship bi-directional?

CHAPTER 2 BACKGROUND

This chapter provides an overview of current literature on anxiety and sleep, the relationships between them and the perinatal period. The final section provides the Aotearoa, New Zealand context for this research and the researcher's background and identity.

2.1 Anxiety

Anxiety is defined as a physiological reaction in combination with a cognitive reaction. It is an instinctual, survival reaction to potential danger that creates a physiological reaction causing an individual to take action to protect themselves from a threat (Sadock & Sadock, 2003; Kim & Gorman 2005). Neurologically, anxiety is deeply rooted in the more primitive parts of the brain, particularly the amygdala. The amygdala is the central relay point for a series of neurological events that occur when a potential threat is detected; this process is known as the fear circuit (Kim & Gorman 2005).

All anxiety disorders have a distinct physiological reaction, commonly referred to as the 'fight or flight' response as a reaction to a threatening situation. The distinction between fear and anxiety relates to the nature of the threat, with fear occurring in response to a known, external, definite and non-conflictual threat and anxiety in response to an unknown, internal, vague or conflictual threat (Sadock & Sadock, 2003).

Anxiety disorders are the most common psychiatric disorders with a projected lifetime risk of 31.5% and prevalence as high as one in four in people (Baxter et al., 2013; Kessler et al., 2005; Remes et al., 2016; Sadock & Sadock, 2003; Somers et al., 2006). Research shows that women are significantly more likely to be affected than men (up to twice as likely in some studies) and young adults (under 35 years) are also more likely to be affected (Baxter et al., 2013; Remes et al., 2016; Somers et al., 2006).

There are several types of anxiety disorder, including panic disorder, generalised anxiety disorder, post-traumatic stress disorder, obsessive-compulsive disorder, social phobia and specific phobias. All are related to the experience of anxiety (physiologically and cognitively) for a period of time that is experienced as challenging. This can occur when the fear circuit in the brain cannot regulate itself and is triggered too often by the inability to distinguish between real threats and benign threats (Kim & Gorman 2005; Sadock & Sadock, 2003).

The physical reaction is what all these disorders have in common, but it is the cognitive aspect that distinguishes them. While perinatal anxiety is not a separate, diagnosable disorder in the DSM-5 or the OCD-11 (the two internationally recognised diagnostic tools), there are distinct cognitive features, in particular what women worry about, and these worries tend to be related to the perinatal period.

Worry is the primary cognitive characteristic of anxiety and excessive and uncontrollable worry is a key feature of generalised anxiety disorder (Hirsch & Mathews, 2012). Worry occurs alongside other associated symptoms such as concentration problems, sleep disturbance, muscle tension and fatigue (Hirsch et al., 2013; Sadock & Sadock, 2003).

In their proposed cognitive model of pathological worry, Hirsch and Mathews (2012) present evidence that pathological worry arises from habitual biases in processing of information that increase the likelihood that situations will be perceived negatively and lead to intrusive, negative thoughts. Those with high levels of worry and anxiety (as seen in generalised anxiety disorder) are more likely to interpret ambiguous situations in a negative way and perceive situations as threatening when others may not (Hirsch & Mathews, 2012). These thoughts then influence behaviour and often result in avoidance of the perceived threat, thus reinforcing the avoidant behaviour, as the threat is not realised.

2.1.1 Anxiety in the perinatal period

While the somatic presentation of generalised anxiety is similar to what is seen outside the perinatal period, it is the focus of the anxiety that is distinct (Folliard et al., 2020). Maternal anxiety is often focused on topics related to the baby and/or childbirth and centres around concerns relating to the transition to motherhood, and safety and wellbeing of the infant (Highet et al., 2014).

High maternal anxiety can impact self-confidence and body image and is associated with increased childbirth fear, decreased effective coping strategies, spending less time with the baby and increased risk of suicide (Dennis et al., 2017; Highet et al., 2014). Several studies have found that anxiety can lead to mothers overstimulating their infants, being overprotective and more intrusive and less predictable in their parenting style as well as missing cues from their infants (Barnett 1986; Feldman 2007; Feldman et al. 2009).

At a biological level, maternal anxiety triggers the release of stress hormones which have a direct and measurable impact on the foetus and have been shown to increase blood pressure, heart rate and activity level of the foetus (Sadock & Sadock, 2003). Mothers with high levels of anxiety are more likely to have babies that are hyperactive, irritable and have problems sleeping than those with low symptoms of anxiety (Sadock & Sadock, 2003; Field, 2018). Lower birth weight and Apgar scores are also more likely, and maternal anxiety has been shown to affect obstetric outcomes, increasing the likelihood of anaemia, caesarean delivery, early delivery and low birth weight (Cunningham et al., 2021; Low et al., 2021).

Maternal anxiety can present increased challenges in the parent-child relationship and attachment with the mother (Cunningham et al., 2021; Field, 2018; Foreman, 1998; Matthies et al., 2020; Wright, 2019). Wright's (2019) study highlights the importance of keeping mothers and babies together through treatment whenever possible and ensuring a

focus on the wellbeing of infants through infant-focussed interventions while also treating maternal mental illness.

Field (2018) reviewed published literature since 2010 and found compelling evidence of the negative impacts that postnatal anxiety can have on bonding and attachment. They identified several studies that showed children of mothers who have anxiety disorders had insecure attachment, with rates of up to 80% (Foreman, 1998; Matthies et al., 2020).

Maternal anxiety can also lead to the development of emotional, behavioural and attention issues in children as well as anxiety disorders later in life for these offspring (Clavarino et al., 2010; Cunningham et al., 2021; Stevenson-Hinde et al., 2011; Warren et al., 1997). Conversely, strong maternal attachment during pregnancy has been shown to be a protective factor which can reduce symptoms of anxiety postpartum (Matthies et al., 2020).

Bauer et al. (2016), looked at the economic costs of perinatal anxiety and depression on society and found that the negative impacts are substantial, particularly on children. Their estimates were based on mean probabilities of perinatal anxiety (development and persistence) and the cost of health and social care for people with anxiety disorders. They estimated the total lifetime costs at £75,728 ($149,342 NZ dollars based on 25/03/23 exchange rate) per affected mother due to the long-lasting adverse impacts on children in terms of morbidity (physical and mental), quality of life and career prospects, with the majority of these costs being carried by the individual and society as a whole (including health and social care).

2.1.2 Prevalence of anxiety in the perinatal period

Several factors have been identified that increase the risk of a woman experiencing perinatal anxiety including being a young mother, lower socio-economic status, previous history of mental health issues, pregnancy and birth complications and having a poor relationship with their partner (Field, 2018; Ross & McLean, 2006). The two strongest

predictors of depression and anxiety are previous history of depression or anxiety disorder and poor partner relationship (Schmied et al., 2013; Vythilingum, 2008). History of an anxiety disorder appears to be a stronger predictor of postpartum mood disorder (anxiety or depression) than a history of depression (Matthey et al., 2003).

Anxiety and depression often occur together with co-morbidity rates as high as 50% in the perinatal period (Andrews et al., 2000; Borri et al., 2008; Dubber et al., 2015; Goodman et al., 2014; Hendrick et al., 2000). Maternity carers are often on the lookout for depressive symptoms, but anxiety symptoms can be missed and there is less information available to support women experiencing anxiety (Folliard et al., 2020; Highet et al., 2014).

Many studies focus on depression with less research available on anxiety and it is often not distinguished from depression. This can make it difficult to identify prevalence which likely leads to an under-estimation of prevalence rates for perinatal anxiety. Matthey et al. (2003) found that the methodology often used in prevalence studies identified postnatal depression but missed anxiety symptoms and several studies include descriptions of anxiety symptoms as part of depression.

Prevalence rates for anxiety range from 8-25% during pregnancy and between 10-20% postpartum (Andrews et al., 2000; Borri et al., 2008; Cunningham et al., 2021; Dennis et al., 2017; Dubber et al., 2015; Fairbrother et al., 2016; Goodman et al., 2014; Hendrick et al., 2000; Heron et al., 2004). Ross and McLean (2006) reviewed published literature on anxiety disorders during pregnancy and the postpartum period and found that anxiety disorders are common during the perinatal period. Reported rates of obsessive-compulsive disorder and generalised anxiety during this period are also higher than in the general population.

Matthey et al. (2003) interviewed mothers and fathers at 6 weeks postpartum using the Diagnostic Interview Schedule. They included diagnostic criteria for depression, panic disorder and generalised anxiety disorder (except for duration criterion) and found that

inclusion of these criteria increased prevalence rates substantially. Of the women reporting a history of an anxiety disorder, 65.6% developed either anxiety or depression postpartum compared to 29.4% of women who reported a history of depression only (Matthey et al., 2003). Fairbrother et al. (2016) also found that anxiety and related conditions are more prevalent than postpartum depression with 17.1% of their sample having an anxiety or related disorder postpartum compared to 4.8% meeting the diagnostic criteria for postpartum depression (n=310).

Leach et al. (2017) provided an update to the Ross and McLean (2006) review by conducting a systematic review of published research between 2006 and 2014 on prevalence and risk factors for maternal perinatal anxiety. Their review supported the earlier finding that maternal perinatal general anxiety is common, however, there is wide variation in prevalence rates from 6.8-59.5% during pregnancy and 4.7-33% during the postpartum period. They found that when continuous measures with thresholds were used, rates were higher compared to diagnostic interviews that reported prevalence of diagnosed anxiety disorders rather than symptoms. Their results are supported by several other studies that have found that prevalence rates for perinatal anxiety are higher when self-reported (as compared to clinical diagnosis) and can range from 18-24% in pregnancy and 15-18% postpartum (Cunningham et al., 2021).

Schmied et al. (2013) reviewed longitudinal studies of women in Australia and NZ and reported point prevalence of anxiety between 8-10% in pregnancy and six months postpartum, however one study reported a prevalence of 15.7% in the first 3 months postpartum (Schmeid et al., 2013). Some other studies have estimated rates of anxiety disorders to be as high as 25% prenatally and 11% in the postpartum period (Andrews et al., 2000; Borri et al., 2008; Dubber et al., 2015; Goodman et al., 2014; Hendrick et al., 2000).

Heron et al. (2004) found that 21% of a large community sample (n=8323) had clinically significant symptoms of anxiety in pregnancy and of these, 64% continued to experience

these symptoms postnatally. Their study confirmed that anxiety in pregnancy is common, often occurs with depression and can increase the likelihood of postnatal depression (Heron et al., 2004).

Dennis et al. (2017) conducted a systematic review and meta-analysis of published literature on perinatal anxiety and found that self-reported anxiety increases over the course of pregnancy. Studies reviewed showed increasing prevalence with rates of 18.2% for women in the first trimester of pregnancy, 19.1% in the second and 24.6% in the third. Overall prevalence was 15.2% for any anxiety disorder which is higher than the general adult population. Postnatally, prevalence was 15% and rates were higher in low to middle income countries.

Leach et al. (2017) found that the studies reviewed reinforced identified risk factors for anxiety and depression: previous psychiatric history, poor relationships with partner, previous perinatal loss and difficult birth experiences. They highlighted the need to more clearly define the characteristics of perinatal anxiety to reduce variation across studies focused on this area.

2.1.3 Measuring anxiety symptoms in the perinatal period

Many studies use the self-report State-Trait Anxiety Index (STAI) or the Edinburgh Postnatal Depression Scale (EPDS) to measure anxiety symptoms. The EPDS is a well validated and widely used tool to screen for perinatal depression and anxiety and includes a three item sub-scale that has been shown to consistently identify anxiety symptoms (Brouwers et al., 2001; Jomeen & Martin, 2005; Matthey et al., 2013; Swalm et al., 2010).

Swalm et al. (2010) looked at a sample of women antenatally (n=4,706) and postnatally (n=3,853) and undertook a factor analysis to look at the concurrent validity of the EPDS anxiety subscale when compared to anxiety-related items on the demographic and psychosocial risk factor questionnaire. They found that anxiety symptoms were higher in

pregnancy than postnatally. Their study concluded that the anxiety subscale (items 3, 4, and 5) of the EPDS is a reliable and valid tool to screen for anxiety and used a cut-off score of four or more to detect the top 25% of scores (Swalm et al., 2010).

Matthey (2008) compared data from a sample of men and women to determine the optimal cut-off score for the anxiety subscale of the EPDS. Matthey used diagnostic criteria to conclude an optimal cut-off score of six or more to screen for anxiety symptoms in women. Matthey also found that several women (11/18) screened in his total sample (n=238) scored below the cut-off score for depressive symptoms so would have been missed if the anxiety subscale had not been included.

Matthey et al. (2013) reviewed literature since 1987 (when the EPDS was published) to look at key considerations of using the EPDS to screen for anxiety disorders. They confirmed that anxiety symptoms are common in pregnant women and there is an emerging body of evidence that EPDS can reliably detect clinically significant symptoms of anxiety. While studies are mixed on the capacity for the EPDS anxiety subscale to distinguish between anxiety and depression, it is also noted that a screening tool is not intended to replace diagnostic assessment (Matthey et al., 2013).

2.2 Human Sleep

Sleep is a critical function for humans (and all mammals) to be able to maintain mental and physical functions effectively. In terms of behaviour, sleep is described as “a reversible behavioral state of perceptual disengagement from and unresponsive to the environment” (Kryger et al., 2010, p. 16). Humans are classified as diurnal animals, meaning they are generally active in the daytime hours and sleep at night, however, these ancient patterns are often disrupted in the modern world (Paschos, 2021; Walker et al., 2020).

Chattu et al. (2018) argue that insufficient sleep is becoming a major issue. They highlight that there is evidence that the average number of hours people are sleeping has been reducing over the last few decades. Lack of sleep can have serious adverse effects on health and is associated with higher mortality and reduced cognitive performance and productivity. In their paper, Chattu et al. (2018) propose that the benefits of sleep need to be promoted worldwide.

2.2.1 Physiological drivers of sleep

There are two physiological drivers of sleep, and these regulate our sleep/wake cycles. These are the circadian biological clock and sleep homeostat and both influence sleep and related sleep variables such as alertness and sleepiness (Deboer, 2018).

The circadian biological clock developed early in the evolution of mammals and regulates key bodily functions such as sleep and wakefulness, body temperature and cognitive processing, synchronising these functions to the daily rotation of the earth across an approximate 24-hour cycle. A circadian rhythm is defined as a self-sustaining, oscillating pattern that occurs over a 24-hour period even when external cues (such as light) are removed (Deboer, 2018; Roenneburg et al., 2007). In humans, the circadian biological clock is located in the brain, in a part of the hypothalamus called the suprachiasmatic nucleus (SCN) and is part of the limbic system that evolved thousands of years ago to help ensure our survival (Albrecht & Eichele, 2003; Deboer, 2018; Roxo et al., 2011).

The circadian biological clock regulates the timing of sleep and alertness and ensures it remains in step with the time of the day. The circadian rhythm of sleep and wakefulness follows an approximate 24-hour cycle, but this it is not exact and under normal circumstances external cues called zeitgebers provide information to keep the circadian biological clock in step with the day night cycle (Roenneberg et al., 2007). The most important of these is light and in humans (as with all mammals), light is detected by special

cells in our eyes and this information is relayed to our SCN and in turn synchronises our clock to the earth's rotation (Roenneberg et al., 2007). This process is called entrainment and while this has worked well over 300,000 years to adjust our sleep/wake cycle to the changing seasons, in the modern world, our circadian clock can be disrupted by a number of factors including zeitgeber strength (by working inside), travelling across time zones (jet lag) or working at different times in the day night cycle.

There is also the impact of 'social time,' where we may deliberately adjust our internal clock using external cues such as alarms. Roenneburg et al. (2007) found that the timing of sleep changed drastically between work days and non-work days and that people woke up on average 2 hours earlier on a work day than they did on a non-work day. In their study they also looked at sleep duration and found that on average, people sleep longer on non-work days than they do on work days.

Disruptions to circadian rhythms are strongly associated with mood disorders and there is evidence of a bi-directional relationship between the two (Walker et al., 2020). Night-shift work, jet-lag and exposure to artificial light has been shown to bring on or exacerbate affective symptoms in those who are susceptible. Those with diagnosed mood disorders often experience disrupted circadian rhythms and associated issues such as disrupted sleep and cortisol secretion (Walker et al. 2020).

The other physiological driver of sleep is a homeostatic process. Homeostasis refers to a self-regulating biological process to maintain stability and in this instance the brain's increasing need for sleep with increasing wakefulness (Deboer, 2018; Sorenson et al., 2007). Sleep homeostatis describes how the need for sleep increases steadily while awake and decreases during sleep, impacting on the need for sleep as well as how quickly people fall asleep and enter into deep sleep or slow-wave sleep (SWS). When sleep homeostatis is at the lower limit, waking is triggered and when at its highest limit, sleep is triggered (Deboer, 2018).

While the total loss of sleep is followed by an increased need for sleep, complete recovery hour for hour is not necessarily required as part of the sleep homeostat response (Deboer, 2018). Data suggests that mammals can recover from sleep loss in two different ways- through increasing the amount of sleep as well as deepening sleep and increasing SWS (Deboer, 2018). Interestingly, increasing the time awake will increase the length of deep sleep during recovery sleep but there is no such increase observed in REM sleep (Webb & Agnew, 1971 cited in Cai, 1991).

The circadian biological clock and sleep homeostat work together to regulate timing, duration, depth and maintenance of sleep and are described in the two-process model of sleep regulation (Borbély, 2009). While this model has been developed further, it is accepted that circadian clock and sleep homeostat are the two core processes that influence human sleep (Deboer, 2018; Wurts & Edgar, 2000).

2.2.2 Sleep architecture

Despite a fascination with sleep that dates back to early civilisations, sleep science is a relatively young field since rapid eye movement (REM) sleep was first studied and documented in the 1950s (Dement, 2005). Sleep science has identified two different states of sleep and during normal human sleep, people cycle between non-REM sleep (NREM) and REM sleep (Williams et al., 2010).

There are different stages of NREM human sleep which are defined by patterns of brain waves (as measured by electroencephalogram or EEG), eye movements (electrooculogram or EOG) and muscle tone (measured by electromyogram or EMG). During NREM sleep, a synchronous pattern is seen as people pass through the stages of NREM sleep. The three stages are on a continuum of arousal with people most easily woken from stage 1 (N1) and the highest in stage 3 (N3) (Carskadon & Dement, 2011).

N1 is the beginning of sleep in which a person transitions from wakefulness to light sleep and usually lasts a few minutes (1 to 7 minutes). During this stage, low levels of brain activity are recorded by the EEG and brain waves slow from alpha waves (8-13Hz) to theta waves (3-7Hz), eyes begin to roll slowly and muscle jerks often occur (Carskadon & Dement, 2011). Stage 2 (N2) is when NREM begins, and brain waves slow further, and larger delta waves (<2 Hz) begin to occur occasionally. When these slower delta waves make up 20-50% of our sleep this is considered deep sleep or slow-wave sleep (SWS) and it is during this stage (N3) that people will be the hardest to wake up (Deboer, 2018).

During NREM, brain activity slows, but this increases as the person enters REM sleep. REM sleep is characterised by a high level of cortical brain activity, desynchronised EEG patterns, atonic muscles, episodic bursts of rapid eye movement and dreaming (Carskadon & Dement, 2011). The brain activity that occurs during REM is associated with dreaming and muscle twitches and cardiorespiratory changes are also observed during REM sleep.

Normal human sleep follows a pattern of falling asleep, entering into NREM sleep, moving through each stage of NREM (N1-N3) and then into REM sleep, usually 80-100 minutes later. As sleep continues, a cyclical pattern occurs of REM and NREM states of sleep of approximately 90 minutes each, with REM sleep periods lengthening through the night (Carskadon & Dement, 2011). In normal human sleep, SWS dominates the first third of a night's sleep and REM dominates the last third of the night and is linked to the circadian rhythm of body temperature (Carskadon & Dement, 2011). REM sleep usually makes up about 20% to 25% of total sleep time and is affected by many factors including age, tiredness (homeostatic load), circadian patterns, temperature, drugs and sleep disorders (Carskadon & Dement, 2011).

2.2.3 Measuring sleep

Sleep is a series of complex physiological processes, and a single measure is not able to capture all these dimensions (Ladyman et al., 2021). There are several ways to measure sleep, some that directly measure activity in the brain while asleep and some that are more subjective and involve remembering the experience of sleep and sleep patterns once awake. The gold standard and most objective measure of sleep is polysomnography (PSG), which involves electrodes on the head to measure brain activity, eye movement and muscle tone (Harvey et al., 2006). It is through this method that we now understand the stages of sleep as previously described and how NREM and REM sleep was first discovered. While this method has provided a wealth of knowledge in relation to the activity occurring in the brain while asleep, it is also the most expensive and most intrusive, as studies are conducted in a sleep laboratory rather than the person's usual sleeping environment and the electrodes themselves make sleeping more uncomfortable (Sargent et al., 2016).

The second method that is often used is actigraphy, which involves wearing a monitor on the wrist to measure activity. This method is less intrusive and uses detection of movement to determine sleep with an accuracy of 82% in identifying sleep (Harvey et al., 2006). One of the challenges with actigraphy is that, because it relies on movement, someone could be lying still rather than asleep, and this measure has been shown to have reduced accuracy for people with depression or insomnia who may lie still for long periods (Harvey et al., 2006). While less expensive than polysomnography, it does still incur some cost and does not measure brain activity so stages of sleep cannot be determined.

Sleep diaries and questionnaires are more subjective and rely on the person remembering how they slept and the duration of sleep. Sleep diaries are used to record sleep as soon as the person wakes up and are correlated with objective measures (Wilson et al., 1998). These methods are useful as a subjective measure to look at sleep satisfaction, duration, timing, and continuity. Someone's perception of how well and how long they slept is an

important factor and it has been found to influence their functioning during the day (Semler & Harvey, 2005).

Several questionnaires have been validated to measure sleep disturbance, insomnia and daytime sleepiness including the General Sleep Disturbance Scale (Lee & Gay, 2004; Shahid et al., 2011) and the Epworth Sleepiness Scale (Doneh, 2015; Johns, 1992). The advantages of using subjective measures are that they are the least intrusive and do not disrupt normal sleep patterns as people continue to sleep in their usual environment and can complete a sleep diary or questionnaire when awake. For a larger sample size, this method may be the most practical and is widely used to look at dimensions of sleep (Girschik et al., 2012).

2.2.4 Functions of sleep

There is no doubt that sleep is essential to all birds and mammals, and it is universally present, even when sleep can endanger an animal due to the environment in which they live. An example of this is the bottlenose and Amazonian dolphins who need to remain awake to keep swimming and breathing, so have evolved to sleep with one hemisphere of their brain at a time (Cai, 1991).

While there is no consensus in the literature on the core function of sleep, there are many theories on why sleep is so critical. These theories are often based on observations made when animals (including humans) are deprived of sleep. Sleep deprivation has been used as a form of torture and is known to have a negative impact on metabolism, immune response, motor skill learning, memory, cognitive performance, mood and overall mortality (Assefa et al., 2015).

One theory is that sleep provides physical restoration (by conserving energy) and allows the body to allocate energy to essential biological processes. This is supported by the findings that growth hormones are released during SWS sleep and energy requirements are

decreased, however during REM sleep, brain activity, energy use and metabolism increase so the amount of energy saved is minimal (Assefa et al., 2015).

Another theory is that sleep is critical for memory and learning and this is supported by studies showing that the degree of motor skill learning is associated with the percentage of SWS. Memory formation and retention is also associated with SWS and negative impacts on motor skill learning and memory are clearly demonstrated when sleep is restricted (Assefa et al., 2015). It is not only the amount of sleep but the architecture of sleep that is important, as when sleep has been restricted, the proportion of SWS and REM remains stable in recovery sleep while stages 1 and 2 decrease dramatically, demonstrating the importance of SWS and REM in particular (Assefa et al., 2015).

Cai (1991) reviewed phylogenetic studies and research to understand the functions of SWS and REM and what it is that makes sleep essential to life. Cai proposes that it is SWS that is essential and forms the inherent obligatory role of sleep as this is present in all birds and mammals. While REM is present in all marsupials, birds and some placental mammals, it is absent in Echidna who are primitive mammals.

Cartwright, Young et al. (1998, cited in Harvey et al., 2006), found that the more negative or unpleasant dreams an individual experienced, the less likely it was for that person to have depression a year later compared to baseline. This finding suggests that emotional issues are processed through dreaming (that occurs during REM sleep) and more effective processing may help to resolve these issues (Harvey et al., 2006). Conversely, inadequate sleep has been shown to negatively impact on emotions, with people experiencing more negative emotions and affecting the way they understand and express these emotions (Palmer & Alfano, 2017).

Key findings from several studies support the theory that REM sleep plays a role in emotional processing and regulation. Firstly, disruption to REM sleep is often observed in

people diagnosed with psychiatric disorders including schizophrenia and major depression (Perlis and Nielson, 1993). Secondly, REM sleep can be influenced by daytime mood and stress and this affects what people dream about, as well as their emotional reactions to a dream, and latency to REM, and REM density (De Koninck & Brunette, 1991). Thirdly, this relationship is bi-directional and there is evidence that dreaming can influence daytime mood as well (Perlis & Neilson, 1993).

There is clear evidence that sleep is critical for physical and mental restoration and emotional regulation. Both SWS and REM sleep are important for restoration; physical restoration appears to occur during SWS while REM is the period where emotional processing and regulation occur (Larkin & Butler, 2000).

2.2.5 Sleep and anxiety

The interplay between sleep, emotional regulation and anxiety is complex. The amygdala is part of the limbic system, as is the hypothalamus, which is home to the control centre of sleep. The amygdala plays an important role in human emotions and behaviour and also plays a critical role in anxiety and fear (Milosevic & McCabe, 2015; Roxo et al., 2011;). The amygdala is also one of the areas of the brain that is active during REM sleep, further supporting the theory that REM sleep plays an important role in emotional regulation (Harvey et al., 2006).

Many studies have found that sleep deprivation can cause significant psychological disturbance and alter emotions, affect and mood (Palmer & Alfano, 2017). Not enough sleep (under 5 hours) has been shown to increase activity of the sympathetic nervous system which stimulates the fight or flight response (Assefa et al., 2015). Sleep disturbance is a common feature in mental illness and two of the anxiety disorders include it in their diagnostic criteria- generalised anxiety disorder and PTSD (Mellman, 2006; Sadock & Sadock, 2003).

Sleep disturbance is not only a common symptom of mental illness, but it is also a risk factor. Freeman et al. (2017) conducted a large (n=3755) randomised controlled trial of a psychological intervention (digital cognitive behaviour therapy (CBT)) for the treatment of insomnia. While the study was focussed on psychotic experiences (paranoia and hallucinations), they found that depression and anxiety symptoms also improved as a result of digital CBT, providing strong evidence that insomnia is a causal factor for mental health issues (Freeman et al., 2017).

2.2.6 Sleep health

Although sleep health is a concept that has been discussed in several articles, it was Buysse (2014) who proposed a definition that has been largely adopted. Buysse's (2014) model of sleep health aligns with the holistic definition of health adopted by the World Health Organization constitution in 1948 that health is, "a state of complete physical, mental and social wellbeing and not merely the absence of disease" (World Health Organization, 2022a). Buysse (2014) proposed a model that identifies dimensions associated with health outcomes and can be expressed in positive terms thus shifting the focus from sleep disorders and problems. The five dimensions he proposed have the advantage of being measurable (through self-report, behavioural or physiological measures) and readily understood by both health professionals and the public.

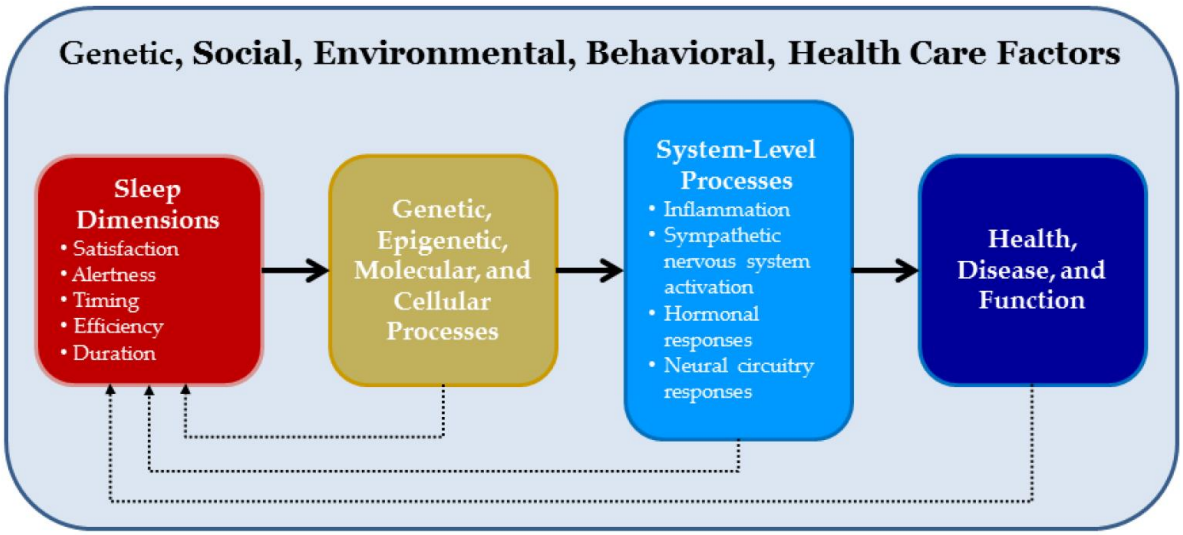
Buysse (2014) identified the following five dimensions to measure sleep health:

1. Sleep duration: this is the total amount of sleep in a 24-hour period.
2. Sleep continuity or efficiency: how easy it is to fall asleep and return to sleep after being woken.
3. Timing: when sleep occurs in a 24-hour period.
4. Alertness/sleepiness: ability to maintain attention while awake.

5. Satisfaction/Quality: how someone subjectively assesses their sleep e.g. good or poor.

Figure 1

Buysse's conceptual model of sleep health



Buysse's model has been well used to understand sleep and the dimensions provide a comprehensive framework for further research (e.g. Ladyman et al., 2021; Signal et al., 2022).

2.3 Sleep during the perinatal period

It is well documented that sleep patterns change over the life course and the perinatal period is a particularly disruptive period for sleep. From pregnancy through to after the baby is born, physiological, hormonal, physical and lifestyle changes and the obvious impacts of caring for a new-born baby around the clock, all have a dramatic effect on sleep timing, quality and duration. Studies show that three out of every four women will experience sleep disruption, insomnia or poor quality sleep during this period (Ladyman et al., 2022).

2.3.1 Sleep in pregnancy

Sleep disturbance and fatigue are common experiences during pregnancy, with many women experiencing poorer quality sleep while pregnant compared to pre-pregnancy (Ladyman & Signal, 2018; Pein & Schwab, 2004; Sedov et al., 2018; Sweeney, 2013). Several studies have found that sleep disturbances are more common during pregnancy and one study found that 97% of pregnant women experience sleep disturbance at some stage in their pregnancy, with a significant number reporting symptoms indicative of obstructive sleep apnoea (Mindell & Jacobson, 2000).

Sedov et al. (2018) looked at 24 research articles to understand how prevalent poor quality sleep (as measured by a score of 5 or more on the Pittsburgh Sleep Quality Index) is during pregnancy. They found that 45.7% of pregnant women experienced poor quality sleep and the quality of sleep worsened over the course of pregnancy with sleep being more disturbed in the third trimester (Sedov et al., 2018). Sweeney's (2013) study also found a deterioration in sleep duration and quality over the course of pregnancy and found that the duration and quality of sleep was highest before pregnancy, lowest in late pregnancy and had not returned to pre-pregnancy levels by 3 months postpartum.

In their study, Signal et al. (2016) investigated abnormal sleep duration and daytime sleepiness in a sample of pregnant women compared to non-pregnant women. They found that the total sleep time for pregnant women was 30 minutes shorter than non-pregnant women and pregnant women were three times more likely to sleep for 6 or less hours and 1.8 times more likely to sleep over 9 hours. Pregnant women were also 1.8 times more likely to experience excessive daytime sleepiness. The likelihood of experiencing abnormal sleep duration was higher for Māori, unemployed and those who work nights. Previous studies have found that excessive daytime sleepiness occurs more frequently during pregnancy than at other time points in the perinatal period and some studies have found younger

women have higher odds of experiencing it (Bourjeily et al., 2013; Nakagome et al., 2014; Signal et al., 2014).

Pregnant women report several reasons for sleep disturbance including physical discomfort (needing to urinate, caring for partner or children, body aches and sleeping position) as well as hormonal changes and there are observed changes to sleep architecture during this period (Ladyman & Signal, 2018; Pein & Schwab, 2004; Sedov et al., 2018). Many women experience insomnia in the later stages of their pregnancy with the risk estimated to be two times higher in later pregnancy compared with early pregnancy (Sedov et al., 2018). Sleep disordered breathing is another common complaint and there is evidence that this can have a negative impact on the mother as well as the foetus (Pein & Schwab, 2004). The negative effects of sleep disturbance on the mother and her baby are of concern and there is substantial evidence that poor sleep increases the likelihood of preterm birth, caesarean, longer labour, and increases the risk of perinatal depression (Blair et al., 2015; Naghi et al., 2011; Okun et al., 2011; Pietikäinen et al., 2019).

Most of the research into sleep during pregnancy has focused on sleep disturbance with fewer studies looking at healthy sleep during this time and the differences between pregnant and non-pregnant women. Ladyman and Signal (2018) undertook a scoping review of current literature to understand sleep health during pregnancy based on the five dimensions outlined in Buysse's definition of sleep health (Buysse, 2014). While there is large variability between women, available evidence did not support the assumption that there are large changes to sleep during healthy pregnancies. Research on duration, sleep continuity/efficiency and sleep disturbances show large variability but some evidence of increased waking in the third trimester. There is limited research on sleep timing, alertness/sleepiness and sleep satisfaction/quality however the studies that were reviewed, indicate that in the third trimester, average sleep times are later and

satisfaction/quality of sleep decreases (Facco et al., 2010; Sedov et al., 2018; Tsai et al., 2012).

2.3.2 Sleep in the postnatal period

As all new parents will know, welcoming a new-born into your life can be very disruptive to usual sleeping patterns as an infant's sleep-wake cycle is developing. Infants will often wake frequently in the night, causing a major disruption to usual parental sleep patterns, as the greatest drive for sleep is between 1am and 4am (Bangura, 1998 cited in Larken & Butler 2000).

Studies show that maternal sleep duration and efficiency decreases after birth and women report more sleep disturbance, less total sleep time, waking more often, spending more time awake at night and napping more often (Lee et al., 2000; Swain et al., 1997). Sleep is most disturbed in the first month following birth and one study found that sleep fragmentation increased twofold in the 15 days after birth (Coo et al., 2014).

Kennedy et al. (2007) found that while sleep patterns change in pregnancy, these escalate postpartum, and all of the 20 mothers included in their qualitative study experienced disturbed sleep and exhaustion postpartum. Mothers described a range of challenges that also compounded sleep disruption including exhaustion from labour and birth, breastfeeding and sleeping arrangements. This finding supports an earlier study that found that mothers reported feeling more tired and less rested due to many interruptions to their sleep, despite their sleep duration being similar to pre-pregnancy (Campbell, 1986).

Signal et al. (2007) found that the largest changes in sleep occurred in the first week postpartum with new mothers having, on average, 1.5 hours less sleep than during their pregnancy and 70% were regularly napping during the day. Their study found that during the first week postpartum, sleep duration per 24 hours was lowest and daytime napping, multiple sleep episodes and WASO (waking after sleep onset) was the highest. At six weeks

postpartum, total sleep time had increased, multiple sleep episodes were less common and WASO was lower than in pregnancy. This study shows that the sleep is most disturbed in the first week postpartum and highest variability is also seen during this period.

This is consistent with the findings of the meta-analysis undertaken by Yang et al. (2020) which found that sleep deprivation and chronic sleep disruption are highest in the first few days after birth but still higher in pregnancy when compared with non-pregnant women. Infant sleep-wake patterns, physical discomforts and levels of progesterone are all commonly reported as contributing to sleep disruption. Their study showed that poor sleep quality is higher in postnatal women than in prenatal women with one study finding that 77% of women reported poor sleep postnatally.

2.3.3 Sleep disorders

Pregnancy can cause changes to the respiratory system, particularly in late pregnancy, which can lead to snoring and breathing issues (Santiago et al., 2001). Obstructive sleep apnoea is a sleep disorder which is characterised by interrupted breathing while sleeping and presenting symptoms include excessive sleepiness and snoring (Caples et al., 2005). Studies have found that sleep apnoea can go undiagnosed in pregnant women unless there is someone there able to witness it (Santiago et al., 2001).

Restless legs syndrome (RLS) is another condition that disrupts sleep and there are four clinical characteristics that indicate restless legs syndrome (Trenkwalder et al., 2005). They are as follows:

1. An urge to move your legs
2. This urge is worse at night
3. It is more noticeable when resting
4. It is relieved by movement.

RLS is common in pregnancy and can affect up to a quarter of pregnant women but is often not picked up by maternity carers (Pein & Schwab, 2004). Women with pre-existing RLS often experiencing a worsening of the condition during pregnancy and while there are many causes, some studies have found it can be a sign of iron or folate deficiency (Pein & Schwab, 2004; Trenkwalder et al., 2005) while others have found links with use of antidepressants (Kolla et al., 2018; Rottach et al., 2008).

Periodic leg movements in sleep (PLMS) are repetitive movements in the legs and feet that occur while sleeping and can be part of RLS but can also be related to other sleep disorders and other diseases (Hornyak et al., 2006). Leg twitching or jerking while sleeping are signs of potential PLMS and can cause frequent arousal from sleep, thus impacting on the restorative value of sleep (Hornyak et al., 2006).

2.3.4 Sleep and maternal mental health

It is well recognised that inadequate sleep has a negative impact on mental health and the bi-directional relationship between mood and sleep is supported by substantial evidence. Given the sleep disruption that often occurs during the perinatal period, it is no surprise to see strong links between postnatal depression and sleep deprivation following childbirth (Ladyman et al., 2022; Piteo et al., 2013; Sweeney, 2013). As previously described, depression and anxiety disorders are the most common maternal mental health issues experienced but PTSD and postpartum psychosis can also occur during the perinatal period.

Studies show that women who reported more sleep disruption and poorer sleep during pregnancy and postnatally, were more likely to experience depressive symptoms (Ladyman et al., 2022; Pietikäinen et al., 2019). Sweeney (2013) also found that poor sleep was related to postnatal depression, and this relationship was strongest when quality and quantity of sleep declined after birth. In this study, an intervention of sleep education and follow up phone calls resulted in increased quantity of sleep and higher levels of confidence in

mothers. In another study using phone call follow ups, it was found that when mothers received emotional support and empathetic listening, they reported feeling less tired and reported receiving more sleep than the control group, even though they had about the same amount of sleep (Thome, 1999 cited in Larkin & Butler, 2000).

Many studies focus on sleep during the postnatal period and often look at infant sleep and the impact that this has on the mother's mental health. This is a complex relationship and some studies have shown that maternal mood disturbance during pregnancy (anxiety and depression) can impact on sleeping patterns of infants and children (O'Connor et al., 2007).

There is substantial evidence of a strong link between poor infant sleep (thus causing sleep disruption to mothers and other carers) and maternal mental health issues, particularly postnatal depression (Dennis & Ross, 2005; Goldberg et al., 2013; Hiscock et al., 2007; Hiscock et al., 2008). This is most likely a bi-directional relationship as high anxiety can lead to mothers overstimulating their infants and being more intrusive, thus impacting on the infant's sleep and ability to settle (Seymour et al., 2015). There is also evidence of infant/child sleep problems affecting maternal mood. Armstrong et al. (1998) studied the effects of modifying problematic sleeping patterns of children (mean age 19.1 months) and found a significant improvement in maternal mood when there was an improvement in problematic childhood sleep.

2.4 Aotearoa/New Zealand context

Aotearoa/New Zealand (NZ) is home to an estimated 5,151,600 people as at 31 Dec 2022 and the population grew by 0.7% over the 2022 calendar year (Stats NZ, 2023). Māori are the indigenous people of NZ and the population is growing at a faster rate than non-Māori across most areas of NZ. Depending on future trends in birth rates, Māori could account for 21 percent of NZ's total population by 2043 (1.14-1.35 million), and nearly one-third of NZ's child population (Stats NZ, 2022).

Māori women are having babies at a younger age compared to non-Māori women with 26% of the Māori babies born to Māori mothers under 25, compared to 11.4% of the babies born to non-Māori mothers who were under 25 years of age (Stats NZ, 2022). There were 58,659 live births in 2021 and 17,145 of these were born to Māori mothers. The total fertility rate was 1.64 compared to 1.99 for Māori mothers (Stats NZ, 2022).

In 2010, when many women were recruited for the *Moe Kura* study, there were 63,897 live births and 18,459 of these babies were born to Māori mothers. Māori mothers tended to be younger and 37% of the babies born were to Māori mothers under 25, compared to 21% of the babies born to non-Māori mothers who were under 25 years of age (Stats NZ, 2022).

2.4.1 Historical context

Aotearoa (NZ) was home to Māori long before the first Europeans were known to have reached here in 1642. According to Te Ao Māori (Māori world view), hapu (pregnant) women are tapu or sacred and given special status on the marae with special kai (food) being prepared for them. Traditionally, when labour began, they were surrounded by support and supporters who chanted to protect them and guide their pēpi into te ao Márama – the world of light (Walker, 2022).

Te Tiriti o Waitangi (the Treaty of Waitangi) was signed by Māori and the British Crown in 1840 and is considered the founding document of New Zealand but it has not been without its challenges (Ministry of Culture and Heritage, 2020). There are widely debated issues with the translation of the English version into Te Reo Māori and there were fundamental differences in the way that key terms were understood by each of the parties. In essence, the Treaty was a governance agreement for non-Māori settlement and intended to protect Māori interests from the negative impacts of settlement (Paine & Muller, 2023).

In the years following the signing of the Treaty, the representatives of the Crown did not always honour it and many years later in 1975, Whina Cooper organised a protest hikoi

(march) from the top of the North Island (Te Hāpua) to Parliament in Wellington (Ministry of Culture and Heritage, 2021). The land march, as it was known, was in protest of the loss of Māori land over the preceding decades and led to the Treaty of Waitangi Act which was passed in 1975 and the establishment of the Waitangi Tribunal. The Tribunal was a permanent commission of inquiry to make recommendations on claims brought by Māori in relation to Crown actions that breach the promises made in the Treaty of Waitangi (Network Waitangi, 2018).

2.4.2 Inequitable health and social outcomes

Māori have continued to experience persistent and compelling inequities in health status regardless of educational, occupational or income level, experiencing poorer health status than non-Māori (Paine & Muller, 2023). Initiated in 2016, the Waitangi Tribunal Health Services and Outcomes Inquiry (Wai 2575) heard all claims concerning grievances in relation to health services and outcomes of national significance for Māori. There were three stages to the Inquiry and stage two (part two) was focused on Māori mental health (Ministry of Justice, 2022).

In 2019, the NZ Ministry of Health (MoH) published the Wai 2575 Māori Health Trends Report. This report compares key health and social indicators between the Māori and non-Māori population and presents statistical trends from 1990-2015. Statistical evidence shows that the differences between outcomes for Māori and non-Māori has reduced in several areas (including rates of low birthweight and infant and mortality rates). Overall, however, health outcomes remain inequitable and in some areas the gap has widened over this time period, specifically for smoking rates, assault and homicide mortality for females 15 years old and over (MoH, 2019). Also of concern is the higher incidence of suicide for Māori women who are more than twice as likely to die by suicide than non-Māori women (MoH, 2019). There has also been a steep increase over time in intentional self-harm hospitalisations for female Māori, going up 80% from 1996–98 to 2014–16 (MoH, 2019).

The Māori Mental Health report (Gassin, 2019) commissioned by the Waitangi Tribunal, highlights the concern that the "prevalence of mental illness and suicide amongst Māori remains alarmingly and stubbornly high" (p. 182) and there are clearly disparities between Māori and non-Māori populations. Te Rau Hinengaro (Oakley Browne et al., 2006) showed that Māori experience the highest prevalence of mental health disorders overall, are more likely to experience serious disorders and co-morbidities and have the highest 12-month prevalence of substance disorders compared to non-Māori. Despite the advances that have been made in mental health and addiction services over several decades, Māori continue to experience the greatest burden due to mental health issues of any ethnic group in NZ (Gassin, 2019).

This is further evidenced in Ministry of Health reports which show that Māori are over-represented in terms of accessing mental health and addiction services (6.1% compared to 3.1% for non-Māori) and the most recent report shows little change from previous years (MoH, 2022b). In relation to the use of the Mental Health (Compulsory Assessment and Treatment) Act 1992, Māori are 3.4 times more likely to be under an inpatient treatment order than non-Māori and 4 times more likely to be subject to a community treatment order (MoH, 2022b). These latest figures further highlight the need to address inequitable outcomes and better understand the disparities are evident in the current health system.

Mental health and wellbeing are strongly influenced by the social determinants of health, including low income, unemployment and a lower standard of living (Ministry of Health, 2016; World Health Organization, 2014). There is substantial evidence, both internationally and in NZ, that factors such as socioeconomic status, ethnicity, gender and geographical location all impact health outcomes (Acheson 1998; Howden-Chapman & Tobias 2000) and in countries with a colonial history, indigenous people often have poorer outcomes than other population groups (MoH, 2016). Socioeconomic position is considered a key

determinant of health and is often used to understand inequitable outcomes in health (MoH, 2018c).

In NZ, Māori are over-represented in the lower deciles and in 2013, data from Statistics NZ showed that non-Māori were more advantaged than Māori across all socioeconomic indicators used. Māori adults had higher rates of unemployment, lower incomes, were less likely to own their own home and more likely to live in a crowded household (MoH, 2018b).

These inequities are evident in mental health where 51% of Māori (and 53% Pacific) under a community treatment order for mental health were living in the most deprived areas (quintile 5), compared with 27% of non-Māori and non-Pacific peoples (MoH, 2022b). The interplay between social determinants, ethnicity and health outcomes is not straightforward and several studies have sought to understand this better.

Paine and Muller (2023) looked at socioeconomic differences in relation to sleep and identified three distinct characteristics that help illustrate the complex relationships between socio-economic position (SEP), ethnicity and health disparities. These are the 'distribution gap', the 'outcome gap' and the 'gradient gap'. The distribution gap shows that Māori are overrepresented in the more deprived areas and underrepresented in the least deprived. The outcome gap refers to the evidence that shows that even when SEP is accounted for, Māori still have poorer health outcomes. The gradient gap refers to the relationship between the two which shows that as deprivation increases, disparity of health outcomes also increases (Paine & Muller, 2023).

NZ epidemiological data shows that Māori have poorer sleep health than non-Māori and socioeconomic deprivation is the most consistent, independent risk factor for poor sleep health (Paine & Muller, 2023). This highlights the importance of considering social determinants of health in all sleep health research and interventions to understand ethnic sleep inequities.

2.4.3 Maternal mental health in Aotearoa/New Zealand

In NZ, the largest cause of maternal death is suicide and Māori mothers are almost three times more likely to die by suicide compared to NZ European mothers according to the 2022 report from the Perinatal and Maternal Mortality Review Committee (PMMRC). Screening for depression and anxiety is not routinely undertaken during pregnancy or in the postpartum period making it more challenging to accurately estimate population prevalence, however, several studies give an indication.

An estimated 14% of people in NZ develop depression, anxiety or other mental health issues during the perinatal period. Both Signal et al. (2016) and Waldie et al. (2015) studied NZ women in late pregnancy and found that depressive and anxiety symptoms were more prevalent for Māori women than for non-Māori women.

In 2012, the Ministry of Health published Healthy Beginnings (2012) to provide guidance on improving the range, quality and national consistency of perinatal and infant mental health services in NZ (Ministry of Health, 2012). Healthy Beginnings has led to an increased range of services being available including individualised care packages, respite care in the community, as well as increased clinical responsiveness and acute inpatient services.

To improve outcomes for Māori and non-Māori women, children and their families, there needs to be a better understanding of maternal mental health and the factors that impact on maternal mental health for Māori and non-Māori mothers. PMMRC (2022) recommends an overarching emphasis on achieving equity for Māori whānau, ensuring early recognition, comprehensive assessment and active follow-up with a focus on evidence-based solutions for younger mothers and identification of modifiable risk factors for all mothers. The report also endorses strengthening services and following up on the recommendations of Maternal Mental Health Service Provision in New Zealand report (MoH, 2021) which included developing kaupapa Māori models of care (Section 5.8).

By understanding how pregnant and postnatal women are sleeping, feeling and experiencing their worlds, insights can be gained into how to recognise women who are struggling earlier, to ensure better support and interventions are available. Support needs to be readily available, easily accessible and culturally appropriate so women and caregivers feel comfortable and safe to access this support.

Ladyman et al. (2021) found that a large proportion of Māori and non-Māori women experience significant depressive symptoms in the perinatal period and 3 years after birth, however depressive symptoms improved at 12 weeks for both Māori and non-Māori. Māori women were more likely to experience depressive symptoms at 35-37 weeks pregnant with 22% of the Māori women included in the study showing clinically significant symptoms compared to 14.5% of non-Māori women. In their longitudinal study, they looked at three time points of the *Moe Kura* study (35-37 weeks pregnancy, 12 weeks postpartum and 3 years postpartum) and found that this difference continued at 3 years postpartum. Depressive symptoms were associated with poor sleep quality, continuity, latency and daytime sleepiness. This study was focused on depressive symptoms so further research is needed to understand whether these same differences can be observed for Māori and non-Māori women with high anxiety symptoms.

2.4.4 Researcher's background and identity

Sonya Russell (nee Petricevich) is of Croatian, Pākehā and Ngāpuhi descent. Over the last few years, Sonya has learned more about her Ngāpuhi ancestry and has been to visit Tāheke marae of her hapu, Ngāti Pakau. Sonya lives in Titirangi, Tāmaki Makaurau (Auckland) with her husband David and their two teenage boys Sean and Zakary.

Sonya has a background in psychology and a strong commitment to strengths-based approaches that enable people to thrive. She has worked in mental health and addiction services for over 20 years, directly with tangata whaiora (people seeking health and

wellbeing), with community providers, district health boards (DHBs), the Ministry of Health and now with Te Whatu Ora, Health New Zealand. Sonya is at the beginning of her journey of understanding Te Ao Māori (Māori world view) and brings a willingness to learn and a commitment to taking action to address long-standing inequitable health and social outcomes.

Having had her own experience of maternal mental health challenges, improving experiences and outcomes is a strong driver for Sonya and she has been involved in a range of maternal mental health service developments including setting up maternal crisis respite (the first of its kind in NZ), and development of both specialist and community services.

CHAPTER 3 METHODS

This chapter describes the methods used to gather and analyse data in the *Moe Kura: Maternal Sleep and Health in Aotearoa/New Zealand (Moe Kura)* cohort study. How the pregnant women were recruited, criteria for inclusion and data collection are described. Each of the measures relevant to this study are described, along with the evidence base that supported their use. The final sections outline statistical methods used to analyse *Moe Kura* data to address the research questions (Section 1.1).

3.1 Moe Kura study

This research used data collected in the *Moe Kura* cohort study conducted by a team of researchers at the Sleep/Wake Research Centre, Massey University. *Moe Kura* was an extension of the original study called *E Moe Māmā: Maternal Sleep and Health in Aotearoa/New Zealand (E Moe, Māmā)* which was a community based, longitudinal study designed to investigate relationships between sleep, birth outcomes and maternal mood across the perinatal period for a cohort of 1144 women (406 Māori and 738 non-Māori) (Signal et al., 2022).

The *E Moe, Māmā* study (later known as *Moe Kura*) was grounded in three key Kaupapa Māori epidemiological research principles: Māori participation and control at all stages of the research process; appropriate collection and classification of ethnicity data to identify and monitor health disparities; and equal explanatory and analytical power for Māori (Paine et al., 2013). Shared decision-making was enabled through Māori and non-Māori co-leadership of the study and the application of Kaupapa Māori research principles meant there was Māori participation and control throughout the entire research process (Paine et al., 2013; Signal et al., 2022).

Tikanga Māori principles provided a framework and informed the research ethics of whanautanga (building trusting relationships and seeking out connections), manaakitanga (caring for and nurturing research relationships and encourage generosity through sharing skills and knowledge) and kaitiakitanga (decision-making focused on the research participants, their values and knowledge) (Paine et al., 2013). Māori researchers led the recruitment and retention approaches for Māori women and acted as kaitiaki (guardians) of both the participants and their information (Paine et al, 2013).

Between October 2009 and September 2011, pregnant women were recruited by the Sleep/Wake Research Centre at Massey University from Capital & Coast, Mid-Central and Hawkes Bay districts. Early recruitment processes resulted in low numbers of Māori participants so key changes were made to the recruitment strategy, in line with the Kaupapa Māori epidemiological principles of the study to increase engagement with Māori communities (Paine et al., 2013). The revised strategy involved recruitment being closed earlier for non-Māori than for Māori women and expanding to the rest of NZ which meant that more pregnant Māori women could be recruited (Paine et al., 2013; Signal et al., 2022).

This approach resulted in a high number of Māori women involved in this study. This allows equal explanatory and analytical power and ensures that the findings are useful and relevant to both Māori and non-Māori as well as giving the opportunity to explore differences between them (Paine et al., 2013). The study has demonstrated the importance of sustained and trusting relationships with Māori to increase retention (rate was 92% for Māori women) in longitudinal studies and the value added by embedding Kaupapa Māori principles from the beginning (Paine et al., 2013; Signal et al., 2022).

The Central Region Health and Disability Ethics Committee granted ethics approval for the *E Moe, Māmā* study in October 2009 (CEN 09/09/070) and approved an amendment for *Moe Kura* in November 2012 (CEN 09/09/070/AM02). Women needed to be 16 years or older to participate and be carrying a single foetus. Participants were asked to complete a

questionnaire at different points of their perinatal period- firstly at 35-37 weeks gestation (paper), 6 weeks postpartum (by phone), 12 weeks postpartum (paper) and then again at 3 years (paper). Of the 2,755 study packs that were sent out to women, 1,199 consent forms were returned resulting in a sample size of 1144 (Figure 1).

In 2012, an amendment to the original ethics approval was granted to undertake further research to follow up with the women who participated in *E Moe Māmā* to complete questionnaires (paper) on maternal and child sleep and health when children (born in the study) were 3 years old. In 2013, Dr Te Huirangi Waikerepuru (Taranaki) from Te Matahiapo gifted the name *Moe Kura* to the study which is based on "te au moe kura i te ao mārama: the peaceful treasured sleep as of the child into the world of ancient wisdom, wonderment and light" (Signal et al., 2022).

These current analyses used data collected at four time points over the perinatal period- prior to pregnancy (self-reported at 35-37 weeks gestation- T1), data at 35-37 weeks gestation (T2), data gathered at 6 weeks (T3) and at 12 weeks postpartum (T4). Data from the 3-year dataset were not analysed as the focus of the current study was on the perinatal period. The total sample size differed at each time point and, on some occasions, not all questions were answered. The number of responses for each question is recorded in the results section.

3.1.1 First questionnaire completed at 35-37 weeks gestation (T1 and T2)

The first questionnaire (Q1) was completed when participants were approximately 35-37 weeks pregnant and included questions relating to their experiences prior to pregnancy (T1) and a range of questions relating to their current situation (T2). The 'Sleep and Health during Pregnancy' questionnaire consisted of 58 questions (Appendix A) covering a range of topics. Questions included demographic information (age, ethnicity, address, household

income, relationship status, stressful life events and employment), sleep, mood, history of depression prior to pregnancy and other health related questions. Women completed a paper questionnaire and sent it back to researchers by post. The questionnaire included several validated scales such as the General Sleep Disturbance Scale (GSDS) (Lee, 1992), the Edinburgh Postnatal Depression Scale (EPDS) (Cox et al, 1987), the Stressful Life Events scale (Centers for Disease Control and Prevention, 2022) and the Brief Measure of Worry Severity (Gladstone et al., 2005).

3.1.2 Second questionnaire completed at 4-6 weeks postpartum (T3)

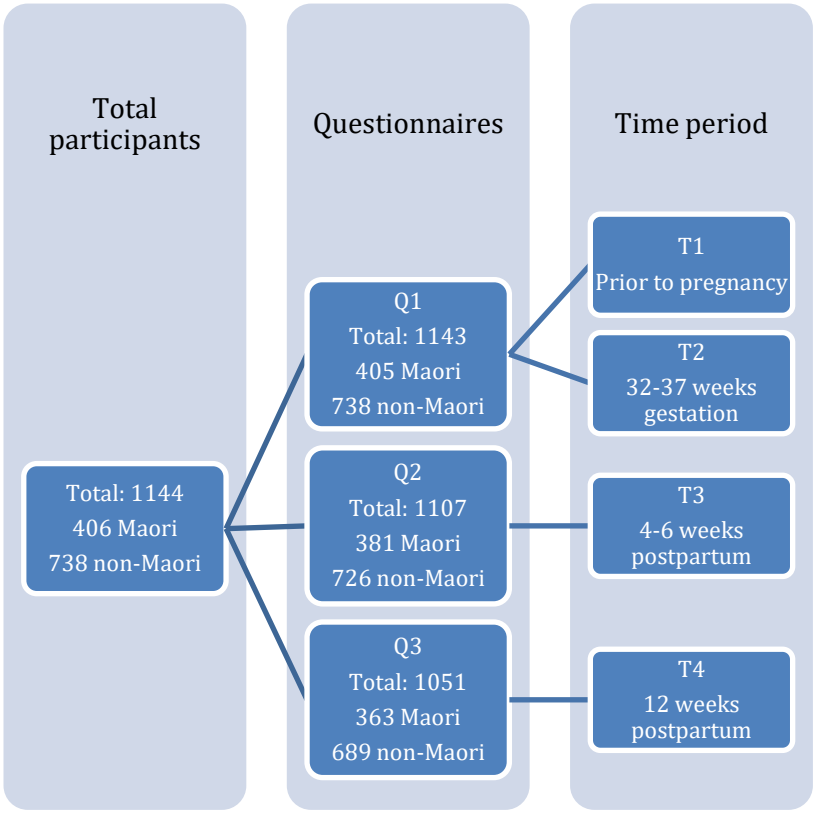
The second questionnaire (Q2) was completed at approximately 4-6 weeks postpartum (T3). Participants were interviewed by phone and completed a short 10 question survey with responses recorded (in writing) by the researcher conducting the interview (Appendix B). This included information about birth date and place, three questions about sleep and three questions relating to feelings of anxiety using the anxiety subscale of the EPDS (Matthey, 2008).

3.1.3 Third questionnaire completed at 12 weeks postpartum (T4)

At approximately 12 weeks postpartum (T4), a third questionnaire (Q3) was completed which consisted of 91 questions (Appendix C) including some repeated questions from Q1 on demographics, sleep and health and the validated scales included in Q1 (GSDS, EPDS and Stressful Life Events). It also included a range of questions on the birth experience and behaviour and sleep of the baby. Mothers completed a paper questionnaire and sent it back to researchers by post.

Figure 2

Participant responses for each of the Moe Kura questionnaires



3.2 Anxiety measures

In terms of anxiety measures, Q1 and Q3 included the full Edinburgh Postnatal Depression Scale (EPDS) and the Brief Measure of Worry Severity (BMWS). Q2 included only the EPDS anxiety subscale.

3.2.1 Anxiety subscale of the EPDS

As discussed previously (section 2.1.3), the anxiety subscale of the EPDS has been well validated as a screening tool for identifying anxiety symptoms in perinatal women (Brouwers et al., 2001; Jomeen & Martin, 2005; Matthey et al., 2013; Swalm et al., 2010). Validity has been demonstrated through high correlations between EPDS and the State-Trait Anxiety Inventory and while the internal reliability is not as high as the total EPDS (Cronbach's alpha score of 0.60 compared to 0.80) (Brouwers et al., 2001 (1)), this is due to

a low number of items (three) in the subscale which lowers the possible alpha score (Field, 2009).

The anxiety subscale of the EPDS consists of 3 statements relating to feeling anxious in the last 7 days as follows: 1. I have blamed myself unnecessarily when things went wrong, 2. I have been anxious or worried for no good reason, 3. I have felt scared or panicky for no very good reason. Participants rate themselves on a scale of 0-3 with 0 being "no, have never felt this way" to 3 being "yes, have felt this way often" (Appendix A). Therefore, the total possible score is 9 across the 3 items. A score of 4 or more on the anxiety subscale of the EPDS can be used as a threshold to indicate symptoms of anxiety, however previous studies have determined that a score of 6 or more is a better indicator of high anxiety symptoms that would cause distress and indicate a probable anxiety disorder (Matthey, 2008).

The EPDS anxiety subscale was completed at T2, T3 and T4. Using this same measure at each time point allowed changes in anxiety over time (longitudinally) to be measured for Māori and non-Māori women. Women were categorised into two groups based on their anxiety symptoms at 35-37 weeks pregnant, at 4-6 weeks postpartum and at 12 weeks postpartum. Scores of the EPDS anxiety subscale were coded as a dichotomous variable with a cut-off of 6 (scores of 6 or more were considered high anxiety symptoms) (Table 1). It should be noted that the anxiety subscale of the EPDS is not a diagnostic measure but rather a screening tool so while women may score high on the anxiety subscale in terms of the symptoms they are experiencing, a full diagnostic assessment would be required to determine if a diagnosis of anxiety disorder is appropriate.

3.2.2 Brief Measure of Worry Severity

Excessive worry is the main defining feature of generalised anxiety disorder (GAD) and is considered the cognitive component that occurs along with other associated symptoms such as concentration problems, sleep disturbance, muscle tension and fatigue (Borkovec &

Inz, 1990; Hirsch et al., 2013; Sadock & Sadock, 2003). The Brief Measure of Worry Severity (BMWS) includes 8 items related to dysfunctional worry and participants rate statements from 0-3 depending on how true the statements were. This measure has been shown to have good construct validity and is significantly associated with high anxiety with a score of 13 or more being considered excessive worry (Gladstone et al., 2005).

The BMWS was collected at T2 and T4 as a measure of psychological health and was included in the descriptive data analysis (Table 4), however it was not used in the logistic regression analyses. This is because it is significantly associated with high trait anxiety (Gladstone et al., 2005) which was also measured in this study by the EPDS anxiety subscale (Brouwers et al., 2001). The EPDS anxiety subscale data were gathered at each of the three time points (T2, T3 and T4) which allowed for cross-sectional as well as longitudinal comparisons.

3.3 Sleep measures

Buysee's (2014) model of sleep health (section 2.2.6) informed the selection of sleep variables that were used in this study and enabled patterns of multiple aspects of sleep over the course of pregnancy and early motherhood to be further investigated. This study utilised sleep variables that measure sleep quality, latency, continuity, daytime sleepiness and symptoms of sleep disorders at T2 and T4. At T3, only sleep duration (including sleep periods) and quality were measured.

3.3.1 Sleep duration

Sleep duration was measured using self-reported sleep time in the last 24 hours, including naps. Data were collected at T1, T2, and T4 via the question, "How many hours sleep do you usually get in 24 hours, including naps?" At T3, a slightly different question was asked, "In the last 24 hours how many sleep periods have you had- so what that means is, in the last

24 hours, how many times have you gone to sleep- including naps?" and a follow up question asked, "So in total, how much sleep have you had in the last 24 hours?"

In line with the National Sleep Foundation guidelines (Hirshkowitz et al., 2015), the NZ Ministry of Health (2018a) recommends 7-9 hours sleep per day for adults up to 65 years old, which is considered the amount needed to support health and wellbeing. Sleep duration was categorised as short sleep (<7 hours), recommended sleep (7-9 hours) and long sleep (>9 hours). Number of sleep periods was only measured at T3 and data were organised into three categories (one, two and three or more).

3.3.2 Sleep quality

As one indicator of sleep quality at T1, participants were asked, "Before this pregnancy, how often did you get a good night's sleep?" and at T2 and T4 they were asked "In the last week, how often did you get a good night's sleep?" Less than three nights was defined as poor quality sleep, based on the criteria for insomnia in DSM-IV (Howe et al., 2015).

At T3, participants were asked, "How would you rate the quality of your sleep in the last 24 hours?" on a scale from 0-3 (0 being very good and 3 being very poor). Responses were categorised as good quality (< 2) and poor quality (≥ 2). In contrast, the quality subscale of the General Sleep Disturbance Scale (described below) was used at T2 and T4.

3.3.3 General Sleep Disturbance Scale

The General Sleep Disturbance Scale (GSDS) was completed at T2 and T4 (Appendix A). The GSDS was originally developed by Lee (1992) to measure sleep disturbance in employed women (nurses) and has good internal consistency (Cronbach's alpha of 0.88). Since the original paper in 1992, several studies (e.g. Galeoto et al., 2019; Gay et al., 2004) have confirmed its validity and test-retest reliability with one of these studies finding an intraclass correlation coefficient (ICC) of 0.78 for Italian populations (Galeto et al., 2019).

The GSDS includes 21 items and can be used as a total score or as subscales to look at aspects of sleep disturbance. For this study, 3 items were not used (relating to alcohol, tobacco and medication use to help with sleep) due to the study's population of pregnant women. This reduced the scale to 18 items however none of the subscales were affected by this change (Ladyman, 2013). Participants were asked how often in the last week they experienced different aspects of sleep disturbance. As some questions were asked in the positive, they needed to be reverse scored (items 4, 10 and 11). For each question, participants could choose from 0 nights through to 7 nights in the last week. The GSDS includes the quality subscale (questions 4, 5 and 10), the sleep continuity subscale (questions 2 and 3) and the sleep latency subscale (question 1).

For each of the subscales, a mean score of 3 or more indicates a significant level of sleep disturbance and has been used to classify participants as 'good' sleepers (< 3) or 'poor' sleepers (≥ 3) (Lee & Gay, 2004). The GSDS sleep quality subscale is made up of three questions which ask how often in the last week participants: item 4. Feel rested upon awakening at the end of the sleep period, item 5. Sleep poorly and item 10. Feel satisfied with the quality of your sleep. Two items were reverse scored (questions 4 and 10), and the mean of these three scores was used with less than 3 nights, considered good sleep and 3 or more nights, considered poor sleep. The sleep continuity subscale included two questions asking how often in the last week participants woke up during a sleep period and woke up too early at the end of a sleep period. The mean score of these two questions was used with a cut-off of < 3 and ≤ 3 nights, as per the quality subscale. The latency subscale consists of only one question (How often in the last week did you have difficulty getting to sleep) so the score was used with a cut-off as described for the quality and continuity subscales (Table 1).

3.3.4 Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS) was completed at T2 and T4. The ESS has been shown to be a simple and reliable method for measuring daytime sleepiness in adults with a Cronbach's alpha of 0.88 (Johns, 1992). It consists of eight questions and participants were asked how likely they were to doze off or fall asleep in a range of different situations, such as watching TV or talking to someone or in a car (Appendix A). Each question is rated on a scale of 0-3 from 'would never doze' to 'high chance'. Therefore, the possible range of total scores is 0-24 with a score of 10 or higher meeting the threshold for excessive daytime sleepiness (Doneh, 2015).

3.3.5 Measures of sleep disorders

Snoring, breathing pauses and leg twitching/jerking are all symptoms of sleep disorders with the former two symptoms of sleep apnoea and the latter linked to periodic limb movement disorder (PLMS) (section 2.3.1). Measures of each of these were included at T1, T2 and T4. Participants were asked "how often in the last week has anyone told you that you did any of these" with response options from 0 to 7 nights. If women reported more than three nights per week, the symptom was considered to be frequent (Howe et al., 2015).

Restless legs syndrome (RLS) (described earlier in section 2.3.1) is a separate sleep disorder that also disrupts sleep. There are four clinical criteria that indicate RLS: an urge to move legs, urge is worse at night, more noticeable while resting, and relieved by movement (Trenkwalker et al., 2005; Howe et al., 2015). For this study, only those participants that selected "yes" to all four of the above criteria were coded as having symptoms indicating RLS (0=less than four and 1=all four criteria).

The measures used to capture snoring, breathing pauses, leg twitching/jerking and RLS were taken from the Pittsburgh Sleep Quality Index (PSQI) which has been found to have strong reliability (Cronbach's alpha of 0.83) and validity (diagnostic sensitivity of 89.6%) in

both clinical practice as well as research (Buysse et al., 1989; Mollayeva et al., 2016; Okun et al., 2009).

3.4 Sociodemographic measures (covariates)

Several covariates that are known to influence anxiety and sleep, were included in the descriptive statistics and the binary logistical regression models. Each of these variables are described below, along with how they were categorised.

3.4.1 Ethnicity

The *Moe Kura* study used the statistical standard for the definition of ethnicity as described is the HISO 10001:2017 ethnicity data protocols (MoH, 2017). Ethnicity is defined as "the ethnic group or groups that people identify with or feel they belong to" (p 6). The protocols identify three key elements that need to be reflected: ethnicity must be self-identified, people may identify with more than one ethnic group and ethnicity may change over time (p. 6, MoH, 2017). As per the protocols, ethnicity was self-identified in the *Moe Kura* study at T2 and participants who selected Māori (only or along with another ethnic group/s) were categorised as Māori and all others as non-Māori (Ladyman et al. 2021; Paine & Muller, 2023).

This study utilised data collected in the *Moe Kura* study and upholds the Kaupapa Māori principles previously described (section 3.1). In accordance with these principles and Te Tiriti o Waitangi (Treaty of Waitangi), analysis was undertaken to compare anxiety symptoms and sleep health both within the groups of Māori and non-Māori women as well as between them. This was to ensure that inequities could be identified, and research findings could be useful and relevant to both Māori and non-Māori (Paine et al., 2013; Reid & Robson, 2000).

3.4.2 Maternal age

Maternal age was calculated based on a participant's date of birth provided in the first questionnaire (T2) and used for all analyses. For the descriptive statistics, maternal age was used as a categorical variable with four categories (< 25 yrs, 25-29 yrs, 30-34 yrs and ≥ 35 yrs). For both cross-sectional and longitudinal binary logistic regression models, it was used as a continuous variable.

3.4.3 NZ Deprivation Index

The NZ Deprivation Index (NZDep) is commonly used to measure socio-economic position in NZ and utilises data collected by Statistics NZ as part of the national census (Atkinson et al., 2014). The NZDep2013 uses nine variables (reflecting eight dimensions of deprivation: income, employment, communication, transport, support, qualifications, home ownership and living space) to provide a relative deprivation score for each meshblock (small geographical unit) in NZ (Atkinson et al., 2014). The scale ranges from 1 to 10 with 1 being the 10% of least deprived areas and 10 being the 10% of most deprived areas of NZ. The NZDep is considered a useful and practical tool to measure socioeconomic position, however, while it gives an indication of the area people live in, it is not an individual metric (Salmond & Crampton, 2012).

An external service was used to map residential addresses provided at T2 to NZDep scores. For the descriptive statistics and cross-sectional analyses, deciles were collapsed into quintiles, reducing the scale to 1-5 with each quintile representing 2 deciles combined. For the longitudinal analyses (Table 1), deciles were condensed into 3 levels- low (deciles 1-3), medium (deciles 4-7) and high deprivation (8-10).

3.4.4 Parity

Parity is the term used to describe whether a woman has previously given birth. At T1, women were asked if they had ever been pregnant before and if the response was yes, then

a follow up question was asked "how many times have you given birth to a baby, alive or not, after at least 20 weeks of pregnancy?" If they answered more than once to this question, then it was coded as multiparous (has given birth previously) and if it was their first pregnancy this question was missed so no answer was coded as nulliparous (not given birth before). Several studies have found that multiparity can adversely impact on sleep through the perinatal period (Christian et al., 2019) and nulliparity is a risk factor for depressive symptoms early in the postpartum period (Ji et al., 2011).

3.4.5 History of depression

The first questionnaire included items relating to prior to pregnancy (T1) including two on previous depression and anxiety symptoms. The first question asked if participants had ever been told by a health professional that they were depressed or needed antidepressants (Appendix A). Answers to these questions were dichotomised into yes/no. This variable was reported in the descriptive statistics and included in cross-sectional and longitudinal logistic regression models. The second question asked participants if they had been distressed by feelings of anxiety or depression during this pregnancy (T2) and data were analysed as part of the descriptive statistics but not included in binary logistic regression models. The reason for this is that responses to the second question would have been confounded with EPDS anxiety subscale scores and prior history of depression was considered a more robust measure to use as numerous studies have found a significant relationship between a history of depression and anxiety symptoms in the perinatal period (Grigoriadis et al., 2019; O'Hara & Swain, 1996; Robertson et al., 2004; Schmied et al. 2013; Vythilingum, 2008).

3.4.6 Relationship status

Participants were asked about their relationship with their partner at T2 and again at T4 (using the same question). They were asked, "if you have a partner, how is your relationship

with them at the moment?" with response options ranging from 0 (perfectly happy) to 7 (extremely unhappy) or 8 (not applicable).

This question and associated ratings were based on a study by Webster et al. (1994) that found that women who were unhappy in their relationship were more likely to experience postnatal depression. A similar question was used by Abbott and Williams (2006) who found that, for Pacific women, the strongest risk factor for experiencing depressive symptoms was dissatisfaction with their relationship or not being in a relationship. Relationship status is considered an aspect of social support and there is evidence of it being a protective factor for depression and anxiety (Roohafza et al., 2014). Conversely, low social support in pregnancy has been found to predict postnatal depression in several studies (Leahy-Warren et al., 2012; Robertson et al., 2004; Schmied et al., 2013; Taylor et al., 2022).

3.4.7 Stressful Life Events

A 13-item scale was used to measure stressful life events in the last 12 months, based on the scale used as part of the Pregnancy Risk Monitoring System (PRAMS) developed by the Centers for Disease Control and Prevention in the USA (Centers for Disease Control and Prevention, 2022). The Stressful Life Events scale was completed at T2 and T4. Women were asked to tick as many listed stressful events that had happened to them in the last 12 months, such as, "I broke up with, got separated or divorced from my partner", "I had a lot of bills I couldn't pay" and "Someone very close to me died" (Appendix A). Less than 2 stressful events was considered low stress and 2 or more were categorized as high stress (Mukherjee et al., 2017). This measure was included as stressful life events have been shown to have a causal relationship with mental health issues, particularly depression (Kendler et al., 1999; Kessler, 1997; Schwarzer & Lusczczynska, 2013). Stressful life events have also been shown to directly affect sleep quality (Li et al., 2019) and one study found that quality sleep can be a protective factor, reducing the likelihood of depressive symptoms following an above average number of stressful life events (Leggitt et al., 2016).

3.5 Statistical analysis

Analyses were undertaken using the statistical software programme IBM SPSS for MS Windows (Version 28.0).

3.5.1 Descriptive statistics

Descriptive statistics were calculated to describe study variables for Māori women with high anxiety symptoms and those without and for non-Māori women with high anxiety symptoms and those without. Percentages and 95% confidence intervals were calculated for categorical variables and mean, median, standard deviation and range were calculated for continuous variables. Pearson's chi-square tests were used to test univariate associations between categorical variables (Field, 2009). Univariate analyses (independent *t*-tests) were also used to examine relationships between continuous variables (means) where appropriate.

Table 1

List of variables used in analysis

Variable	Collected	Categories	Description
Anxiety symptoms	T2, T3, T4	<6 (low symptoms) ≥6 (high symptoms)	EPDS subscale, feelings in the last 7 days
Ethnicity	T1	Non-Māori Māori	Self-identified ethnicity
Maternal age[a]	T1	< 25 yrs 25-29 yrs 30-34 yrs ≥ 35 yrs	Based on date of birth given
NZ Dep (quintiles)[b]	T2, T4	1=Least deprived 2 3 4 5=Most deprived	NZDep2013 deprivation index quintile based on address details
NZ Dep (deciles)[c]	T2, T4	1-3 deciles (low deprivation) 4-7 deciles (medium deprivation) 8-10 deciles (high deprivation)	NZDep2013 deprivation index decile based on address details
Parity	T1	No previous babies Previous babies	Given birth to a baby after at least 20 weeks
History of depression	T1	No diagnosis Previously diagnosed	Told by a health professional or needed antidepressants

Relationship status	T2, T4	<3 Happy ≥ 3 Not happy or N/A	Feelings about relationship with partner right now
Stressful Life Events	T1, T4	<2 low stress ≥2 high stress	Events in the last 12 months
Distressed by feelings of anxiety or depression	T2, T4	No Yes	Distressed for 2 weeks or more
Brief measure of worry severity	T2, T4	< 13 ≥ 13	Rating of statements in relation to general/usual experience of worrying
Total sleep time (TST)	T1, T2, T3, T4	< 7 hours (short sleep) 7-9 hours (rec sleep) > 9 hours (long sleep)	Usually/ in the last week, total sleep time including naps
Good night's sleep	T1, T2, T4	≥3 nights (good) <3 nights (poor)	In the last week, how many good night's sleep
Sleep quality	T3	<2 (good) ≥2 (poor)	In the last 24 hours, quality of sleep
Sleep periods	T3	1 sleep period 2 sleep periods 3 or more	Number of times gone to sleep in the last 24 hours, including naps
GSDS quality subscale	T2, T4	<3 (good) >=3 (disturbed)	Nights in the last week quality was disrupted- mean of the 3 items of GSDS quality subscale
GSDS continuity subscale	T2, T4	<3 (good) >=3 (disturbed)	Nights in the last week continuity was disrupted- mean of the 2 items of GSDS continuity subscale
GSDS latency subscale	T2, T4	<3 (good) >=3 (disturbed)	Nights in the last week had difficulty getting to sleep
Epworth Sleepiness Scale	T2, T4	<10 (not excessively sleepy) ≥10 (excessively sleepy)	Rating of likelihood of falling asleep in a range of situations
Frequent snoring	T1, T2, T4	<3 nights (not frequent) ≥3 nights (frequent)	Number of nights someone has told you that you are snoring
Frequent breath pauses	T1, T2, T4	<3 nights (not frequent) ≥3 nights (frequent)	Number of nights someone has told you that your breathing pauses while sleeping
Frequent leg twitching or jerking	T1, T2, T4	<3 nights (not frequent) ≥3 nights (frequent)	Number of nights someone has told you that your legs are twitching or jerking while sleeping
Restless legs	T2, T4	Did not meet criteria 4 criteria (restless legs)	Ever experience an urge to move legs, if yes, worse at night, more noticeable at rest and relieved by movement

Note. Rec is an abbreviation of recommended.

[a] Maternal age was used as a categorical variable for the descriptive statistics and a continuous variable for the cross-sectional and longitudinal logistic regression models.

[b] NZDep quintiles were used for descriptive statistics and cross-sectional logistic regression models.

[c] NZDep decile categories were used for longitudinal logistic regression models.

3.6 Binary logistic regression: Cross-sectional analysis

To investigate cross-sectional relationships between symptoms of anxiety and sleep health in pregnancy, and at 6 weeks and 12 weeks postpartum (research question 3, Section 1.1), binary logistic regression models were used. In this study, dependent (outcome) variables were categorical (anxiety symptoms and sleep health variables) with two levels, and independent (predictor) variables were categorical (covariates), and continuous (maternal age).

Models were not completed for T1, as EPDS anxiety subscale data were not collected prior to pregnancy. The Wald statistic was used to test for statistical significance (a value of <0.05 was considered significant) (Field, 2009) and odds ratios and 95% confidence intervals were calculated.

Collinearity tests were run on all groups of variables included in multivariable models. This was to check for potential multicollinearity and ensure it was not biasing the regression model. All independent variables in models had a variance inflation factor (VIF) of less than 10 and tolerance above 0.2 which indicates there is no collinearity within the data (Field, 2009).

Maternal age, ethnicity, NZDep, previous history of depression, relationship status and stressful life events were included as covariates in all cross-sectional models. These were selected a priori based on substantial evidence that there is a relationship between these variables and sleep and anxiety (Grandner et al., 2010; Patel et al., 2006; Sawyer et al. 2010; Schwarzer & Lusczczynska, 2013; Verbeek et al., 2019).

Initially it was intended that cross-sectional models would be run separately for Māori and non-Māori, however the number of Māori women with high anxiety symptoms was too low at T3 and T4 (n=35 Māori and n=39 non-Māori at T3; n=42 Māori and n=49 non-Māori at

T4) to be able to run statistically robust models. For this reason, ethnicity was included as a covariate in all adjusted models.

The total sleep time (TST) variable consisted of three categories: short sleep (<7 hours), recommended sleep (7-9 hours) and long sleep (>9 hours). For the cross-sectional and longitudinal analyses, two binary categories of TST were created comparing short sleep to recommended sleep and long sleep to recommended sleep (with recommended sleep as the reference category). This meant that when these categories of TST were included, the sample size for logistic regression models was reduced to only include those with either short or recommended sleep (short sleep) or long or recommended sleep (long sleep). At T3, the number of women who reported high anxiety symptoms in this sub-sample (either recommended or long sleep) was too small to be able to run statistically valid logistic regression models (Field, 2009).

3.6.1 Series 1: Cross-sectional models with anxiety as the dependent variable

The first cross-sectional models used anxiety symptoms as the dependent variable to investigate factors associated with women scoring high or low on the anxiety subscale of the EPDS. Each model was first run as an unadjusted model with a single sleep health variable as the independent variable and then as an adjusted model including the covariates outlined below in Table 2 and 3.

Table 2

Structure of Series 1 models

	Unadjusted	**Adjusted**	**Reference category**
Dependent variable	Anxiety symptoms	Anxiety symptoms	<6 (low symptoms)
Independent variables	Sleep health variable[a]	Sleep health variable[a]	
		Maternal age	Continuous
		Ethnicity	Non-Māori
		NZ Deprivation Index (quintile 1-5)	1=Least deprived
		Parity	No previous births
		History of depression	No diagnosis

	Relationship status	<3 Happy
	Stressful Life Events	<2 low stress

[a] One sleep variable was used per model- see Table 3 below for sleep variables used at each time point.

Table 3

Sleep health variables used in Series 1 models

Independent variables	Reference category	T2	T3	T4
Short sleep (less than 7 hours)	7-9 hours (recommended)	x	x	x
Long sleep (over 9 hours)	7-9 hours (recommended)	x		x
Good night's sleep	≥3 nights (good)	x		x
Sleep quality	≤1 (good)		x	
Sleep periods	1 sleep period		x	
GSDS quality subscale	<3 (good)	x		x
GSDS continuity subscale	<3 (good)	x		x
GSDS latency subscale	<3 (good)	x		x
Epworth Sleepiness Scale	<10 (not excessively sleepy)	x		x
Frequent snoring	<3 nights (not frequent)	x		x
Frequent breath pauses	<3 nights (not frequent)	x		x
Frequent leg twitch/jerk	<3 nights (not frequent)	x		x
Restless legs	<4 criteria	x		x

3.6.2 Series 2: Cross-sectional models with sleep health as the dependent variables

The second series of models used each of the sleep health variables as a single dependent variable and anxiety symptoms as the independent variable. Each model was first run as an unadjusted model with the anxiety symptoms variable as the independent variable in this instance and then with the covariates outlined below in Table 4 and 5.

For binary regression models to be statistically valid, a minimum event per variable (EPV) is needed to avoid overfitting of regression models where there are more independent (predictor) variables than are needed for the data available (Austin & Steyerberg, 2015). EPV was calculated by dividing the number of events (smallest group of responses) by the number of independent variables in the model (Austin & Steyerberg, 2015). A pragmatic decision was made to use an EPV of 5 or more based on the findings of Vittinghoff & McCulloch, (2007). EPV was calculated for all dependent variables and as a result models

were not run for three sleep health variables due to an EPV below 5 (T2 breath pauses, T4 breath pauses and T4 leg twitch/jerk).

Table 4

Structure of series 2 models

	Unadjusted	**Adjusted**	**Reference category**
Dependent variable	Sleep health variable[a]	Sleep health variable[a]	
Independent variables	Anxiety symptoms	Anxiety symptoms	<6 (low symptoms)
		Maternal age	Continuous
		Ethnicity	Non-Māori
		NZ Deprivation Index (quintile 1-5)	1 Least deprived
		Parity	No previous births
		History of depression	No diagnosis
		Relationship status	<3 Happy
		Stressful Life Events	<2 low stress

[a] One sleep variable was used per model- see Table 3 below for sleep variables used at each time point.

Table 5

Sleep health variables used in Series 2 models

Dependent variables	**Reference category**	**T2**	**T3**	**T4**
Short sleep (less than 7 hours)	7-9 hours (recommended)	x	x	x
Long sleep (over 9 hours)	7-9 hours (recommended)	x		x
Good night's sleep	≥3 nights (good)	x		x
Sleep quality	≤1 (good)		x	
Sleep periods	1 sleep period		x	
GSDS quality subscale	<3 (good)	x		x
GSDS continuity subscale	<3 (good)	x		x
GSDS latency subscale	<3 (good)	x		x
Epworth Sleepiness Scale	<10 (not excessively sleepy)	x		x
Frequent snoring	<3 nights (not frequent)	x		x
Frequent leg twitch/jerk	<3 nights (not frequent)	x		
Restless legs	<4 criteria	x		x

3.7 Binary logistic regression: Longitudinal analysis

Binary logistic regression analyses were also conducted to investigate longitudinal relationships between symptoms of anxiety and sleep health across the perinatal period, from late pregnancy through to 12 weeks postpartum. Binary logistic regression was appropriate as the dependent variables were categorical (with two levels) and the independent variables were categorical and continuous (Field, 2009). The Wald statistic was used to test for statistical significance (a value of <0.05 was considered significant) (Field, 2009) and odds ratios and 95% confidence intervals were calculated. Maternal age, ethnicity, NZ Dep, previous history of depression, relationship status and stressful life events were included as covariates in all longitudinal models (Table 4 and 5).

A decision was made to focus the longitudinal analyses on anxiety symptoms and sleep health at T4. Data collected at T2 and T4 were more comprehensive, covering a wider range of areas so focussing on T4 allowed independent variables from T2, T3 and T4 (from pregnancy through to 12 weeks postpartum) to be included in all longitudinal models.

As previously explained (Section 3.6), the total sleep time (sleep duration) variable had three categories so two binary categories were used (short sleep and long sleep compared to recommended sleep) however this reduced the total sample size when each of these were included in models.

3.7.1 Series 3: Longitudinal models with anxiety at 12 weeks postpartum as the dependent variable

The first models used T4 anxiety symptoms as the dependent variable and sleep variables at T2-T4 as the independent variables. Each model was first run as an unadjusted model with relevant sleep variables as the independent variable and then as an adjusted model including the covariates (Table 6).

Some of the sleep variables were collected at all time points (total sleep time, frequent snoring, frequent breath pauses, frequent leg twitching/jerking and restless legs) while others were collected only at T2 and T4. None of the sleep duration (TST) variables were included in Series 3 due to the number of independent variables in the model (19) being too high compared to the number of events (55), resulting in an EPV of less than 5. As previously described (Section 3.6.2) an EPV of 5 or more is needed to ensure models are statistically valid (Austin & Steyerberg, 2015).

Table 6

Structure of Series 3 models

Model	Variable type	Unadjusted	Adjusted	Reference category
1	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 Good night's sleep	T2 Good night's sleep	≥3 nights (good)
		T3 Sleep quality	T3 Sleep quality	≤1 (good)
		T4 Good night's sleep	T4 Good night's sleep	≥3 nights (good)
			Covariates[a]	
2	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 GSDS quality subscale	T2 GSDS quality subscale	<3 nights (good)
		T3 Sleep quality	T3 Sleep quality	≤1 (good)
		T4 GSDS quality subscale	T4 GSDS quality subscale	<3 nights (good)
			Covariates[a]	
3	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 GSDS continuity subscale	T2 GSDS continuity subscale	<3 nights (good)
		T3 Sleep quality	T3 Sleep quality	≤1 (good)
		T4 GSDS continuity subscale	T4 GSDS continuity subscale	<3 nights (good)
			Covariates[a]	
4	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 GSDS latency subscale	T2 GSDS latency subscale	<3 nights (good)
		T3 Sleep quality	T3 Sleep quality	≤1 (good)
		T4 GSDS latency subscale	T4 GSDS latency subscale	<3 nights (good)
			Covariates[a]	

5	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 Epworth Sleepiness Scale	T2 Epworth Sleepiness Scale	<10 (not excessively sleepy)
		T4 Epworth Sleepiness Scale	T4 Epworth Sleepiness Scale	<10 (not excessively sleepy)
			Covariates[a]	
6	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 Frequent snoring	T2 Frequent snoring	<3 nights (not frequent)
		T4 Frequent snoring	T4 Frequent snoring	<3 nights (not frequent)
			Covariates[a]	
7	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 Frequent breath pauses	T2 Frequent breath pauses	<3 nights (not frequent)
		T4 Frequent breath pauses	T4 Frequent breath pauses	<3 nights (not frequent)
			Covariates[a]	
8	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 Frequent leg twitch/jerk	T2 Frequent leg twitch/jerk	≥3 nights (good)
		T4 Frequent leg twitch/jerk	T4 Frequent leg twitch/jerk	≥3 nights (good)
			Covariates[a]	
9	Dependent variable	T4 Anxiety symptoms	T4 Anxiety symptoms	<6 (low symptoms)
	Independent variables	T2 Restless legs	T2 Restless legs	<4 criteria
		T4 Restless legs	T4 Restless legs	<4 criteria
			Covariates[a]	

[a] Covariates were added to each adjusted model- see Table 7 below for list of covariates.

Table 7

Sleep health variables used in Series 3 models

Covariates	**Reference category**
T2 Maternal age	Continuous
T2 Ethnicity	Non-Māori
T4 NZ Deprivation Index (deciles)	1-3 deciles (low deprivation)
T1 Parity	No previous births
T1 History of depression	No diagnosis
T4 Relationship status	<3 Happy
T4 Stressful Life Events	<2 low stress

3.7.2 Series 4: Longitudinal models with sleep health at 12 weeks postpartum as the dependent variables

The last series of models used T4 sleep variables as the dependent variable and anxiety symptoms at T2, T3 and T4 and sleep variables at earlier time points as the independent variables. Each model was first run as an unadjusted model with a sleep variable at T4 as the dependent variable and anxiety symptoms at T2, T3 and T4 as independent variables, and then as an adjusted model including the covariates as outlined below in Table 8.

For the cross-sectional analyses, two binary categories of TST were created comparing short sleep to recommended sleep and long sleep to recommended sleep (with recommended sleep as the reference category). This meant that when these categories of TST were included, the sample size for logistic regression models was reduced to only include those with either short or recommended sleep (short sleep) or long or recommended sleep (long sleep). At T3, the number of women who reported high anxiety symptoms in this sub-sample (either recommended or long sleep) was too small to be able to run statistically valid logistic regression models (Field, 2009).

Total Sleep Time (TST) was used as a dependent variable in Series 4 (Table 8), as well as the two binary categories of short sleep and long sleep as previously described (Section 3.6). TST (T2 and T3), short sleep at earlier time points (T2 and T3) and long sleep (T2 and T3) were used as independent variables. Frequent snoring, breath pauses, leg twitching or jerking and restless legs were not included as dependent variables in Series 4 (Table 8). This was due to small sample size and no theoretical basis to suggest that these signs of disordered sleep would be predicted by high anxiety symptoms.

Table 8

Structure of Series 4 models

Model	Variable type	Unadjusted	Adjusted	Reference category
1	Dependent variable	T4 Short sleep	T4 Short sleep	7-9 hours (rec)

	Independent variables	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	<6 (low symptoms)
			T2 Total sleep time T3 Total sleep time	7-9 hours (rec)
			T2 Short sleep T3 Short sleep	7-9 hours (rec)
			T2 Long sleep T3 Long sleep	7-9 hours (rec)
			Covariates[a]	
2	Dependent variable	T4 Good night's sleep	T4 Good night's sleep	≥3 nights (good)
	Independent variables	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	<6 (low symptoms)
			T2 Good night's sleep	≥3 nights (good)
			T3 Sleep quality	≤1 (good)
			Covariates[a]	
3	Dependent variable	T4 GSDS quality subscale	T4 GSDS quality subscale	<3 nights (good)
	Independent variables	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	<6 (low symptoms)
			T3 Sleep quality	≤1 (good)
			T4 GSDS continuity subscale	<3 nights (good)
			Covariates[a]	
4	Dependent variable	T4 GSDS continuity subscale	T4 GSDS continuity subscale	<3 nights (good)
	Independent variables	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	<6 (low symptoms)
			T3 Sleep quality	≤1 (good)
			T4 GSDS continuity subscale	<3 nights (good)
			Covariates[a]	
5	Dependent variable	T4 GSDS latency subscale	T4 GSDS latency subscale	<3 nights (good)
	Independent variables	T2 Anxiety symptoms	T2 Anxiety symptoms	<6 (low symptoms)

		T3 Anxiety symptoms T4 Anxiety symptoms	T3 Anxiety symptoms T4 Anxiety symptoms	
			T3 Sleep quality	≤1 (good)
			T4 GSDS latency subscale	<3 nights (good)
			Covariates[a]	
6	Dependent variable	T4 Epworth Sleepiness Scale	T4 Epworth Sleepiness Scale	<10 (not excessively sleepy)
	Independent variables	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	T2 Anxiety symptoms T3 Anxiety symptoms T4 Anxiety symptoms	<6 (low symptoms)
		T2 Epworth Sleepiness Scale	T2 Epworth Sleepiness Scale	<10 (not excessively sleepy)
			Covariates[a]	

Note. Rec is an abbreviation of recommended.
[a] Covariates were added to each adjusted model- see Table 9 below for list of covariates.

Table 9

Sleep health variables used in Series 4 models

Covariates	**Reference category**
T2 Maternal age	Continuous
T2 Ethnicity	Non-Māori
T4 NZ Deprivation Index (deciles)	1-3 deciles (low deprivation)
T1 Parity	No previous births
T1 History of depression	No diagnosis
T4 Relationship status	<3 Happy
T4 Stressful Life Events	<2 low stress

CHAPTER 4 RESULTS

This chapter describes the results of the analyses as described in the Methods section (chapter 3). Firstly, the characteristics of the sample are described. The next section covers the cross-sectional analyses that were completed at each time point data were gathered. Analyses are presented, with anxiety symptoms as the dependent variable and sleep variables as independent variables and then vice versa.

The final section presents the results from longitudinal analyses and this section is organised into models with anxiety symptoms during the perinatal period as the dependent variable and sleep variables at each time point as independent variables. A second set of models are then presented where sleep variables are the dependent variables and anxiety symptoms over time are the independent variables.

4.1 Sample characteristics

The characteristics of the sample are described to answer the following research question (section 1.1):

- What is the prevalence of symptoms of anxiety across the perinatal period for Māori and non-Māori women?

The first questionnaire, which covers T1 and T2, was completed by 1,143 women, 35% who identified as Māori. Anxiety symptoms were not measured at T1. At T2, 25% of Māori women reported high anxiety symptoms compared to 20% of non-Māori women. The questionnaire at T3 was completed by 1,107women, 34% who identified as Māori. A small proportion of women reported high anxiety symptoms; 9% of Māori women and 5% of non-Māori women. The questionnaire at T4 was completed by 1,051 women, 35% who identified

as Māori. Twelve percent of Māori women reported high anxiety symptoms compared to 7% of non-Māori women.

Results from analysis of key demographic variables and other covariates are presented in Table 10 (T1 and T2) and Table 11 (T4). Pearson's chi-square tests were used to test associations between categorical variables however it should be noted that chi-square results can be inflated at low frequencies (Field, 2009).

Māori women were, on average, younger than non-Māori women with the largest proportion of Māori women under 25 years old (Table 10). A greater proportion of those with high anxiety symptoms were younger when compared to those with lower anxiety symptoms, for both Māori and non-Māori. Of the women with high anxiety symptoms, 50% of Māori women were under 25 years old compared to 18.2% of non-Māori women. Compared to Māori women, there was a greater proportion of non-Māori women with high anxiety symptoms who were 35 or older (29.1% compared to 8.8%).

Differences in socio-economic deprivation were evident between Māori and non-Māori with higher proportions of Māori women in the higher deciles (more deprived areas) compared to non-Māori women, in both women with and without high symptoms of anxiety (Table 10). For non-Māori women, a significantly greater proportion of women with high anxiety symptoms were in quintile 5 (most deprived areas) compared to those with low anxiety symptoms.

A greater proportion of non-Māori women with low anxiety symptoms were having their first child compared to Māori women with low anxiety symptoms, however this same pattern was not seen in women with high anxiety symptoms (Table 10). Women with a prior history of depression were more likely to have high anxiety symptoms than those with no prior history and this difference was seen in both Māori and non-Māori. No differences were seen between Māori and non-Māori with high anxiety but there were differences for those

with low anxiety symptoms, with a higher proportion of non-Māori having a prior history of depression (24.1% compared to 17.2%).

Māori women with high anxiety symptoms were more likely to express dissatisfaction with their relationship (or answered not applicable to this question) and were more likely to have experienced life stress during their pregnancy compared to Māori women with low anxiety symptoms (Table 10). There was a significant difference between Māori and non-Māori with high anxiety symptoms and this same pattern was seen between Māori and non-Māori with lower anxiety symptoms. A large proportion of Māori women with high anxiety symptoms had experienced significant life stress, and although the pattern was similar for non-Māori women, the proportion was lower (43% non-Māori versus 70% Māori).

Compared to late pregnancy there was an increase in the proportion of women reporting dissatisfaction with their relationship at 12 weeks postpartum. Māori women with high anxiety symptoms report the greatest increase (Table 11). In relation to stressful life events, T4 results showed a similar pattern to T1 with significantly more Māori than non-Māori women experiencing life stress irrespective of anxiety symptoms. For non-Māori women, those with high anxiety symptoms were more likely to have experienced life stress than those with lower anxiety.

Women who had been distressed by feelings of anxiety and depression for 2 weeks or more during pregnancy and women who scored high on the BMWS (at T1) were more likely to experience high anxiety symptoms, and this pattern was seen in both Māori and non-Māori. A similar pattern was seen at T4 with significant differences on both these measures between those with high anxiety symptoms and those without, for both Māori and non-Māori (Table 11).

Table 10

Demographic variables and other covariates reported at 35-37 weeks pregnant (T1 &T2)

	High anxiety symptoms (≥ 6 on EPDS anxiety subscale)			**Low anxiety symptoms (< 6 on EPDS anxiety subscale)**			**Anx M vs low-anx M**	**Anx nM vs low-anx nM**
	Māori (n=102)	Non-Māori (n=148)	M vs nM	Māori (n=303)	Non-Māori (n=590)	M vs nM		
Maternal age	102	148		303	590			
< 25 yrs	50.0 (40.4-59.6)	18.2 (12.7-25.0)	**p<.0001**	32.3 (27.3-37.8)	8.0 (6.0-10.4)	**p<.0001**	**p=.009**	p=.**003**
25-29 yrs	17.6 (11.2-25.9)	19.6 (13.8-26.5)		24.1 (19.5-29.1)	21.7 (18.5-25.2)			
30-34 yrs	23.5 (16.1-32.4)	33.1 (25.9-41.0)		26.7 (22.0-31.9)	39.3 (35.4-43.3)			
≥ 35 yrs	8.8 (4.5-15.5)	29.1 (22.2-36.7)		16.8 (12.9-21.3)	31.0 (27.4-34.8)			
NZ Deprivation quintile	102	148		303	588			
1 (least deprived)	11.8 (6.6-19.1)	21.6 (15.6-28.8)	**p=.001**	10.9 (7.8-14.8)	29.9 (26.3-33.7)	**p<.0001**	p=.952	**p=.013**
2	8.8 (4.5-15.5)	19.6 (13.8-26.5)		10.9 (7.8-14.8)	24.8 (21.5-28.4)			
3	18.6 (12.0-27.0)	25.0 (18.6-32.4)		20.1 (15.9-24.9)	21.1 (17.9-24.5)			
4	23.5 (16.1-32.4)	15.5 (10.4-22.0)		24.1 (19.5-29.1)	14.5 (11.8-17.5)			
5 (most deprived)	37.3 (28.3-46.9)	18.2 (12.7-25.0)		34.0 (28.8-39.5)	9.7 (7.5-12.3)			
Parity	98	146		294	582			
Nulliparous	50.0 (40.2-59.8)	52.7 (44.7-60.7)	p=.675	42.5 (37.0-48.2)	54.8 (50.8-58.8)	**p=.001**	p=.197	p=.653
Multiparous	50.0 (40.2-59.8)	47.3 (39.3-55.3)		57.5 (51.8-63.0)	45.2 (41.2-49.2)			
Prior history of depression	102	147		302	588			
No	73.5 (64.4-81.3)	65.3 (57.4-72.6)	p=.169	82.8 (78.2-86.7)	75.9 (72.3-79.2)	**p=.018**	**p=.042**	**p=.009**
Yes	26.5 (18.7-35.6)	34.7 (27.4-42.6)		17.2 (13.3-21.8)	24.1 (20.8-27.7)			
Relationship status	94	145		277	585			
Good	56.4 (46.3-66.1)	75.9 (68.4-82.3)	**p=.002**	75.5 (70.1-80.2)	84.4 (81.3-87.2)	**p=.001**	**p<.0001**	**p=.014**
Poor or N/A	43.6 (33.9-53.7)	24.1 (17.7-31.6)		24.5 (19.8-29.9)	15.6 (12.8-18.7)			
Stressful life events	102	148		303	590			
< 1	30.4 (22.1-39.8)	57.4 (49.4-65.2)	**p<.0001**	50.2 (44.6-55.8)	72.7 (69.0-76.2)	**p<.0001**	**p=.001**	**p<.0001**
≥ 2	69.6 (60.2-77.9)	42.6 (34.8-50.6)		49.8 (44.2-55.4)	27.3 (23.8-31.0)			
Distressed by feelings of anxiety or depression	101	148		302	588			
No	68.3 (58.8-76.8)	69.6 (61.9-76.6)	p=.830	86.1 (81.9-89.6)	90.6 (88.1-92.8)	**p=.039**	**p=<.0001**	**p=<.0001**
Yes	31.7 (23.2-41.2)	30.4 (23.4-38.1)		13.9 (10.4-18.1)	9.4 (7.2-11.9)			
Brief measure of worry	101	148		302	588			
< 13	62.4 (52.7-71.4)	65.5 (57.6-72.8)	p=.609	94.4 (91.3-96.6)	92.5 (90.2-94.4)	p=.300	**p<.0001**	**p<.0001**

≥ 13	37.6 (28.6-47.3)	34.5 (27.2-42.4)		5.6 (3.4-8.7)	7.5 (5.6-9.8)	

Note. M vs nM is an abbreviation of Māori versus non-Māori. Anx is an abbreviation of anxiety symptoms.

Table 11

Demographic variables and other covariates reported at 12 weeks postpartum (T4)

	High anxiety symptoms (≥ 6 on EPDS anxiety subscale)			**Low anxiety symptoms (< 6 on EPDS anxiety subscale)**			**Anx M vs low-anx M**	**Anx nM vs low-anx nM**
	Māori (n=42)	Non-Māori (n=49)	M vs nM	Māori (n=321)	Non-Māori (n=640)	M vs nM		
Relationship status	38	47		300	627			
Good	31.6 (18.6-47.3)	59.6 (45.3-72.7)	**p=0.10**	58.7 (53.0-64.1)	77.5 (74.1-80.6)	**p<.0001**	**p=.002**	**p=.005**
Poor or N/A	68.4 (52.7-81.4)	40.4 (27.3-54.7)		41.3 (35.9-47.0)	22.5 (19.4-25.9)			
Stressful life events	42	49		321	640			
< 1	26.2 (14.8-40.8)	51.0 (37.3-64.6)	**p=0.16**	41.1 (35.8-46.6)	69.8 (66.2-73.3)	**p<.0001**	p=.063	**p=.006**
≥ 2	73.8 (59.2-85.2)	49.0 (35.4-62.7)		58.9 (53.4-64.2)	30.2 (26.7-33.8)			
Distressed by feelings of anxiety or depression	41	48		321	639			
No	34.1 (21.1-49.3)	45.8 (32.3-59.8)	p=.263	78.5 (73.8-82.7)	83.4 (80.4-86.1)	p=.063	**p<.0001**	**p<.0001**
Yes	65.9 (50.7-78.9)	54.2 (40.2-67.7)		21.5 (17.3-26.2)	16.6 (13.9-19.6)			
Brief measure of worry	41	49		319	638			
< 13	68.3 (53.2-80.9)	61.2 (47.3-73.9)	p=.485	94.7 (91.8-96.7)	95.5 (93.6-96.9)	p=.593	**p<.0001**[a]	**p<.0001**[a]
≥ 13	31.7 (19.1-46.8)	38.8 (26.1-52.7)		5.3 (3.3-8.2)	4.5 (3.1-6.4)			

Note. M vs nM is an abbreviation of Māori versus non-Māori. Anx is an abbreviation of anxiety symptoms.

[a] More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.

4.1.1 Sleep variables

Results from analysis of sleep variables are presented in Tables 12, 13, 14 and 15 and are organised according to time point (T1, T2, T3 and T4).

Māori women with high anxiety symptoms reported longer sleep prior to pregnancy compared to non-Māori but this difference was not seen at T2, T3 or T4. For women with low anxiety symptoms, Māori women slept longer than non-Māori prior to pregnancy, and at T2, T3 and T4 (Tables 12-15).

A significantly greater proportion of Māori women with high anxiety symptoms experienced difficulties falling asleep and daytime sleepiness at T2 and T4 compared to non-Māori women with high anxiety symptoms and Māori women with low anxiety symptoms (Tables 13 and 15). There was a higher proportion of non-Māori women with high anxiety symptoms who experienced longer sleep latencies when compared to non-Māori with low at both T2 and T4.

A greater proportion of Māori women with high anxiety symptoms experienced poor quality sleep, breathing pauses and leg twitching than non-Māori with high anxiety symptoms at T2 but at T4 only breath pauses, and leg twitching/jerking were significantly different (Tables 13 and 15). Results were inconsistent in relation to restless legs and snoring and there was no clear pattern over time. At T2, restless legs were less prevalent for Māori women with low anxiety symptoms than non-Māori with low anxiety symptoms and the proportion of Māori women with restless legs differed significantly between those with and without high anxiety symptoms. At T4, the only difference seen was between non-Māori women with high and low anxiety symptoms with prevalence significantly higher for non-Māori women with high anxiety symptoms. Frequent snoring was more prevalent for non-Māori women with high anxiety symptoms than non-Māori with low at T2 and T4. At T4, more Māori women

with low anxiety symptoms reported frequent snoring than non-Māori with low anxiety symptoms but no difference was seen at T2.

Table 12

Sleep variables before pregnancy, reported at 35-37 weeks pregnant (T1)

	High anxiety symptoms (≥6 on EPDS anxiety subscale)			Low anxiety symptoms (<6 on EPDS anxiety subscale)			Anx M vs low-anx M	Anx nM vs low-anx nM
	Māori (n=102)	Non-Māori (n=148)	M vs nM	Māori (n=303)	Non-Māori (n=589)	M vs nM		
Total sleep time	102	148		298	588			
< 7 hours	5.9 (2.5-11.7)	6.8 (3.5-11.7)	**p<.0001**	7.3 (4.8-10.7)	4.7 (3.2-6.7)	**p<.0001**	p=.515	p=.578
7-9 hours	65.7 (56.1-74.4)	85.8 (79.5-90.7)		69.7 (64.3-74.7)	88.5 (85.7-90.9)			
> 9 hours	28.4 (20.4-37.7)	7.4 (4.0-12.5)		23.0 (18.5-28.0)	6.8 (5.0-9.0)			
Good night's sleep	102	148		303	589			
< 3 nights	5.9 (2.5-11.7)	8.1 (4.5-13.3)	p=.503	5.3 (3.2-8.2)	3.9 (2.6-5.7)	p=.341	p=.817	p=.032
≥ 3 nights	94.1 (88.3-97.5)	91.9 (86.7-95.5)		94.7 (91.8-96.8)	96.1 (94.3-97.4)			

Note. M vs nM is an abbreviation of Māori versus non-Māori. Anx is an abbreviation of anxiety symptoms.

Table 13

Sleep variables reported at 35-37 weeks pregnant (T2)

	High anxiety symptoms (≥6 or more on EPDS anxiety subscale)			Low anxiety symptoms (<6 on EPDS anxiety subscale)			Anx M vs low-anx M	Anx nM vs low-anx nM
	Māori (n=102)	Non-Māori (n=148)	M vs nM	Māori (n=303)	Non-Māori (n=590)	M vs nM		
Total sleep time	100	148		302	588			
< 7 hours	37.0 (28.0-46.7)	46.6 (38.7-54.7)	p=.200	33.9 (28.7-39.4)	34.2 (30.4-38.1)	**p<.0001**	p=.658	p=.011
7-9 hours	45.0 (35.5-54.8)	41.9 (34.2-49.9)		44.0 (38.4-49.6)	55.1 (51.1-59.1)			
> 9 hours	18.0 (11.4-26.4)	11.5 (7.1-17.4)		22.1 (17.7-27.1)	10.7 (8.4-13.4)			
Good night's sleep	101	148		302	590			
< 3 nights	56.4 (46.7-65.8)	54.7 (46.7-62.6)	p=.790	51.3 (45.7-56.9)	47.1 (43.1-51.2)	p=.234	p=.373	p=.098
≥ 3 nights	43.6 (34.2-53.3)	45.3 (37.4-53.3)		48.7 (43.1-54.3)	52.9 (48.8-56.9)			
GSDS quality subscale	101	148		302	590			
< 3	38.6 (29.5-48.3)	59.5 (51.4-67.1)	**p=.001**	49.3 (43.7-55.0)	50.8 (46.8-54.9)	p=.670	p=.061	p=.061
≥ 3	61.4 (51.7-70.5)	40.5 (32.9-48.6)		50.7 (45.0-56.3)	49.2 (45.1-53.2)			
Mean	3.23	2.77		2.98	2.94	T-test		
Median	3.00	2.67		3.00	2.67	p=.639		

SD	1.06	0.83	**T-test p<.0001**	1.01	0.86			
Minimum	1.00	0.00		0.00	0.00			
Maximum	6.33	5.00		7.00	7.00			
GSDS continuity subscale	101	148		303	590			
< 3	2.0 (0.4-6.2)	6.8 (3.5-11.7)	p=.084[a]	9.2 (6.4-12.9)	8.6 (6.6-11.1)	p=.766	**p=.016**	p=.456
≥ 3	98.0 (93.8-99.6)	93.2 (88.3-96.5)		90.8 (87.1-93.6)	91.4 (88.9-93.4)			
Mean	5.87	5.51	T-test p=.058	4.93	5.21	**T-test p=.020**		
Median	6.00	6.00		5.00	5.50			
SD	1.27	1.58		1.70	1.65			
Minimum	1.50	1.50		0.00	0.00			
Maximum	7.00	7.00		7.00	7.00			
GSDS latency subscale	101	148		302	589			
< 3	22.8 (15.4-31.6)	42.6 (34.8-50.6)	**p=.001**	47.4 (41.8-53.0)	63.8 (59.9-67.6)	**p<.0001**	**p<.0001**	**p<.0001**
≥ 3	77.2 (68.4-84.6)	57.4 (49.4-65.2)		52.6 (47.0-58.2)	36.2 (32.4-40.1)			
Mean	4.37	3.21	**T-test p<.0001**	2.97	2.31	**T-test p<.0001**		
Median	5.00	3.00		3.00	2.00			
SD	2.203	2.278		2.380	2.228			
Minimum	0.00	0.00		0.00	0.00			
Maximum	7.00	7.00		7.00	7.00			
Daytime sleepiness	101	143		294	579			
< 10	63.4 (53.7-72.3)	75.5 (68.0-82.0)	**p=.040**	81.3 (76.5-85.4)	84.5 (81.3-87.2)	p=.235	**p<.0001**	**p=.011**
≥ 10	36.6 (27.7-46.3)	24.5 (18.0-32.0)		18.7 (14.6-23.5)	15.5 (12.8-18.7)			
Frequent snoring	99	143		299	582			
No	74.7 (65.6-82.5)	68.5 (60.6-75.7)	p=.294	79.6 (74.8-83.9)	80.2 (76.9-83.3)	p=.821	p=.309	**p=.002**
Yes	25.3 (17.5-34.4)	31.5 (24.3-39.4)		20.4 (16.1-25.2)	19.8 (16.7-23.1)			
Pauses between breaths	97	142		295	573			
No	85.6 (77.6-91.5)	96.5 (92.5-98.6)	**p=.002**	97.3 (94.9-98.7)	97.0 (95.4-98.2)	p=.832	**p<.0001**	p=.732
Yes	14.4 (8.5-22.4)	3.5 (1.4-7.5)		2.7 (1.3-5.1)	3.0 (1.8-4.6)			
Leg twitching/ jerking	99	145		297	576			
No	61.6 (51.8-70.7)	79.3 (72.2-85.3)	**p=.002**	88.2 (84.2-91.5)	91.7 (89.2-93.7)	p=.100	**p<.0001**	**p<.0001**
Yes	38.4 (29.3-48.2)	20.7 (14.7-27.8)		11.8 (8.5-15.8)	8.3 (6.3-10.8)			
Restless legs (4 criteria)	102	148		303	590			
No	80.4 (71.9-87.2)	80.4 (73.5-86.2)	p=.998	88.4 (84.5-91.7)	82.9 (79.7-85.8)	**p=.028**	**p=.040**	p=.480
Yes	19.6 (12.8-28.1)	19.6 (13.8-26.5)		11.6 (8.3-15.5)	17.1 (14.2-20.3)			

Note. M vs nM is an abbreviation of Māori versus non-Māori. Anx is an abbreviation of anxiety symptoms.

[a] More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.

Table 14

Sleep variables reported at 4-6 weeks postpartum (T3)

	High anxiety symptoms (≥ 6 on EPDS anxiety subscale)			**Low anxiety symptoms (< 6 on EPDS anxiety subscale)**			**Anx M vs low-anx M**	**Anx nM vs low-anx nM**
	Māori (n=35)	Non-Māori (n=39)	M vs nM	Māori (n=346)	Non-Māori (n=687)	M vs nM		
Total sleep time	35	39		346	687			
< 7 hours	22.9 (11.4-38.5)	28.2 (16.0-43.5)	p=.447[a]	29.8 (25.1-34.7)	31.3 (27.9-34.8)	**p=.003**	p=.630	p=.724
7-9 hours	60.0 (43.5-74.9)	64.1 (48.5-77.7)		52.0 (46.8-57.3)	58.1 (54.4-61.7)			
> 9 hours	17.1 (7.5-32.0)	7.7 (202-19.1)		18.2 (14.4-22.5)	10.6 (8.5-13.1)			
Sleep quality	35	39		346	688			
Good	74.3 (58.3-86.4)	82.1 (68.0-91.6)	p=.418	87.0 (831-90.2)	86.9 (84.2-89.3)	p=.973	p=.040[a]	p=.385
Poor	25.7 (13.6-41.7)	17.9 (8.4-32.0)		13.0 (9.8-16.9)	13.1 (10.7-15.8)			
Number of sleep periods	35	39		346	688			
1	11.4 (4.0-24.9)	0.0	p=.095[a]	6.9 (4.6-10.0)	4.1 (2.8-5.7)	p=0.86	p=.586	p=.292
2	31.4 (18.0-47.8)	35.9 (22.3-51.5)		30.1 (25.4-35.0)	28.1 (24.8-31.5)			
3 or more	57.1 (40.7-72.4)	64.1 (48.5-77.7)		63.0 (57.8-68.0)	67.9 (64.3-71.3)			

Note. M vs nM is an abbreviation of Māori versus non-Māori. Anx is an abbreviation of anxiety symptoms.
[a] More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.

Table 15

Sleep variables reported at 12 weeks postpartum (T4)

	High anxiety symptoms (≥ 6 on EPDS anxiety subscale)			**Low anxiety symptoms (< 6 on EPDS anxiety subscale)**			**Anx M vs low-anx M**	**Anx nM vs low-anx nM**
	Māori (n=42)	Non-Māori (n=49)	M vs nM	Māori (n=321)	Non-Māori (n=640)	M vs nM		
Total sleep time	40	48		316	635			
< 7 hours	27.5 (15.6-42.5)	35.4 (23.1-49.5)	p=.194[a]	22.2 (17.8-27.0)	25.8 (22.5-29.3)	**p<.0001**	p=.741	p=.344
7-9 hours	57.5 (42.1-71.9)	60.4 (46.3-73.3)		62.7 (57.2-67.9)	69.9 (66.3-73.4)			
> 9 hours	15.0 (6.5-28.3)	4.2 (0.9-12.7)		15.2 (11.6-19.5)	4.3 (2.9-6.0)			
Good night's sleep	42	48		319	635			
< 3 nights	35.7 (22.6-50.8)	47.9 (34.3-61.8)	p=.242	28.2 (23.5-33.3)	34.0 (30.4-37.8)	p=.070	p=.314	p=.052
≥ 3 nights	64.3 (49.2-77.4)	52.1 (38.2-65.7)		71.8 (66.7-76.5)	66.0 (62.2-69.6)			

GSDS quality subscale	42	48		321	639			
< 3	66.7 (51.7-79.4)	70.8 (57.0-82.2)	p=.670	58.9 (53.4-64.2)	57.3 (53.4-61.1)	p=.635	p=.333	p=.066
≥ 3	33.3 (20.6-48.3)	29.2 (17.8-43.0)		41.1 (35.8-46.6)	42.7 (38.9-46.6)			
Mean	2.30	2.33	T-test	2.61	2.60	T-test		
Median	2.33	2.33	p=.894	2.67	2.67	p=.949		
SD	1.025	1.005		1.146	1.103			
Minimum	0	0		0	0			
Maximum	4	4		7	6			
GSDS continuity subscale	42	48		321	639			
< 3	33.3 (20.6-48.3)	22.9 (12.8-36.2)	p=.271	40.8 (35.5-46.2)	36.9 (33.3-40.7)	p=.244	p=.352	p=.051
≥ 3	66.7 (51.7-79.4)	77.1 (63.8-87.2)		59.2 (53.8-64.5)	63.1 (59.3-66.7)			
Mean	3.63	4.34	T-test	3.26	3.69	T-test		
Median	3.50	4.25	p=.117	3.50	3.50	**p=.005**		
SD	2.31	1.97		2.23	2.30			
Minimum	0	0		0	0			
Maximum	7	7		7	7			
GSDS latency scale	42	48		321	639			
< 3	57.1 (42.1-71.2)	60.4 (46.3-73.3)	p=.753	79.1 (74.4-83.3)	82.6 (79.5-85.4)	p=.188	**p=.002**	**p<.0001**
≥ 3	42.9 (28.8-57.9)	39.6 (26.7-53.7)		20.9 (16.7-25.6)	17.4 (14.6-20.5)			
Mean	2.40	2.52	T-test	1.42	1.27	T-test		
Median	2	2	p=.780	1	1	p=.204		
SD	2.013	1.913		1.759	1.595			
Minimum	0	0		0	0			
Maximum	7	7		7	7			
Daytime sleepiness	42	47		311	633			
< 10	64.3 (49.2-77.4)	80.9 (68.0-90.1)	p=.079	82.0 (77.4-86.0)	83.4 (80.4-86.2)	p=.586	**p=.007**	p=.650
≥ 10	35.7 (22.6-50.8)	19.1 (9.9-32.0)		18.0 (14.0-22.6)	16.6 (13.8-19.6)			
Frequent snoring	42	47		320	635			
No	95.2 (85.6-99.0)	85.1 (73.0-93.1)	p=.114[a]	91.9 (88.5-94.5)	95.1 (93.2-96.6)	**p=.046**	p=.443[a]	**p=.004**[a]
Yes	4.8 (1.0-14.4)	14.9 (6.9-27.0)		8.1 (5.5-11.5)	4.9 (3.4-6.8)			
Pauses between breaths	40	46		317	635			
No	97.5 (88.9-99.7)	97.8 (90.3-99.8)	p=.920[a]	100.0	99.2 (98.3-99.7)	p=.113[a]	**p=.005**[a]	p=.331[a]
Yes	2.5 (0.3-11.1)	2.2 (0.2-9.7)		0.0	0.8 (0.3-1.7)			
Leg twitching/jerking	41	46		318	634			
No	87.8 (75.3-95.2)	93.5 (83.6-98.1)	p=.361[a]	95.3 (92.5-97.2)	97.9 (96.6-98.8)	**p=.022**	**p=.049**[a]	p=.053[a]
Yes	12.2 (4.8-24.7)	6.5 (1.9-16.4)		4.7 (2.8-7.5)	2.1 (1.2-3.4)			

Restless legs (4 criteria)	42	47		320	635			
No	90.5 (78.9-96.7)	85.1 (73.0-93.1)	p= .442	95.9 (93.3-97.7)	94.5 (92.5-96.1)	p=.333	p=.116[a]	**p=.010**[a]
Yes	9.5 (3.3-21.1)	14.9 (6.9-27.0)		4.1 (2.3-6.7)	5.5 (3.9-7.5)			

Note. M vs nM is an abbreviation of Māori versus non-Māori. Anx is an abbreviation of anxiety symptoms.
[a] More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.

4.2 Cross-sectional analyses: the relationship between symptoms of anxiety and sleep health in pregnancy and at 6 and 12 weeks postpartum

This section presents the results of cross-sectional binary logistic regression models at each time point (T2, T3 and T4) to answer the following research question (section 1.1):

- What is the cross-sectional relationship between symptoms of anxiety and sleep health in pregnancy, at 4-6 weeks postpartum and at 12 weeks postpartum for Māori and non-Māori women? Is this relationship bi-directional?

4.2.1 Series 1: Anxiety symptoms as the dependent variable at T2

Results of binary logistic regression analyses using high anxiety symptoms at late pregnancy as dependent variables and sleep variables and covariates as independent variables are presented in Table 16.

In both unadjusted and adjusted models, short sleep, difficulty falling asleep and excessive daytime sleepiness were all associated with women experiencing high anxiety symptoms (Table 16). Women who had difficulty getting to sleep and those who scored highly on the ESS were over twice as likely to experience high anxiety symptoms and those who slept under 7 hours were one and a half times more likely. Disturbed continuity of sleep was associated with high anxiety symptoms, but this relationship was no longer significant once covariates were included in the model.

Frequency of snoring, breath pauses and leg twitching or jerking while sleeping were all significant in both unadjusted and adjusted models. Snoring was associated with 1.66 greater odds, and breath pauses, and leg twitching were associated with 2.70 and 2.96 greater odds respectively, of high anxiety symptoms at T2 in fully adjusted models. Sleeping

longer (over 9 hours), frequency of getting a good night's sleep, quality of sleep and restless legs were not associated with high anxiety symptoms (Table 16).

Table 16

Results of cross-sectional binary logistic regression analysis at T2 (Anxiety as dependent variable)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted	
			Sig.	**OR 95% CI**		**Sig.**	**OR 95% CI**
High anxiety symptoms (≥ 6 on EPDS anxiety subscale)	Short sleep	970	**.01**	1.49 (1.10-2.03)	913	**.009**	1.56 (1.12-2.17)
	Maternal age					.065	0.97 (0.94-1.00)
	Māori					.925	0.98 (0.68-1.43)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.999	1.00 (0.59-1.70)
	NZ Dep 3					.364	1.26 (0.76-2.09)
	NZ Dep 4					.430	1.24 (0.73-2.12)
	NZ Dep 5 (most deprived)					.146	1.50 (0.87-2.60)
	Parity					.820	0.96 (0.68-1.36)
	History of depression					**.006**	1.67 (1.16-2.40)
	Relationship status					**<.001**	2.09 (1.42-3.06)
	Stressful life events					**.004**	1.68 (1.18-2.38)
High anxiety symptoms	Long sleep	726	.513	1.15 (0.75-1.77)	684	.510	0.85 (0.52-1.38)
	Maternal age					**.002**	0.94 (0.91-0.98)
	Māori					.577	1.14 (0.72-1.81)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.956	1.02 (0.54-1.91)
	NZ Dep 3					.786	0.92 (0.50-1.70)
	NZ Dep 4					.457	0.78 (0.41-1.50)
	NZ Dep 5 (most deprived)					.723	0.89 (1.46-1.71)
	Parity					.810	0.95 (0.63-1.44)
	History of depression					.271	1.30 (0.82-2.06)
	Relationship status					.158	1.40 (0.88-2.25)
	Stressful life events					**.003**	1.92 (1.26-2.92)
High anxiety symptoms	Good night's sleep	1141	.055	1.32 (0.99-1.75)	1071	.135	1.26 (0.93-1.71)
	Maternal age					**.044**	0.97 (0.94-1.00)
	Māori					.896	0.98 (0.69-1.38)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.825	0.95 (0.58-1.55)

	NZ Dep 3					.288	1.28 (0.81-2.04)
	NZ Dep 4					.804	1.07 (0.65-1.76)
	NZ Dep 5 (most deprived)					.200	1.39 (0.84-2.28)
	Parity					.576	0.91 (0.66-1.26)
	History of depression					**.003**	1.66 (1.18-2.33)
	Relationship status					**.004**	1.68 (1.18-2.39)
	Stressful life events					**.003**	1.63 (1.18-2.25)
High anxiety symptoms	GSDS quality subscale	1141	.852	0.97 (0.74-1.29)	1071	.964	0.99 (0.73-1.35)
	Maternal age					.052	0.97 (0.94-1.00)
	Māori					.939	0.99 (0.70-1.39)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.851	0.95 (0.58-1.56)
	NZ Dep 3					.309	1.27 (0.80-2.02)
	NZ Dep 4					.825	1.06 (0.64-1.74)
	NZ Dep 5 (most deprived)					.215	1.37 (0.83-2.25)
	Parity					.629	0.92 (0.67-1.27)
	History of depression					**.003**	1.66 (1.19-2.33)
	Relationship status					**.004**	1.69 (1.19-2.40)
	Stressful life events					**.002**	1.66 (1.20-2.29)
High anxiety symptoms	GSDS continuity subscale	1142	**.041**	1.92 (1.03-3.58)	1072	.082	1.77 (0.93-3.36)
	Maternal age					**.042**	0.97 (0.94-1.00)
	Māori					.874	0.97 (0.69-1.37)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.884	0.96 (0.59-1.58)
	NZ Dep 3					.290	1.28 (0.81-2.03)
	NZ Dep 4					.784	1.07 (0.65-1.77)
	NZ Dep 5 (most deprived)					.196	1.39 (0.84-2.29)
	Parity					.748	0.95 (0.69-1.31)
	History of depression					**.002**	1.69 (1.21-2.38)
	Relationship status					**.004**	1.67 (1.18-2.38)
	Stressful life events					**.003**	1.63 (1.18-2.25)
High anxiety symptoms	GSDS latency subscale	1140	**<.001**	2.64 (1.97-3.55)	1070	**<.001**	2.11 (1.54-2.90)
	Maternal age					.159	0.98 (0.95-1.01)

	Māori					.596	0.91 (0.64-1.29)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.947	0.98 (0.60-1.61)
	NZ Dep 3					.302	1.28 (0.80-2.04)
	NZ Dep 4					.950	0.98 (0.59-1.63)
	NZ Dep 5 (most deprived)					.296	1.31 (0.79-2.17)
	Parity					.563	0.91 (0.66-1.26)
	History of depression					**.009**	1.58 (1.12-2.22)
	Relationship status					**.011**	1.59 (1.11-2.27)
	Stressful life events					**.004**	1.61 (1.16-2.24)
High anxiety symptoms	Epworth Sleepiness Scale	1117	**<.001**	2.10 (1.51-2.92)	1051	**<.001**	2.14 (1.50-3.05)
	Maternal age					**.047**	0.97 (0.94-1.00)
	Māori					.963	1.01 (0.71-1.43)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.672	0.90 (0.55-1.48)
	NZ Dep 3					.286	1.29 (0.81-2.06)
	NZ Dep 4					.956	0.99 (0.59-1.64)
	NZ Dep 5 (most deprived)					.285	1.32 (0.80-2.17)
	Parity					.454	0.88 (0.64-1.22)
	History of depression					**.005**	1.65 (1.16-2.33)
	Relationship status					**.003**	1.72 (1.20-2.47)
	Stressful life events					**.006**	1.59 (1.14-2.21)
High anxiety symptoms	Frequent snoring	1123	**.003**	1.63 (1.18-2.25)	1055	**.004**	1.66 (1.17-2.34)
	Maternal age					**.022**	0.97 (0.94-1.00)
	Māori					.728	0.94 (0.66-1.34)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.757	0.92 (0.56-1.53)
	NZ Dep 3					.286	1.29 (0.81-2.06)
	NZ Dep 4					.674	1.12 (0.67-1.86)
	NZ Dep 5 (most deprived)					.182	1.41 (0.85-2.34)
	Parity					.677	0.93 (0.68-1.29)
	History of depression					**.013**	1.55 (1.10-2.20)
	Relationship status					**.004**	1.71 (1.19-2.45)
	Stressful life events					**.002**	1.66 (1.20-2.31)

High anxiety symptoms	Frequent breath pauses	1107	**<.001**	2.91 (1.58-5.39)	1040	**.004**	2.70 (1.38-5.26)
	Maternal age					.056	0.97 (0.94-1.00)
	Māori					.757	0.95 (0.66-1.35)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.952	0.99 (0.60-1.63)
	NZ Dep 3					.276	1.30 (0.81-2.08)
	NZ Dep 4					.937	1.02 (0.61-1.71)
	NZ Dep 5 (most deprived)					.148	1.45 (0.88-2.41)
	Parity					.750	0.95 (0.69-1.31)
	History of depression					**.017**	1.53 (1.08-2.17)
	Relationship status					**.008**	1.63 (1.13-2.34)
	Stressful life events					**.002**	1.67 (1.20-2.33)
High anxiety symptoms	Frequent leg twitch/jerk	1117	**<.001**	3.68 (2.57-5.27)	1049	**<.001**	2.96 (2.00-4.37)
	Maternal age					.093	0.98 (0.95-1.00)
	Māori					.641	0.92 (0.64-1.31)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.872	0.96 (0.58-1.59)
	NZ Dep 3					.375	1.24 (0.77-1.99)
	NZ Dep 4					.828	1.06 (0.63-1.77)
	NZ Dep 5 (most deprived)					.252	1.35 (0.81-2.25)
	Parity					.895	0.98 (0.71-1.36)
	History of depression					**.012**	1.57 (1.11-2.23)
	Relationship status					**.013**	1.59 (1.10-2.28)
	Stressful life events					**.007**	1.59 (1.14-2.21)
High anxiety symptoms	Restless legs	1143	.098	1.36 (0.95-1.95)	1073	.131	1.34 (0.92-1.97)
	Maternal age					**.047**	0.97 (0.94-1.00)
	Māori					.990	1.00 (0.71-1.41)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.910	0.97 (0.59-1.59)
	NZ Dep 3					.303	1.27 (0.80-2.02)
	NZ Dep 4					.874	1.04 (0.63-1.72)
	NZ Dep 5 (most deprived)					.197	1.39 (0.84-2.28)
	Parity					.627	0.92 (0.67-1.27)

	History of depression	**.003**	1.66 (1.18-2.33)
	Relationship status	**.003**	1.70 (1.20-2.41)
	Stressful life events	**.002**	1.66 (1.20-2.29)

4.2.2 Series 2: Sleep variables as dependent variables at T2

Results of binary logistic regression analyses using sleep variables as dependent variables at late pregnancy and anxiety symptoms and covariates as independent variables are presented in Table 17.

Women with high anxiety symptoms were more likely to sleep for less than 7 hours, and experience longer sleep latency or daytime sleepiness and these relationships were significant in the unadjusted as well as the adjusted models. For women with high anxiety symptoms, the odds of experiencing short sleep were 1.54 times higher and they were more than twice as likely to experience longer sleep latency and daytime sleepiness compared to women with low anxiety symptoms, after adjusting for covariates (Table 17).

High anxiety symptoms were associated with an increased likelihood that women would experience frequent snoring (OR = 1.66) and leg twitching and jerking (OR = 2.95) in adjusted models (Table 17).

High anxiety symptoms were associated with disrupted continuity of sleep but only in the unadjusted model (Table 17). Once covariates were added, this relationship was no longer significant. High anxiety symptoms showed no relationship with long sleep (over 9 hours), frequency of good night's sleep, quality of sleep or restless legs.

Table 17

Results of cross-sectional binary logistic regression analysis at T2 (Sleep variables as dependent variables)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted	
			Sig.	OR 95% CI		Sig.	OR 95% CI
Short sleep (<7 hours)	High anxiety symptoms	970	**.01**	1.49 (1.10-2.03)	913	**.01**	1.54 (1.11-2.15)
	Maternal age					**.001**	1.05 (1.02-1.08)
	Māori					.088	1.32 (0.96-1.81)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.363	1.21 (0.81-1.81)
	NZ Dep 3					.907	0.98 (0.66-1.45)
	NZ Dep 4					.835	1.05 (0.68-1.62)
	NZ Dep 5 (most deprived)					.471	1.18 (0.75-1.86)
	Parity					.437	1.12 (0.85-1.48)
	History of depression					.996	1.00 (0.73-1.37)
	Relationship status					.879	1.03 (0.72-1.46)
	Stressful life events					.495	0.90 (0.67-1.22)
Long sleep (>9 hours)	High anxiety symptoms	726	.513	1.15 (0.75-1.77)	684	.465	0.83 (0.51-1.36)
	Maternal age					**<.001**	0.91 (0.88-0.95)
	Māori					**.008**	1.82 (1.17-2.84)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.958	0.98 (0.54-1.80)
	NZ Dep 3					.328	0.74 (0.40-1.35)
	NZ Dep 4					.164	0.64 (0.34-1.20)
	NZ Dep 5 (most deprived)					.666	0.87 (0.47-1.63)
	Parity					**.01**	0.58 (0.38-0.88)
	History of depression					.308	0.77 (0.47-1.27)
	Relationship status					.106	1.48 (0.92-2.38)
	Stressful life events					.29	0.79 (0.52-1.22)
Good night's sleep	High anxiety symptoms	1141	.055	1.32 (0.99-1.75)	1071	.137	1.26 (0.93-1.700
	Maternal age					.215	1.02 (0.99-1.04)
	Māori					.156	1.23 (0.92-1.64)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.535	1.13 (0.78-1.630

	NZ Dep 3					.367	0.85 (0.59-1.22)
	NZ Dep 4					.872	0.97 (0.65-1.44)
	NZ Dep 5 (most deprived)					.297	0.80 (0.53-1.21)
	Parity					**.01**	1.40 (1.09-1.81)
	History of depression					.281	1.17 (0.88-1.57)
	Relationship status					.934	1.01 (0.74-1.39)
	Stressful life events					**.009**	1.44 (1.09-1.89)
GSDS quality subscale	High anxiety symptoms	1141	.852	0.97 (0.74-1.29)	1071	.951	0.99 (0.73-1.34)
	Maternal age					.726	1.00 (0.97-1.02)
	Māori					.055	1.33 (0.99-1.77)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.259	1.24 (0.85-1.800
	NZ Dep 3					**.037**	0.68 (0.47-0.98)
	NZ Dep 4					.995	1.00 (0.67-1.49)
	NZ Dep 5 (most deprived)					.732	0.93 (0.62-1.40)
	Parity					**<.001**	0.61 (0.47-0.79)
	History of depression					.114	0.79 (0.59-1.06)
	Relationship status					.211	0.82 (0.60-1.12)
	Stressful life events					.689	1.06 (0.80-1.39)
GSDS continuity subscale	High anxiety symptoms	1142	**.041**	1.92 (1.03-3.58)	1072	.073	1.80 (0.95-3.43)
	Maternal age					.074	1.04 (1.00-1.09)
	Māori					.259	1.36 (0.80-2.31)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.723	0.88 (0.44-1.77)
	NZ Dep 3					.635	0.85 (0.42-1.69)
	NZ Dep 4					.459	0.76 (0.36-1.58)
	NZ Dep 5 (most deprived)					.265	0.66 (0.31-1.38)
	Parity					**.002**	0.46 (0.29-0.75)
	History of depression					.058	0.62 (0.38-1.02)
	Relationship status					.333	1.35 (0.73-2.49)
	Stressful life events					**.048**	1.71 (1.01-2.91)
GSDS latency subscale	High anxiety symptoms	1140	**<.001**	2.64 (1.97-3.55)	1070	**<.001**	2.11 (1.54-2.90)
	Maternal age					**<.001**	0.96 (0.93-0.98)

		Māori					**.003**	1.57 (1.17-2.10)
		NZ Dep 1 (least deprived)					Ref	
		NZ Dep 2					.43	0.85 (0.58-1.26)
		NZ Dep 3					.929	0.98 (0.67-1.44)
		NZ Dep 4					.062	1.48 (0.98-2.23)
		NZ Dep 5 (most deprived)					.315	1.25 (0.81-1.91)
		Parity					.449	1.11 (0.85-1.45)
		History of depression					.052	1.35 (1.00-1.83)
		Relationship status					**.009**	1.55 (1.11-2.15)
		Stressful life events					.304	1.16 (0.87-1.54)
Epworth Sleepiness Scale		High anxiety symptoms	1117	**<.001**	2.10 (1.51-2.92)	1051	**<.001**	2.15 (1.51-3.06)
		Maternal age					.168	1.02 (0.99-1.06)
		Māori					.124	1.33 (0.93-1.91)
		NZ Dep 1 (least deprived)					Ref	
		NZ Dep 2					.248	1.33 (0.82-2.15)
		NZ Dep 3					.453	0.82 (0.50-1.37)
		NZ Dep 4					.411	1.24 (0.74-2.07)
		NZ Dep 5 (most deprived)					.563	1.17 (0.69-1.97)
		Parity					.485	1.13 (0.81-1.57)
		History of depression					.991	1.00 (0.69-1.45)
		Relationship status					.514	0.88 (0.59-1.31)
		Stressful life events					**.029**	1.47 (1.04-2.08)
Frequent snoring		High anxiety symptoms	1123	**.003**	1.63 (1.18-2.25)	1055	**.004**	1.66 (1.17-2.34)
		Maternal age					.098	1.03 (1.00-1.06)
		Māori					.542	1.11 (0.79-1.57)
		NZ Dep 1 (least deprived)					Ref	
		NZ Dep 2					.92	0.98 (0.63-1.52)
		NZ Dep 3					.897	0.97 (0.63-1.50)
		NZ Dep 4					.148	0.69 (0.42-1.14)
		NZ Dep 5 (most deprived)					.89	1.04 (0.64-1.68)
		Parity					.993	1.00 (0.74-1.36)
		History of depression					.106	1.32 (0.94-1.85)
		Relationship status					.498	0.88 (0.60-1.29)
		Stressful life events					.498	1.12 (0.81-1.55)

Frequent leg twitch/jerk	High anxiety symptoms	1117	**<.001**	3.68 (2.57-5.27)	1049	**<.001**	2.95 (2.00-4.36)
	Maternal age					**.036**	0.96 (0.93-1.00)
	Māori					.267	1.27 (0.84-1.92)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.705	0.88 (0.46-1.70)
	NZ Dep 3					.572	1.19 (0.66-2.15)
	NZ Dep 4					.484	1.25 (0.67-2.30)
	NZ Dep 5 (most deprived)					.236	1.45 (0.79-2.66)
	Parity					.187	0.76 (0.51-1.14)
	History of depression					.499	1.16 (0.75-1.81)
	Relationship status					.213	1.32 (0.85-2.04)
	Stressful life events					.239	1.28 (0.85-1.92)
Restless legs	High anxiety symptoms	1143	.098	1.36 (0.95-1.95)	1073	.134	1.34 (0.91-1.96)
	Maternal age					.804	1.00 (0.96-1.03)
	Māori					.072	0.70 (0.47-1.03)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.128	0.67 (0.39-1.13)
	NZ Dep 3					.936	0.98 (0.61-1.58)
	NZ Dep 4					.387	1.25 (0.76-2.06)
	NZ Dep 5 (most deprived)					.863	0.95 (0.55-1.64)
	Parity					.852	0.97 (0.69-1.36)
	History of depression					.785	0.95 (0.64-1.40)
	Relationship status					.513	1.15 (0.76-1.72)
	Stressful life events					.893	1.03 (0.71-1.47)

4.2.3 Series 1: Anxiety symptoms as dependent variable at 4-6 weeks postpartum

Results of binary logistic regression analyses using high anxiety symptoms at four to six weeks postpartum as dependent variables and sleep variables and covariates as independent variables are presented in Table 18.

For this analysis, a smaller number of sleep variables were included- short sleep (under 7 hours), long sleep (over 9 hours), sleep quality and number of sleep periods. None of these sleep variables were associated with high anxiety symptoms for women at 4-6 weeks postpartum in either the unadjusted or adjusted models (Table 18).

Table 18

Results of cross-sectional binary logistic regression analysis at T3 (Anxiety as dependent variable)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted	
			Sig.	OR 95% CI		Sig.	OR 95% CI
High anxiety symptoms (≥ 6 on EPDS anxiety subscale)	Short sleep	988	.232	0.72 (0.41-1.24)	909	.271	0.72 (0.40-1.30)
	Maternal age					.745	1.01 (0.96-1.06)
	Māori					**.042**	1.86 (1.02-3.38)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.338	1.51 (0.65-3.52)
	NZ Dep 3					.803	0.89 (0.35-2.27)
	NZ Dep 4					.169	1.85 (0.77-4.44)
	NZ Dep 5 (most deprived)					.402	1.49 (0.58-3.82)
	Parity					.491	0.82 (0.46-1.45)
	History of depression					**.009**	2.14 (1.21-3.77)
	Relationship status					.351	0.71 (0.35-1.46)
	Stressful life events					.105	1.61 (0.91-2.88)
High anxiety symptoms	Sleep quality	1136	.054	1.77 (0.99-3.16)	1044	.091	1.72 (0.92-3.21)
	Maternal age					.848	1.00 (0.95-1.05)
	Māori					.052	1.75 (1.00-3.06)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.327	1.51 (0.66-3.43)
	NZ Dep 3					.888	1.06 (0.45-2.50)
	NZ Dep 4					.182	1.75 (0.77-3.98)
	NZ Dep 5 (most deprived)					.59	1.28 (0.52-3.13)
	Parity					.456	0.82 (0.48-1.40)
	History of depression					**.014**	1.96 (1.14-3.36)
	Relationship status					.396	0.76 (0.40-1.45)
	Stressful life events					.067	1.66 (0.96-2.87)
High anxiety symptoms	Sleep periods	1136	.256	0.76 (0.47-1.22)	1044	.72	0.91 (0.54-1.53)
	Maternal age					.883	1.00 (0.95-1.05)
	Māori					.056	1.73 (0.99-3.03)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.38	1.44 (0.64-3.28)

	NZ Dep 3	.975	1.01 (0.43-2.38)
	NZ Dep 4	.208	1.69 (0.75-3.83)
	NZ Dep 5 (most deprived)	.666	1.22 (0.50-2.97)
	Parity	.546	0.85 (0.50-1.45)
	History of depression	**.01**	2.03 (1.19-3.47)
	Relationship status	.411	0.76 (0.40-1.46)
	Stressful life events	**.041**	1.76 (1.02-3.03)

4.2.4 Series 2: Sleep variables as dependent variables at 4-6 weeks postpartum

Results of binary logistic regression analyses using sleep variables at four to six weeks postpartum as dependent variables and anxiety symptoms and covariates as independent variables are presented in Table 19.

High anxiety symptoms were not associated with short sleep, long sleep, sleep quality or the number of sleep periods women had in either the unadjusted or adjusted models.

Table 19

Results of cross-sectional binary logistic regression analysis at T3 (Sleep variables as dependent variables)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted			
			Sig.	OR 95% CI		Sig.	OR 95% CI		
Short sleep (<7 hours)	High anxiety symptoms	988	.232	0.72 (0.41-1.24)	909	.266	0.71	0.39	1.29
	Maternal age					.048	1.03	1.00	1.06
	Māori					.768	1.05	0.76	1.46
	NZ Dep 1 (least deprived)					Ref			
	NZ Dep 2					.126	1.39	0.91	2.12
	NZ Dep 3					**.002**	1.92	1.27	2.91
	NZ Dep 4					**.012**	1.82	1.14	2.89
	NZ Dep 5 (most deprived)					**.035**	1.68	1.04	2.72
	Parity					**.025**	1.39	1.04	1.86
	History of depression					.727	1.06	0.77	1.46
	Relationship status					.709	1.07	0.75	1.54
	Stressful life events					.854	0.97	0.71	1.33
Long sleep (>9 hours)	High anxiety symptoms	783	.592	0.82 (0.39-1.71)	723	.481	0.75	0.33	1.69
	Maternal age					**.008**	0.95	0.91	0.99
	Māori					.067	1.51	0.97	2.33
	NZ Dep 1 (least deprived)					Ref			
	NZ Dep 2					.12	0.56	0.27	1.16
	NZ Dep 3					.148	1.55	0.86	2.79
	NZ Dep 4					.051	1.82	1.00	3.32
	NZ Dep 5 (most deprived)					.627	1.17	0.62	2.23
	Parity					.286	0.80	0.53	1.21
	History of depression					.487	0.84	0.51	1.37
	Relationship status					.064	1.56	0.97	2.50
	Stressful life events					.379	0.82	0.53	1.27
Sleep quality	High anxiety symptoms	1136	.054	1.77 (0.99-3.16)	1044	.104	1.68 (0.90-3.16)		
	Maternal age					.565	1.01 (0.98-1.05)		
	Māori					.848	1.04 (0.69-1.58)		
	NZ Dep 1 (least deprived)					Ref			
	NZ Dep 2					.131	0.66 (0.38-1.14)		

	NZ Dep 3					.107	0.64 (0.38-1.10)
	NZ Dep 4					.209	0.69 (0.39-1.23)
	NZ Dep 5 (most deprived)					.174	0.66 (0.36-1.21)
	Parity					**.025**	1.56 (1.06-2.29)
	History of depression					**.006**	1.72 (1.17-2.55)
	Relationship status					.701	1.09 (0.70-1.70)
	Stressful life events					**<.001**	1.97 (1.33-2.92)
Sleep periods	High anxiety symptoms	1136	.256	0.76 (0.47-1.22)	1044	.673	0.89 (0.53-1.51)
	Maternal age					.092	1.02 (1.00-1.05)
	Māori					.065	0.75 (0.56-1.02)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.556	1.13 (0.76-1.67)
	NZ Dep 3					.129	1.35 (0.92-2.00)
	NZ Dep 4					.696	1.09 (0.72-1.65)
	NZ Dep 5 (most deprived)					.984	1.00 (0.65-1.55)
	Parity					.211	0.84 (0.64-1.10)
	History of depression					.596	0.92 (0.68-1.25)
	Relationship status					.085	1.35 (0.96-1.91)
	Stressful life events					.063	1.32 (0.99-1.77)

4.2.5 Series 1: Anxiety symptoms as dependent variable at 12 weeks postpartum

Results of binary logistic regression analyses using high anxiety symptoms at 12 weeks postpartum as dependent variables and sleep variables and covariates as independent variables are presented in Table 20.

Sleeping for less than 7 hours was associated with 1.7 greater odds of high anxiety symptoms at 12 weeks postpartum in the adjusted model (Table 20). Sleep continuity and latency were also associated with high anxiety symptoms, with increased odds of 1.72 and 2.71 respectively. This relationship was significant for continuity in the adjusted model and for latency in both the unadjusted and adjusted model.

Restless legs were associated with high anxiety symptoms and this relationship was significant in both the unadjusted and adjusted models (Table 20). Women with restless legs had 2.48 times the odds of experiencing high anxiety symptoms than those without. For frequency of good night's sleep, quality, daytime sleepiness (ESS) and leg twitching/jerking, only the unadjusted models were significant. Frequent snoring and breathing pauses were not significant in either the unadjusted or the adjusted models.

Table 20

Results of cross-sectional binary logistic regression analysis at T4 (Anxiety as dependent variable)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted	
			Sig.	OR 95% CI		Sig.	OR 95% CI
High anxiety symptoms (≥ 6 on EPDS anxiety subscale)	Short sleep	983	.103	1.49 (0.92-2.40)	907	**.049**	1.70 (1.00-2.87)
	Maternal age					.763	0.99 (0.95-1.04)
	Māori					.966	1.01 (0.58-1.78)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.281	0.64 (0.28-1.45)
	NZ Dep 3					.82	0.92 (0.42-1.97)
	NZ Dep 4					.655	0.83 (0.37-1.87)
	NZ Dep 5 (most deprived)					.215	1.62 (0.76-3.48)
	Parity					.661	1.12 (0.67-1.89)
	History of depression					**.002**	2.25 (1.34-3.77)
	Relationship status					**.003**	2.17 (1.30-3.64)
	Stressful life events					**.035**	1.78 (1.04-3.04)
High anxiety symptoms	Long sleep	794	.518	1.29 (0.59-2.82)	734	.687	1.19 (0.51-2.78)
	Maternal age					.574	1.02 (0.96-1.07)
	Māori					.518	1.24 (0.64-2.41)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.121	0.43 (0.15-1.25)
	NZ Dep 3					.585	0.79 (0.34-1.85)
	NZ Dep 4					.347	0.63 (0.24-1.65)
	NZ Dep 5 (most deprived)					.594	1.27 (0.53-3.02)
	Parity					.78	0.92 (0.50-1.68)
	History of depression					**.025**	1.99 (1.09-3.64)
	Relationship status					**.003**	2.47 (1.35-4.50)
	Stressful life events					.503	1.23 (0.67-2.23)
High anxiety symptoms	Good night's sleep	1074	**.041**	1.58 (1.02-2.44)	983	.099	1.50 (0.93-2.43)
	Maternal age					.616	0.99 (0.95-1.03)
	Māori					.733	1.10 (0.65-1.86)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.273	0.63 (0.28-1.43)

	NZ Dep 3					.951	1.02 (0.50-2.11)
	NZ Dep 4					.837	0.92 (0.43-2.00)
	NZ Dep 5 (most deprived)					.214	1.59 (0.77-3.27)
	Parity					.8	1.07 (0.65-1.74)
	History of depression					**.007**	1.98 (1.21-3.26)
	Relationship status					**.002**	2.14 (1.31-3.50)
	Stressful life events					.072	1.59 (0.96-2.62)
High anxiety symptoms	GSDS quality subscale	1080	**.035**	0.61 (0.38-0.96)	988	.069	0.63 (0.38-1.04)
	Maternal age					.81	1.00 (0.95-1.04)
	Māori					.662	1.13 (0.66-1.92)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.328	0.67 (0.29-1.51)
	NZ Dep 3					.887	0.95 (0.45-1.98)
	NZ Dep 4					.861	0.93 (0.43-2.02)
	NZ Dep 5 (most deprived)					.204	1.60 (0.77-3.31)
	Parity					.899	1.03 (0.63-1.69)
	History of depression					**.005**	2.04 (1.24-3.36)
	Relationship status					**.004**	2.07 (1.27-3.38)
	Stressful life events					**.041**	1.69 (1.02-2.80)
High anxiety symptoms	GSDS continuity subscale	1079	.064	1.56 (0.97-2.51)	988	**.046**	1.72 (1.01-2.93)
	Maternal age					.621	0.99 (0.95-1.03)
	Māori					.62	1.14 (0.67-1.95)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.308	0.65 (0.29-1.48)
	NZ Dep 3					.906	0.96 (0.46-2.00)
	NZ Dep 4					.726	0.87 (0.40-1.89)
	NZ Dep 5 (most deprived)					.238	1.55 (0.75-3.21)
	Parity					.694	1.10 (0.67-1.81)
	History of depression					**.007**	2.00 (1.21-3.29)
	Relationship status					**.003**	2.11 (1.29-3.45)
	Stressful life events					.076	1.58 (0.95-2.63)
High anxiety symptoms	GSDS latency subscale	1079	**<.001**	2.99 (1.91-4.69)	988	**<.001**	2.71 (1.65-4.44)
	Maternal age					.976	1.00 (0.96-1.04)

	Māori					.705	1.11 (0.65-1.90)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.264	0.63 (0.27-1.43)
	NZ Dep 3					0.744	0.88 (0.42-1.86)
	NZ Dep 4					.662	0.84 (0.38-1.84)
	NZ Dep 5 (most deprived)					.29	1.49 (0.71-3.12)
	Parity					.701	1.10 (0.67-1.81)
	History of depression					**.004**	2.10 (1.27-3.48)
	Relationship status					**.005**	2.05 (1.25-3.36)
	Stressful life events					.066	1.61 (0.97-2.69)
High anxiety symptoms	Epworth Sleepiness Scale	1063	**.02**	1.81 (1.10-2.97)	972	.093	1.60 (0.93-2.78)
	Maternal age					.534	0.99 (0.94-1.03)
	Māori					.696	1.11 (0.65-1.90)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.205	0.58 (0.25-1.35)
	NZ Dep 3					.88	0.95 (0.45-1.98)
	NZ Dep 4					.642	0.83 (0.38-1.81)
	NZ Dep 5 (most deprived)					.258	1.52 (0.74-3.15)
	Parity					.66	1.12 (0.68-1.84)
	History of depression					**.007**	2.02 (1.22-3.36)
	Relationship status					**.003**	2.13 (1.30-3.49)
	Stressful life events					.052	1.66 (1.00-2.75)
High anxiety symptoms	Frequent snoring	1074	.14	1.74 (0.83-3.64)	985	.201	1.66 (0.76-3.59)
	Maternal age					.488	0.99 (0.94-1.03)
	Māori					.805	1.07 (0.63-1.83)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.314	0.66 (0.29-1.49)
	NZ Dep 3					.969	0.99 (0.48-2.04)
	NZ Dep 4					.642	0.83 (0.38-1.83)
	NZ Dep 5 (most deprived)					.321	1.45 (0.70-2.99)
	Parity					.593	1.15 (0.70-1.88)
	History of depression					**.009**	1.95 (1.18-3.22)
	Relationship status					**.001**	2.25 (1.38-3.67)
	Stressful life events					.071	1.60 (0.96-2.65)

High anxiety symptoms	Frequent breath pauses	1068	.071	4.59 (0.88-24.03)	980	.34	2.35 (0.41-3.54)
	Maternal age					.316	0.98 (0.94-1.02)
	Māori					.686	1.12 (0.65-1.93)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.326	0.66 (0.29-1.51)
	NZ Dep 3					.985	0.99 (0.48-2.06)
	NZ Dep 4					.5	0.76 (0.34-1.70)
	NZ Dep 5 (most deprived)					.443	1.34 (0.64-2.79)
	Parity					.47	1.20 (0.73-1.99)
	History of depression					**.007**	2.02 (1.21-3.37)
	Relationship status					**.002**	2.20 (1.34-3.62)
	Stressful life events					.067	1.61 (0.97-2.69)
High anxiety symptoms	Frequent leg twitch/jerk	1069	**.004**	3.28 (1.45-7.42)	980	.058	2.40 (0.97-5.92)
	Maternal age					.447	0.98 (0.94-1.03)
	Māori					.784	1.08 (0.63-1.85)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.301	0.65 (0.28-1.48)
	NZ Dep 3					.921	0.96 (0.47-2.00)
	NZ Dep 4					.467	0.74 (0.33-1.66)
	NZ Dep 5 (most deprived)					.49	1.30 (0.62-2.72)
	Parity					.453	1.21 (0.73-2.00)
	History of depression					**.006**	2.05 (1.24-3.40)
	Relationship status					**.001**	2.24 (1.37-3.68)
	Stressful life events					.054	1.65 (0.99-2.76)
High anxiety symptoms	Restless legs	1074	**.006**	2.66 (1.33-5.31)	983	**.019**	2.48 (1.16-5.29)
	Maternal age					.864	1.00 (0.95-1.04)
	Māori					.616	1.15 (0.67-1.96)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.43	0.72 (0.31-1.64)
	NZ Dep 3					.801	1.10 (0.53-2.31)
	NZ Dep 4					.943	1.03 (0.47-2.26)
	NZ Dep 5 (most deprived)					.145	1.73 (0.83-3.63)
	Parity					.817	1.06 (0.65-1.74)

	History of depression	**.014**	1.89 (1.14-3.13)
	Relationship status	**.001**	2.26 (1.38-3.70)
	Stressful life events	.126	1.48 (0.90-2.45)

4.2.6 Series 2: Sleep variables as dependent variables at 12 weeks postpartum

Results of binary logistic regression analyses using sleep variables at 12 weeks postpartum as dependent variables and anxiety symptoms and covariates as independent variables are presented in Table 21.

High anxiety symptoms were associated with longer sleep latencies and the occurrence of restless legs at 12 weeks postpartum, in both the unadjusted and adjusted models (Table 21). Women with symptoms of high anxiety had 2.66 times the odds of long sleep latency and 2.45 times the odds of restless legs than those with low anxiety symptoms. High anxiety symptoms were also associated with an increased likelihood of poor sleep continuity in the adjusted model only (adjusted OR 1.71).

Frequency of good night's sleep, quality, daytime sleepiness and leg twitching were significant in the unadjusted models but after adjusting for model covariates, these relationships were no longer significant.

Table 21

Results of cross-sectional binary logistic regression analysis at T4 (Sleep variables as dependent variables)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted	
			Sig.	**OR 95% CI**		**Sig.**	**OR 95% CI**
Short sleep (<7 hours)	High anxiety symptoms	983	.103	1.49 (0.92-2.40)	907	.058	1.66 (0.98-2.80)
	Maternal age					.062	1.03 (1.00-1.06)
	Māori					.449	1.15 (0.80-1.65)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.607	1.12 (0.73-1.71)
	NZ Dep 3					.238	0.77 (0.49-1.19)
	NZ Dep 4					.627	0.89 (0.56-1.42)
	NZ Dep 5 (most deprived)					.093	0.63 (0.37-1.08)
	Parity					.066	1.34 (0.98-1.82)
	History of depression					.687	0.93 (0.66-1.32)
	Relationship status					.994	1.00 (0.71-1.41)
	Stressful life events					.946	0.99 (0.71-1.38)
Long sleep (>9 hours)	High anxiety symptoms	794	.518	1.29 (0.59-2.82)	734	.753	1.15 (0.48-2.77)
	Maternal age					**<.001**	0.91 (0.86-0.95)
	Māori					**.01**	2.18 (1.21-3.94)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.622	0.77 (0.28-2.15)
	NZ Dep 3					.627	1.24 (0.52-2.96)
	NZ Dep 4					.922	1.05 (0.42-2.59)
	NZ Dep 5 (most deprived)					.501	1.35 (0.57-3.19)
	Parity					.217	0.70 (0.40-1.23)
	History of depression					.665	0.86 (0.45-1.67)
	Relationship status					.151	1.51 (0.86-2.66)
	Stressful life events					.668	1.13 (0.65-1.95)
Good night's sleep	High anxiety symptoms	1074	**.041**	1.58 (1.02-2.44)	983	.11	1.48 (0.92-2.39)
	Maternal age					.089	1.02 (1.00-1.05)
	Māori					.338	0.85 (0.61-1.18)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.545	1.13 (0.76-1.69)

	NZ Dep 3					.472	0.86 (0.58-1.29)
	NZ Dep 4					.444	0.84 (0.55-1.31)
	NZ Dep 5 (most deprived)					.126	0.69 (0.43-1.11)
	Parity					**.02**	1.40 (1.05-1.85)
	History of depression					.144	1.26 (0.92-1.72)
	Relationship status					.14	1.26 (0.93-1.72)
	Stressful life events					.783	1.04 (0.77-1.41)
GSDS quality subscale	High anxiety symptoms	1080	**.035**	0.61 (0.38-0.96)	988	.09	0.65 (0.39-1.07)
	Maternal age					.531	1.01 (0.98-1.03)
	Māori					.733	0.95 (0.70-1.29)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.383	1.19 (0.80-1.77)
	NZ Dep 3					.587	1.11 (0.76-1.64)
	NZ Dep 4					.111	1.40 (0.93-2.11)
	NZ Dep 5 (most deprived)					.447	1.19 (0.76-1.84)
	Parity					**.02**	0.73 (0.56-0.95)
	History of depression					**.021**	0.69 (0.51-0.95)
	Relationship status					.236	0.84 (0.62-1.13)
	Stressful life events					.127	1.25 (0.94-1.65)
GSDS continuity subscale	High anxiety symptoms	1079	.064	1.56 (0.97-2.51)	988	**.048**	1.71 (1.00-2.90)
	Maternal age					**.036**	1.03 (1.00-1.06)
	Māori					.528	0.90 (0.66-1.24)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.456	1.17 (0.78-1.75)
	NZ Dep 3					.973	1.01 (0.68-1.49)
	NZ Dep 4					.416	1.19 (0.78-1.83)
	NZ Dep 5 (most deprived)					.852	1.04 (0.67-1.63)
	Parity					.116	0.80 (0.61-1.06)
	History of depression					**.005**	1.60 (1.16-2.21)
	Relationship status					.549	0.91 (0.67-1.24)
	Stressful life events					**.016**	1.43 (1.07-1.92)
GSDS latency subscale	High anxiety symptoms	1079	**<.001**	2.99 (1.91-4.69)	988	**<.001**	2.66 (1.62-4.36)
	Maternal age					.086	0.97 (0.94-1.00)

	Māori					.71	1.07 (0.74-1.56)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.239	1.36 (0.82-2.26)
	NZ Dep 3					.354	1.27 (0.77-2.10)
	NZ Dep 4					.195	1.41 (0.84-2.38)
	NZ Dep 5 (most deprived)					.268	1.36 (0.79-2.34)
	Parity					.212	0.81 (0.58-1.13)
	History of depression					.59	1.11 (0.76-1.61)
	Relationship status					.442	1.15 (0.80-1.65)
	Stressful life events					.546	1.11 (0.79-1.57)
Epworth Sleepiness Scale	High anxiety symptoms	1063	**.02**	1.81 (1.10-2.97)	972	.094	1.59 (0.92-2.75)
	Maternal age					**.02**	1.04 (1.01-1.07)
	Māori					.093	1.40 (0.95-2.07)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.214	1.38 (0.83-2.28)
	NZ Dep 3					.817	0.94 (0.56-1.58)
	NZ Dep 4					.369	1.28 (0.75-2.17)
	NZ Dep 5 (most deprived)					.963	1.01 (0.57-1.81)
	Parity					.733	0.94 (0.66-1.33)
	History of depression					.223	1.27 (0.87-1.85)
	Relationship status					.488	1.14 (0.79-1.65)
	Stressful life events					.137	1.31 (0.92-1.88)
Frequent snoring	High anxiety symptoms	1074	.14	1.74 (0.83-3.64)	985	.217	1.63 (0.75-3.52)
	Maternal age					.527	0.98 (0.94-1.03)
	Māori					.615	1.16 (0.64-2.11)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.486	1.34 (0.59-3.02)
	NZ Dep 3					.629	1.22 (0.55-2.73)
	NZ Dep 4					.512	0.73 (0.28-1.88)
	NZ Dep 5 (most deprived)					.435	1.40 (0.60-3.27)
	Parity					.368	1.28 (0.75-2.21)
	History of depression					.296	1.36 (0.77-2.41)
	Relationship status					.822	0.94 (0.53-1.67)
	Stressful life events					.07	1.67 (0.96-2.92)

Restless legs	High anxiety symptoms	1074	**.006**	2.66 (1.33-5.31)	983	**.02**	2.45 (1.15-5.20)
	Maternal age					.995	1.00 (0.95-1.06)
	Māori					.176	0.63 (0.32-1.24)
	NZ Dep 1 (least deprived)					Ref	
	NZ Dep 2					.293	0.63 (0.27-1.48)
	NZ Dep 3					.635	0.83 (0.38-1.81)
	NZ Dep 4					.62	0.81 (0.35-1.88)
	NZ Dep 5 (most deprived)					.507	0.73 (0.29-1.84)
	Parity					.837	1.06 (0.60-1.88)
	History of depression					.101	1.63 (0.91-2.92)
	Relationship status					.616	0.85 (0.45-1.60)
	Stressful life events					**.043**	1.84 (1.02-3.32)

4.2.7 Covariate relationships

Several of the model covariates showed significant independent cross-sectional relationships with high anxiety symptoms (Tables 16, 18 and 20). Prior history of depression was associated with high anxiety symptoms and this relationship was evident across all three time points and all models except one (long sleep). Women with a prior history of depression were 1.6 times more likely to experience high anxiety symptoms during late pregnancy and approximately twice as likely to experience them postnatally.

Relationship status and stressful life events were also associated with high anxiety symptoms across the perinatal period and the relationship was significant across a number of models. Ethnicity was not independently associated with high anxiety symptoms in most models except for T3 where being Māori was significantly associated with high anxiety symptoms (Table 18).

Some covariates also had a significant relationship with sleep health (Tables 17, 19 and 21). Stressful life events and parity was associated with experiencing sleep issues and this was significant across all time points where sleep was the dependent variable. Maternal age was also associated with sleep, and this was evident at all time points, with the odds of experiencing most sleep issues decreasing slightly with maternal age.

Some relationships were only seen at particular time points. During pregnancy and at T4, Māori were more likely to sleep longer than non-Māori (Tables 17 and 21). At T3, those in lower deciles (more deprived) had a greater likelihood of experiencing short sleep (Table 19).

4.3 Longitudinal analyses: the relationship between symptoms of anxiety and sleep health across the perinatal period

This section presents the results of longitudinal binary logistic regression models comparing variables across the perinatal period (T1, T2, T3 and T4) to answer the following research questions (Section 1.1):

- What is the relationship between symptoms of prenatal anxiety and postnatal anxiety for Māori and non-Māori women?
- What is the relationship between anxiety and sleep across the perinatal period for Māori and non-Māori women? Is this relationship bi-directional?

4.3.1 Series 3: Anxiety symptoms at T4 as the dependent variable

Results of binary logistic regression analyses using anxiety symptoms at T4 as the dependent variable and sleep variables, covariates, and anxiety symptoms at T2 and T3 as independent variables are presented in Table 22.

Several sleep variables were associated with high anxiety symptoms in unadjusted models (T3 sleep quality, T4 latency, T2 ESS, T4 leg twitching/jerking and restless legs) but only sleep latency remained significant when covariates were added to models (Table 22). Sleep latency at T4 was associated with an increased likelihood (adjusted OR 2.21) of high anxiety symptoms at T4, after adjusting for all model covariates. High anxiety symptoms at T2 or T3 was associated with anxiety at T4 in all models.

Table 22

Results of longitudinal binary logistic regression analysis (Anxiety as dependent variable)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted	
			Sig.	**OR 95% CI**		**Sig.**	**OR 95% CI**
T4 High anxiety symptoms (≥ 6 on EPDS anxiety subscale)	T2 Good night's sleep	1019	.083	1.54 (0.95-2.49)	957	.44	1.24 (0.72-2.13)
	T3 Sleep quality		**.012**	2.01 (1.16-3.47)		.181	1.52 (0.82-2.82)
	T4 Good night's sleep		.144	1.43 (0.89-2.30)		.108	1.55 (0.91-2.64)
	T2 Maternal age					.907	1.00 (0.95-1.05)
	T2 Māori					.989	1.00 (0.56-1.79)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.957	1.02 (0.54-1.93)
	T4 NZ Dep (high deprivation)					.362	1.39 (0.69-2.80)
	T1 Parity					.398	1.27 (0.73-2.18)
	T1 History of depression					**.033**	1.79 (1.05-3.04)
	T4 Relationship status					.055	1.69 (0.99-2.90)
	T4 Stressful life events					.11	1.58 (0.90-2.75)
	T2 High anxiety symptoms					**<.001**	4.18 (2.49-7.02)
	T3 High anxiety symptoms					**.002**	3.04 (1.48-6.24)
T4 High anxiety symptoms	T2 GSDS quality subscale	1025	.191	1.36 (0.86-2.17)	962	.244	1.36 (0.81-2.30)
	T3 Sleep quality		**.003**	2.25 (1.32-3.85)		.129	1.62 (0.87-3.00)
	T4 GSDS quality subscale		.127	0.68 (0.42-1.11)		.215	0.71 (0.41-1.22)
	T2 Maternal age					.862	1.00 (0.96-1.06)
	T2 Māori					.969	1.01 (0.56-1.83)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.95	0.98 (0.51-1.87)
	T4 NZ Dep (high deprivation)					.399	1.35 (0.67-2.73)
	T1 Parity					.423	1.25 (0.72-2.17)
	T1 History of depression					**.022**	1.87 (1.09-3.19)
	T4 Relationship status					.053	1.70 (0.99-2.91)
	T4 Stressful life events					.078	1.65 (0.95-2.87)
	T2 High anxiety symptoms					**<.001**	3.88 (2.31-6.51)
	T3 High anxiety symptoms					**.002**	3.23 (1.56-6.71)
	T2 GSDS continuity subscale	1026	.934	1.04 (0.40-2.71)	963	.737	0.84 0.31 2.31

T4 High anxiety symptoms	T3 Sleep quality		**.005**	2.18 (1.27-3.73)		.143	1.59	0.86	2.96
	T4 GSDS continuity subscale		.096	1.56 (0.93-2.62)		.123	1.60	0.88	2.92
	T2 Maternal age					.979	1.00	0.95	1.05
	T2 Māori					.903	1.04	0.58	1.86
	T4 NZ Dep (low deprivation)					Ref			
	T4 NZ Dep (med deprivation)					.905	0.96	0.51	1.83
	T4 NZ Dep (high deprivation)					.46	1.30	0.65	2.63
	T1 Parity					.404	1.26	0.73	2.18
	T1 History of depression					**.03**	1.81	1.06	3.09
	T4 Relationship status					**.05**	1.72	1.00	2.95
	T4 Stressful life events					.093	1.61	0.92	2.81
	T2 High anxiety symptoms					**<.001**	3.94	2.34	6.62
	T3 High anxiety symptoms					**.003**	3.03	1.47	6.28

T4 High anxiety symptoms	T2 GSDS latency subscale	1025	.05	1.62 (1.00-2.63)	962	.959	0.99 (0.56-1.72)	
	T3 Sleep quality		**.009**	2.06 (1.20-3.55)		.129	1.62 (0.87-3.01)	
	T4 GSDS latency subscale		**<.001**	2.54 (1.56-4.14)		**.006**	2.21 (1.26-3.86)	
	T2 Maternal age					.782	1.01 (0.96-1.06)	
	T2 Māori					.998	1.00 (0.55-1.81)	
	T4 NZ Dep (low deprivation)					Ref		
	T4 NZ Dep (med deprivation)					.798	0.92 (0.48-1.76)	
	T4 NZ Dep (high deprivation)					.548	1.25 (0.61-2.55)	
	T1 Parity					.388	1.28 (0.74-2.21)	
	T1 History of depression					**.019**	1.91 (1.11-3.26)	
	T4 Relationship status					.066	1.66 (0.97-2.86)	
	T4 Stressful life events					.081	1.64 (0.94-2.87)	
	T2 High anxiety symptoms					**<.001**	3.75 (2.21-6.35)	
	T3 High anxiety symptoms					**.004**	3.00 (1.42-6.32)	

T4 High anxiety symptoms	T2 Epworth Sleepiness Scale	1012	**0.009**	1.98 (1.18-3.30)	931	.165	1.53 (0.84-2.80)	
	T4 Epworth Sleepiness Scale		0.305	1.33 (0.77-2.31)		.481	1.26 (0.66-2.40)	
	T2 Maternal age					.969	1.00 (0.95-1.05)	
	T2 Māori					.949	0.98 (0.54-1.78)	
	T4 NZ Dep (low deprivation)					Ref		
	T4 NZ Dep (med deprivation)					.711	0.89 (0.46-1.69)	
	T4 NZ Dep (high deprivation)					.553	1.24 (0.61-2.49)	

	T1 Parity					.28	1.36 (0.78-2.36)
	T1 History of depression					**.026**	1.85 (1.08-3.18)
	T4 Relationship status					**.029**	1.83 (1.06-3.15)
	T4 Stressful life events					.092	1.62 (0.93-2.85)
	T2 High anxiety symptoms					**<.001**	3.76 (2.22-6.37)
	T3 High anxiety symptoms					**.002**	3.19 (1.52-6.70)
T4 High anxiety symptoms	T2 Frequent snoring	1030	.65	0.88 (0.50-1.54)	948	.311	0.71 (0.37-1.37)
	T4 Frequent snoring		.084	1.99 (0.91-4.36)		.099	2.14 (0.87-5.28)
	T2 Maternal age					.606	0.99 (0.94-1.04)
	T2 Māori					.812	0.93 (0.51-1.69)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.729	0.89 (0.47-1.70)
	T4 NZ Dep (high deprivation)					.741	1.13 (0.56-2.29)
	T1 Parity					.204	1.43 (0.82-2.49)
	T1 History of depression					.074	1.65 (0.95-2.87)
	T4 Relationship status					**.019**	1.92 (1.12-3.32)
	T4 Stressful life events					.073	1.68 (0.95-2.94)
	T2 High anxiety symptoms					**<.001**	4.27 (2.52-7.24)
	T3 High anxiety symptoms					**.007**	2.87 (1.33-6.16)
T4 High anxiety symptoms	T2 Frequent breath pauses	1008	.474	1.45 (0.53-3.98)	928	.598	0.64 (0.13-3.31)
	T4 Frequent breath pauses		.119	3.91 (0.70-21.72)		.285	2.84 (0.42-19.24)
	T2 Maternal age					.375	0.98 (0.93-1.03)
	T2 Māori					.982	0.99 (0.54-1.82)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.653	0.86 (0.45-1.66)
	T4 NZ Dep (high deprivation)					.964	1.02 (0.49-2.09)
	T1 Parity					.142	1.53 (0.87-2.70)
	T1 History of depression					**.043**	1.78 (1.02-3.12)
	T4 Relationship status					**.039**	1.80 (1.03-3.13)
	T4 Stressful life events					**.06**	1.73 (0.98-3.07)
	T2 High anxiety symptoms					**<.001**	4.46 (2.61-7.62)
	T3 High anxiety symptoms					**.006**	2.97 (1.37-6.43)
	T2 Frequent leg twitch/jerk	1017	.406	1.30 (0.70-2.42)	936	.645	0.84 (0.40-1.75)

T4 High anxiety symptoms	T4 Frequent leg twitch/jerk		**.015**	2.96 (1.24-7.09)		.294	1.82 (0.60-5.55)
	T2 Maternal age					.626	0.99 (0.94-1.04)
	T2 Māori					.936	0.98 (0.54-1.78)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.555	0.82 (0.43-1.57)
	T4 NZ Dep (high deprivation)					.996	1.00 (0.49-2.06)
	T1 Parity					.115	1.57 (0.90-2.76)
	T1 History of depression					**.025**	1.87 (1.08-3.24)
	T4 Relationship status					**.015**	1.97 (1.14-3.41)
	T4 Stressful life events					**.045**	1.79 (1.01-3.15)
	T2 High anxiety symptoms					**<.001**	4.66 (2.70-8.01)
	T3 High anxiety symptoms					**.003**	3.13 (1.46-6.69)
T4 High anxiety symptoms	T2 Restless legs	1045	.9	0.96 (0.53-1.75)	959	.921	0.97 (0.50-1.89)
	T4 Restless legs		**.008**	2.71(1.29-5.69)		.052	2.39 (0.99-5.76)
	T2 Maternal age					.712	1.01 (0.96-1.06)
	T2 Māori					.967	1.01 (0.56-1.82)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.955	1.02 (0.54-1.94)
	T4 NZ Dep (high deprivation)					**.36**	1.39 (0.69-2.82)
	T1 Parity					**.37**	1.28 (0.74-2.21)
	T1 History of depression					**.049**	1.72 (1.00-2.94)
	T4 Relationship status					**.018**	1.92 (1.12-3.28)
	T4 Stressful life events					.12	1.55 (0.89-2.70)
	T2 High anxiety symptoms					**<.001**	4.22 (2.52-7.07)
	T3 High anxiety symptoms					**.001**	3.40 (1.64-7.05)

4.3.2 Series 4: Sleep variables at T4 as the dependent variables

Results of binary logistic regression analyses using sleep variables at T4 as dependent variables and anxiety symptoms at each time point, sleep variables and covariates as independent variables are presented in Table 23.

T4 high anxiety symptoms was associated with sleep latency at T4, and women with high anxiety were more than twice as likely to experience long sleep latency. High anxiety symptoms were associated with several of the sleep variables at different time points- frequency of good night's sleep, continuity, and daytime sleepiness but only in the unadjusted models and when covariates were added, they were no longer significant (Table 23).

Those who slept under 7 hours earlier in the perinatal period (T2 and T3) were over 2.5 more likely also have short sleep at T4. Those who slept over 9 hours at T3 had decreased odds of experiencing short sleep at T4. Similar patterns were seen with frequency of good night's sleep, sleep quality, disrupted continuity, long sleep latency and daytime sleepiness and all were more likely at T4 if they had been experienced at earlier time points. For example, the odds of daytime sleepiness at T4 were 6.5 times higher if previously experienced at T2 (Table 23).

Table 23

Results of longitudinal binary logistic regression analysis (Sleep variables as dependent variables)

Dependent variable	Independent variables	N	Unadjusted		N	Adjusted	
			Sig.	OR 95% CI		Sig.	OR 95% CI
T4 Short sleep (<7 hours)	T2 High anxiety symptoms	937	.94	1.01 (0.70-1.47)	882	.554	0.88 (0.58-1.34)
	T3 High anxiety symptoms		.624	1.16 (0.65-2.07)		.451	1.30 (0.66-2.57)
	T4 High anxiety symptoms		.168	1.44 (0.86-2.43)		.223	1.45 (0.80-2.63)
	T2 Maternal age					.899	1.00 (0.97-1.04)
	T2 Māori					.581	1.12 (0.76-1.65)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.054	0.70 (0.48-1.01)
	T4 NZ Dep (high deprivation)					**.049**	0.63 (0.40-1.00)
	T1 Parity					.316	1.19 (0.85-1.65)
	T1 History of depression					.491	0.88 (0.60-1.28)
	T4 Relationship status					.874	0.97 (0.67-1.41)
	T4 Stressful life events					.683	0.93 (0.65-1.33)
	T2 Total sleep time 7-9 hrs					Ref	
	T2 Short sleep					**<.001**	2.72 (1.94-3.82)
	T2 Long sleep					.167	0.63 (0.33-1.21)
	T3 Total sleep time 7-9 hrs					Ref	
	T3 Short sleep					**<.001**	2.51 (1.79-3.52)
	T3 Long sleep					**.034**	0.48 (0.24-0.95)
T4 Good night's sleep	T2 High anxiety symptoms	1020	.547	0.90 (0.64-1.26)	957	.274	0.81 (0.56-1.18)
	T3 High anxiety symptoms		.106	1.53 (0.91-2.56)		.155	1.52 (0.85-2.71)
	T4 High anxiety symptoms		**.034**	1.68 (1.04-2.70)		.187	1.43 (0.84-2.43)
	T2 Maternal age					.119	1.02 (0.99-1.05)
	T2 Māori					.223	0.81 (0.57-1.14)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.434	0.88 (0.63-1.22)
	T4 NZ Dep (high deprivation)					.192	0.76 (0.51-1.15)
	T1 Parity					.187	1.22 (0.91-1.64)
	T1 History of depression					.36	1.17 (0.84-1.61)
	T4 Relationship status					.238	1.22 (0.88-1.68)
	T4 Stressful life events					.558	0.91 (0.66-1.25)

	T2 Good night's sleep					**<.001**	2.49 (1.86-3.33)
	T3 Sleep quality					**<.001**	2.06 (1.38-3.07)
T4 GSDS quality subscale	T2 High anxiety symptoms	1026	.951	0.99 (0.72-1.36)	962	.911	0.98 (0.70-1.39
	T3 High anxiety symptoms		.819	0.94 (0.56-1.59)		.757	0.91 (0.51-1.64
	T4 High anxiety symptoms		.133	0.68 (0.42-1.12)		.235	0.72 (0.42-1.24
	T2 Maternal age					.58	1.01 (0.98-1.03
	T2 Māori					.568	0.91 (0.66-1.25
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.236	1.21 (0.88-1.65)
	T4 NZ Dep (high deprivation)					.223	1.27 (0.87-1.85)
	T1 Parity					.141	0.81 (0.61-1.07)
	T1 History of depression					.063	0.74 (0.54-1.02)
	T4 Relationship status					.284	0.85 (0.62-1.15)
	T4 Stressful life events					**.086**	1.29 (0.97-1.73)
	T2 GSDS quality subscale					**<.001**	1.93 (1.47-2.52)
	T3 Sleep quality					**.013**	0.59 (0.39-0.89)
T4 GSDS continuity subscale	T2 High anxiety symptoms	1026	.671	0.93 (0.67-1.29)	963	.429	0.87 (0.61-1.24)
	T3 High anxiety symptoms		**.017**	2.07 (1.14-3.78)		.054	1.94 (0.99-3.80)
	T4 High anxiety symptoms		.101	1.55 (0.92-2.62)		.127	1.58 (0.88-2.86)
	T2 Maternal age					**.039**	1.03 (1.00-1.06)
	T2 Māori					.462	0.89 (0.64-1.23)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.797	1.04 (0.76-1.44)
	T4 NZ Dep (high deprivation)					.458	1.16 (0.78-1.71)
	T1 Parity					.157	0.81 (0.61-1.08)
	T1 History of depression					**.004**	1.64 (1.17-2.31)
	T4 Relationship status					.363	0.86 (0.63-1.18)
	T4 Stressful life events					**.048**	1.36 (1.00-1.84)
	T2 GSDS continuity subscale					**<.001**	3.76 (2.26-6.26)
	T3 Sleep quality					**.002**	2.08 (1.32-3.27)
T4 GSDS latency subscale	T2 High anxiety symptoms	1026	**.002**	1.76 (1.22-2.52)	962	.362	1.21 (0.81-1.81)
	T3 High anxiety symptoms		.262	1.39 (0.78-2.46)		.506	1.24 (0.65-2.37)
	T4 High anxiety symptoms		**.001**	2.31 (1.40-3.81)		**.005**	2.22 (1.28-3.86)

	T2 Maternal age					.569	0.99 (0.96-1.02)
	T2 Māori					.953	0.99 (0.67-1.46)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.264	1.26 (0.84-1.90)
	T4 NZ Dep (high deprivation)					.189	1.37 (0.86-2.21)
	T1 Parity					.062	0.72 (0.51-1.02)
	T1 History of depression					.902	0.98 (0.66-1.44)
	T4 Relationship status					.653	1.09 (0.75-1.59)
	T4 Stressful life events					.968	1.01 (0.70-1.45)
	T2 GSDS latency subscale					**<.001**	2.52 (1.78-3.59)
	T3 Sleep quality					.249	1.31 (0.83-2.07)
T4 Epworth Sleepiness Scale	T2 High anxiety symptoms	1009	.484	0.86 (0.57-1.31)	931	.191	0.73 (0.46-1.17)
	T3 High anxiety symptoms		**.048**	1.81 (1.00-3.26)		.424	1.34 (0.66-2.73)
	T4 High anxiety symptoms		**.034**	1.80 (1.05-3.11)		.367	1.34 (0.71-2.53)
	T2 Maternal age					.093	1.03 (1.00-1.07)
	T2 Māori					.257	1.28 (0.84-1.96)
	T4 NZ Dep (low deprivation)					Ref	
	T4 NZ Dep (med deprivation)					.84	0.96 (0.63-1.46)
	T4 NZ Dep (high deprivation)					.407	0.81 (0.48-1.35)
	T1 Parity					.675	0.92 (0.63-1.35)
	T1 History of depression					.224	1.29 (0.86-1.95)
	T4 Relationship status					.199	1.31 (0.87-1.96)
	T4 Stressful life events					.814	1.05 (0.71-1.56)
	T2 Epworth Sleepiness Scale					**<.001**	6.51 (4.42-9.59)

4.3.3 Covariate relationships over the perinatal period

Having a history of depression was associated with high anxiety symptoms and this was significant in all the models where anxiety symptoms at T4 was the dependent variable (Table 22). Relationship status was significantly associated with anxiety symptoms at T4 in five models (continuity, daytime sleepiness, breath pauses, leg twitching and restless legs) and stressful life events were significantly associated with high anxiety symptoms at T4 for models incorporating breathing pauses and leg twitches (Table 22).

In terms of associations with sleep health at T4, women living in more deprived areas (lower deciles) were less likely to experience short sleep, and life stress was associated with poorer sleep quality and disrupted continuity. Older maternal age and a history of depression was also associated with disrupted sleep continuity (Table 23).

CHAPTER 5 DISCUSSION

In this chapter, key findings are summarised and discussed in relation to the research questions (Section 1.1) and supporting literature. Clinical and policy implications of findings are considered and how this study adds further weight to the need for early intervention to improve outcomes and ensure these are equitable for Māori and non-Māori. The final section focuses on strengths and limitations of this study, areas for further research and concluding comments.

5.1 Key findings

This study clearly shows that there were relationships between anxiety and sleep health, and that these associations were bi-directional. Results indicated that high anxiety symptoms and issues relating to sleep health frequently co-occur. The aspect of sleep most consistently associated with high anxiety symptoms for both Māori and non-Māori women was the length of time it takes to get to sleep (latency), and this relationship was evident in late pregnancy and at 12 weeks postpartum. Women with long sleep latencies were more than twice as likely to experience high anxiety symptoms (OR=2.11 at T2 and 2.71 at T4) and vice versa (OR=2.11 at T2 and 2.66 at T4).

For several sleep variables (short sleep, daytime sleepiness and leg twitching/jerking), a bi-directional relationship with high anxiety symptoms was found during late pregnancy but was not evident at other time points in the cross-sectional results. Longitudinal findings in this study showed that these sleep disturbances in pregnancy were not associated with high anxiety symptoms postpartum and high anxiety symptoms in pregnancy were not associated with sleep disturbances after the baby was born.

Longitudinal analyses showed the most consistent predictor of high anxiety symptoms postpartum was high anxiety symptoms in late pregnancy. This relationship was seen in all longitudinal models.

5.2 Prevalence of high anxiety symptoms

The prevalence of high anxiety symptoms was greatest in late pregnancy (T2, 34% Māori and 24% non-Māori), lowest at 4-6 weeks postpartum (10% Māori and 6% non-Māori) and possibly increased slightly at 12 weeks postpartum compared to 4-6 weeks postpartum (13% Māori and 8% non-Māori). This finding is consistent with numerous studies that have shown anxiety rates are higher in pregnancy than postnatally (Engle et al., 1990; Matthey et al., 2013; Swalm et al., 2010) and that self-reported anxiety is highest in the third trimester compared to the first two trimesters (24.6% in the third trimester compared to 18% and 19% in the first two trimesters respectively) (Dennis et al., 2017).

There are several reasons why anxiety symptoms may be higher in pregnancy and why late pregnancy may be a time of greater anxiety than other times. Pregnancy is a period of adjustment and change and has substantial implications for health, wellbeing, lifestyle and role in society. Fear of childbirth is a common feature of anxiety in the prenatal period and as the birth date gets closer, there is evidence that anxiety symptoms increase (Nekoee & Zarei, 2015; Saisato & Halmesmaki 2003; Wijma & Wijma, 2017). One study found positive correlations between anxiety, fear of childbirth and sleep deprivation with higher levels of anxiety predicting higher levels of childbirth fear (Hall et al., 2019). Several studies have investigated 'pregnancy anxiety' and consider it a distinct syndrome that relates specifically to fears relating to pregnancy, childbirth and child health (Brunton et al., 2019; Huizink et al., 2004; Levin, 1991).

In late pregnancy, the greatest proportion of women with high anxiety symptoms were younger Māori mothers. Of the Māori women who participated in *Moe Kura*, a much higher

proportion (50%) of women under 25 years experienced high anxiety symptoms compared to older (Māori and non-Māori) women. The same pattern was seen in non-Māori mothers, where there was a higher proportion of mothers under 25 with high anxiety symptoms, with the proportion decreasing in the older age groups (Table 10).

Existing research provides evidence of increased rates of anxiety symptoms and disorders in younger people with prevalence decreasing with age (Goodwin et al., 2020; Henderson et al., 1998). The results of the NZ Health survey 2021/2022 support this finding with the highest rates of psychological distress in young people aged 15-24 years. Nearly one in four (23.6%) young people reported experiencing distress in the last 4 weeks (MoH, 2022a).

These findings have important implications for those supporting pregnant women through the perinatal period in terms of their clinical practice (Section 5.7) as well as for policy development (Section 5.8) to ensure that younger mothers are well supported and anxiety symptoms in pregnancy are part of any screening programme.

5.2.1 Ethnicity and socio-economic deprivation

Ethnic inequities in maternal anxiety symptoms were evident in the present study whereby Māori women were disproportionately impacted by high anxiety symptoms compared to non-Māori women. When other covariates were adjusted for, the differences between Māori and non-Māori were no longer significant in most cases highlighting that these differences were driven by a range of inequitably distributed social determinants of health rather than identifying as Māori per se.

There was, however, an exception at 4-6 weeks postpartum where identifying as Māori was independently associated with increased odds of high anxiety symptoms. This may indicate a difference in experience for Māori and non-Māori women in the early postpartum period but needs to be further investigated to determine if it is a significant finding or a potential type I error (a false positive which is showing a significant difference when there isn't one) due to the

number of models run (Field, 2009). These analyses could not account for all the factors that may have influenced women's experience including racism, access to health services and whānau support. Further research to investigate the experiences of Māori and non-Māori women in the early postpartum period is warranted.

Descriptive statistics showed significant differences in terms of socioeconomic deprivation between Māori women and non-Māori women, and highlighted that Māori were over-represented in more deprived areas. The pattern seen in the *Moe Kura* cohort is consistent with the general population which shows that higher proportions of Māori live in high deprivation areas (MoH, 2018b). NZDep2013 figures showed that 40% of Māori live in quintile 5 areas (most deprived) compared to 15% non-Māori, while only 8.6% of Māori lived in least deprived areas compared to 23% non-Māori (MoH, 2018b).

Paine and Muller (2023) refer to this overrepresentation of Māori in lower socioeconomic areas as the 'distribution gap' and one of the three distinct characteristics that illustrate the complexities of the relationship between ethnicity and socioeconomic deprivation (Section 2.4.2). The other two gaps are the 'outcome gap' which refers to findings that poorer health outcomes persist even when socioeconomic status is considered and the 'gradient gap' which shows increasing inequities as deprivation increases (Paine & Muller, 2023).

The cross-sectional analyses showed that anxiety symptoms during the perinatal period were independently associated with area-level deprivation, relationship status and life stress and that Māori women were disproportionally affected by these factors. So, while ethnicity was not a significant predictor of high anxiety symptoms in multivariable models, the clear differences in prevalence between Māori and non-Māori highlight the disproportionate impact of social determinants of health on Māori women. This study adds to the findings of Ladyman et al. (2021) who also analysed data from the *Moe Kura* dataset and found that Māori women have a higher likelihood of experiencing chronic depressive symptoms than non-Māori.

These findings emphasise the inequities in NZ society between Māori and non-Māori and the impacts are clearly reflected in NZ health statistics. For example, life expectancy for Māori women is 7.3 years lower than for non-Māori women and Māori women have an increased likelihood of psychological distress, intentional self-harm and suicide compared to non-Māori women (MoH, 2019; Stats NZ, 2022; MoH, 2022a).

Living in a lower socioeconomic area is associated with an increased risk of perinatal anxiety as well as the risk of worse perinatal outcomes, including mortality (Field, 2018; PMMRC, 2022; Ross & McLean, 2006). The 2021/22 NZ Health Survey (MoH, 2022a) results showed that people living in the most deprived areas are 1.7 times more likely to experience psychological distress than those living in least deprived areas. In their population-based cohort study, Verbeek et al. (2019) found that not only did socio-economic position and life stress impact antenatal anxiety and depression, but low socioeconomic status actually increased the negative effects of stressful life events.

This study contributes to the body of evidence demonstrating that Māori health outcomes are being negatively impacted by social determinants of health, which are inequitably distributed for Māori and non-Māori (Durie, 2004; Paine et al., 2016; Reid & Robson, 2000). There is substantial international evidence of the negative impacts of socioeconomic position, and it is considered one of the main determinants of health (Acheson 1998; Howden-Chapman & Tobias 2000; MoH, 2018c). Research has also shown that it is not only socioeconomic factors that contribute to health inequity, but interpersonal and institutional racism must also be considered if Māori health outcomes are to be improved (Curtis et al., 2019; Harris et al., 2006; Paine et al., 2016; Reid & Robson, 2000). Signal et al. (2022) describe the Kaupapa Māori approach used as a framework for the *Moe Kura* cohort study and explain that self-identified ethnicity is considered "a measure of 'riskiness' that exists for Māori living in a racialised society" (p. 286) rather than a risk factor.

In the latest report from the Perinatal and Maternal Mortality Review Committee (2022), maternal suicide prevention is identified as a critical equity issue for NZ with suicide rates for Māori mothers almost three times higher than non-Māori. Risk factors include mental health issues, life stress, relationship difficulties and socioeconomic factors such as housing and finances.

For Māori women in the present study, greater socio-economic deprivation was not associated with a higher prevalence of anxiety symptoms, but for non-Māori women there was an association. Māori women were over-represented in the lower quintiles, which for these women, may have masked the relationship between socio-economic deprivation and anxiety symptoms. The finding for non-Māori women is consistent with substantial evidence that socio-economic deprivation impacts perinatal anxiety (Field, 2018; Ross & McLean, 2006; Verbeek et al., 2019).

5.3 The relationship between prenatal and postnatal anxiety symptoms

This study found a relationship between prenatal and postnatal anxiety. Longitudinal analyses showed that high anxiety symptoms in late pregnancy were associated with an increased likelihood of a woman experiencing high anxiety symptoms postnatally. Women with high anxiety symptoms in late pregnancy were, on average, 4 times more likely to experience high anxiety at 12 weeks postpartum. This relationship remained significant in adjusted models. This finding highlights the importance of identifying anxiety symptoms in pregnancy and ensuring women are supported to access appropriate treatment and have strategies in place to support their mental health throughout the perinatal period.

The findings from this thesis address an important research gap as not many studies have focused on understanding anxiety symptoms across the perinatal period. The two studies that have (Heron et al., 2004; Matthey et al., 2003) support the current findings. Heron et al. (2004)

found that 64% of the women in their sample with clinically significant anxiety symptoms in pregnancy, also experienced these postnatally. They also looked at postnatal depression and found that prenatal anxiety predicted postnatal depression at 8 weeks and 8 months postpartum. Evidence of this relationship was also found by Matthey et al. (2003) who found that having a previous history of an anxiety disorder put women at a greater risk of a postnatal mood disorder (anxiety or depression).

Several studies of maternal anxiety have focused on the effects on child development, birth outcomes and the mother-baby relationship and there is clear evidence of the detrimental effects of maternal anxiety on these aspects of child and maternal wellbeing (Cunningham et al., 2021; Hakanen et al., 2019; Stevenson-Hinde et al., 2011; Warren et al., 1997; Wright, 2019). Findings from the current study indicate that sleep health issues can be another sign of high anxiety, providing a potential opportunity to pick up issues earlier, thus ensuring better outcomes for both the mother and her baby.

In the present study, women who had high scores on the Brief Measure of Worry Severity scale (BMWS) at T2 were also more likely to report being distressed by feelings of anxiety and depression for 2 weeks or more and were more likely to experience high anxiety symptoms at this time. While the BMWS was not used in the multivariable models due to confounding with the EPDS anxiety subscale, this finding supports previous validity studies and the use of the BMWS to measure BMWS to measure anxiety symptoms (Gladstone et al., 2005; Tunay & Soygüt, 2009).

5.4 The relationship between anxiety and sleep

This study showed clear relationships between anxiety and sleep health, and these relationships were bi-directional. High anxiety symptoms were associated with sleep and sleep disturbance is associated with anxiety symptoms. The most consistent relationship was

between sleep latency and anxiety and both Māori and non-Māori women with high anxiety symptoms were more likely to experience longer sleep latency and vice versa.

In late pregnancy, results of cross-sectional analyses showed that women with short sleep had an increased likelihood of experiencing high anxiety symptoms and those with high anxiety symptoms were more likely to experience short sleep. At 12 weeks postpartum, women with short sleep were more likely to experience high anxiety symptoms but high anxiety symptoms did not increase the likelihood of experiencing short sleep. Two other sleep variables (excessive daytime sleepiness and leg twitching/jerking) were associated with high anxiety symptoms in late pregnancy (and vice versa) but not at 12 weeks postpartum. In this current study, there was also a bi-directional relationship between sleep continuity and high anxiety symptoms at 12 weeks postpartum.

These findings are consistent with other studies that show a cross-sectional relationship with longer sleep latency and anxiety in late pregnancy (Aukia et al., 2020; Polo-Kantola et al., 2017). One study also found a significant association between insomnia in pregnancy and postpartum anxiety (Osnes et al., 2019).

At a physiological level, anxiety is a state of increased arousal, so it is not surprising that this adversely impacts sleep and sleep disturbance is one of the most common symptoms of psychological distress (Staner, 2022). There is substantial evidence of the detrimental impacts of sleep deprivation on mental health (Freeman et al., 2017; Mellman, 2006; Palmer & Alfano, 2017) and lack of sleep has been shown to stimulate the fight or flight response (Assefa et al, 2015). Neurologically, the two parts of the brain that are associated with both anxiety and sleep are the amygdala and the hypothalamus and are part of the limbic system (Section 2.2.5). Studies show complex interconnections between neurons and neurotransmitters in this area (Chellappa & Aeschbach, 2022).

In addition to the physiological symptoms of anxiety such as muscle tension and increased arousal, anxiety is also associated with worry and intrusive thoughts, as well as a feeling of being on edge (Adwas et al., 2019; Hirsch et al., 2013; Sadock & Sadock, 2003). Going to sleep requires relaxation of both the mind and muscles of the body so it is not unexpected that there is a significant association between anxiety symptoms and taking longer to get to sleep.

In the general population, many studies have found high comorbidity rates between sleep disturbances and anxiety and evidence of a bi-directional relationship whereby each impacts the other (Alvaro et al., 2013). In their review of sleep disturbance among patients with anxiety disorders, Papadimitriou and Linkowski (2005) found that many people with generalised anxiety disorder experience longer sleep latency, decreased total sleep time and decreased sleep continuity while sleep architecture and REM are generally unaffected. In this current study, a greater proportion of women experienced high anxiety symptoms during pregnancy than at other time points and disrupted sleep is likely to have contributed to this.

This finding of some sleep health variables having a bi-directional relationship in pregnancy but not at other time points may be explained, at least in part by the many other factors that change during pregnancy. Hormonal levels and the physically uncomfortable nature of late pregnancy can lead to disruption to usual sleep patterns (Coo et al., 2014; Ladyman & Signal, 2018; Pein & Schwab, 2004; Sedov et al., 2018).

Disruption to sleep continuity and short sleep is also to be expected in the postnatal period due to a range of reasons including the sleep patterns of infants or other children and sleep disruption is well known to impact on anxiety as described above (Coo et al., 2014; Touchette et al., 2005). Further investigation is needed to determine why the relationship with short sleep is bi-directional in late pregnancy but not at 12 weeks postpartum.

In the cross-sectional analyses, a bi-directional relationship between high anxiety symptoms and restless legs was found at 12 weeks postpartum but not at any other time points. The

causes of restless legs syndrome are not well understood, and further investigation is needed to fully understand this finding and why this relationship may appear postnatally but not prenatally. Restless legs are most commonly experienced in late pregnancy and in most cases, disappear within one month postpartum (Ohayon et al., 2012). This finding may indicate that when restless legs persist beyond pregnancy into the postpartum period, the sleep disruption caused can result in increased anxiety. Ohayon et al. (2012) reviewed several epidemiological studies and found that restless legs were associated with other sleep difficulties and people with restless legs syndrome were two to three times more likely to report other sleep disruptions (latency, continuity and quality) than those who did not have restless legs.

While Ladyman et al. (2021) found several sleep variables were related to depressive symptoms (quality, latency, continuity and daytime sleepiness) in the *Moe Kura* cohort, this study found that for high anxiety symptoms, long sleep latency was the most consistently associated across the perinatal period and daytime sleepiness was significantly associated with high anxiety symptoms during late pregnancy but not at 12 weeks postpartum. As previously discussed, anxiety is characterised by a high state of arousal so longer sleep latency is to be expected and daytime sleepiness may be related to the interaction between sleep disruption and increased anxiety related to pregnancy itself.

Several sleep variables (short sleep, frequency of good night's sleep, sleep quality, disrupted continuity, long sleep latency and daytime sleepiness) were independently associated and all were more likely postpartum if they had been experienced in late pregnancy. These associations highlight the importance of supporting women with sleep health during pregnancy to help reduce the negative impacts of sleep disruption over the perinatal period.

5.5 Covariate relationships

In addition to the univariate relationships between ethnicity and socio-economic deprivation and anxiety prevalence (described in Section 5.3.1), ethnicity, relationship status, life stress,

parity, maternal age and history of depression were all independently associated with high anxiety symptoms and sleep health at particular time points.

5.5.1 Ethnicity

The univariate relationship between ethnicity and anxiety has previously been discussed (Section 5.3.1). This section focuses on ethnicity and sleep and the findings that the prevalence of long sleep differed by ethnicity. Descriptive statistics showed Māori women (both those with high and low anxiety symptoms) reported sleeping longer prior to pregnancy than non-Māori. In cross-sectional models, identifying as Māori was independently associated with sleeping over 9 hours in pregnancy and at 12 weeks postpartum. This finding has also been found in other studies using the *Moe Kura* dataset (Signal et al., 2022) and multiple factors may contribute to this finding including Māori being over-represented in more deprived areas. Several international studies have shown a relationship between low socio-economic status and increased likelihood of long sleep (Grandner et al., 2010; Patel et al., 2006). It could also be related to maternal age as the sample includes a larger proportion of Māori women under 25 years old and studies show that sleep duration decreases with age (Åkerstedt, 2017; Ohayon et al., 2004).

In late pregnancy, a greater proportion of Māori women with high anxiety symptoms experienced poor quality sleep, longer sleep latency, daytime sleepiness, breath pauses and leg twitching/jerking than non-Māori with high anxiety symptoms. At 12 weeks postpartum a greater proportion of Māori women with low anxiety symptoms reported frequent snoring than non-Māori with low anxiety symptoms. These findings support other studies using the *Moe Kura* dataset that have found that a greater proportion of Māori experience poorer sleep health, including poor sleep quality, more sleep disorder symptoms and sleep durations outside the recommendations compared to non-Māori (Gander et al., 2005; Mihaere et al., 2009; Paine et al., 2004, 2005; Paine & Muller, 2023; Signal et al., 2022). As discussed previously (Section 5.3.1) social determinants of health play an important part in

understanding these differences and Māori outcomes are substantially impacted by systemic issues that have disadvantaged Māori in NZ society (Paine & Muller, 2023).

5.5.2 Maternal age and parity

Cross-sectional analyses showed that maternal age was independently associated with several sleep variables, with the likelihood of long sleep, long sleep latency and leg twitching/jerking (in late pregnancy) decreasing with age. The likelihood of short sleep (in late pregnancy) and poor sleep continuity and daytime sleepiness increased with age (at 12 weeks postpartum). This is consistent with sleep research that sleep duration and continuity decrease with age and latency increases (Ohayon et al., 2004; Rayner & Horne, 1995). Maternal age also showed an independent association with anxiety in late pregnancy, with the likelihood decreasing with age. This supports previous studies that show higher rates of anxiety in younger age groups as discussed previously (Field, 2018; Ross & McLean, 2006; Sawyer et al., 2010).

There were clear differences between Māori and non-Māori in age distribution across this cohort with more younger Māori women under 25 (37%) compared to non-Māori (10%) which reflects the trends seen in the general population (Signal et al. 2022; Stats NZ 2022). Māori are more likely to have babies younger and in 2010 (when many women were recruited to *Moe Kura*), 37% of all babies born that year were born to Māori mothers under 25 compared to 21% of non-Māori mothers under 25 (Stats NZ, 2022). For non-Māori women, the greatest proportion of women reporting high anxiety symptoms was those between 30-34 years with proportions more evenly spread across the maternal age range (Table 10).

Parity (Section 3.4.4) was independently associated with several sleep variables although results were mixed. The likelihood of some sleep health variables increased (having a good night's sleep at T2, short sleep and quality at T3) and others decreased (long sleep, quality, continuity in T2 and quality at T4).

At 12 weeks postpartum, having given birth before was associated with increased odds of high anxiety symptoms but not at any other time point. This may reflect the increased demands of caring for more than one child leading to more sleep disruption and higher anxiety symptoms however this is contrary to other studies that have found that first time mothers experience higher anxiety symptoms (Swalm et al., 2010). Previous studies using the *Moe Kura* dataset have found that having a previous child is associated with an increased likelihood of depressive symptoms in late pregnancy (Signal et al., 2022) but further investigation is needed to understand the relationship between parity and anxiety symptoms.

5.5.3 Relationship status and life stress

Clear differences in relationship status and life stress were seen between those with high anxiety symptoms and those without, for both Māori and non-Māori. At 12 weeks postpartum, a larger proportion of women reported dissatisfaction with their relationship than in late pregnancy and this increase was highest for Māori women. More Māori than non-Māori women had experienced life stress and for non-Māori women, those with high anxiety were more likely to have experienced life stress.

As discussed previously (Section 5.3.1) there were significant differences in the proportions of Māori and non-Māori women living in socio-economically deprived areas in the *Moe Kura* cohort (Signal et al., 2022). It is likely that these differences in life stress and relationship status (level of social support) were related to social determinants of health and there is evidence that stress related to poverty and maternal deprivation negatively impact sleep health (Paine & Muller, 2023). Relationship status is an indicator of social support and mothers with reliable support are better prepared for the challenges of parenthood (MoH, 2012), with some studies finding that social support can be a protective factor against the impacts of lower socio-economic status (Antonucci et al., 1999; Huurre et al., 2007).

These covariates were included in the adjusted models because numerous studies have found that poor relationship status and stressful life events are strong predictors of perinatal mental health issues and this study provides further evidence of this (Abbott & Williams, 2006; Kendler et al., 1999; Kessler, 1997; Paine & Muller, 2023; Schwarzer & Lusczczynska, 2013; Webster et al., 1994). Further investigation is needed to understand the complexity of the relationships between life stress, relationship status, socio-economic status and anxiety symptoms.

5.5.4 Prior history of depression

A greater proportion of women, both Māori and non-Māori, with high anxiety symptoms had a prior history of depression and this further supports numerous studies that have shown that depression is predictive of perinatal anxiety (Ross & McLean, 2006; Field, 2018; Schmied et al. 2013; Vythilingum, 2008). For those with low anxiety symptoms, there was a higher proportion of non-Māori women who had a prior history of depression. This may reflect differences in access rates to health services as there is evidence that Māori are less likely to have accessed the health system and received a diagnosis and/or treatment of depression (MoH, 2018d; Oakley Browne et al., 2006).

Having a prior history of depression was associated with greater odds of experiencing high anxiety symptoms at all time points studied and longitudinal results showed that a history of depression prior to pregnancy may predict high anxiety symptoms at 12 weeks postpartum. Previous studies have found that having a history of depression is one of the strongest predictors of perinatal anxiety (along with poor partner relationship and life stress) and the present findings support this (Grigoriadis et al., 2019; O'Hara & Swain, 1996; Robertson et al., 2004; Schmied et al. 2013; Vythilingum, 2008).

5.6 Clinical implications

Maternal anxiety can negatively impact both the mother and her infant and there is substantial evidence that intervening early can protect against lifelong negative consequences and significantly improve longer-term outcomes and reduce future dependence on the health and social system (Gluckman 2011; McGorry et al 2007: MoH, 2012). Several studies have shown that anxiety can lead to mothers being overprotective of their babies and not allowing family/whānau to help, having a negative effect on mothers who may feel overwhelmed by the responsibility of caring for their infant (Dennis et al., 2017; Highet et al., 2014).

High anxiety symptoms can lead to a breakdown of the natural supports (e.g. whānau and friends) that mothers need at this time and make early motherhood a very lonely and distressing time (Allison, 2021; Cunningham et al., 2021). Identifying developing mental health issues early in the perinatal period allows intervention before symptoms become unmanageable and numerous studies support this approach (Austin & Priest, 2005; Milford & Oates, 2009; Austin 2004).

This study adds further support to this approach as it highlights the relationship between prenatal and postnatal anxiety and the increased likelihood that both Māori and non-Māori women will experience high anxiety symptoms postnatally if they have experienced anxiety prenatally. In addition to collecting information on the prior history of depression or anxiety disorders, identifying women with high anxiety symptoms in pregnancy means that women can be supported through the perinatal period and have access to the support and treatment they need.

Creating safe and supportive environments where pregnant women feel comfortable sharing how they are feeling and where they are able to have early conversations about how long it takes them to get to sleep (latency) may be helpful. Questions about sleep health could be incorporated into a screening tool to identify women who have an increased likelihood of

experiencing high anxiety symptoms. This may be an easier way to start a conversation about anxiety symptoms, lead to further discussion and prompt administration of the EPDS subscale to determine if anxiety symptoms are at a level of concern. The EPDS anxiety subscale is a reliable screening tool to identify symptoms that are clinically significant and, as it is only three questions, it can be administered quickly and easily and is not too overwhelming for women who are already feeling anxious. The EPDS subscale could identify anxiety symptoms in pregnancy, allowing interventions and additional support to be provided and initiate a referral to specialist mental health services for a diagnostic assessment and treatment as required.

Those working in this area have an important role to play and professionals such as midwives, Well Child / Tamariki Ora nurses (including Plunket nurses), GP teams (including primary mental health) and early childhood teachers are just some of the roles that support parents and whānau through the perinatal period (MoH, 2018c). Professional training and educational opportunities on sleep health and mental health need to be readily available and easy to access so those working in this area are supported to have these conversations with women.

5.7 Policy implications

From a policy perspective, it is important to include perinatal anxiety and sleep health in all policies relating to maternal mental health. These policies need to be equity-focused and co-designed with Māori to ensure they can be implemented in a way that ensures rangatiratanga. To date, the focus has been largely on perinatal depression, but this study adds to previous studies that have found that anxiety symptoms are common in the perinatal period but are often missed (Folliard et al., 2020; Highet et al., 2014).

This study also highlights the importance of sleep health and the relationships between sleep health and anxiety. Pregnant women are rarely asked about sleep health, but there is strong evidence that significant disruption to sleep can result in negative outcomes for the mother and her baby (Signal et al., 2022). This study adds to these findings by showing the bi-

directional relationships between sleep and anxiety and further reinforces the importance of sleep health during the perinatal period. While some disruption to sleep and feelings of anxiety are normal in pregnancy, if these issues become clinically significant, then early intervention is key to being able to support mothers and babies to achieve the best outcomes.

Screening is an important tool to enable early identification of anxiety and sleep concerns however, in NZ, there are no consistent screening tools used (MoH, 2021). One of the key insights of the stocktake of Maternal Mental Health Service Provision undertaken by the Ministry of Health (2021) was that "early screening and intervention as soon as issues begin to present are critical to achieving the best outcomes for mothers, babies and the wider whānau" (p. vi). Women with high anxiety symptoms may not require specialist maternal mental health care but they may need to access primary care or support in their local community.

There are currently gaps in service provision that need to be addressed to ensure women and whānau can access the right level of support to meet their needs (MoH, 2021). Healthy Beginnings (MoH, 2012) provided guidance for health planners and providers on developing services to address the mental health needs (including alcohol and drug use) of mothers and infants. It is now almost 12 years on and the recent stocktake highlights the gaps we are still seeing in service provision (MoH, 2021). To meet the goals of the national Child and Youth Wellbeing Strategy (DPMC, 2019) and ensure all pēpi (babies) and tamariki (children) are loved, safe and nurtured; mothers and whānau need to be well supported.

In NZ, Māori and non-Māori health outcomes are not equitable and Māori are significantly disadvantaged (MoH, 2018b). NZ studies have confirmed the significant impacts of social determinants on maternal and perinatal outcomes (Dawson et al., 2022). This study also highlights these impacts and the contribution that inequities in social determinants of health make to increased prevalence of high anxiety symptoms for Māori women compared to non-Māori. This further reinforces the importance of embedding a Tiriti o Waitangi dynamic health

system that can enhance rangatiratanga (self-determination) for Māori over their own health (Durie, 2004; MoH, 2020; Te Aka Whai Ora & Te Whatu Ora, 2022).

Dawson et al., (2022) concludes that achieving equitable outcomes requires addressing inequities in social determinants and the systemic issues that maintain them as well as a strength-based approach to identify the common features of positive outcomes to avoid further stigmatising those who are already significantly disadvantaged. The right to health and the right of self-determination for Māori (and all Indigenous peoples and ethnic minority groups) must be upheld and this study further highlights the range of factors that impact on inequities; most notably, the social determinants of health (Paine & Muller, 2023).

Using Kaupapa Māori principles to design interventions to reduce health inequities provides an opportunity to improve outcomes for Māori women and their babies. Cultural models of care also need to be strengthened as many districts do not offer Kaupapa Māori maternal mental health options (MoH, 2021). In their paper, Lawton et al. (2013) highlighted the importance of understanding the 'lived realities' of pregnant young Māori women. As Lawton et al. (2013) points out, Māori communities are very aware of how they are portrayed by negative population statistics and stigma is a real issue.

Maternal wellbeing is a protective factor for infants and children (MoH, 2021) and needs to be nurtured, supported and protected. Māori have long understood the importance of the perinatal period for long term whānau wellbeing and research on the impacts of perinatal distress provides further evidence of the importance of these cultural practices (Walker, 2022). In her report, Walker (2022) recommends prioritising perinatal and maternal health in the reformed health system and developing a perinatal mental wellbeing action plan for NZ. While there are no explicit plans to develop an action plan, Te Pae Tata (Interim New Zealand Health Plan) has included Kahu Taurima (Maternity and early years) as one of the priority areas for improving health outcomes and equity (Te Whatu Ora & Te Aka Whai Ora, 2022). It will be important to include perinatal anxiety and sleep health when progressing the action to

"Establish maternal mental health and wellbeing pathways, including pathways for bereavement and access to specialist mental health services" (p. 37).

Over the course of this current study, the world faced the global COVID-19 pandemic. The impacts of the pandemic are far-reaching and affected women at all stages of the perinatal period. Delivery of health care changed and whānau were not always able to be there for the birth as intended (PMMRC, 2022). While it is too early to tell the full impacts of the COVID-19 pandemic on maternal mental health and wellbeing, there is evidence of increased prevalence of anxiety symptoms and sleep disturbance during the pandemic (Lakhan et al., 2020; Moyer et al., 2020; Xiao et al., 2020). Moyer et al. (2020) found that pregnancy-related anxiety was amplified by the pandemic, and the measures that protected people from the spread of COVID-19 such as social distancing have had a negative effect on many mothers' mental health. These studies further strengthen the importance of ensuring early signs of anxiety and sleep health issues are picked up so women can get the support they need.

5.8 Strengths and limitations

One of the major strengths of this study is that the analysis used data collected in the *Moe Kura* cohort study. The *Moe Kura* study was designed from a strong foundation of Kaupapa Māori epidemiological research principles and Māori/non-Māori co-leadership ensured Māori participation and control throughout (Paine et al., 2013; Signal et al., 2022). The cohort includes a high number of Māori women allowing equal explanatory power for Māori and non-Māori (Paine et al., 2013). The large sample size and range of questions including the use of well validated measures meant that this cohort study has provided a rich dataset that has helped many researchers understand the experiences of Māori and non-Māori women through the perinatal period (Signal et al., 2022).

A strength of this current research is that anxiety symptoms were analysed both cross-sectionally and longitudinally across the perinatal period, adding to the literature on sleep and

anxiety and inequities between Māori and non-Māori. Including multiple aspects of sleep health enabled relationships to be differentiated and highlighted that some aspects were more affected by anxiety symptoms than others.

The data analysed from the *Moe Kura* study included self-reported anxiety symptoms rather than clinically diagnosed anxiety. Studies have found that prevalence rates are higher when self-reported data, as opposed to clinical diagnosis, are utilised (Cunningham et al., 2021) therefore, prevalence rates in this study will be higher than rates of anxiety disorders. In this study, a higher EPDS anxiety subscale threshold was used (6 rather than 4) as a score of 6 or more is indicative of the threshold for a clinical diagnosis of anxiety disorder (Matthey, 2008). While the EPDS anxiety subscale has been shown to be a reliable measure of anxiety symptoms, it is a screening tool not a diagnostic assessment of anxiety disorder therefore this study's findings relate to anxiety symptoms rather than anxiety disorders. As the primary focus of this study was anxiety symptoms, it did not investigate total scores on the EPDS or the co-occurrence of anxiety and depression symptoms in relation to sleep health.

In conducting the *Moe Kura* study, women with high anxiety or depression scores were offered support in line with the ethical responsibilities of conducting research with this population. A protocol was put in place while conducting the *Moe Kura* study to contact women who had elevated EPDS or BMWS scores (Appendix D). Participants were contacted and advised to discuss further with their Lead Maternity Carer (LMC) or GP and consent was sought for the researchers to follow up with the health professional directly. In cases of acute distress, the mental health crisis teams were contacted or emergency services if required. Each time this protocol was enacted, the phone call itself was an intervention and may have resulted in women accessing clinical treatment and/or additional support being put in place. This could have contributed to a reduction in anxiety symptoms and altered EPDS anxiety subscale scores at future time points and explain higher rates seen in pregnancy.

The questionnaire at 4-6 weeks postpartum was conducted over the phone, compared to hard copy questionnaires that were posted out to participants at the other two time points (late pregnancy and 12 weeks postpartum). Researchers recorded the answers as they spoke to participants during the 4–6 week postpartum phone call which may have increased the chance of transcribing errors. This phone call could have been a positive intervention as women had an opportunity to talk to someone and express how they were feeling. There was also a different sleep quality question used at the 4-6 week postpartum time point meaning that responses were not directly comparable with the GSDS quality subscale question that was used at the two other time points. This may have affected the results of the cross-sectional analyses at 4-6 weeks postpartum and the longitudinal results involving this variable.

5.9 Further research

This study highlights the importance of investigating the nature of the relationships between sleep health and anxiety across the perinatal period. Future research could use a clinical diagnostic assessment of anxiety disorder to determine severity of symptoms and objective sleep measures to better understand the complexity of the relationship between anxiety and sleep health. Analysis of the onset and course of perinatal anxiety and sleep health issues would be advantageous as well as investigating the effects of treatment on anxiety symptoms and sleep health issues across the perinatal period to understand how anxiety and sleep can positively impact on each other.

Differences in prevalence rates of high anxiety symptoms between Māori and non-Māori require further investigation and while this study showed the impact of covariates, even after adjusting for these an independent relationship between high anxiety symptoms and identifying as Māori was still evident at 4-6 weeks postpartum. This study couldn't adjust for all potential confounding covariates and further investigation is needed to better understand potential differences in Māori and non-Māori women's experiences in the early postpartum

period. Qualitative research using the narrative responses that women provided in the *Moe Kura* study at this point may help to understand this better.

Another area for further investigation is the relationship between high anxiety symptoms and restless legs. This relationship was bi-directional at 12 weeks postpartum but not at other time points. There may be other variables contributing to restless legs at this time and persistent restless legs may led to increased anxiety and while this study did not look at other potential causes of restless legs syndrome, prior research has shown that restless legs can be related to iron deficiency (Allen & Earley, 2007; Leschziner & Gringras, 2012) and can also be a side effect of anti-depressant medication (Rottach et al., 2008).

5.10 Conclusion

This study focused on understanding relationships between anxiety and sleep across the perinatal period. The design and application of Kaupapa Māori epidemiological principles ensured equal explanatory power for Māori and non-Māori and provided valuable insights into the experiences of NZ women as well as the differences between them.

The finding of a bi-directional relationship between increased sleep latency and high anxiety symptoms could be used to guide the development of questions to ask women early in their pregnancies. This would aid in identifying such issues and allow follow up if needed. This is critical as the most consistent predictor of high anxiety symptoms postpartum was high symptoms in late pregnancy.

Many previous studies have looked at perinatal depression and anxiety together, but this study shows that there were significant differences in the relationships between sleep health and anxiety compared to depression. Further research on pregnancy-related anxiety as well as perinatal anxiety is warranted. This study also highlights the high prevalence of anxiety and sleep health issues in pregnancy and the importance of ensuring that clinical pathways include

identification, treatment and support of women across the perinatal period and that health policies, plans and resources reflect and enable this.

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APPENDIX A. First Questionnaire completed at T1 & T2

Sleep and Health during Pregnancy

THIS QUESTIONNAIRE SHOULD BE COMPLETED WHEN YOU ARE 35-37 WEEKS PREGNANT

1. **What is your date of birth?** ..... / ..... / .....
   (day) (month) (year)

2. **When is your baby due?** ..... / ..... / .....
   (day) (month) (year)

3. **How many weeks pregnant are you now?** ..... weeks

4. **Write your NHI number here if you know it:**
   (This is your National Health Index number – your midwife or doctor will have this).

5. **Which ethnic group do you belong to?** *Mark the space or spaces which apply to you.*
   - ❍ New Zealand European
   - ❍ Māori
   - ❍ Samoan
   - ❍ Cook Island Māori
   - ❍ Tongan
   - ❍ Niuean
   - ❍ Chinese
   - ❍ Indian
   - ❍ Other such as DUTCH, JAPANESE, TOKELAUAN. Please state: .....

6. **Where do you usually live?**
   Street number..... Flat number.....
   Street name .....
   Suburb or rural locality ..... Post Code.....
   City, town or district .....
   Telephone number..... Cell phone number .....

7. **In the last 12 months what was your households total income, before tax or anything else was taken out of it?**
   - 1 ❍ Loss
   - 2 ❍ Zero income
   - 3 ❍ $1 - $5,000
   - 4 ❍ $5,001 - $10,000
   - 5 ❍ $10,001 - $15,000
   - 6 ❍ $15,001 - $20,000
   - 7 ❍ $20,001 - $25,000
   - 8 ❍ $25,001 - $30,000
   - 9 ❍ $30,001 - $35,000
   - 10 ❍ $35,001 - $40,000
   - 11 ❍ $40,001 - $45,000
   - 12 ❍ $45,001 - $50,000
   - 13 ❍ $50,001 - $70,000
   - 14 ❍ $70,001 – $100,000
   - 15 ❍ $100,001 - $150,000
   - 16 ❍ $150,001 or more
   - 17 ❍ don't know

Please go to next page ☞

Paid Work (These questions refer to your work in the last month)

8. Do you currently work for pay, profit or income?

1 ○ Yes, one paid job 2 ○ Yes, more than one paid job

0 ○ No *Comments welcome →*

If you answered 'No' please go to question 12, if 'Yes' go to question 9.

9. On average, how many HOURS A WEEK did you work for pay, profit or income? Just think about the LAST MONTH.

Please write how many hours a week here →..... hours a week

10. In the LAST MONTH did you work for pay, profit or income for at least 3 hours between midnight and 5am?

1 ○ Yes 0 ○ No *(please go to question 12)*

11. In the LAST MONTH what is the total number of nights that you worked for at least 3 hours between midnight and 5am? *Please write how many nights here →*..... nights

12. Return to work

1 ○ I have no plans to return to work

2 ○ I plan to return to work but have no date in mind

3 ○ I expect to be back at work when my baby is ..... *(write baby's age)*

Support & dependents

13. How many people normally live in your home?.....

14. How many of these people need looking after by you (not counting you)?.....

What are their ages? .....

15. Support for you at home

Do you live with anyone you can count on to help you with:

Financial support 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent).....

Emotional support (e.g. someone who listens or is 'there' for you) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent).....

Advice (e.g. can give information or guidance about pregnancy, birth and parenting) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent).....

Concrete/Practical support (e.g. baby care, housework, cooking) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent).....

Please go to next page ☞

16. Support for you – outside of home

Are there other people, not living with you, who you can count on to help with:

Financial support 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Emotional support (e.g. someone who listens or is 'there' for you) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Advice (e.g. can give information or guidance about pregnancy, birth and parenting) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Concrete/Practical support (e.g. baby care, housework, cooking) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Pregnancy can affect how we feel about relationships. We are interested to know how you feel about your relationship with your partner right now. We understand that this may not be how you usually feel. If you do not have a partner please go to Question 19.

17. If you have a partner, how is your relationship with them at the moment?

Please circle one number

Perfectly Happy							Extremely Unhappy	OR 8 ○ Not applicable
0	1	2	3	4	5	6	7	

18. How supportive of this pregnancy is your partner?: *Please circle one number*

Completely supportive							Not at all supportive	OR 8 ○ Not applicable
0	1	2	3	4	5	6	7	

19. How often is a private motor vehicle (not counting motorbikes) available for your use?

	NO DAYS							EVERY DAY
Circle the number of days a week	0	1	2	3	4	5	6	7

Sleep – before this pregnancy

20. Before this pregnancy, how many hours sleep did you usually get in 24 hours, including naps?

Please write the number of hours here ..... hours

21. Before this pregnancy, how often did you get a good night's sleep?

	NO NIGHTS							EVERY NIGHT
Circle the number of nights	0	1	2	3	4	5	6	7

Please go to next page ☞

22. Before this pregnancy, has anyone told you that during sleep you do any of the following things? *Please circle how often*

	NO NIGHTS							EVERY NIGHT
Loud snoring	0	1	2	3	4	5	6	7
Long pauses between breaths while asleep	0	1	2	3	4	5	6	7
Legs twitching or jerking while you sleep	0	1	2	3	4	5	6	7

Sleep – during this pregnancy

23. How many hours sleep do you usually get in 24 hours, including naps?
(Just think about the last week).

Please write the number of hours here ..... hours

24. In the last week, how often did you get a good night's sleep?

	NO NIGHTS							EVERY NIGHT
Circle the number of days	0	1	2	3	4	5	6	7

25. On how many days in the last week did you have a daytime nap?

	NO NIGHTS							EVERY NIGHT
Circle the number of days	0	1	2	3	4	5	6	7

26. How long on average, per day, do you spend outside (really outside) exposed to daylight?

..... hours ..... minutes

27. On how many nights in the last week did the following things disturb your sleep?
Please circle one number in every row.

	NO NIGHTS							EVERY NIGHT
Circle the number of nights								
Going to the bathroom	0	1	2	3	4	5	6	7
Pain in back/neck/joints	0	1	2	3	4	5	6	7
Dreams	0	1	2	3	4	5	6	7
Nightmares	0	1	2	3	4	5	6	7
Heartburn	0	1	2	3	4	5	6	7
Nasal congestion (blocked nose)	0	1	2	3	4	5	6	7
Leg cramps	0	1	2	3	4	5	6	7
Contractions	0	1	2	3	4	5	6	7
Feeling too hot or cold	0	1	2	3	4	5	6	7
Thinking or worrying about things	0	1	2	3	4	5	6	7
Baby moving around (baby kicking)	0	1	2	3	4	5	6	7
Other children	0	1	2	3	4	5	6	7

Please go to next page ☞

Circle the number of nights	NO NIGHTS							EVERY NIGHT
Just can't get comfortable	0	1	2	3	4	5	6	7
Just can't get to sleep	0	1	2	3	4	5	6	7
Disturbed by partner (e.g. snoring)	0	1	2	3	4	5	6	7
Other	0	1	2	3	4	5	6	7

If you circled '**Other**', what were the other things that disturbed your sleep?

28. During sleep in the <u>LAST WEEK</u>, has anyone told you that you did any of the following?
Please circle how often.

Circle the number of nights	NO NIGHTS							EVERY NIGHT
Loud snoring	0	1	2	3	4	5	6	7
Long pauses between breaths while asleep	0	1	2	3	4	5	6	7
Legs twitching or jerking while you sleep	0	1	2	3	4	5	6	7

29. Do you ever experience an urge to move your legs (usually accompanied by unpleasant sensations)?

1 ❍ Yes 0 ❍ No – *if "No" please go to question 31.*

30. If you answered "Yes" in question 29, is this: *Tick all that apply to you.*

1 ❍ Worse at night?

2 ❍ More noticeable when you rest?

3 ❍ Relieved by movement?

31. How often in the <u>last week</u> did you:

Please circle one number in every row	NO NIGHTS							EVERY NIGHT
Have difficulty getting to sleep	0	1	2	3	4	5	6	7
Wake up during your sleep period	0	1	2	3	4	5	6	7
Wake up too early at the end of a sleep period	0	1	2	3	4	5	6	7
Feel rested upon awakening at the end of a sleep period	0	1	2	3	4	5	6	7
Sleep poorly	0	1	2	3	4	5	6	7
Feel sleepy during the day	0	1	2	3	4	5	6	7
Struggle to stay awake during the day	0	1	2	3	4	5	6	7
Feel irritable during the day	0	1	2	3	4	5	6	7
Feel tired or fatigued during the day	0	1	2	3	4	5	6	7
Feel satisfied with the quality of your sleep	0	1	2	3	4	5	6	7

Please go to next page ☞

Please circle one number in every row	NO NIGHTS							EVERY NIGHT
Feel alert and energetic during the day	0	1	2	3	4	5	6	7
Get too much sleep	0	1	2	3	4	5	6	7
Get too little sleep	0	1	2	3	4	5	6	7
Take a nap at a scheduled time	0	1	2	3	4	5	6	7
Fall asleep at an unscheduled time	0	1	2	3	4	5	6	7
Use a prescription sleeping pill to help you get to sleep	0	1	2	3	4	5	6	7
Use any pain medication to help you get to sleep (e.g. Panadol)	0	1	2	3	4	5	6	7
Take or use anything else to help you sleep	0	1	2	3	4	5	6	7

If so, what did you take or use:

32. How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? *This refers to your usual way of life in recent times.*

PLEASE TICK ONE CIRCLE ON EACH LINE

	would never doze	slight chance	moderate chance	high chance
Sitting and reading	0 ○	1 ○	2 ○	3 ○
Watching TV	0 ○	1 ○	2 ○	3 ○
Sitting inactive in a public place (e.g. movies, meeting)	0 ○	1 ○	2 ○	3 ○
As a passenger in a car for an hour without a break	0 ○	1 ○	2 ○	3 ○
Lying down in the afternoon when circumstances permit	0 ○	1 ○	2 ○	3 ○
Sitting and talking to someone	0 ○	1 ○	2 ○	3 ○
Sitting quietly after a lunch without alcohol	0 ○	1 ○	2 ○	3 ○
In a car, while stopped for a few minutes in traffic	0 ○	1 ○	2 ○	3 ○

PLEASE MAKE SURE YOU HAVE TICKED ONE BOX ON EACH LINE

Feelings in pregnancy

33. Please tick the answer which comes closest to how you have felt IN THE LAST 7 DAYS, not just how you feel today.

I have been able to laugh and see the funny side of things.

0 ○ As much as I always could
1 ○ Not quite so much now
2 ○ Definitely not so much now
3 ○ Not at all

I have looked forward with enjoyment to things.

0 ○ As much as I ever did
1 ○ Rather less than I used to
2 ○ Definitely less than I used to
3 ○ Hardly at all

Please go to next page ☞

I have blamed myself unnecessarily when things went wrong.

3 ○ Yes, most of the time
2 ○ Yes, some of the time
1 ○ Not very often
0 ○ No, never

I have been anxious or worried for no good reason.

0 ○ No, not at all
1 ○ Hardly ever
2 ○ Yes, sometimes
3 ○ Yes, very often

I have felt scared or panicky for no very good reason.

3 ○ Yes, quite a lot
2 ○ Yes, sometimes
1 ○ No, not much
0 ○ No, not at all

Things have been getting on top of me.

3 ○ Yes, most of the time I haven't been able to cope at all
2 ○ Yes, sometimes I haven't been coping as well as usual
1 ○ No, most of the time I have coped quite well
0 ○ No, I have been coping as well as ever

I have been so unhappy that I have had difficulty sleeping.

3 ○ Yes, most of the time
2 ○ Yes, sometimes
1 ○ Not very often
0 ○ No, not at all

I have felt sad or miserable.

3 ○ Yes, most of the time
2 ○ Yes, quite often
1 ○ Not very often
0 ○ No, not at all

I have been so unhappy that I have been crying.

3 ○ Yes, most of the time
2 ○ Yes, quite often
1 ○ Only occasionally
0 ○ No, never

The thought of harming myself has occurred to me.

3 ○ Yes, quite often
2 ○ Sometimes
1 ○ Hardly ever
0 ○ Never

Please go to next page ☞

34. The following are statements about worrying. Please read each statement and indicate how true each one is in describing your general/usual experience of worrying.

Please tick the one option that most likely applies to you for each statement

When I worry, it interferes with my day-to-day functioning (e.g. stops me getting my work done, organising myself or my activities).

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

When I think I should be finished worrying about something, I find myself worrying about the same thing, over and over.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

My worrying leads me to feel down and depressed.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

When I worry, it interferes with my ability to make decisions or solve problems.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

I feel tense and anxious when I worry.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

I worry that bad things or events are certain to happen.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

I often worry about not being able to stop myself from worrying.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

As a consequence of my worrying, I tend to feel emotional unease or discomfort.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

This pregnancy and birth

35. Who is providing professional health care for you in this pregnancy?

○ Independent (self-employed) midwife/team
○ Hospital based midwife/team
○ Hospital high risk team
○ Specialist Obstetrician
○ Shared care (e.g. midwife & obstetrician, midwife & GP)
○ No one
○ Other *(who)*_____

36. What was your weight before this pregnancy? ..... kgs **OR** ..... stones ..... lbs

37. What is your height? .....cms **OR** .....feet .....inches

38. When you got pregnant, were you trying to get pregnant?

1 ○ Yes 0 ○ No

39. Did you require the assistance of reproductive technology to become pregnant this time?

(e.g. IVF, GIFT, ICSI) 1 ○ Yes 0 ○ No

Please go to next page ☞

Mood

40. **<u>Before this pregnancy</u> did you ever have a period of 2 weeks or more when you felt particularly miserable or depressed?**

1 ○ Yes 0 ○ No – *go to question 41*

If so, did being depressed:

a) Interfere with your ability to get things done or your relationships with family and friends?

Circle one number

Not at all		Somewhat			Very much
0	1	2	3	4	5

b) Lead you to seek professional help?

1 ○ Yes 0 ○ No

41. **Have you ever been told by a health professional you were depressed or needed antidepressants?**

1 ○ Yes 0 ○ No

42. **<u>During this pregnancy</u> have you been distressed by feelings of anxiety or depression for 2 weeks or more?**

1 ○ Yes 0 ○ No– *go to question 43*

If so, did this distress:

a) Interfere with your ability to get things done or your relationships with family and friends?

Circle one number

Not at all		Somewhat			Very much
0	1	2	3	4	5

b) Lead you to seek professional help?

1 ○ Yes 0 ○ No

43. **Before this pregnancy, have you ever had depression during pregnancy** (antenatal depression) **or after having a baby** (postnatal depression)**?**

1 ○ Yes 0 ○ No

44. **Has anyone in your family ever been told by a health professional that they have depression or another mental health problem?**

1 ○ Yes 0 ○ No

If '**Yes**' who was that:.....

45. **Has anyone in your family ever had antenatal or postnatal depression?**

1 ○ Yes 0 ○ No

If "**Yes**" who was that: .....

Please go to next page ☞

Pregnancy history

46. How many times have you ever been pregnant, including this one? ..... times

Comments welcome →

If this is your first pregnancy, please go to Question 50. If you have been pregnant more than once please answer the following:

47. How many times have you given birth to a baby, alive or not, after at least 20 weeks of pregnancy?

Comments welcome →

48. Have any of your previous babies had significant health problems which were identified in pregnancy or at birth?

1 ○ Yes 0 ○ No *Comments welcome →*

49. Have you had a caesarean section in the past?

1 ○ Yes 0 ○ No

50. Are you currently having any treatment or monitoring for any of these conditions?

Please tick one circle on every line.

	Yes	No	Don't know/ can't remember
High blood pressure (including hypertension, pre-eclampsia, toxaemia, chronic hypertension)	1 ○	0 ○	2 ○
Pregnancy or pre-existing diabetes (gestational diabetes managed using dietary control, with or without insulin)	1 ○	0 ○	2 ○
Low iron or anaemia	1 ○	0 ○	2 ○
Abnormal vaginal bleeding	1 ○	0 ○	2 ○
Placenta/whenua low down near the cervix (placenta praevia/low lying placenta)	1 ○	0 ○	2 ○

Please go to next page ☞

51. Are you currently having <u>any treatment or monitoring</u> for any other conditions such as:
If 'No' please go to question 52

Other medical problem(s) – please specify (e.g thyroid problem, severe back problem, severe carpal tunnel syndrome, any other medical condition):

Mental health problem(s) – please specify (e.g. depression, bipolar disorder, schizophrenia, or other mental health condition):

A diagnosed sleep disorder – please specify:

52. Please list any medicines you are currently taking.

Life events

53. This question is about things that may have happened during the last 12 months.
Tick all that apply to you - if none of these apply please go to question 54

- ❍ A close family member was very sick and had to go into hospital
- ❍ I broke up with, got separated or divorced from my partner
- ❍ I moved to a new address
- ❍ I was homeless
- ❍ My partner lost their job
- ❍ I lost my job even though I wanted to go on working
- ❍ I argued with my partner more than usual
- ❍ My partner said they did not want me to be pregnant
- ❍ I had a lot of bills I couldn't pay
- ❍ I was in a physical fight
- ❍ My partner or I went to jail
- ❍ Someone very close to me had a bad problem with drinking or drugs
- ❍ Someone very close to me died

Please go to next page ☞

54. Do you describe yourself as a: *Please tick the circle that applies to you*

3 ○ regular smoker (I smoke one or more cigarettes per day)
2 ○ occasional smoker (I do not smoke every day)
1 ○ ex-smoker (I used to smoke but not any more)
0 ○ non-smoker (I have never smoked regularly)

55. During this pregnancy how often do you drink alcohol? *Please tick the circle that applies to you*

0 ○	1 ○	2 ○	3 ○	4 ○
Never	Less than once a week	Once every 3-7 days	Once every 2 days	Daily

56. On a typical drinking occasion (in this pregnancy), how many drinks do you have? **(One drink equals a glass of beer or a glass of wine or a nip of spirits)?** *Please tick the circle that applies to you*

0 ○	1 ○	2 ○	3 ○	4 ○
None	Less than 2 drinks	2 to 4 drinks	5 to 6 drinks	More than 6 drinks

57. During this pregnancy how often do you use street or recreational drugs, including party pills?

Please tick the circle that applies to you

0 ○	1 ○	2 ○	3 ○	4 ○
Never	Less than once a week	Once every 3 to 7 days	Once every 2 day	Daily

58. Date questionnaire completed ..... / ..... / .....
(day) (month) (year)

Please take a moment now to flick through every page of this survey and check that you have answered all the questions you meant to.

A $20 voucher, from the choice of three options, below will be posted to you when we receive this completed questionnaire. Please ensure you advise us if your address changes.

Please indicate the type of voucher you would prefer (tick one):

Petrol ☐ (MTA) Supermarket ☐ (New World) Department store ☐ (Farmers)

Return questionnaire to Sleep/Wake Research Centre, Massey University, PO Box 756, Wellington 6140.

Important note

If you feel concerned about *any* of the issues raised by completing this questionnaire, we suggest that you discuss these with your Lead Maternity Carer, doctor or other health professional.

The end – thank you.

APPENDIX B. Second questionnaire completed at T3

E Moe, Māmā – 4-6 weeks postpartum telephone survey

Participant ID: ___ ___ ___ ___ EDD: _____ / _____/_____

Date this survey **completed**: _____ / _____/_____

Time survey was **completed:** _____

EPDS score Q1: _____

What date was your baby born on?	
So their age now is...	
And where did you give birth?	
Three questions now about **your** sleep in the last 24 hours:	
1. In the last 24 hours, how many 'sleep periods' have you had – so what that means is, in the last 24 hours, how many times have you gone to sleep – including naps. "	
2. So in total, how much sleep have you had in the last 24 hours?	
3. Quality of sleep: how would you rate the quality of your sleep in the last 24 hours? Note comments here:	0- very good 1- good 2- poor 3- very poor
Now we have three questions about how you have been feeling in the last 7 days – you have already answered questions like these in the first questionnaire. I will read you a statement and then ask you to choose from 4 response options.	
1. I have blamed myself unnecessarily when things went wrong.	3 ❍ Yes, most of the time 2 ❍ Yes, some of the time 1 ❍ Not very often 0 ❍ No, never
2. I have been anxious or worried for no good reason.	0 ❍ No, not at all 1 ❍ Hardly ever 2 ❍ Yes, sometimes 3 ❍ Yes, very often
3. I have felt scared or panicky for not very good reason.	3 ❍ Yes, quite a lot 2 ❍ Yes, sometimes 1 ❍ No, not much 0 ❍ No, not at all
Follow up required Y / N	**EPDS Total**

Is there anything else you would like to know about the study, or that you would like to tell us? *(Continue on back of sheet if required).*

E Moe, Māmā – Contact Log

Four to Six-weeks postpartum telephone survey questions

Participant ID: ___ ___ ___ ___

Name:.....

Home Phone:.....

Cell Phone:.....

Notes: .....

.....

.....

Intro self.

"You are enrolled in our study of sleep changes in pregnancy and after birth, and we have received the first questionnaire from you. Thank you. Do you have 3-4 minutes now to answer a few short questions?

CALLING RECORD

Date	Time	# Called	Code	Notes	Staff

CODES:

BU	busy (phone line busy)	CB	participant requested call back	WD	withdrew from study
CC	call completed	MV	moved	WN	wrong number
MM	left message on machine	NA	no answer	NT	see notes
MP	left message with person	NE	no English	WR	will return by (time)
PB	participant called back	OT	other (explain)	SC	subject called
CT	Call terminated				

APPENDIX C. Third questionnaire completed at T4

ID:

Postnatal Sleep and Health

PLEASE COMPLETE THIS QUESTIONNAIRE WHEN YOUR BABY IS 12 WEEKS OLD

1. **What is your date of birth?** ..... / ..... / .....
(day) (month) (year)

2. **When was your baby born?** ..... / ..... / .....
(day) (month) (year)

3. **Please write your NHI number here:**
(This is your National Health Index number – your midwife or doctor will have this).

4. **Which ethnic group do you belong to?** *Mark the space or spaces which apply to you.*

- ○ New Zealand European
- ○ Māori
- ○ Samoan
- ○ Cook Island Māori
- ○ Tongan
- ○ Niuean
- ○ Chinese
- ○ Indian
- ○ Other such as DUTCH, JAPANESE, TOKELAUAN. Please state: .....

5. **Which ethnic group does your baby belong to?** *Mark the space or spaces which apply to you.*

- ○ New Zealand European
- ○ Māori
- ○ Samoan
- ○ Cook Island Māori
- ○ Tongan
- ○ Niuean
- ○ Chinese
- ○ Indian
- ○ Other such as DUTCH, JAPANESE, TOKELAUAN. Please state: .....

6. **Where do you usually live?**

Street number ..... Flat Number .....

Street name .....

Suburb or rural locality ..... Post Code .....

City, town or district .....

Telephone number ..... Cellphone number .....

7. **In the last 12 months what was your households total income, before tax or anything else was taken out of it?**

1 ○ Loss
2 ○ Zero income
3 ○ $1 - $5,000
4 ○ $5,001 - $10,000
5 ○ $10,001 - $15,000
6 ○ $15,001 - $20,000
7 ○ $20,001 - $25,000
8 ○ $25,001 - $30,000
9 ○ $30,001 - $35,000
10 ○ $35,001 - $40,000
11 ○ $40,001 - $45,000
12 ○ $45,001 - $50,000
13 ○ $50,001 - $70,000
14 ○ $70,001 – $100,000
15 ○ $100,001 - $150,000
16 ○ $150,001 or more
17 ○ don't know

Please go to next page ☞

Paid Work (These questions refer to your work in the **last month**)

8. Do you currently work for pay, profit or income?

1 ○ Yes, one paid job 2 ○ Yes, more than one paid job

0 ○ No *Comments welcome →*

If you answered 'No' please go to question 12, if 'Yes' go to question 9.

9. On average, how many HOURS A WEEK did you work for pay, profit or income? Just think about the LAST MONTH.

Please write how many hours a week here →..... hours a week

10. In the LAST MONTH did you work for pay, profit or income for at least 3 hours between midnight and 5am?

1 ○ Yes 0 ○ No *(please go to question 12)*

11. In the LAST MONTH what is the total number of nights that you worked for at least 3 hours between midnight and 5am? *Please write how many nights here →*..... nights

12. If you are NOT currently working for pay, profit or income, are you taking paid parental leave?

1 ○ Yes 0 ○ No

13. Return to work

1 ○ I have no plans to return to work

2 ○ I plan to return to work but have no date in mind

3 ○ I expect to be back at work when my baby is ..... *(write baby's age)*

Support & dependents

14. How many people normally live in your home? .....

15. How many of these people need looking after by you (not counting you)?

What are their ages? .....

16. Support for you at home

Do you live with anyone you can count on to help you with:

Financial support 1 ○ Yes 0 ○ No

If Yes, who? (e.g. partner, friend, parent) .....

Emotional support (e.g. someone who listens or is 'there' for you) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Advice (e.g. can give information or guidance about baby care and parenting) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Concrete/Practical support (e.g. baby care, housework, cooking) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

17. Support for you – outside of home

Are there other people, not living with you, who you can count on to help with:

Financial support 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Emotional support (e.g. someone who listens or is 'there' for you) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Advice (e.g. can give information or guidance about baby care and parenting) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

Concrete/Practical support (e.g. baby care, housework, cooking) 1 ○ Yes 0 ○ No

If YES, who? (e.g. partner, friend, parent) .....

18. If you have a partner do they currently work for pay, profit or income?

1 ○ Yes 0 ○ No **OR** 2 ○ Not applicable

If "Yes", have they been able to take time off work to be with you and the baby?

1 ○ Yes - how much time? .....

0 ○ No

Please go to next page ☞

Having a baby can affect how we feel about relationships. We are interested to know how you feel about your relationships with your partner right now. We understand that this may not be how you usually feel. If you do not have a partner please go to Question 20.

19. If you have a partner, how is your relationship with them at the moment?:
Please circle one number

Perfectly Happy 0 1 2 3 4 5 6 7 Extremely Unhappy

OR 8 ○ Not applicable

20. How often is a motor vehicle (not counting motorbikes) available for your use?

Circle the number of days a week

NO DAYS 0 1 2 3 4 5 6 7 EVERY DAY

Birth

21. How old is your baby now? .....weeks

22. How many weeks pregnant were you when your baby was born? .....weeks

23. At what time was your baby born? .....pm / am (please write the time and circle pm or am)

24. What was your baby's birth weight? .....grams or ..... pounds/ounces

25. What was your baby's length at birth? .....cm

26. What was your weight when your baby was born?

.....kgs OR ..... stones ..... lbs ○ Don't know

27. If you experienced labour, how long was it for – from the time you started to experience regular contractions? .....hours

28. Where was your baby born? (e.g. at home, or name of maternity unit/hospital)

Is this where you planned to give birth? 1 ○ Yes 0 ○ No

If 'No', where did you plan to give birth? (e.g. at home, or name of maternity unit/hospital)

Please go to next page ☞

29. How was your baby born? *Tick all that apply*

- ❍ Induced (you had an "induction")
- ❍ Vaginally
- ❍ With the help of forceps or ventouse (vacuum)
- ❍ A planned caesarean (you were expecting to have a caesarean that day)
- ❍ An emergency, but pre-planned caesarean (you were expecting to have a caesarean on another day)
- ❍ An unexpected or emergency caesarean (you weren't expecting to have a caesarean)

30. Overall, how was your experience of labour and birth? *Please circle one number*

0	1	2	3	4	5
Great Better than I thought		Challenging but manageable			Terrible, never again Much worse than I thought

Comments welcome:

Anaesthesia

31. Did you have an epidural (injection in the back) **during labour?**

0❍ No 1❍ Yes *Comments welcome:*

32. Did you have a general anaesthetic for the birth? *(You were given medicine to make you go to sleep for the birth – sometimes this happens for a caesarean section).*

0❍ No 1❍ Yes *Comments welcome:*

If "Yes" – was this planned: 1❍ No 0❍ Yes

33. Were there any complications during the birth?

0❍ No 1❍ Yes *Comments welcome:*

34. Did you bleed excessively at, or after birth?

0❍ No 1❍ Yes

Please go to next page ☞

35. **Did you require a blood transfusion during or after birth?**

0 ○ No 1 ○ Yes

36. **If you gave birth in hospital, how long did you stay there after your baby was born?**

.....hours **OR** .....nights

37. **Did your baby have any illness in the first week of life that required assessment by a paediatrician or admission to the neonatal or special care baby unit?**

0 ○ No 1 ○ Yes *Comments welcome:*

38. **Was your baby born with any congenital abnormalities that required assessment by a paediatrician or admission to the neonatal or special care baby unit?**

0 ○ No 1 ○ Yes *Comments welcome:*

39. **Did you feel you knew enough about what was going on during your birth experience?**

0	1	2	3	4	5
Not at all					Very much

40. **Did you feel listened to during your labour and birth experience?**

0	1	2	3	4	5
Not at all					Very much

Please go to next page ☞

Feeding your baby

41. How would you describe feeding your baby to start with?

Please circle one number

0	1	2	3	4	5
Easy - no problems					Very difficult - lots of problems

Comments welcome:

42. If feeding was difficult at the start, how long was it difficult for? ..... weeks

43. What was your baby's source of milk in the last 48 hours?

1 ○ Baby has received breast milk only, in the last 48 hours
2 ○ Baby has received some breast milk and some formula in the last 48 hours
3 ○ Baby has received only infant formula in the last 48 hours
4 ○ Other, in the last 48 hours – *please describe* →

44. Has your baby only ever received breast milk (no water, formula or other foods)?

1 ○ Yes 0 ○ No

45. Is this how you hoped to be feeding your baby?

1 ○ Yes 0 ○ No 2 ○ Don't know

Comments welcome:

46. How is feeding going now? *Please circle*

0	1	2	3	4	5
Easy - no problems					Very difficult - lots of problems

Comments welcome:

Please go to next page ☞

47. **Are you the only one who feeds your baby?** 1 ○ Yes 0 ○ No

If "No", on how many days a week does someone else feed your baby?

Circle the number of days a week

1 (Once a week) 2 3 4 5 6 7 (Daily)

48. **How many times has your baby fed in the last 24 hours?**

Please circle one number

1 2 3 4 5 6 7 8 9 10 or more

49. **How many times did you wake up last night to feed your baby?**

Please circle one number

0 1 2 3 4 5 or more

50. **How many times did you wake up for your baby last night for another reason?**

Please circle one number

0 1 2 3 4 5 or more

51. **How often do you have help at night with baby care, if you want it?**

Please circle one number

NO NIGHTS 0 1 2 3 4 5 6 7 EVERY NIGHT

OR I could have help at night but I don't need it 8 ○

Sleep – since you have had your baby

52. **How many hours sleep, including naps, do you usually get in 24 hours?**
(just think about the last week)

Please write the number of hours here ..... hours

53. **In the last week, how often did you get a good night's sleep?**

Circle the number of days

NO NIGHTS 0 1 2 3 4 5 6 7 EVERY NIGHT

54. **How long on average, per day, do you spend outside (really outside) exposed to daylight?**

..... hours ..... minutes

Please go to next page ☞

55. On how many nights in the last week did the following things disturb your sleep?

Please circle one number in every row.

	NO NIGHTS							EVERY NIGHT
Going to the bathroom	0	1	2	3	4	5	6	7
Pain in back/neck/joints	0	1	2	3	4	5	6	7
Dreams	0	1	2	3	4	5	6	7
Nightmares	0	1	2	3	4	5	6	7
Heartburn	0	1	2	3	4	5	6	7
Nasal congestion (blocked nose)	0	1	2	3	4	5	6	7
Leg cramps	0	1	2	3	4	5	6	7
Feeling too hot or cold	0	1	2	3	4	5	6	7
Thinking or worrying about things	0	1	2	3	4	5	6	7
Just can't get comfortable	0	1	2	3	4	5	6	7
Just can't get to sleep	0	1	2	3	4	5	6	7
Feeding baby	0	1	2	3	4	5	6	7
Breast leaking or uncomfortable	0	1	2	3	4	5	6	7
Other baby care	0	1	2	3	4	5	6	7
Other children	0	1	2	3	4	5	6	7
Disturbed by partner (e.g. snoring)	0	1	2	3	4	5	6	7
Other	0	1	2	3	4	5	6	7

56. During sleep in the LAST WEEK, has anyone told you that you did any of the following? Please circle how often

Circle one number in every row	NO NIGHTS							EVERY NIGHT
Loud snoring	0	1	2	3	4	5	6	7
Long pauses between breaths while asleep	0	1	2	3	4	5	6	7
Legs twitching or jerking while you sleep	0	1	2	3	4	5	6	7

57. Do you ever experience an urge to move your legs (usually accompanied by unpleasant sensations)?

1 ○ Yes 0 ○ No – *if "No" please go to question 59*

58. If you answered "Yes" in Question 57, is this: *Tick all that apply to you*

1 ○ worse at night?

2 ○ more noticeable when you rest?

3 ○ relieved by movement?

Please go to next page ☞

59. How often in the last week did you:

Please circle one number in every row.

	NO NIGHTS							EVERY NIGHT
Have difficulty getting to sleep	0	1	2	3	4	5	6	7
Wake up during your sleep period	0	1	2	3	4	5	6	7
Wake up too early at the end of a sleep period	0	1	2	3	4	5	6	7
Feel rested upon awakening at the end of a sleep period	0	1	2	3	4	5	6	7
Sleep poorly	0	1	2	3	4	5	6	7
Feel sleepy during the day	0	1	2	3	4	5	6	7
Struggle to stay awake during the day	0	1	2	3	4	5	6	7
Feel irritable during the day	0	1	2	3	4	5	6	7
Feel tired or fatigued during the day	0	1	2	3	4	5	6	7
Feel satisfied with the quality of your sleep	0	1	2	3	4	5	6	7
Feel alert and energetic during the day	0	1	2	3	4	5	6	7
Get too much sleep	0	1	2	3	4	5	6	7
Get too little sleep	0	1	2	3	4	5	6	7
Take a nap at a scheduled time	0	1	2	3	4	5	6	7
Fall asleep at an unscheduled time	0	1	2	3	4	5	6	7
Use a prescription sleeping pill to help you get to sleep	0	1	2	3	4	5	6	7
Use any pain medication to help you get to sleep (e.g. Panadol)	0	1	2	3	4	5	6	7
Take anything else to help you sleep	0	1	2	3	4	5	6	7

If so, what did you take to help you sleep: _____

60. How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? *This refers to your usual way of life in recent times.*

PLEASE TICK ONE CIRCLE ON EACH LINE

	would never doze	slight chance	moderate chance	high chance
Sitting and reading	0	1	2	3
Watching TV	0	1	2	3
Sitting inactive in a public place (e.g. movies, meeting)	0	1	2	3
As a passenger in a car for an hour without a break	0	1	2	3
Lying down in the afternoon when circumstances permit	0	1	2	3
Sitting and talking to someone	0	1	2	3
Sitting quietly after a lunch without alcohol	0	1	2	3
In a car, while stopped for a few minutes in traffic	0	1	2	3

PLEASE MAKE SURE YOU HAVE TICKED ONE BOX ON EACH LINE

Please go to next page ☞

General health and well-being

61. Are you currently having any treatment or monitoring for any of these conditions?

Please tick one circle on every line.

	Yes	No	Don't know/ can't remember
High blood pressure (hypertension)	1 ○	0 ○	2 ○
Pain as a result of the birth	1 ○	0 ○	2 ○
Breast infection (mastitis)	1 ○	0 ○	2 ○
Low iron or anaemia	1 ○	0 ○	2 ○
Birth related infection	1 ○	0 ○	2 ○
Urinary incontinence	1 ○	0 ○	2 ○
Faecal incontinence	1 ○	0 ○	2 ○

62. Are you currently having any treatment or monitoring for any other conditions such as:

If 'No' please go to question 63

Other medical problem(s) – please specify (e.g. diabetes, severe back problem, another medical condition):

Mental health problem(s) – please specify (e.g. depression or other mental health condition):

Diagnosed sleep disorder – please specify:

63. Please list any medicines you are currently taking.

64. During this most recent pregnancy were you distressed by feelings of anxiety or depression for 2 weeks or more?

1 ○ Yes 0 ○ No– *go to question 65*

If so, did this distress:

a) Interfere with your ability to get things done or your relationships with family and friends?

Please circle one number

0	1	2	3	4	5
Not at all		somewhat			very much

b) Lead you to seek professional help?

1 ○ Yes 0 ○ No

Please go to next page ☞

65. **In the first week after your baby was born did you experience times of unexplained tears, feeling very up and then very down or feeling like you were on an emotional roller-coaster – sometimes called the "baby blues"?**

1 ○ Yes 0 ○ No– *go to question 66*

If "Yes", how long did these feelings last? *Please circle one number*

0	1	2	3
Less than than a day	One to two days	Three days to a week	More than a week

Life events

66. **This question is about things that may have happened during the last 12 months.**
Tick all that apply to you - if none of these apply please go to question 67

- ○ A close family member was very sick and had to go into hospital
- ○ I broke up with, got separated or divorced from my partner
- ○ I moved to a new address
- ○ I was homeless
- ○ My partner lost their job
- ○ I lost my job even though I wanted to go on working
- ○ I argued with my partner more than usual
- ○ My partner said they did not want me to be pregnant
- ○ I had a lot of bills I couldn't pay
- ○ I was in a physical fight
- ○ My partner or I went to jail
- ○ Someone very close to me had a bad problem with drinking or drugs
- ○ Someone very close to me died

Feelings since you have had your baby

67. **Please tick the answer which comes closest to how you have felt IN THE LAST 7 DAYS, not just how you feel today.**

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

I have looked forward with enjoyment to things.
0 ○ As much as I ever did
1 ○ Rather less than I used to
2 ○ Definitely less than I used to
3 ○ Hardly at all

Please go to next page ☞

I have blamed myself unnecessarily when things went wrong.

1 ○ Yes, most of the time
2 ○ Yes, some of the time
1 ○ Not very often
0 ○ No, never

I have been anxious or worried for no good reason.

0 ○ No, not at all
1 ○ Hardly ever
2 ○ Yes, sometimes
3 ○ Yes, very often

I have felt scared or panicky for no very good reason.

3 ○ Yes, quite a lot
2 ○ Yes, sometimes
1 ○ No, not much
0 ○ No, not at all

Things have been getting on top of me.

3 ○ Yes, most of the time I haven't been able to cope at all
2 ○ Yes, sometimes I haven't been coping as well as usual
1 ○ No, most of the time I have coped quite well
0 ○ No, I have been coping as well as ever

I have been so unhappy that I have had difficulty sleeping.

3 ○ Yes, most of the time
2 ○ Yes, sometimes
1 ○ Not very often
0 ○ No, not at all

I have felt sad or miserable.

3 ○ Yes, most of the time
2 ○ Yes, quite often
1 ○ Not very often
0 ○ No, not at all

I have been so unhappy that I have been crying.

3 ○ Yes, most of the time
2 ○ Yes, quite often
1 ○ Only occasionally
0 ○ No, never

The thought of harming myself has occurred to me.

3 ○ Yes, quite often
2 ○ Sometimes
1 ○ Hardly ever
0 ○ Never

68. The following are statements about worrying. Please read each statement and indicate how true each one is in describing your general/usual experience of worrying.
Please tick the one option that most likely applies to you for each statement

When I worry, it interferes with my day-to-day functioning (e.g. stops me getting my work done, organising myself or my activities).

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

When I think I should be finished worrying about something, I find myself worrying about the same thing, over and over.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

My worrying leads me to feel down and depressed.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

When I worry, it interferes with my ability to make decisions or solve problems.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

I feel tense and anxious when I worry.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

I worry that bad things or events are certain to happen.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

I often worry about not being able to stop myself from worrying.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

As a consequence of my worrying, I tend to feel emotional unease or discomfort.

0 ○ Not true at all 1 ○ Somewhat true 2 ○ Moderately true 3 ○ Definitely true

Your baby

69. In general how often does your baby cry?

0	1	2	3	4	5
Never					Very often

70. When your baby has been upset and you do things to try and calm him/her down (like rocking, walking, showing toys), how often does he/she take more than 10 minutes to calm down?

Please circle one number

Never	Very rarely	Less than half the time	About half the time	More than half the time	Almost always	Always
1	2	3	4	5	6	7

71. When being held, how often does your baby:

Pull away or kick?

Please circle one number

Never	Very rarely	Less than half the time	About half the time	More than half the time	Almost always	Always
1	2	3	4	5	6	7

Seem to enjoy him/herself?

Please circle one number

Never	Very rarely	Less than half the time	About half the time	More than half the time	Almost always	Always
1	2	3	4	5	6	7

72. When going to bed, how often does your baby settle within 10 minutes?

Please circle one number

Never	Very rarely	Less than half the time	About half the time	More than half the time	Almost always	Always
1	2	3	4	5	6	7

73. When your baby is upset about something, how often does s/he stay upset for 20 minutes or longer?

Please circle one number

Never	Very rarely	Less than half the time	About half the time	More than half the time	Almost always	Always
1	2	3	4	5	6	7

Baby's health

74. Which of the following has your baby had during the LAST WEEK?

Tick all that apply (or go to question 75 if none apply)

- ❍ Fever (high temperature)
- ❍ Diarrhoea
- ❍ Vomiting
- ❍ Ear infection
- ❍ Colic
- ❍ Fussy or irritable
- ❍ Reflux
- ❍ Runny nose or cold
- ❍ Cough or wheeze
- ❍ Chest infection
- ❍ Asthma
- ❍ Food allergy
- ❍ Eczema (atopic dermatitis)
- ❍ None of these

75. Did your baby receive any of the following medicines in the last 2 weeks?

(Please do not include vitamins or minerals).

Antibiotics 1❍ Yes 0❍ No

Other prescription medicine 1❍ Yes 0❍ No

If "Yes" please write the name of the medicine(s) here:

Non-prescription medicine 1❍ Yes 0❍ No

If "Yes" please write the name of the medicine(s) here:

76. Has your baby received immunisation injections in the last 48-hours?

1❍ Yes 0❍ No

Baby's sleep in the last week

77. Where does your baby sleep *most* of the time during the DAY?

In his/her own room 1❍

In parents' room 2❍

In sibling or other's room 3❍

In another room of the house 4❍

With you or another person e.g. being held or in a sling 5❍

Moving around with you e.g. in a pram or basket 6❍

Other – please state where: 7❍

78. Where does your baby sleep *most* of the time at NIGHT?

In his/her own room	1 ○
In parents' room	2 ○
In sibling or other's room	3 ○
In another room of the house	4 ○
Other – please state where:	5 ○

79. What does your baby sleep in *most* of the time during the DAY?

Bassinet	1 ○
Cot	2 ○
Parents' bed	3 ○
Infant seat	4 ○
Being held or in a sling/front pack	5 ○
In a pram or buggy	6 ○
Other – please state what:	7 ○

80. What does your baby sleep in *most* of the time at NIGHT?

Bassinet	1 ○
Cot	2 ○
Parents' bed	3 ○
Infant seat	4 ○
In a pram or buggy	5 ○
Other – please state what:	6 ○

81. In the last week did your baby start their night sleep in one location, and then move to another location during the night?

(For example, baby went to sleep in own cot, then moved to your bed and went to sleep again).

1 ○ Yes 0 ○ No – *go to question 83*

If "Yes", on how many nights did they change their sleep location?

Circle the number of nights 1 2 3 4 5 6 7

Please go to next page ☞

82. **If you answered "Yes" to question 81, why did your baby move sleep location during the night?** *(Feel free to list more than one reason).*

83. **How often does your baby go off to sleep with help from others?**
(e.g. being fed, rocked or cuddled)

Circle one number

0	1	2	3
Never	Rarely	Often	Always

84. **In general do you consider your child's sleep as a problem?**

2 ○ A very serious problem

1 ○ A small problem

0 ○ Not a problem at all

85. **How many times does your baby usually wake up between 10pm and 6am?**

0	1	2	3	4 or more
Not at all				times

86. **What is the *longest* stretch of time that your baby is asleep during the night without waking up?**

0	1	2	3	4	5
Less than 30 minutes	30 mins to 1 hour	1 to 2 hours	2 to 3 hours	3 to 4 hours	More than than 4 hour

87. **What is the *longest* stretch of time that your baby usually sleeps during the day?**

0	1	2	3	4	5
Less than 30 minutes	30 mins to 1 hour	1 to 2 hours	2 to 3 hours	3 to 4 hours	More than than 4 hour

88. **How often do your baby's sleep patterns allow you to get a reasonable, total amount of sleep in 24 hours?**

Circle the number of days

NO DAYS							EVERY DAY
0	1	2	3	4	5	6	7

89. **How often do your baby's daytime sleep patterns allow you to have a break?**

NO DAYS ——— EVERY DAY

Circle the number of days 0 1 2 3 4 5 6 7

90. **How much do your baby's sleep patterns change from day to day?**

0	1	2	3
Always the same	Change occasionally	Change often	Everyday is different

91. **Date questionnaire completed** ..... / ..... / .....
(day) (month) (year)

Please take a moment now to flick through every page of this survey and check that you have answered all the questions you meant to.

A $20 voucher, from the choice of three options, below will be posted to you when we receive this completed questionnaire. Please ensure you advise us if your address has changed.

Please indicate the type of voucher you would prefer (tick one):

Petrol ☐ (NTA) Supermarket ☐ (New World) Department store ☐ (Farmers)

Important note

If you feel concerned about *any* of the issues raised by completing this questionnaire, we suggest that you discuss these with your Lead Maternity Carer, doctor or other health professional.

The end. Thank you.

E Moe, Māmā, Maternal Sleep and Health
in Aotearoa/New Zealand

For more information contact: mumsleep@massey.ac.nz or visit http://sleepwake.massey.ac.nz/
or freephone 0800MUMSLEEP (0800 686 7537) or free text SLEEP to 5222.

Return to: Sleep/Wake Research Centre, Massey University, PO Box 756, Wellington 6140

APPENDIX D. Phone call protocols for elevated scores

Edinburgh Postnatal Depression Scale (EPDS): Phone Call Protocols for elevated scores.

When phoning women, keep in mind they may find this information distressing.

35-37 Week Antenatal EPDS & 12 Week Postnatal

Criteria	Action
EPDS Score ≥ 13 & Q10= '0' or '1'	**Participant** 1. Call participant to inform of high/elevated score, which may indicate symptoms of depression. 2. Advise that they she should discuss this further with her LMC/GP. 3. Follow-up regarding consent to contact LMC. 4. Send letter to woman if requested EPDS_Letter to Participant_35_37wks.doc; EPDS_Letter to Participant_12 week post.doc EPDS_Letter to Participant_6 week post.doc **Midwife/LMC/GP** 1. If consent obtained, phone LMC to advise of elevated scores and that they may want to re-administer the EPDS and consider a referral for further evaluation/treatment: *<u>If EPDS≥ 18</u> discuss possible referral to Maternal Mental Health Service. If they are unsure on the process they can consult with [maternal mental health clinicians/collaborators].* *<u>If EPDS 13-17</u> consider referral to a PHO/NGO service, generally via their GP.* 2. Send Letter to Midwife/LMC/GP EPDS_Letter to LMC or GP.doc EPDS_Letter to LMC or GP_12 Week Post.doc
EPDS Score ≥ 13 & Q10= '2' or '3' OR Any EPDS score and Q10='2' or '3'	• Discuss with [psychiatrist] ↓ • Phone call to participant to inform of elevated score/risk on Q10. Advise that we highly recommend she should discuss this further with her LMC/GP and get consent to inform LMC/GP. ↓ • Phone LMC/GP to inform of elevated scores and potential risk. Advise that they may want to re-administer the EPDS and further assess. Also, consider a referral for further evaluation/treatment. Discuss possible referral to Maternal Mental Health Service and in any emergency/urgent situation the first point of contact 111 and/or Crisis Assessment Treatment Team. If they are unsure they can consult further with [maternal mental health clinicians/collaborators]. ↓

	• Send letter to woman (discuss this first) & LMC/GP. *EPDS_Letter to LMC or GP_elevated risk Q10.doc*
Elevated score on Brief Measure of Worry Scale	If high scores are identified on this scale it should correlate with the EPDS score. ↓ Review any discrepancies in scores with [psychiatrist]
If the woman advises that she requires/may require acute assistance.	Provide CATT team number/Mental Health Crisis Line number (see Appendix 1). Let them know they may have to leave a message. ↓ Also inform Midwife
Emergency or urgent situation	Call 111

6-Week Phone call*

Criteria	Action
EPDS-3 ≥ 4	• Phone call to participant to inform of elevated score, which may indicate symptoms of depression. Advise that they she should discuss this further with her LMC/GP. ↓ Phone LMC (if consented) to advise of elevated scores and that they may want to re-administer the EPDS and consider a referral for further evaluation/treatment. If EPDS-3 >5 discuss possible referral to Maternal Mental Health Service. If they are unsure on the process they can consult with [psychiatrist]. If EPDS 4-5 consider referral to a PHO/NGO service. ↓ Send letter to woman & LMC/GP <<letter.doc>>.
If women advises that she requires acute/after hours assistance	Provide Mental Health line number or CATT team number. They may have to leave a message. Also inform LMC/GP.

* Note: At 6 week phone call woman are no longer under the care of LMC and may not be registered with a GP – discuss with woman how we may facilitate access to an appropriate service.

Adjusted EPDS-3 Scores

EPDS-3 scores	0	1	2	3	4	5	6	7	8	9
Adjusted EPDS-3 scores	0	3	7	10	13	17	20	23	27	30