Sleep Medicine 15 (2014) 1477–1483

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Prevalence of abnormal sleep duration and excessive daytime sleepiness in pregnancy and the role of socio-demographic factors: comparing pregnant women with women in the general population

T. Leigh Signal [a,*], Sarah-Jane Paine [a], Bronwyn Sweeney [a], Monique Priston [a], Diane Muller [a], Alexander Smith [a], Kathryn A. Lee [b], Mark Huthwaite [c], Papaarangi Reid [d], Philippa Gander [a]

[a] Sleep/Wake Research Centre, Massey University, Wellington, New Zealand
[b] School of Nursing, University of California, San Francisco, CA, USA
[c] Department of Psychological Medicine, University of Otago, Wellington, New Zealand
[d] Department of Māori Health, Faculty of Medical and Health Sciences, University of Auckland, Auckland, New Zealand

ARTICLE INFO

Article history:
Received 3 March 2014
Received in revised form 26 June 2014
Accepted 1 July 2014
Available online 3 September 2014

Keywords:
Age
Employment
Ethnicity
Excessive daytime sleepiness
Long sleep
Short sleep

ABSTRACT

Objectives: To compare the prevalence of self-reported abnormal sleep duration and excessive daytime sleepiness in pregnancy among Māori (indigenous New Zealanders) and non-Māori women versus the general population, and to examine the influence of socio-demographic factors.
Methods: Self-reported total sleep time (TST) in 24-hrs, Epworth Sleepiness Scale scores and socio-demographic information were obtained from nullipara and multipara women aged 20–46 yrs at 35–37 weeks pregnant (358 Māori and 717 non-Māori), and women in the general population (381 Māori and 577 non-Māori).
Results: After controlling for ethnicity, age, socio-economic status, and employment status, pregnant women average 30 min less TST than women in the general population. The distribution of TST was also greater in pregnant women, who were 3 times more likely to be short sleepers (≤6 h) and 1.9 times more likely to be long sleepers (>9 h). In addition, pregnant women were 1.8 times more likely to report excessive daytime sleepiness (EDS). Pregnant women >30 years of age experienced greater age-related declines in TST. Identifying as Māori, being unemployed, and working at night increased the likelihood of reporting abnormal sleep duration across all women population in this study. EDS also more likely occurred among Māori women and women who worked at night.
Conclusions: Pregnancy increases the prevalence of abnormal sleep duration and EDS, which are also higher among Māori than non-Māori women and those who do night work. Health professionals responsible for the care of pregnant women need to be well-educated about the importance of sleep and discuss sleep issues with the women they care for.

1. Introduction

Alterations to sleep during the third trimester of pregnancy and concomitant increases in daytime sleepiness have been well documented [1]. Due to the physiological and psychological processes that are a normal part of pregnancy, some changes in sleep are not surprising. Regardless of the nature and extent of these changes, they are often accepted by pregnant women and their healthcare providers as the norm.

Aside from symptoms of sleep disorders, it is not clear what constitutes normal variation in sleep and sleepiness during pregnancy and at what point these changes have implications for the health of the mother and her unborn child. Emerging evidence suggests altered sleep is associated with adverse pregnancy [2,3] and birth outcomes [4–6], and with poorer perinatal mental health [7,8]. The extent of change from non-pregnant sleep may be an important indicator of increasing risk of adverse outcomes, but few studies have addressed this.

Due to logistical challenges, including high rates of unplanned pregnancies [9], very few studies follow women longitudinally from prior to conception through to birth. One study that recorded sleep polysomnography prior to pregnancy and in each trimester found an increase in total sleep time (TST) in the first trimester and a change in sleep architecture, with a decline in slow wave sleep (SWS)

* Corresponding author at: Sleep/Wake Research Centre, Massey University, Private Bag 756, Wellington 6140, New Zealand. Tel.: +61 4 8015799; fax: +61 4 3800629.
E-mail address: t.l.signal@massey.ac.nz (T.L. Signal).

http://dx.doi.org/10.1016/j.sleep.2014.07.007
1389-9457/

from pre-pregnancy values. As pregnancy progresses, total sleep time and sleep efficiency generally decrease [10]. Although previous small-scale studies have compared sleep and sleepiness among pregnant and non-pregnant women (e.g. [11–13]), to our knowledge, no large epidemiological studies have done so.

The sleep of pregnant women is potentially affected by more than just the biological changes that occur due to pregnancy. In general population surveys, greater risk for reporting poor quality sleep is seen among ethnically non-dominant groups, the socio-economically disadvantaged, and those who work at night [14]. These findings have also been reported in a structured random sample of New Zealand adults (national population 4.4 million, 15% Māori who are indigenous New Zealanders). Minimal research has addressed socio-demographic disparities in sleep during pregnancy. One recent study reported that employment early in pregnancy was associated with sleeping <7 h per night, and that poorer overall sleep quality was associated with age >35 years and identifying as either African-American or Hispanic race/ethnicity, compared to women of white and other race [15]. Women from ethnically non-dominant groups are also more likely to experience poorer pregnancy and birth-related outcomes [16], and disparities have been reported in the proportion of ethnically non-dominant and socio-economically deprived women requiring a cesarean birth, with either significantly higher or lower rates [17,18].

The aim of this study was to compare self-reported sleep duration and daytime sleepiness in a large sample of Māori and non-Māori New Zealand women in late pregnancy with women of the same age from the general population. The study also examined socio-demographic factors associated with sleep in pregnant and non-pregnant women.

2. Methods

Data from two studies are utilized here. Both utilized Kaupapa Māori epidemiological research principles [19] which included aiming to recruit equal numbers of Māori and non-Māori participants to provide equal explanatory power for both populations [14].

2.1. Pregnant sample

A sample of nullipara and multipara pregnant women was obtained from a larger study investigating sleep changes across the perinatal period and the relationship with maternal health.

Ethical approval was obtained from the Central Region Health and Disability Ethics Committee (protocol CEN 09/09/070). Pregnant women were recruited from across New Zealand using a wide range of methods tailored to achieve the aim of recruiting equal numbers of pregnant Māori and non-Māori women [20]. Due to a strong recruitment drive in this area, 69% of the final sample was from the Wellington region (southern end of the North Island of New Zealand, including the cities of Wellington, Porirua, Lower Hutt, and Upper Hutt). Women received study questionnaires and information either via their lead maternity carer (midwife or obstetrician), community health group, or from a member of the research team.

Across a two-year period (October 2009–October 2011), 1186 women enrolled in the study; 407 Māori and 737 non-Māori women completed comprehensive paper-based questionnaires providing socio-demographic information and details on their sleep and health during pregnancy. Questionnaires were completed by 1089 women between 35 and 37 weeks of gestation.

2.2. General population sample

The Wellington Regional Ethics Committee reviewed and approved the original study (protocol 0104037) which focused on the prevalence of insomnia symptoms in New Zealand. A random sample of 2100 Māori and 1900 non-Māori adults, aged 20–59 years, was selected from the New Zealand electoral rolls in June 2001. A two-page questionnaire including socio-demographic and sleep items was mailed to individuals along with a pre-paid reply envelope. A total of 2670 responses were received from men and women, and 1446 were from women (whose reproductive status was unknown). Further details of this study can be found elsewhere [21].

2.3. Combined dataset

Secondary analysis of these datasets was approved as "low risk notification" by Massey University Ethics Committee. In order to match the samples more closely in age, only women between 20 and 46 years of age were included in the final dataset (see Table 1 for further details).

Only certain items from each of the studies described above were comparable between the two samples and are used in analyses described here. They are:

1. Age categorized in five-year bands derived from the date of birth provided.
2. Socio-economic deprivation determined using the New Zealand Deprivation Index (NZDep2001 for the general population sample [22] and NZDep2006 for the pregnant sample [23]). This is a validated small-area index of socio-economic deprivation that has been widely used in research and shown to be associated with mortality, morbidity, and poor health [24]. It is based on responses to nine items from the national census, namely: having no access to a telephone; receiving a means-tested benefit; being unemployed; low household income; no access to a car; single parent family; no educational qualification; not living in own home; and living in an overcrowded home. The index provides deprivation scores which are categorized into deciles from 1 (least deprived) to 10 (most deprived) based on an individual's residential address. A street address is mapped to a census meshblock, which is a geographic area containing a median of 90 people, to which an NZDep value has previously been assigned.
3. Self-identified ethnicity using the New Zealand census question [25] and categorized as Māori (anyone who identifies as Māori either alone or in combination with another ethnic group/s) or non-Māori (all others).
4. Employment status based on the New Zealand census question [26], categorized as: not currently working for pay, profit or income; in paid work without night work in the last month; in paid work with night work in the last month (for ≥3 h between midnight and 05:00) [27].
5. Total sleep duration in 24 h. In the pregnant sample, due to the possibility of sleep changing markedly over time, the question asked about the last week. In the general population sample, the question asked about usual sleep duration. This was analyzed as a continuous variable and categorized as either short (≤6 h), normal (>6 h and ≤9 h), or long (>9 h).
6. Daytime sleepiness was measured by the Epworth Sleepiness Scale (ESS) [28], which is a widely used measure that asks about the likelihood of falling asleep (on a four-point scale) in eight different situations or activities that people would encounter in normal daily life (e.g. lying down in the afternoon when circumstances permit, sitting and talking to someone). It has been used successfully in previous epidemiological studies of Māori and non-Māori new Zealanders [29]. Daytime sleepiness scores were analyzed as a continuous variable and categorized as excessive daytime sleepiness (EDS, classified as ESS >10) or not.

Table 1
Comparison of pregnant women and women in the general population for each ethnic group, according to age and work status.

Category	Māori women			Non-Māori women		
	Pregnant ($N = 358$) (%, 95% CI)	General population ($N = 381$) (%, 95% CI)	χ^2, P-value	Pregnant ($N = 717$) (%, 95% CI)	General population ($N = 577$) (%, 95% CI)	χ^2, P-value
Age category (years)						
20–24 (%)	28.5 (23.8–33.2)	14.4 (10.9–18.0)		7.4 (5.5–9.3)	12.9 (10.3–15.7)	
25–29 (%)	25.4 (20.9–29.9)	16.3 (12.6–20.0)		21.9 (18.9–24.9)	17.7 (14.6–20.8)	
30–34 (%)	29.3 (24.6–34.1)	20.5 (16.4–24.5)		39.2 (35.6–42.8)	17.5 (14.4–20.6)	
35–39 (%)	13.7 (10.1–17.3)	20.5 (16.4–24.5)		25.9 (22.7–29.1)	17.3 (14.2–20.4)	
40–46 (%)	3.1 (1.3–4.9)	28.3 (23.8–32.9)	$\chi^2(4) = 108.63$, $P < 0.001$	5.6 (3.9–7.3)	34.5 (30.6–38.4)	$\chi^2(4) = 219.34$, $P < 0.001$
Not in paid work (%)	43.8 (38.7–49.0)	33.1 (28.3–37.8)		30.0 (26.7–33.4)	24.0 (20.5–27.5)	
Paid work without night work (%)	53.7 (48.5–58.8)	59.0 (54.0–64.0)		67.4 (64.0–70.9)	69.2 (65.4–73.0)	
Paid work with night work (%)	2.5 (0.9–4.2)	7.9 (5.2–10.7)	$\chi^2(2) = 16.56$, $P < 0.001$	2.5 (1.4–3.7)	6.8 (4.8–8.9)	$\chi^2(2) = 17.75$, $P < 0.001$

CI, confidence interval.

2.4. *Statistical analyses*

All analyses were conducted in SAS v9.3 (SAS, Cary, NC, USA). Proportions and 95% confidence intervals (CIs) are used to describe categorical variables of interest and χ^2-analyses were used to determine whether there were differences in the proportion of women: (1) by ethnicity (Māori/non-Māori) within each sample (pregnant/general population); and (2) between each sample for women of the same ethnicity.

Multivariate analyses were conducted for the following outcome variables: total sleep time in 24 h; sleep duration categorized as short, normal, and long; daytime sleepiness; and daytime sleepiness categorized as excessive or not. For continuous variables, analysis of variance (ANOVA) was employed using a generalized linear model to investigate the independent contribution of sample (pregnant/general population), ethnicity (Māori/non-Māori), age (in five-year categories), socio-economic position (NZDep in quintiles), and employment (not currently in paid work, in paid work without night work, and in paid work with night work). Initial models included all main effects and two-way interactions between sample and other variables. Interactions that were not significant ($P > 0.05$) were subsequently removed until only significant interactions and main effects remained. Post-hoc analyses were adjusted for multiple comparisons [30]. A series of logistic multivariate regression models were used to determine the independent predictors of short sleep (vs normal sleep), long sleep (vs normal sleep) and EDS (vs ESS <10). As with the ANOVAs, sample, ethnicity, age, socio-economic deprivation, employment status, and the two-way interactions between sample and other variables were entered into the model simultaneously. Results for these models are presented as odds ratios (ORs) and 95% CIs. In all multivariate analyses, only complete cases were included.

3. Results

Māori women, both pregnant and from the general population, were over-represented in the most deprived socio-economic deciles and non-Māori women were over-represented in the least-deprived deciles (Fig. 1).

3.1. *Differences between Māori and non-Māori women within each sample*

Compared to pregnant non-Māori women, pregnant Māori women were: more likely to be aged 20–24 years and less likely to be aged 30–39 years [$\chi^2(4) = 101.04$, $P < 0.001$]; more likely not to be currently working for pay and more likely to be in paid work that included night work [$\chi^2(2) = 20.13$, $P < 0.001$]; more likely to be long sleepers [$\chi^2(2) = 18.53$, $P < 0.001$]; and more likely to report EDS [$\chi^2(1) = 5.74$, $P = 0.017$].

Compared to non-Māori women in the general population, Māori women in the general population were: more likely not to be currently working for pay and more likely to be in paid work that included night work [$\chi^2(2) = 10.79$, $P = 0.005$]; more likely to be short sleepers and less likely to be normal sleepers [$\chi^2(2) = 15.62$, $P < 0.001$]; and more likely to report EDS [$\chi^2(1) = 4.71$, $P = 0.030$].

3.2. *Differences between samples for Māori and non-Māori women*

Compared to Māori women in the general population, pregnant Māori women were: more likely to be aged 20–334 years years and less likely to be aged 40–46 years (Table 1); more likely not to be currently working for pay, and less likely to be doing paid work that included night work; more likely to report short and long sleep (Table 2); and more likely to report EDS.

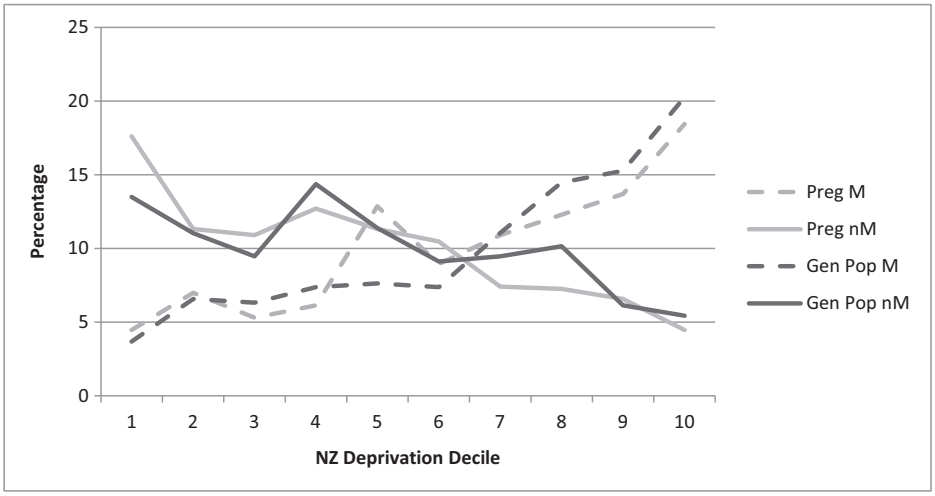

Fig. 1. Proportion of women in each sample by socio-economic decile (1 = 10% of population who are least deprived; 10 = 10% of population who are most deprived. Preg M, pregnant Māori; Preg nM, pregnant non-Māori; Gen Pop M, general population Māori; Gen Pop nM, general population non-Māori).

Compared to non-Māori women in the general population, pregnant non-Māori women were: less likely to be aged 20–24 years, more likely to be aged 30–39 years, and less likely to be aged 40–46 years; less likely to be in paid work involving night work; more likely to be short sleepers and less likely to be normal sleepers; and more likely to report EDS.

3.3. Factors affecting total sleep time

Factors affecting total sleep in 24 h are summarized in Table 3. Pregnant women reported obtaining less sleep than women in the general population (estimated means 7.3 h vs 7.8 h) and younger women reported obtaining more sleep than older women (women aged 20–24 years had more sleep than women aged ≥30 years, all *P*-values < 0.001; women aged 25–29 years had more sleep than women aged 35–39 years, $P = 0.033$, and 40–46 years, $P = 0.007$). Not currently working for pay, profit, or income was associated with reporting more sleep compared to paid work without night work (estimated means 7.7 h vs 7.5 h, $P = 0.042$). Only the interaction of sample and age was significant, with pregnant women aged 30–34 years sleeping less than women in the general population aged 20–24 years ($P < 0.001$), 25–29 years ($P = 0.003$), and 35–39 years ($P = 0.004$). Pregnant women aged 35–39 years reported less sleep than all age categories in the general population sample (all *P* values < 0.001); and pregnant women aged 40–46 years reported less sleep than women in the general population aged 20–24 years ($P < 0.001$), 25–29 years ($P = 0.010$), and 35–39 years ($P = 0.012$).

Results to determine the independent predictors of short versus normal, and long versus normal sleep duration are presented in Table 4. Being pregnant was associated with an increased likelihood of being both a short and long sleeper, as was identifying as Māori. Being aged >30 years independently increased the risk of reporting sleeping ≤6 h per night and decreased the risk of sleeping >9 h per night. Paid work that included night work increased the likelihood of being both a short and long sleeper, whereas currently not in paid employment was associated with a greater likelihood of being a long sleeper. There were no significant interactions.

3.4. Factors affecting daytime sleepiness

Pregnant women were found to be sleepier than women in the general population (estimated means 7.92 vs 6.76) and Māori women were also sleepier than non-Māori women (estimated means 7.84 vs 6.83) (Table 3). Women who were in paid work with night work were sleepier than those in paid work without night work (estimated means 8.82 vs 6.70, $P < 0.001$) and those currently not working (estimated mean 6.49, $P < 0.001$). There were no associations between age, socio-economic position, TST, and daytime sleepiness, and no significant interaction effects. When daytime sleepiness was categorized as excessive or not, logistic regression analyses showed similar findings, with EDS more likely for pregnant women, Māori women and women who had paid night work after adjusting for age and socio-economic deprivation (Table 4).

4. Discussion

These comparisons between a large sample of Māori and non-Māori pregnant women and women from the general population confirm that abnormal sleep durations and daytime sleepiness are strongly influenced by pregnancy. As shown previously [15], TST was shorter in late pregnancy. However, the mean difference was not large, with pregnant women reporting an average of 30 min less sleep per 24 h than women in the general population. There was also a marked increase in the prevalence of short sleep in pregnancy. Thirty percent of pregnant Māori and non-Māori women reported sleep durations ≤6 h, which is two to three times the unweighted prevalence seen in women in the general population. Long sleep (≥9 h) was also more prevalent in pregnancy, particularly among Māori women, with the unweighted prevalence during pregnancy approximately twice that of Māori women in the general population.

These findings suggest that focusing on mean sleep durations between pregnant and non-pregnant populations may be less informative than exploring the change in the distribution of sleep duration. This is of relevance given recent evidence of relationships between abnormal sleep duration and maternal and fetal outcomes in pregnancy.

In addition to describing the effect of pregnancy on sleep, this study sought to understand the contribution of socio-demographic factors to reporting abnormal sleep durations and EDS. On the whole, socio-demographic factors were not found to interact with pregnancy to further alter sleep or daytime sleepiness, with age as the only exception. The sleep of pregnant women and women in the general population was similarly affected by the socio-demographic factors examined, with the likelihood of reporting abnormal sleep duration higher for Māori women and women who were

Table 2
Comparison of pregnant women and women in the general population for each ethnic group, according to prevalence of sleep categories and excessive daytime sleepiness.

Sleep category	Māori women			Non-Māori women		
	Pregnant (%, 95% CI)	General population (%, 95% CI)	χ^2, P-value	Pregnant (%, 95% CI)	General population (%, 95% CI)	χ^2, P-value
Short (%, ≤6 h)	29.2 (24.4–33.9)	16.6 (12.7–20.5)		29.9 (26.6–33.3)	9.5 (7.0–11.9)	
Normal (%, >6, and ≤9 h)	51.8 (46.6–57.1)	72.8 (68.1–77.5)		60.3 (56.7–63.9)	83.6 (80.5–86.7)	
Long (%, >9 h)	19.0 (14.9–23.1)	10.6 (7.4–13.8)	$\chi^2(2) = 32.75$, $P < 0.001$	9.8 (7.6–12.0)	6.9 (4.8–9.0)	$\chi^2(2) = 89.08$, $P < 0.001$
Excessive daytime sleepiness (%, >10)	23.3 (18.8–27.7)	16.8 (13.0–20.5)	$\chi^2(1) = 4.82$, $P = 0.028$	17.1 (14.3–19.9)	11.8 (9.1–14.4)	$\chi^2(1) = 7.02$, $P = 0.008$

CI, confidence interval.

Table 3
Factors affecting total sleep time (TST) in 24 h and daytime sleepiness (analysis of variance).

Factor	TST in 24 h ($n = 1946$)	Daytime sleepiness ($n = 1896$)
Sample	$F(1) = 31.19$, $P < 0.001$	$F(1) = 35.72$, $P < 0.001$
Ethnicity	$F(1) = 0.08$, $P = 0.782$	$F(1) = 26.04$, $P < 0.001$
Age	$F(1) = 10.39$, $P < 0.001$	$F(1) = 1.02$, $P = 0.397$
Socio-economic position	$F(1) = 1.39$, $P = 0.235$	$F(1) = 0.66$, $P = 0.618$
Employment	$F(1) = 3.12$, $P = 0.045$	$F(1) = 13.32$, $P < 0.001$
Sample × age	$F(1) = 3.46$, $P = 0.008$	NA
Current TST	NA	$F(1) = 0.65$, $P = 0.421$

NA, not applicable.

unemployed or working at night. EDS was also more likely for Māori women and women who worked at night.

These findings add to our understanding of sleep health disparities, demonstrating that they persist in pregnancy. In the present study, and consistent with previous research [14], Māori women were more likely to be short and long sleepers, have higher average ESS scores, and experience EDS. However, in contrast to previous epidemiological sleep research [21,31], the area-based measure of socio-economic deprivation was not associated with sleep duration and daytime sleepiness outcomes. It may be that, for pregnant women, the New Zealand deprivation index is a less sensitive measure of deprivation, as it is area-based rather than addressing personal deprivation levels. Pregnant women may experience large changes in individual socio-economic status over a short period of time, due to altered personal and household income when they cease work in the later stages of pregnancy, but do not necessarily change their residential address (on which the New Zealand deprivation index is based). The application of the index to the limited age range of the sample (20–46 years) may also have contributed to this finding. A recent study investigating socio-economic status and sleep in early pregnancy also did not find an association with sleep duration when using household income levels [32]. This study did find an association between household income and sleep quality and fragmentation. These findings, in conjunction with our own, suggest that changes in sleep duration right across pregnancy are not as strongly influenced by socio-economic position compared to the biological changes that occur and other socio-demographic factors, such as age and employment, but that sleep quality might be.

Age was strongly associated with sleep duration in pregnancy but not with daytime sleepiness, with older pregnant women obtaining less sleep than both younger pregnant women and women of similar age in the general population. In contrast, young pregnant women, particularly women aged <25 years, were more likely to sleep for longer, and TST did not differ from their age-related peers in the general population. To our knowledge, this interaction of pregnancy with age, which results in a decline in sleep for pregnant women aged >30 years, has not been previously demonstrated. It may be that the sleep of older women is restricted by greater work, childcare, and household demands. For women who are pregnant, this is possibly compounded by the physiological changes and psychological stressors associated with pregnancy, placing them at greater risk of experiencing the adverse outcomes associated with short sleep in pregnancy. On the other hand, younger women may also be at an increased risk of adverse outcomes associated with long sleep durations. Williams et al. [2]. demonstrated an association between short and long sleep and pregnancy-induced hypertension and pre-eclampsia. These models were adjusted for age, but included only a small proportion of women aged <25 years. Further research is required to explore the relationship between abnormal sleep durations, age, parity, and adverse pregnancy-related outcomes.

Table 4
Factors related to sleep duration [logistic regression: odds ratios (95% confidence intervals)].

Characteristic	Short (≤6 h) vs normal (>6 h and ≤9 h) (n = 1737)	Long (>9 h) vs normal (>6 h and ≤9 h) (n = 1522)	Excessive daytime sleepiness (n = 1896)
Sample (pregnant vs general population)	3.90[a] (2.96–5.16)	1.86[a] (1.33–2.59)	1.79[a] (1.35–2.38)
Ethnicity (Māori vs non-Māori)	1.43[a] (1.11–1.84)	1.56[a] (1.12–2.19)	1.49[a] (1.14–1.95)
Age (years)			
25–29 vs 20–24	1.26 (0.81–1.96)	0.68 (0.44–1.04)	0.88 (0.57–1.37)
30–34 vs 20–24	1.74[a] (1.14–2.64)	0.53[a] (0.34–0.82)	1.07 (0.71–1.62)
35–39 vs 20–24	1.61[a] (1.03–2.49)	0.28[a] (0.16–0.49)	1.37 (0.89–2.11)
40–46 vs 20–24	2.14[a] (1.31–3.49)	0.31[a] (0.17–0.58)	1.25 (0.85–1.87)
NZDep quintile			
3–4 vs 1–2	1.11 (0.78–1.58)	0.80 (0.49–1.30)	1.13 (0.76–1.68)
5–6 vs 1–2	1.12 (0.78–1.59)	0.66 (0.41–1.09)	0.95 (0.64–1.42)
7–8 vs 1–2	1.25 (0.87–1.81)	0.65 (0.39–1.08)	1.26 (0.85–1.87)
9–10 vs 1–2	1.10 (0.75–1.63)	0.95 (0.59–1.53)	1.31 (0.87–1.96)
Night work vs day work	1.74[a] (1.00–3.01)	2.17[a] (1.09–4.32)	2.75[a] (1.66–4.54)
Unemployed vs day work	1.17 (0.91–1.51)	1.83[a] (1.33–2.53)	1.01 (0.77–1.34)

[a] $P < 0.05$.
NZDep, New Zealand Deprivation Index.

Being in paid work that included night work was strongly related to both sleep duration and daytime sleepiness. There is ample previous evidence indicating that night work results in shorter sleep and greater sleepiness due to the displacement of sleep to a less than ideal circadian phase [33] but this has not been explored previously within a pregnant population. A large study of middle-aged women also noted that permanent night work increased the likelihood of reporting long sleep [34]. The present findings suggest that the effect of night work on sleep is relevant during pregnancy and support the International Labour Organisation recommendation that in late pregnancy women should avoid working at night [27]; however, few countries have signed on to this Convention (New Zealand has not).

Unemployment was also associated with long sleep duration in both pregnant women and women in the general population. This finding is also aligned with international literature [34,35] in other non-pregnant samples, although it should be acknowledged that the relationship between unemployment and sleep duration is likely to be complex, and influenced by factors such as socio-economic status, and mental and physical health. It is important to note that both night work and unemployment are more prevalent among Māori [21] and therefore the higher risk of exposure means that Māori will be disproportionately impacted by the negative health effects of abnormal sleep and daytime sleepiness. These findings provide support for sleep health services to be available and accessible to those who work at night, are unemployed and in particular to Māori.

There are a number of limitations that should be considered when interpreting study findings. First, women in the general population sample were not asked whether they were pregnant at the time they completed the study questionnaire. Using census data from 2001 [36], an estimated 6.6% of women drawn from a random sample of New Zealand women would be pregnant at any one time. The presence of pregnant women in the general population sample is expected to reduce the size of differences seen in this study, which are therefore likely to be conservative.

It is acknowledged that there are limitations associated with self-reported sleep duration, with sleep usually being overestimated [37] but this measure of sleep has consistently demonstrated a reliable relationship with health and mortality outcomes [35]. All other data were also self-reported and cross-sectional, so they cannot address causality. There is also the potential for unmeasured confounding, as it was not possible to adjust for all known risk factors for altered sleep durations and daytime sleepiness. Finally, it is recognized that for pregnant women, the biological changes associated with pregnancy and the socio-demographic factors investigated in the present study are not the only issues likely to affect sleep. An enormous range of lifestyle influences, such as responsibilities in the home, level of partner and social support, mental and physical health, and health-related behaviour have the potential to affect sleep during pregnancy. Whereas there are similar factors expected to be influencing sleep for non-pregnant women, it is not known whether any of these broad range of lifestyle and health-related factors interact with pregnancy to exacerbate the biological changes that occur. Further investigation of such issues is warranted.

In the pregnant sample, the greatest proportion of Māori women were in the youngest age category (20–25 years) whereas for non-Māori women the largest group was the 30–34-year age category, a pattern that reflects national data [17]. In the general population sample, the number of women in each age category was more evenly spread due to the sampling strategy, although due to higher response rates in older women, there were greater numbers in the 40–46-year age category. Similarly the differences in socio-economic position between Māori and non-Māori reflect those seen in the wider New Zealand population [24]. This supports the generalizability of these findings to pregnant New Zealand women.

These findings have implications for employers, and health service provision and health provider training. Employers could limit the impact of the pregnancy-related changes in sleep and sleepiness by ensuring that pregnant women are not required to work at night and through the provision of opportunities for workplace naps, thus recognizing their greater levels of daytime sleepiness. For individuals in health services these findings reinforce the need for sleep to be an aspect of health that is discussed in consultations with pregnant women. Healthcare providers have a responsibility to educate women about the role sleep plays in their pregnancy-related health, although it is acknowledged that maternity care consultations are already time-limited and a wide range of topics must be covered. To support healthcare providers, interventions that promote healthy sleep in pregnancy need to be developed and tested. In order for maternity healthcare providers to discuss and assess sleep, they in turn need to be knowledgeable about healthy sleep in pregnancy, the identification of disordered sleep, and possible treatment options, which has implications for the training of the maternity healthcare workforce. Similarly, healthcare providers in the wider community need to be well educated about healthy sleep and inequalities in sleep health so that care is targeted to those most in need. Many of the drivers to enable these changes are at the policy level, where sleep should be considered a fundamental aspect of maternal health and health of the wider population. Consideration should be given to ensuring that health services that promote good sleep and treat disordered sleep are funded, available for, and

accessible to pregnant women and also to Māori, older women, the unemployed, and night workers.

Funding

This work was supported by research grants from the Health Research Council of New Zealand (09/233 and 00/273).

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.07.007.

Acknowledgments

We gratefully acknowledge the contribution of participating women. We thank Dr. Ricci Harris for her thoughtful comments and suggestions on the manuscript.

References

[1] Dzaja A, Arber S, Hislop J, Kerkhofs M, Kopp C, Pollmächer T, et al. Women's sleep in health and disease. J Psychiat Res 2005;39:55–76.
[2] Williams MA, Miller RS, Qiu C, Cripe SM, Gelaye B, Enquobahrie D. Associations of early pregnancy sleep duration with trimester-specific blood pressures and hypertensive disorders in pregnancy. Sleep 2010;33:1363–71.
[3] Facco F, Grobman W, Kramer J, Ho K, Zee P. Self report short sleep duration and frequent snoring in pregnancy: impact on glucose metabolism. Am J Obstet Gynecol 2012;203:e1–5.
[4] Lee KA, Gay CL. Sleep in late pregnancy predicts length of labor and type of delivery. Am J Obstet Gynecol 2004;191:2041–6.
[5] Okun M, Dunkel Schetter C, Glynn LM. Poor sleep quality is associated with preterm birth. Sleep 2011;34:1493–8.
[6] Micheli K, Komninos I, Bagkeris E, Roumeliotaki T, Koutis A, Kogevinas M, et al. Sleep patterns in late pregnancy and risk of preterm birth and fetal growth restriction. Epidemiology 2011;22:738–44.
[7] Okun M, Kiewra K, Luther JF, Wisniewski SR, Wisner KL. Sleep disturbances in depressed and nondepressed pregnant women. Depress Anxiety 2011;28:676–85.
[8] Dørheim SK, Bjorvatn B, Eberhard-Gran M. Insomnia and depressive symptoms in late pregnancy: a population-based study. Behav Sleep Med 2012;10:152–66.
[9] Finer LB, Zolna MR. Unintended pregnancy in the United States: incidence and disparities. Contraception 2006;84:478–85.
[10] Lee KA, Zaffke ME, Mcenany G. Parity and sleep patterns during and after pregnancy. Obstet Gynecol 2000;95:14–18.
[11] Hertz G, Fast A, Feinsilver SH, Albertario CL, Schulman H, Fein AM. Sleep in normal late pregnancy. Sleep 1992;15:246–51.
[12] Iczi B, Martin SE, Dundas KC, Liston WA, Calder AA, Douglas NJ. Sleep complaints: snoring and daytime sleepiness in pregnant and pre-eclamptic women. Sleep Med 2005;6:163–9.
[13] Okun ML, Coussons-Read ME. Sleep disruption during pregnancy: how does it influence serum cytokines? J Reprod Immunol 2007;73:158–65.
[14] Paine SJ, Gander PH. Sleep, sleepiness and sleep disorders: principles for examining differences by ethnicity. In: Kushida CA, editor. The encyclopedia of sleep. Waltham, MA: Academic Press; 2013. p. 691–8.
[15] Facco F, Kramer J, Ho K, Zee P, Grobman W. Sleep disturbances in pregnancy. Obstet Gynecol 2010;115:77–83.
[16] Shen J, Tymkow C, Macmullen N. Disparities in maternal outcomes among four ethnic groups. Ethn Dis 2005;15:492–7.
[17] Ministry of Health, New Zealand. Report on maternity. Wellington: Ministry of Health; 2010. p. 2012.
[18] Bryant A, Washington S, Kupperman M, Cheng Y, Caughey AB. Quality and equality in obstetric care: racial and ethnic differences in cesarean section delivery rates. Pediatr Perinat Epidemiol 2009;23:454–62.
[19] Simmonds S, Robson B, Cram F, Purdie G. Kaupapa Māori epidemiology. Aust Epidemiologist 2008;15:2–6.
[20] Paine SJ, Priston M, Signal TL, Sweeney BM, Muller DP. Developing new approaches for the recruitment and retention of indigenous participants in longitudinal research. MAI J 2013;2:121–32.
[21] Paine SJ, Gander PH, Harris R, Reid P. Who reports insomnia? Relationships with age, sex, ethnicity, and socioeconomic deprivation. Sleep 2004;27:1163–9.
[22] Salmond C, Crampton P. Wellington School of Medicine and Health Sciences NZDep2001 index of deprivation user's manual. Wellington, NZ: Department of Public Health, Wellington School of Medicine and Health Sciences; 2002.
[23] Salmond C, Crampton P, Atkinson J. NZDep2006 index of deprivation user's manual. Wellington: Department of Public Health, University of Otago; 2007.
[24] Salmond C, Crampton P. The development of New Zealand's deprivation index (NZDep) and its uptake as a national policy tool. Can J Public Health 2012;103:S7–11.
[25] Statistics New Zealand. Statistical standard for ethnicity 2005. Wellington: Statistics New Zealand; 2005 <http://www.stats.govt.nz/browse_for_stats/population/census_counts/review-measurement-of-ethnicity.aspx> [accessed 13.08.15].
[26] Statistics New Zealand. Census forms and guide notes. Wellington: Statistics New Zealand; 2011 <http://www.stats.govt.nz/Census/2011-census/2011-census-forms-and-guidenotes.aspx> [accessed 13.10.10].
[27] International Labour Organisation. C171 – Night Work Convention (No. 171). In: Convention concerning night work (entry into force: 4 January 1995). 77th ILC session. Geneva: 1990 26 June 1990.
[28] Johns MW. Sleepiness in different situations measured by the Epworth Sleepiness Scale. Sleep 1994;17:703–10.
[29] Gander P, Marshall N, Harris R, Reid P. The Epworth Sleepiness Scale: influence of age, ethnicity, and socio-economic deprivation. Sleep 2005;28:249–53.
[30] Hsu J. The factor analytic approach to simultaneous inference in the general linear model. J Comput Graph Stat 1992;1:151–68.
[31] Paine SJ, Gander PH, Travier N. The epidemiology of morningness/eveningness: influence of age, gender, ethnicity, and socioeconomic factors in adults (30–49 years). J Biol Rhythms 2006;21:68–76.
[32] Okun ML, Tolge M, Hall M. Low socioeconomic status negatively affects sleep in pregnant women. J Obstet Gynecol Neonat Nurs 2014;43:160–7.
[33] Åkerstedt T. Shift work and disturbed sleep/wakefulness. Occup Med 2003;53:89–94.
[34] Patel S, Malhotra A, Gottlieb D, White D, Hu F. Correlates of long sleep duration. Sleep 2006;29:881–9.
[35] Krueger P, Friedman E. Sleep duration in the United States: a cross-sectional population-based study. Am J Epidemiol 2009;1869:1052–63.
[36] Statistics New Zealand. Births and deaths: births and deaths: year ended March 2012. Wellington: Statistics New Zealand; 2012 <http://www.stats.govt.nz/browse_for_stats/population/births/BirthsAndDeaths_HOTPYeMar12/Commentary.aspx> [accessed 13.11.26].
[37] Lauderdale DS, Knutson KL, Yan LL, Liu K, Rathouz PJ. Self-reported and measured sleep duration: how similar are they? Epidemiology 2008;19:838–45.