



Original Article

Postpartum fatigue, daytime sleepiness, and psychomotor vigilance are modifiable through a brief residential early parenting program

Nathan Wilson^a, Karen Wynter^{b, c}, Clare Anderson^{a, d}, Shantha M.W. Rajaratnam^{a, d, e, f}, Jane Fisher^{b, g}, Bei Bei^{a, *}

^a Monash Institute of Cognitive and Clinical Neurosciences, School of Psychological Sciences, Monash University, Victoria, Australia

^b Global Public Health Unit, Monash University, Victoria, Australia

^c School of Nursing and Midwifery, Western Health Partnership, Deakin University, Victoria, Australia

^d Cooperative Research Centre for Alertness, Safety and Productivity, Clayton, Victoria, Australia

^e NHMRC Centre for Sleep and Circadian Neurobiology, Sydney, New South Wales, Australia

^f Division of Sleep and Circadian Disorders, Departments of Medicine and Neurology, Brigham and Women's Hospital Division of Sleep Medicine, Harvard Medical School, Boston, MA, USA

^g Masada Private Hospital, St Kilda East, Victoria, Australia



ARTICLE INFO

Article history:

Received 21 November 2018

Received in revised form

21 December 2018

Accepted 8 January 2019

Available online 31 January 2019

Keywords:

Postpartum

Postnatal

Sleep

Fatigue

Sleepiness

Psychomotor vigilance test

ABSTRACT

Objective/Background: In the months after childbirth, women are vulnerable to sleep disturbances and sleep-related deficits in functioning, such as fatigue, daytime sleepiness, and attentional lapses. Currently there is limited evidence that these deficits are modifiable. Using both self-report and objective measures, this study examined changes in sleep-related daytime functioning among women attending a residential early parenting program for assistance with unsettled infant behavior and mild to moderate postpartum distress.

Methods: Participants were 78 women (age $M = 34.16$, $SD = 4.16$ years) attending a five-day program with their infants (age $M = 8.67$, $SD = 4.82$ months). Sleep was assessed via self-report. Sleep-related daytime functioning was operationalized as fatigue, sleepiness, and sustained attention, and measured using validated questionnaires (all women) and the 10-min visual Psychomotor Vigilance Test (PVT; subgroup of 47 women). All measures were administered on both admission (baseline) and discharge.

Results: On admission, participants reported elevated sleep disturbance (94%), fatigue (91%), as well as trait (54%) and state (67%) sleepiness. From admission to discharge, there were medium effect size reductions in fatigue and sleepiness, and large effect size improvements in sleep quality related domains such as increased sleep efficiency and reduced nighttime awakenings (all $p < 0.001$); changes in total sleep time were nonsignificant ($p = 0.22$). PVT reciprocal mean reaction times were also significantly faster ($p = 0.001$; medium effect size).

Conclusions: This study demonstrated that among women attending a brief residential early parenting program, fatigue, daytime sleepiness, and objectively measured psychomotor vigilance can be improved. Implications for further research and potential treatments are discussed.

© 2019 Elsevier B.V. All rights reserved.

1. Introduction

Sleep disturbance is a common experience for new parents. Both women and their partners can experience increased nighttime

awakenings (NA), longer wake after sleep onset (WASO), reductions in total sleep time (TST) and reduced sleep efficiency (SE) in the weeks and months following childbirth [1–4]. These disruptions to postpartum sleep patterns are evident in both self-report and objective measures such as actigraphy [3], and are associated with various forms of impairment in daytime functioning, including increased fatigue, daytime sleepiness, and impaired sustained attention [1,3,5,6].

* Corresponding author. Monash Institute of Cognitive and Clinical Neurosciences, School of Psychological Sciences, Faculty of Medicine, Nursing and Health Sciences, Monash University, 18 Innovation Walk, Clayton Campus, Victoria, 3800, Australia.

E-mail address: bei.bei@monash.edu (B. Bei).

1.1. Postpartum fatigue

Fatigue is perhaps the most common form of impaired daytime functioning during the postpartum period. Between 40 and 60% of women report elevated fatigue during the first 18 months postpartum [7,8]. Fatigue is a cluster of subjective physical and psychological symptoms that involve a sense of extreme tiredness or exhaustion and lessens individuals' capacity to function to their expectations [9,10]. Sleep disturbance caused by infant care and settling difficulties are major contributing factors to fatigue symptoms [5,11]. Fatigue is also associated with many other adverse outcomes, including elevated depressive, anxiety, and stress symptoms [12–15]. Both longitudinal and cross-sectional studies have shown that for many women, fatigue symptoms may persist for months into the postpartum period [1,7,16,17].

Despite high prevalence and associated distress [18], postpartum fatigue symptoms have shown either little, or very small-sized response to interventions that specifically targeted fatigue symptoms [19,20]. In comparison, interventions designed to treat both fatigue and distress, or to manage infant sleep and behaviors have shown greater efficacy. A telephone-based treatment for both fatigue and distress symptoms administered to women with elevated depressive symptoms at 2–3 months postpartum led to significantly greater reductions in fatigue compared to control [21]. Also, a residential early parenting program that provided multidisciplinary care and psychoeducation on infant settling for women with infants aged 4–12 months reported significant decreases in fatigue and other mood symptoms at 1- and 6-month follow-up [22].

1.2. Daytime sleepiness

Daytime sleepiness, although less studied than fatigue, may be just as prevalent as fatigue among women in the first months after childbirth [23,24]. Sleepiness is the perceived likelihood of falling asleep when intending to be awake [25]. While mild transient feelings of sleepiness are normal, excessive sleepiness is problematic, particularly in safety-sensitive contexts (eg, driving). A study on community-dwelling women at three months postpartum showed that half of the sample reported elevated daytime sleepiness [23], and that a third of driving episodes occurred while experiencing elevated daytime sleepiness [24].

One longitudinal study showed that sleepiness as measured by the Epworth Sleepiness Scale [26] (ESS) reduced from being above the clinical cut-off towards the higher end of the normal range without intervention from 6 to 18 weeks postpartum in a community sample of women [23]. This suggests that sleepiness may increase after childbirth but decline over time naturally as maternal sleep disturbance gradually decreases [2,23].

However, currently no study has measured postpartum sleepiness using a validated scale after the first 18 weeks postpartum. Further, despite its importance to maternal daytime functioning, no study has examined whether sleepiness levels are responsive to interventions in the postpartum period. Current studies of daytime sleepiness in the postpartum period have also been restricted to community samples of healthy parents [23,27], and findings are not necessarily generalizable to women who seek clinical support.

1.3. Psychomotor vigilance

Sleep disturbance can also impair new parents' ability to sustain attention on tasks. To date, there is only one study that objectively measured sustained attention during the postpartum period. Insana et al., [27] showed that women between 2 and 13 weeks postpartum performed consistently worse on Psychomotor Vigilance Test (PVT) than matched controls, with slower average

reaction times (RT's) and more lapses in attention (RT > 500 ms) [28,29]. Across this early postpartum period, performance on the PVT gradually declined, even though women's sleep durations gradually increased, suggesting that adverse effects of sleep disturbance on performance may be cumulative [28]. Further, higher PVT attention lapses were associated with lower objectively measured TST and SE, greater self-report WASO, later and less stable sleep midpoints [27,30].

No study has assessed PVT performance beyond the first few months postpartum, even though ongoing difficulties with self-report fatigue are frequently reported extend well beyond this period [7,31]. Furthermore, the responsiveness of objectively assessed psychomotor vigilance to postpartum interventions remains unknown. In non-postpartum contexts, sleep and physical activity interventions were shown to improve PVT performance in adults with short (<6 h) sleep duration [32] and obesity [33].

1.4. Current study

The current literature consistently shows that parents in the post-childbirth period can be vulnerable to sleep disturbance and sleep-related deficits in daytime functioning, including fatigue, excessive daytime sleepiness, and deficits in sustained attention. However, this body of research, with the exception of fatigue, is restricted to the first three months postpartum [34], and parents with older infants are largely neglected. Further, it is unclear whether daytime sleepiness and deficits in sustained attention can be improved by intervention, and there is mixed evidence for improving postpartum fatigue symptoms. A further gap in the literature is that all existing studies with measures of sleepiness and the PVT have recruited physically and mentally healthy women in community samples [6,27,28]. Findings from these samples may not generalize to women seeking clinical support, who could potentially experience more significant sleep disturbance, more severe impairments in daytime functioning, and higher levels of psychological distress [35].

In this study, these gaps were addressed by assessing sleep, fatigue, sleepiness, and PVT performance among women attending residential early parenting programs. In Australia, these programs are available through both public and private healthcare settings, and service tens of thousands of families each year [36]. Following a medical referral, the residential programs provide admitted parents with clinical support, respite, and individualized training in managing unsettled infant behavior, which includes persistent and inconsolable crying, resistance to soothing, difficulties with settling to sleep, short sleep periods, and frequent nighttime awakenings [36,37].

These residential early parenting programs have previously been found to reduce maternal depressive, anxiety, stress, fatigue symptoms, and improve infant sleep [22,38–40]. Given that these programs tend to admit parents with older infants and clinically elevated fatigue and/or psychological distress symptoms [22,39], they also serve as a unique opportunity to explore the potential modifiability of fatigue, daytime sleepiness, and sustained attention in a postpartum population with infants older than three months.

On this basis, this study aims to assess whether maternal sleep, fatigue, sleepiness, and PVT performance changed after a brief residential early parenting program. Associations between PVT and self-report fatigue and sleepiness were exploratory.

2. Material and method

2.1. Setting and participants

Data collection was conducted at the Masada Early Parenting Centre (MEPC), Masada Private Hospital, a residential early

parenting program service in Melbourne, Australia. The MEPC is a 20-bed residential unit that admits mother-infant dyads for addressing unsettled infant behavior, as well as maternal fatigue and distress (eg, symptoms of depression and anxiety) through a five day multidisciplinary intervention. The program involves increasing maternal and infant sleep opportunities, psycho-education, medical and psychological support, and supervised practice implementing infant settling strategies. The infants slept in cots in separate rooms to the mothers. An individualized “feed-play-sleep” routine was developed for each mother-infant dyad based on their specific needs. During the initial 1–2 nights, women who were not breastfeeding were offered hypnotics to assist with sleep, and nurses resettled the infant during the night. In addition, infants who required breastfeeding during the night, the nurses woke the mothers to breastfeed, then resettled the infants. During subsequent nights, nurses first demonstrated resettling to the mothers, then supported the mothers to resettle the infants themselves for the remaining 3–4 nights of the program. Further details of the program are described in other publications [36–39,41].

All women were referred by a medical practitioner and admitted with their infants to the five day residential program. All women admitted to the MEPC between June and October 2015 were invited to participate in the study. There were no exclusion criteria. Ethics approval was obtained from the Avenue Hospital Research Ethics Committee and Monash University Human Research Ethics Committee. All participants provided written informed consent.

2.2. Measures

Sleep. Eight self-report sleep items adapted from the Consensus Sleep Diary asked about average bedtime, sleep onset time, the number of awakenings, awakening duration, wake time, and out of bed time over the past week [42]. The following variables were calculated from the self-report responses: TST, SE, Sleep Onset Latency (SOL), WASO, daily nap duration, and NA. Participants also rated the overall quality of their sleep over the past week from 0 (“very bad”) to 3 (“very good”).

Two additional questionnaires were also administered at baseline to characterize self-report sleep quality and sleep-apnea risk. The Pittsburgh Sleep Quality Index (PSQI) is a widely used 19 item self-report measure of sleep disturbance over the past month, with scores > 5 indicating poor sleep [43]. The Multivariate Apnea Prediction Index (MAPI) is a 14-item screening measure for sleep apnea [44]. It assesses symptoms such as snoring and frequent awakening. In combination with body mass index and age, the responses are used to predict a likelihood for apnea symptoms (MAPI > 0.5).

Fatigue. The Fatigue Severity Scale (FSS) measures the severity of the impact of fatigue on daily functioning [45]. It contains nine items rated from 1 (“strongly disagree”) to 7 (“strongly agree”), and yields a total score ranging from 7 to 63, with scores ≥ 36 indicating clinically significant fatigue. The FSS has been used previously in postpartum populations [19]. In this study, internal consistency of FSS was good at both admission (the first day at MEPC, T1; alpha 0.86 and omega 0.87) and discharge (the fifth day at MEPC, T2; alpha 0.90 and omega 0.91).

Sleepiness. The Epworth Sleepiness Scale (ESS) measures the likelihood of falling asleep in eight different scenarios using a 4-point scale from 0 (“never”) to 3 (“high chance”) [26]. Scores across the 8 items are summed to create a total score ranging from 0 to 24 (scores > 9 indicate excessive daytime sleepiness). Although designed as a trait measure of sleepiness, the ESS is sensitive to changes in sleepiness in the postpartum period [6]. Reliability for ESS was 0.77 (alpha) and 0.79 (omega) at T1, and 0.79 (alpha) and 0.82 (omega) at T2.

The Karolinska Sleepiness Scale (KSS) is a single-item measure of subjective state sleepiness [46]. Respondents rate their current sleepiness level from 1 (“extremely alert”) to 9 (“extremely sleepy – fighting sleep”), with scores > 6 indicating state sleepiness. The KSS has been used previously in postpartum mothers [24], and found to correlate with duration of wakefulness [47].

Sustained attention. The Psychomotor Vigilance Test (PVT) is a widely used test of sustained attention and vigilance robust to learning effects while being sensitive to failures in sustained attention [29,48]. The PVT is sensitive to sleep deprivation, partial sleep restriction, circadian disruption, and has previously been used in the early postpartum period [28,48]. This study used a 10-min visual PVT with a random inter-stimulus interval between 2 and 10 s. The PC-PVT platform was used, which is equivalent to the gold-standard PVT-192 but updated for use on modern personal computers [49]. The task was run on laptops with recommended peripheral hardware [49]. Participants were given a 2-min practice session before their first trial at T1. The first presented stimulus at both T1 and T2 were removed from the analysis, as were RT's less than 100 ms [50]. There were no RT's > 10,000 ms. Time of day was not controlled but was recorded for analysis purposes.

PVT outcome measures used were: (a) reciprocal mean reaction time ($1/RT; \frac{1}{\sqrt{RT/1000}}$), with higher values reflecting faster responses, (b) square root transformed number of lapses ($RT > 500$ ms; $\sqrt{x + \sqrt{(x+1)}}$), with higher values reflecting increased attention failure, (c) square root transformed number of false starts ($RT < 100$ ms; $\sqrt{x + \sqrt{(x+1)}}$), and (d) reciprocal RT variability (RTV) [51,52].

Depression. Depressive symptoms were measured to facilitate interpretation of findings. The Edinburgh Postnatal Depression Scale (EPDS) is a widely used 10-item self-report screening tool for postpartum depressive symptoms [53]. Items are rated on 4-point scales and summed to provide a total score (0–30), with scores ≥ 12 suggesting probable depression [53]. Internal consistency of EPDS was good at both T1 (alpha 0.84, omega 0.84) and T2 (alpha 0.84, omega 0.85).

Chronotype. The Circadian Energy Scale (CIRENS) was used as a brief 2-item measure of chronotype [54]. Scores on the CIRENS range from –4 (high morning preference) to 4 (high evening preference).

Demographics. Maternal and infant demographic measures were collected from the survey and extracted from the MEPC medical records for consenting participants.

2.3. Procedure

Recruitment was carried out through an advertisement on the MEPC website, a flyer in the admission pack, and in-person by researchers at admission. All participants gave informed consent and completed self-report measures on paper on the first (T1; sleep items, FSS, KSS, ESS, PSQI, MAPI, and CIRENS) and fifth (ie, final; T2) day of their admission (sleep items, FSS, KSS, ESS, and CIRENS). Additional demographics and EPDS scores were extracted from the medical records.

As women attending the MEPC frequently present with high psychological distress [38], PVT was offered as an optional component to reduce participant burden. Participants were invited to complete the PVT at both T1 and T2 in a well-lit, quiet room when their infant was asleep or being settled by MEPC staff.

2.4. Data analysis

For self-report scales responses, if less than 10% of items were missing, mean replacement was used. Remaining missing data were handled using pairwise deletion for all analyses. Changes in

self-report and PVT measures from T1 to T2 were analyzed using robust dependent *t*-tests, with recommended 20% mean trim, given differences in distribution shapes and heteroscedasticity [55]. Effect size were calculated using Wilcoxon and Tian's explanatory measure of effect size ξ , with 0.15 being a small, 0.3 a medium, and 0.5 a large effect size [55]. Change in self-report measures across over time were analyzed using robust analyses of variance [55].

Change in PVT was also analyzed using distributional analysis involving exploration of frequency distribution plots and cumulative distribution plots. The cumulative distribution plot compared mean log converted RT across the 5th–95th percentile in 5% increments. Planned pairwise comparisons were conducted on participants mean log RT at the 5th, 25th, 50th, 75th and 95th percentiles using robust dependent *t*-tests. Comparisons at the 5th and 25th percentile assess changes in psychomotor speed, at the 50th percentile assess change at the median, and at the 75th and 95th percentiles assess changes in inattention [50,52].

Pearson correlations were used to explore associations between variables. All analyses were conducted in R 3.3.3 [56], and statistical significance was set at $p < 0.05$ (two-tailed).

3. Results

3.1. Sample characteristics

A total of 85 women were recruited; 78 completed surveys at both T1 and T2 and were included in analyses. Among these, 75 provided consent for medical records extraction, and 47 opted in and completed the PVT component at both T1 and T2.

Details on maternal and infant demographics are shown in Table 1. Mean maternal age was 34.16 ($SD = 4.16$) years and mean infant age was 8.68 ($SD = 4.82$) months. In general, participants were highly educated, mostly spoke English, and were predominantly born in Australia. Participants reported a low mean apnea risk score on the MAPI, and low rate of previous treatment for sleep disorders (6%). Over a third (36%) reported previous treatment for a mental health condition, such as depression or anxiety.

Table 1
Descriptive statistics for maternal and infant characteristics at baseline ($N = 78$).

	<i>n</i>	<i>M</i> (<i>SD</i>), range or %
Maternal demographics		
Maternal age (years)	78	34.46 (4.16), 27–49
Education (tertiary degree or above)	58	88.4%
Born in Australia	51	68.0%
Mainly speak English at home	67	89.3%
Living with partner (married or de-facto)	74	90.2%
Not currently in paid employment	54	68.9%
Previous treatment for mental health condition	27	36.0%
Obstetric and health factors		
Primipara	40	54.1%
Caesarean section for last birth	29	38.7%
Currently pregnant	2	2.70%
Multiple birth (twins)	2	2.70%
Body Mass Index	76	24.13 (5.14), 15.56–45.54
Multivariate Apnea Prediction Index	75	0.07 (0.10), 0.01–0.66
Infant Factors		
Infant age (months)	78	8.67 (4.82), 3.00–23.50
Infant sex (female)	37	49.3%
Infant birth weight (kg)	69	3.32 (0.62), 1.31–4.47
Infant awakenings (>3 times per night)	52	70.3%
Infant health (\geq very good)	69	92.0%

3.2. Changes in sleep

Descriptive statistics and the differences in self-report scales between T1 and T2 are reported in Table 2. At T1, participants reported average TST of 7 h 11 min ($SD = 95.03$ min) with a relatively low mean SE of 77.14% ($SD = 13.91$), waking on average four ($SD = 1.85$) times per night, and rated sleep quality as “poor” (see Table 2). This is consistent with mean PSQI global score of 11.06 ($SD = 2.89$), with 94% of participants scoring above the cut-off score for poor sleep quality ($PSQI > 5$). The mean circadian energy rating scale (CIRENS) score indicated that on average participants had neither a strong morning nor evening preference. At T2, participants reported significantly shorter SOL ($p = 0.02$), as well as fewer NA, less WASO, higher SE, and better SQ (all $p < 0.001$), but no significant difference in TST ($p = 0.25$) or daytime nap duration ($p = 0.25$) compared to T1. Effect sizes for the improvements in sleep variables were large for NA, WASO, SE, and SQ, and medium for SOL. There was no significant change in CIRENS scores from T1 to T2 ($p = 0.22$).

3.3. Changes in fatigue, sleepiness, and depressive symptoms

At T1, a large proportion of women reported elevated fatigue on the FSS (91%), sleepiness on ESS (54%) and KSS (67%), and depressive symptoms on EPDS (36%; see cut-offs in the Methods). At T2 there were significant reductions in FSS and ESS scores (medium effect sizes), and in KSS and EPDS scores (large effect sizes; all p -values < 0.001 ; see Table 2). Although reduced compared to T1, the mean FSS score remained above the suggested clinical cut-off at T2.

3.4. Changes in sustained attention

Mean time of the day for PVT testing was 15:42 at T1 (range: 12:30–17:48) and 14:38 (range: 10:57–17:42) at T2. Differences in test timing at T2 ranged between 6 h 14 min earlier to 4 h 22 min later than T1 ($M_{diff} = 63.42$ min; $SD = 141.74$; $p < 0.01$). However, difference in test timing was not associated with: mean 1/RT or transformed lapses at T1 or T2 (range $r = -0.10$ to 0.05; all p -values > 0.05), T1-T2 differences in mean 1/RT ($r = -0.05$, $p > 0.05$), or T1-T2 differences in transformed lapses ($r = -0.17$, $p > 0.05$).

The RT distribution for the PVT is shown in Fig. 1. Overall, there was little difference between the distribution of the reaction times at T1 and T2, and very few RT's at or beyond 500 ms at either time-points. The cumulative distribution plots of mean logRT are in Fig. 2, which shows overall similar patterns for T1 and T2, with T2 having a general increase in speed across the full response range. There were significant reductions in the logRT's at the 5th, 25th, 50th, 75th and 95th percentiles at T2 (all p -values < 0.02 , medium effect size).

Descriptive statistics and differences in PVT summary variables are given in Table 3. There was a medium size and significant reduction in mean 1/RT ($p = 0.001$), but no significant differences in RTV ($p = 0.46$). There was a significant increase in mean lapse frequency from T1 to T2 ($p < 0.001$). However, as overall lapses were very low at both T1 ($M = 0.96$) and T2 ($M = 3.04$), and few (none at T1 and only 1 at T2) of these were long lapses (responses > 2000 ms), this increase in lapses may not be meaningful. Similarly, significant increase in mean transformed false starts from T1 to T2 ($p = 0.002$), may also not be meaningful as there were few false starts at both T1 ($M = 2.96$) and T2 ($M = 2.98$).

Correlation matrices for key variables at T1 and T2 is reported in Table 4. At T1 there were no significant associations between PVT variables and self-report variables. At T2, there were some moderate significant ($p < 0.05$) negative associations between Mean 1/RT and self-report variables (FSS, KSS, EPDS).

Table 2
Changes in maternal self-report sleep, fatigue, sleepiness, and depressive symptoms (N = 78).

	M (SD)		n	95% CI for trimmed mean difference ^a , p	ξ Effect size ^b
	T1 (Admission)	T2 (Discharge)			
Self-report sleep					
TST	431.97 (95.03)	452.39 (64.02)	74	[-33.47, 7.86], 0.219	0.13
SE	77.14 (13.91)	86.82 (9.86)	74	[-12.40, -6.05], <0.001	0.65
NA	4.00 (1.85)	1.91 (1.10)	74	[1.39, 2.41], <0.001	0.87
WASO	40.08 (35.80)	13.60 (14.89)	74	[15.66, 27.52], <0.001	0.66
SOL	60.81 (66.98)	38.81 (38.34)	74	[2.09, 24.86], 0.021	0.32
Nap	6.93 (19.39)	8.20 (20.25)	74	[-33.47, 7.86], 0.219	0.13
SQ	0.99 (0.70)	1.96 (0.58)	72	[-1.33, -0.76], <0.001	0.96
CIRENS	-0.42 (1.54)	-0.42 (1.17)	78	[-0.40, 0.40], 0.999	0.00
PSQI total	11.07 (2.90)	-	76	-	-
Fatigue, sleepiness, and depressive symptoms					
FSS	46.55 (9.17)	39.64 (11.99)	77	[3.94, 10.58], <0.001	0.42
ESS	9.24 (4.31)	6.21 (4.07)	78	[2.31, 4.52], <0.001	0.49
KSS	6.79 (1.54)	4.54 (2.03)	78	[2.12, 3.33], <0.001	0.65
EPDS	10.83 (4.97)	7.19 (4.43)	74	[2.43, 5.01], <0.001	0.50

Note. TST = total sleep time (min); SE = sleep efficiency (%); NA = number of awakenings; WASO = wake after sleep onset (minutes); SOL = sleep onset latency (minutes); Nap = daily nap duration (min); SQ = Sleep Quality; FSS = Fatigue Severity Scale; ESS = Epworth Sleepiness Scale; KSS = Karolinska Sleepiness Scale; CIRENS = Circadian Energy Rating Scale; PSQI = Pittsburgh Sleep Quality Index; EPDS = Edinburgh Postnatal Depression Scale; CI = confidence interval.

^a mean trim at 20%.

^b ξ = 0.15, 0.3, and 0.5 for small, medium, and large effect sizes respectively.

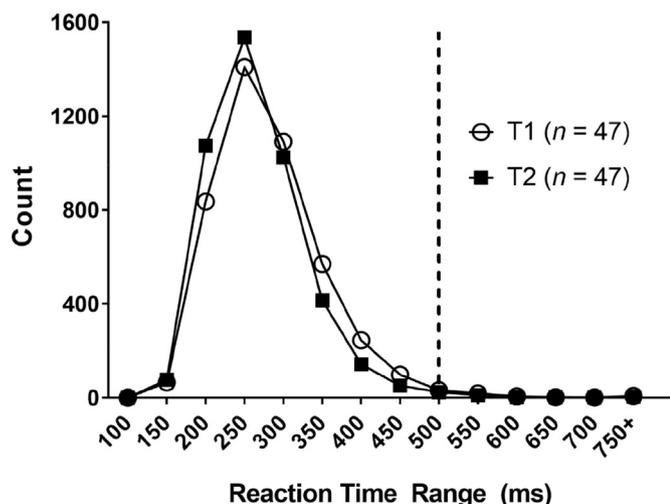


Fig. 1. Group level psychomotor vigilance test reaction time cumulative response distribution at T1 and T2. Responses to the right of the dashed line (>500 ms) represent lapses in attention.

4. Discussion

Women attending a brief residential program that assists with infant settling difficulties and mild to moderate psychological distress self-reported elevated sleep disturbance, fatigue, daytime sleepiness, and depressive symptoms upon admission to the unit. Upon discharge from the program, they reported significant improvements in all these domains, as well as faster reaction time on the PVT.

4.1. Baseline characteristics

Similar to other studies in community and clinical postpartum samples, we found that our sample reported elevated sleep disturbance on admission with elevated PSQI scores [57,58]. Women in our sample reported higher PSQI scores than those previously reported among healthy first-time mothers within the first year after birth [57,58]. Consistent with other studies from community samples of postpartum women in the first three months

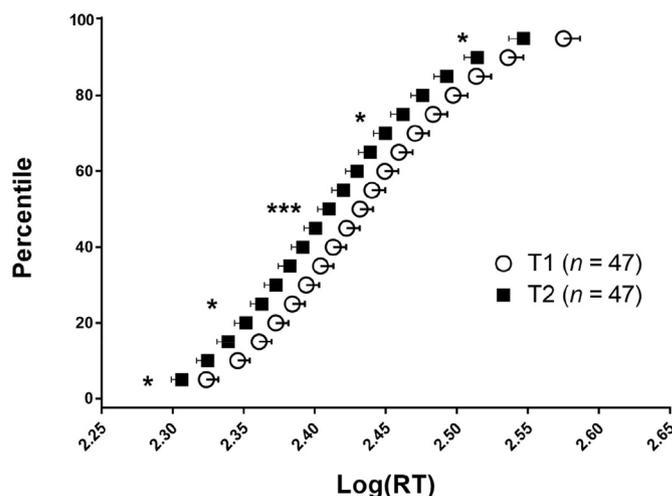


Fig. 2. Group level mean and standard error of the mean response distribution (log RT in ms) for psychomotor vigilance tests at T1 and T2 across the 5th to 95th percentiles, with RTs closer to the 5th percentile representing sensory-motor speed and RTs closer to the 95th percentile representing inattention. RT = reaction time. *p < 0.05, **p < 0.01, ***p < 0.001

after birth, our sample did not show significant compromise in sleep duration, but reported frequent nighttime awakenings and reduced sleep efficiency [28]. This is consistent with the notion that sleep fragmentation being a hallmark of maternal sleep [34].

Women in our sample also self-reported impairment in sleep-related daytime functioning and elevated depressive symptoms. On admission: mean FSS, ESS, KSS, and EPDS scores were approximately 37%, 19%, 23%, and 152% higher than those reported by women in community samples at seven months (FSS), 13 weeks (ESS), 18 weeks (KSS) and six months (EPDS) postpartum respectively [19,23,27,59].

4.2. Changes in self-report measures

After the residential early parenting program, domains of maternal sleep quality improved, including lower frequency (NA) and duration (WASO) of awakenings, shorter SOL, higher SE, and

Table 3
Psychomotor vigilance test variables for T1 and T2 (n = 47).

	T1 (Admission)	T2 (Discharge)	[95% CI], p	ξ
Mean RT				
Untransformed	282.51 (43.35)	268.30 (35.30)		
Transformed	3.75 (0.55)	3.92 (0.49)	[-0.34, -0.10], 0.001	0.28
RTV				
Untransformed	59.70 (30.11)	57.66 (28.99)		
Transformed	0.65 (0.11)	0.67 (0.13)	[-0.05, 0.02], 0.462	0.08
Lapses				
Untransformed	0.96 (2.05)	3.04 (4.11)		
Transformed	1.80 (1.39)	3.15 (1.99)	[-2.38, -0.75], <0.001	0.53
False Starts				
Untransformed	2.96 (5.76)	2.98 (3.17)		
Transformed	2.88 (2.27)	3.33 (1.62)	[-1.55, -0.38], 0.002	0.32

Note. Means (standard deviation) are shown. RT = reaction time (ms); RTV = reaction time variability (SD of RT). Mean RT and RTV are reciprocal transformed (Mean 1/RT), higher values reflect faster RT. Lapses and false starts were square root transformed, with higher values reflecting increased attention failure or initiation errors. CI = confidence interval; 95% CI for difference in trimmed means, with 20% trim. ξ = 0.15, 0.3, and 0.5 for small, medium, and large effect sizes respectively.

Table 4
Correlation matrices at T1 (admission; upper diagonal) and T2 (discharge; lower diagonal).

n = 47	1	2	3	4	5	6	7	8	9	10
1. PVT Mean 1/RT	–	–0.58**	–0.28	–0.04	–0.04	–0.11	–0.01	–0.02	0.14	–0.15
2. PVT Lapses	–0.79**	–	0.19	0.03	0.11	–0.12	–0.05	0.04	0.05	0.13
3. Fatigue Severity Scale	–0.32*	0.25	–	0.13	–0.12	–0.04	–0.06	–0.15	–0.18	0.41**
4. Epworth Sleepiness Scale	0.10	–0.16	0.03	–	0.26	–0.05	0.01	0.00	0.06	0.00
5. Karolinska Sleepiness Scale	–0.35*	0.26	0.07	0.36*	–	–0.14	–0.25	0.08	–0.22	0.07
6. Total Sleep Time	–0.02	–0.01	0.24	–0.02	–0.20	–	0.69**	0.30*	0.18	–0.10
7. Sleep Efficiency	–0.10	0.07	0.43**	–0.12	–0.26	0.68**	–	0.23	0.26	–0.18
8. Number of awakenings	–0.01	0.02	–0.02	0.29	0.39**	0.00	–0.17	–	–0.01	–0.01
9. Sleep quality	–0.00	0.03	0.12	–0.42**	–0.24	0.26	0.15	–0.38**	–	–0.36*
10. Edinburgh Postnatal Depression Scale	–0.38**	0.30*	0.33*	0.17	0.33*	0.08	0.03	0.20	–0.18	–

Note. Effect sizes for r: small 0.10–0.29, medium 0.30–0.49, large 0.50–1.0. *p < 0.05; **p < 0.01.

increased self-report sleep quality (SQ). However, mean sleep duration (TST) did not change significantly. It appears that the combination of the respite and clinical care in the MEPC allowed participants to get to sleep faster and have more consolidated sleep, even though they may not have slept for longer compared to their sleep prior to admission.

There were also significant improvements in self-report daytime functioning, with large effect size reductions for state sleepiness (KSS) and medium effect size reductions for trait sleepiness (ESS) and fatigue (FSS). Our finding of significant reductions in fatigue matches earlier findings from the MEPC using the Profile of Mood States, which found significant reductions one-month post-discharge [39]. The findings of medium size reductions in fatigue in this study differ from other postpartum fatigue interventions in the literature that reported either no change in fatigue symptoms [19] or only small improvements in morning fatigue [20].

Despite the reductions in fatigue and sleepiness symptoms in this study, mean fatigue and sleepiness symptoms at discharge remained elevated above clinical cut-off for the FSS, and above healthy adult levels for the ESS [26]. This finding of ongoing impairments in sleep-related daytime functioning despite improved sleep, is consistent with findings from experimental studies that reported residual deficits in self-report and objective performance for several days during recovery from experimentally induced sleep deprivation/restriction [60–62].

The improvements in sleep, fatigue, and sleepiness seen in this study also coincided with a large effect size reduction in depressive symptoms at discharge. This finding is consistent with past studies at the MEPC and similar residential early parenting services in Australia that have reported significant reductions in depressive symptoms following participation in these programs [39,40].

4.3. Changes in psychomotor vigilance

This is the first study to demonstrate that PVT RT can be improved in the postpartum period. Previous naturalistic study in postpartum women found that women's performance gradually deteriorated in terms of both RT's and lapses across the first three months postpartum [28]. The small increases in transformed lapses and false starts at discharge were unexpected, especially in the context of improved sleep, self-report daytime functioning, and faster RT. However, the frequency of both the lapses and false starts at both admission and discharge was very low and represented only a very small proportion of overall responses on the PVT. Further, the frequency of lapses at both time points is comparable to those recorded by healthy young males during baseline measurement prior to a sleep restriction protocol [63].

The number of lapses recorded in this study was substantially lower than that found in community samples of women during the first three months postpartum, where there were 7–14 times more lapses [6,27,28]. This may be due to methodological differences: we used the 10-min PVT on a computer platform, whilst the previous study used a 5-min PVT on a portable device shown to have a systematic bias for slower RT's, which may contribute to higher lapse frequency [64]. Further, whilst we conducted PVT in a controlled environment, the previous study collected data without supervision in participants' own homes, where they may be distracted while completing the task [6,27,28].

4.4. Limitations and strengths

There are several limitations to the study. First, the lack of a control group means that improved sleep and daytime functioning cannot be readily attributed to the residential program. For

example, the changes in self-report symptoms may occur due to non-specific factors (eg, contact with health professionals, social support from other women on the program), rather than the strategies introduced during the program. Moreover, we are not able to determine which aspects of the MEPC program [22] (eg, respite, psychoeducation for infant settling) contributed to the observed changes. Also, the important and potentially complex relationships between infant sleep and maternal sleep and functioning were not explored in this study. We did attempt to collect follow-up data at two months post-discharge, but only 40% of participants returned the survey, limiting conclusions that can be drawn on whether the reductions in fatigue and sleepiness was sustained.

Second, to minimize disruption to the residential program, time-of-the-day for PVT testing was not strictly controlled, and may have influenced the comparison of PVT performance [65]. However, the average difference in test timing was approximately 1 h, and the difference in test-timing was not associated with PVT results or changes in PVT variables.

Some participants chose to only complete the self-report and not PVT measures. Stress around hospital admission may have contributed to this. Alternately, there were no significant differences in demographics or depressive symptoms between mothers who choose to complete the PVT and those who did not.

The lack of an objective sleep measure is another limitation. Additionally, only mother-infant dyads (not partners such as fathers) were admitted to the MEPC, and we did not assess comparable outcomes in partners of our participants, or how partner-related factors may influence our findings.

Finally, recruitment at a single site may limit generalizability of findings. Given that unsettled infant behavior, postpartum sleep disturbance, and postpartum fatigue are all prevalent [2,37] and there is strong clinical demand for services to treat infant sleep problems [66], these findings are likely to be relevant to many other women.

Despite the above limitations, this is a unique study, in that it is one of the few studies to assess change in sleep, sleepiness, fatigue, and objective psychomotor vigilance simultaneously in a clinical setting, and after three months post-childbirth. Other methodological strengths include using the gold-standard 10-min visual PVT in a supervised controlled environment, the use of well validated self-report measures, and unique sample characteristics.

4.5. Conclusions and implications

This study demonstrates that maternal fatigue, daytime sleepiness, and reaction times on the PVT can all be improved following a brief residential early parenting program. These promising initial results warrant further investigation of the effectiveness of these, and other non-pharmacological programs for treating maternal sleep disturbance and sleep-related daytime functioning. Given that daytime impairments related to sleep disturbance are perceived by postpartum women as overwhelmingly negative, and interfere with caregiving [18], substantial reductions in daytime impairments as seen in this study, would likely help postpartum women cope with the demands of caregiving and other competing demands such as returning to work. Currently, only a few countries offer parenting programs that admit parent-infant dyads; findings from this study could encourage the development of early parenting programs outside of Australia.

Future research could examine if other interventions for infant sleep and settling difficulties, which are frequently applied in community settings [67], may also improve these aspects of maternal self-report and objective daytime functioning without the additional support provided within the residential environment. Future studies could also examine real-world performance and

safety related impairment outcomes other than the PVT, such as equipped motor-vehicles with ocular and driving performance measures [68]. Finally, despite increasing interest [59,69], postpartum experiences in partners (eg, fathers of infants) remain an area for further research.

Funding and disclosure

Nathan Wilson was supported by an Australian Government Research Training Program Scholarship and has nothing to disclose.

Karen Wynter was supported by a Monash University Advancing Women's Research Success grant and has nothing to disclose.

Clare Anderson has received a research award/prize from Sanofi-Aventis, contract research support from VicRoads, Rio Tinto Coal Australia, National Transport Commission, Tontine/Pacific Brands, lecturing fees from Brown Medical School/Rhode Island Hospital, Ausmed, Healthmed and TEVA Pharmaceuticals, and reimbursements for conference travel expenses from Philips Healthcare. In addition, she has served as a consultant through her institution to the Rail, Bus and Tram Union, the Transport Accident Commission (TAC), the National Transportation Committee (NTC) and VicRoads. She has also served as an expert witness and/or consultant in relation to fatigue and drowsy driving. Clare Anderson is a Theme Leader in the Cooperative Research Centre for Alertness, Safety and Productivity. These are not related to this manuscript.

Shantha MW Rajaratnam is a Program Leader for the CRC for Alertness, Safety and Productivity, Australia, which funded this work. He reports grants from Vanda Pharmaceuticals, Philips Respironics, Cephalon, Rio Tinto and Shell, and has received equipment support and consultancy fees through his institution from Optalert, Tyco Healthcare, Compumedics, Mental Health Professionals Network, and Teva Pharmaceuticals. These are not related to this paper.

Jane Fisher is supported by a Monash Professorial Fellowship funded by the Finkel Family Foundation. She reports sessional salary from Ramsay Healthcare as Clinical Psychologist to the Masada Private Hospital Early Parenting Centre.

Bei Bei is supported by National Health and Medical Research Council (NHMRC) Health Professional Research Fellowship (APP1140299), and she has nothing to disclose.

Acknowledgements

The authors are grateful to the staff at Masada Early Parenting Centre, Masada Private Hospital for their support in data collection, Olivia Chung, Hilary Brown, and Hannah Gray for assisted with data collection, and to the women who most generously contributed data.

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: <https://doi.org/10.1016/j.sleep.2019.01.012>

Abbreviations

CIRENS	Circadian Energy Rating Scale
EPDS	Edinburgh Postnatal Depression Scale
ESS	Epworth Sleepiness Scale
FSS	Fatigue Severity Scale
KSS	Karolinska Sleepiness Scale
MAPI	Multivariate Apnea Prediction Index
MEPC	Masada Early Parenting Centre

NA	Number of Awakenings
POMS	Profile of Mood States
PSQI	Pittsburgh Sleep Quality Index
PVT	Psychomotor Vigilance Test
RT	Reaction Time
RTV	Reciprocal Reaction Time Variability
SE	Sleep Efficiency
SOL	Sleep Onset Latency
SQ	Sleep Quality
T1	Admission
T2	Discharge
TST	Total Sleep Time
WASO	Wake after Sleep Onset

References

- Gay CL, Lee KA, Lee S-Y. Sleep patterns and fatigue in new mothers and fathers. *Biol Res Nurs* 2004;5:311–8.
- Montgomery-Downs HE, Insana SP, Clegg-Kraynok MM, et al. Normative longitudinal maternal sleep: the first 4 postpartum months. *Am J Obstet Gynecol* 2010;203. 465.e1-7.
- Bei B, Coo Calcagni S, Milgrom J, et al. Day-to-day alteration of 24-hour sleep pattern immediately before and after giving birth. *Sleep Biol Rhythm* 2012;10: 212–21.
- Coo Calcagni S, Bei B, Milgrom J, et al. The relationship between sleep and mood in first-time and experienced mothers. *Behav Sleep Med* 2012;10: 167–79.
- Rychnovsky J, Hunter LP. The relationship between sleep characteristics and fatigue in healthy postpartum women. *Wom Health Issues* 2009;19:38–44.
- Insana SP, Montgomery-Downs HE. Maternal postpartum sleepiness and fatigue: associations with objectively measured sleep variables. *J Psychosom Res* 2010;69:467–73.
- Parks PL, Lenz ER, Milligan RA, et al. What happens when fatigue lingers for 18 months after delivery? *J Obstet Gynecol Neonatal Nurs* 1999;28:87–93.
- McGovern P, Dowd B, Gjerdingen D, et al. Mothers' health and work-related factors at 11 weeks postpartum. *Ann Fam Med* 2007;5:519–27.
- Aaronson LS, Teel CS, Cassmeyer V, et al. Defining and measuring fatigue. *Image - J Nurs Scholarsh* 1999;31:45–50.
- Milligan RA, Lenz ER, Parks PL, et al. Postpartum fatigue: clarifying a concept. *Sch Inq Nurs Pract* 1996;10:279–91.
- Song J-E, Chang S-B, Park S-M, et al. Empirical test of an explanatory theory of postpartum fatigue in Korea. *J Adv Nurs* 2010;66:2627–39.
- Taylor J, Johnson M. The role of anxiety and other factors in predicting postnatal fatigue: from birth to 6 months. *Midwifery* 2013;29:526–34.
- Wilson N, Lee JJ, Bei B. Postpartum fatigue and depression: a systematic review and meta-analysis. *J Affect Disord* 2018.
- Giallo R, Seymour M, Dunning M, et al. Factors associated with the course of maternal fatigue across the early postpartum period. *J Reprod Infant Psychol* 2015;33:528–44.
- Wilson N, Wynter K, Fisher J, et al. Postpartum fatigue: assessing and improving the psychometric properties of the Fatigue Severity Scale. *Arch Wom Ment Health* 2018;21:471–4.
- Gardner DL. Fatigue in postpartum women. *Appl Nurs Res* 1991;4:57–62.
- Tsuchiya M, Mori E, Iwata H, et al. Fragmented sleep and fatigue during postpartum hospitalization in older primiparous women. *Nurs Health Sci* 2014;17:71–6.
- Runquist J. Persevering through postpartum fatigue. *J Obstet Gynecol Neonatal Nurs* 2007;36:28–37.
- Giallo R, Cooklin A, Dunning M, et al. The efficacy of an intervention for the management of postpartum fatigue. *J Obstet Gynecol Neonatal Nurs* 2014;43: 598–613.
- Troy NW, Dalgas-Pelish P. The effectiveness of a self-care intervention for the management of postpartum fatigue. *Appl Nurs Res* 2003;16:38–45.
- Thome M, Alder B. A telephone intervention to reduce fatigue and symptom distress in mothers with difficult infants in the community. *J Adv Nurs* 1999;29:128–37.
- Fisher J, Rowe H, Feekery C. Temperament and behaviour of infants aged 4–12 months on admission to a private mother-baby unit and at 1- and 6-month follow-up. *Clin Psychol* 2004;8:15–21.
- Filtzess AJ, MacKenzie J, Armstrong K. Longitudinal change in sleep and daytime sleepiness in postpartum women. *PLoS One* 2014;9:e103513.
- Armstrong K, MacKenzie J, Smith S. Postpartum sleepiness and sleepy driving in Australian mothers. *Int J Health Promot Educ* 2015;53:76–86.
- Shen J, Barbera J, Shapiro CM. Distinguishing sleepiness and fatigue: focus on definition and measurement. *Sleep Med Rev* 2006;10:63–76.
- Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep* 1991;14:540–5.
- Insana SP, Stacom EE, Montgomery-Downs HE. Actual and perceived sleep: associations with daytime functioning among postpartum women. *Physiol Behav* 2011;102:234–8.
- Insana SP, Williams KB, Montgomery-Downs HE. Sleep disturbance and neurobehavioral performance among postpartum women. *Sleep* 2013;36: 73–81.
- Dinges DF, Powell JW. Microcomputer analyses of performance on a portable, simple visual RT task during sustained operations. *Behav Res Methods Instrum Comput* 1985;17:652–5.
- McBean AL, Montgomery-Downs HE. Timing and variability of postpartum sleep in relation to daytime performance. *Physiol Behav* 2013;122:134–9.
- Thomas KA, Spieker S. Sleep, depression, and fatigue in late postpartum. *MCN Am J Matern/Child Nurs* 2016;41:104–9.
- Kubo T, Takahashi M, Sato T, et al. Weekend sleep intervention for workers with habitually short sleep periods. *Scand J Work Environ Health* 2011;37: 418–26.
- Monleón C, Ballester R, Sanchis C, et al. The effects of eight-month physical activity intervention on vigilance performance in adult obese population. *J Mot Behav* 2015;47:476–82.
- Montgomery-Downs HE, Stremmler R, Insana SP. Postpartum sleep in new mothers and fathers. *Open Sleep J* 2013;6:87–97.
- Fisher JRW, Feekery CJ, Rowe-Murray HJ. Nature, severity and correlates of psychological distress in women admitted to a private mother-baby unit. *J Paediatr Child Health* 2002;38:140–5.
- Fisher JRW, Feekery C, Rowe H. Psycho-educational early parenting interventions to promote infant mental health. In: Fitzgerald HE, Puura K, Tomlinson M, et al., editors. *International perspectives on children and mental health*. ABC-CLIO; 2011. p. 205–36.
- Fisher JRW, Rowe H, Hiscock H, et al. Understanding and responding to unsettled infant behaviour. Australian research alliance for children and youth. 2011. p. 1–60.
- Wilson N, Wynter K, Anderson C, et al. More than depression: a multi-dimensional assessment of postpartum distress symptoms before and after a residential early parenting program. *BMC Psychiatry* 2019;19(1):48.
- Fisher JRW, Feekery C, Rowe H. Treatment of maternal mood disorder and infant behaviour disturbance in an Australian private mothercraft unit: a follow-up study. *Arch Womens Ment Health* 2004;7:89–93.
- Matthey S, Speyer J. Changes in unsettled infant sleep and maternal mood following admission to a parentcraft residential unit. *Early Hum Dev* 2008;84: 623–9.
- Fisher JRW. Brief behavioural intervention for infant sleep problems reduces depression in mothers. *Evid Based Ment Health* 2009;12:46.
- Carney CE, Buysse DJ, Ancoli-Israel S, et al. The consensus sleep diary: standardizing prospective sleep self-monitoring. *Sleep* 2012;35:287–302.
- Buysse DJ, Reynolds 3rd CF, Monk TH, et al. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatr Res* 1989;28:193–213.
- Maislin G, Pack AI, Kribbs NB, et al. A survey screen for prediction of apnea. *Sleep* 1995;18:158–66.
- Krupp LB, LaRocca NG, Muir-Nash J, et al. The fatigue severity scale. Application to patients with multiple sclerosis and systemic lupus erythematosus. *Arch Neurol* 1989;46:1121–3.
- Akerstedt T, Gillberg M. Subjective and objective sleepiness in the active individual. *Int J Neurosci* 1990;52:29–37.
- Shahid A, Shen J, Shapiro CM. Measurements of sleepiness and fatigue. *J Psychosom Res* 2010;69:81–9.
- Lim J, Dinges DF. Sleep deprivation and vigilant attention. *Ann N Y Acad Sci* 2008;1129:305–22.
- Khitrov MY, Laxminarayan S, Thorsley D, et al. PC-PVT: a platform for psychomotor vigilance task testing, analysis, and prediction. *Behav Res Methods* 2014;46:140–7.
- Sinclair KL, Ponsford JL, Rajaratnam SMW, et al. Sustained attention following traumatic brain injury: use of the Psychomotor Vigilance Task. *J Clin Exp Neuropsychol* 2013;35:210–24.
- Basner M, Dinges DF. Maximizing sensitivity of the psychomotor vigilance test (PVT) to sleep loss. *Sleep* 2011;34:581–91.
- Pearce SC, Stolwyk RJ, New PW, et al. Sleep disturbance and deficits of sustained attention following stroke. *J Clin Exp Neuropsychol* 2016;38: 1–11.
- Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression. Development of the 10-item Edinburgh postnatal depression scale. *Br J Psychiatry* 1987;150:782–6.
- Ottoni GL, Antonioli E, Lara DR. The Circadian Energy Scale (CIRENS): two simple questions for a reliable chronotype measurement based on energy. *Chronobiol Int* 2011;28:229–37.
- Wilcox RR. Introduction to robust estimation and hypothesis testing. Academic Press; 2012.
- Team RC. R: A language and environment for statistical computing. 2017.
- Murphey C, Carter P, Price LR, et al. Psychological distress in healthy low-risk first-time mothers during the postpartum period: an exploratory study. *Nurs Res Pract* 2017;2017:8415083.
- Bei B, Milgrom J, Ericksen J, et al. Subjective perception of sleep, but not its objective quality, is associated with immediate postpartum mood disturbances in healthy women. *Sleep* 2010;33:531–8.
- Wynter K, Rowe H, Fisher JRW. Common mental disorders in women and men in the first six months after the birth of their first infant: a community study in Victoria, Australia. *J Affect Disord* 2013;151:980–5.

- [60] Belenky G, Wesensten NJ, Thorne DR, et al. Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study. *J Sleep Res* 2003;12:1–12.
- [61] Rupp TL, Wesensten NJ, Bliese PD, et al. Banking sleep: realization of benefits during subsequent sleep restriction and recovery. *Sleep* 2009;32:311–21.
- [62] Banks S, Van Dongen HPA, Maislin G, et al. Neurobehavioral dynamics following chronic sleep restriction: dose-response effects of one night for recovery. *Sleep* 2010;33:1013–26.
- [63] Lee J, Manousakis J, Fielding J, et al. Alcohol and sleep restriction combined reduces vigilant attention, whereas sleep restriction alone enhances distractibility. *Sleep* 2015;38:765–75.
- [64] Lamond N, Dawson D, Roach GD. Fatigue assessment in the field: validation of a hand-held electronic psychomotor vigilance task. *Aviat Space Environ Med* 2005;76:486–9.
- [65] Mollicone DJ, Van Dongen HPA, Rogers NL, et al. Time of day effects on neurobehavioral performance during chronic sleep restriction. *Aviat Space Environ Med* 2010;81:735–44.
- [66] Sadeh A, Mindell JA, Owens J. Why care about sleep of infants and their parents? *Sleep Med Rev* 2011;15:335–7.
- [67] Douglas PS, Hill PS. Behavioral sleep interventions in the first six months of life do not improve outcomes for mothers or infants: a systematic review. *J Dev Behav Pediatr* 2013;34:497–507.
- [68] Ftouni S, Sletten TL, Howard M, et al. Objective and subjective measures of sleepiness, and their associations with on-road driving events in shift workers. *J Sleep Res* 2013;22:58–69.
- [69] Wynter K, Wilson N, Thean P, Bei B, Fisher J. Psychological distress, alcohol use, fatigue, sleepiness and sleep quality: an exploratory study among men whose partners are admitted to a residential early parenting service. *Australian Psychologist* In Press.