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REPORT

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Infant sleep and anxiety disorders in early childhood: Findings from an Australian pregnancy cohort study

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Abstract

Emphasis on continuous infant sleep overnight may be driven by parental concern of risk to child mental health outcomes. The Mercy Pregnancy and Emotional Wellbeing Study (MPEWS) examined whether infant sleep at 6 and 12 months postpartum predicts anxiety disorders at 2–4 years, and whether this is moderated by maternal depression, active physical comforting (APC) or maternal cognitions about infant sleep. Data included 349 women and infants. Infant sleep was measured using the Brief Infant Sleep Questionnaire and child anxiety disorders by the Preschool Age Psychiatric Assessment. The risk of developing generalised anxiety or social phobia disorders at 3–4 years was reduced by 42% ($p = 0.001$) and 31% ($p = 0.001$), respectively, for a one standard deviation increase in total sleep at 12 months. No other infant sleep outcomes were

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associated. Maternal depression, APC and cognitions about infant sleep did not significantly moderate these relationships. Focus may need to be on total infant sleep, rather than when sleep is achieved.

Highlights

- To assess whether infant sleep outcomes (i.e., frequency of nocturnal wakes; nocturnal wakefulness and total sleep per day) at 6 and 12 months predict early childhood anxiety disorders at 3–4 years of age.
- Maternally reported infant sleep outcomes were not associated with the risk of developing early childhood anxiety disorders at 3–4 years.
- It may be total infant sleep, irrespective of when sleep occurs or night waking and, independently, active physical comforting that requires further investigation.

KEYWORDS
child mental health, early childhood anxiety disorders, infant sleep, night waking, perinatal depression

1 | INTRODUCTION

Parental concerns regarding infant sleep are amongst the most common referral to infant health services (Algarvio et al., 2013). An Australian population study of 5107 participants found that 17.1% of parents reported their infant's sleep to be a moderate or large problem (Williamson et al., 2019). However, defining 'problematic' sleep is difficult since infant sleep needs are highly variable both between infants of the same age and individually across the first 12 months (Galland et al., 2012). Cultural factors can influence parental expectations (Ball, 2020) and behaviours such as breastfeeding, co-sleeping and physical contact (Ball et al., 2019). Despite this, frequent infant night waking has been reported as predictive of later mental health issues (Cook et al., 2020). Researchers have also questioned whether infant sleep difficulties are indicative of early symptoms of separation anxiety (Cook et al., 2020).

The relationship between early patterns of infant sleep and later manifestations of anxiety is influenced by multiple factors. The early childhood regulation of emotion may be influenced by infant temperament (Cook et al., 2019) and maternal mental health (Hiscock et al., 2007). Equally, parental soothing and settling behaviours have been shown to influence infant sleep (Goodlin-Jones et al., 2001). Reportedly, active physical comforting (APC; i.e., use of physical contact) of infants may be associated with a reduced ability to self-soothe (Sadeh et al., 2009). The relationship between parental soothing and sleep outcomes is dynamic and bidirectional (Sadeh et al., 2010). Whilst APC may moderate the relationship between infant sleep outcomes and child anxiety, APC may equally protect against childhood anxiety by providing maternally sensitive caregiving.

Small associations between infant sleep and child mental health are reported. Increased infant night crying and fussing explained 2.8% of the variance in depressive symptoms at 2 years (Wake et al., 2006a, 2006b); and persistent night waking across the first year accounted for 3% of the variance in emotional and behavioural problems at 3.5 years (Scher et al., 2005). Interestingly, a more recent study found that sleep problems that persist from infancy into middle childhood were associated with emotional and behavioural symptoms at age 10–11 years with moderate

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to large effect sizes (Williamson et al., 2020). Whilst this may indicate, as the researchers concluded, that persistent sleep challenges could be an early indicator of subsequent emotional and behavioural disorders, the relationship may also be the other way, with any continuing childhood sleep challenges the outcome of internalising and externalising symptoms. Consequently, investigation of whether there is any relationship between infant sleep outcomes and early childhood internalising symptoms is necessary with the existing evidence unclear.

Existing studies have some methodological limitations. Many rely upon parental reports of infant sleep, which may be influenced by cultural context; maternal beliefs; parental sleep quality; and depression (Barry, 2021; Hall et al., 2017; Teng et al., 2012; Tinkova & Ball, 2022). Consequently, investigating the role of maternal cognitions in moderating the relationship between infant sleep and childhood anxiety may provide some insight into the impact of any maternal-report bias. With the association between maternal cognitions regarding infant sleep and infant sleep behaviours well documented, the inclusion of maternal cognitions in the context of maternally reported infant sleep behaviours is necessary (Tikotzky & Sadeh, 2009).

We identified one other study examining child anxiety with diagnostic measurement. Children whose mothers consistently reported problematic sleep during infancy were 2.44 and 2.14 times more likely to meet the criteria for separation anxiety and fear of physical injury at 10 years (Cook et al., 2020). However, only maternally reported night waking, which is highly variable in infancy (Galland et al., 2012), was included, with other important outcomes including total infant sleep not examined. Additionally, child anxiety was only assessed at 10 years of age. Given the documented increase in anxiety in children aged 5 years (Merikangas et al., 2022), assessment of any role of infant sleep outcomes as a possible risk factor for child anxiety requires an investigation in early childhood, which may be defined as children under the age of 8 years (World Health Organisation, 2018).

In addition to understanding infant sleep and its possible association with child anxiety, maternal depression has been investigated (Teti & Crosby, 2012; Ystrom et al., 2017). The link between maternal depressive symptoms and infant sleep 'problems' has been shown to be bidirectional, that is maternal depressive symptoms may influence infant sleep behaviours (e.g., night waking; sleep onset), and infant sleep behaviours may interact with maternal depression (Galbally et al., 2018). Unidirectional associations are also observed particularly prenatally between maternal depressive symptoms and infant sleep behaviours (Dias & Figueiredo, 2021), and infant sleep behaviours and increased maternal depressive symptoms (Wake et al., 2006a, 2006b). With evidence of the association between perinatal depression and adverse child outcomes not consistent (Aoyagi & Tsuchiya, 2019), women with perinatal depression need accurate information regarding any possible risks to their child, including in the context of infant sleep and child anxiety.

Questions remain regarding the relationship between infant sleep and anxiety disorders in early childhood, which has implications for the identification and intervention of these disorders. This study aims to examine whether maternally reported infant sleep outcomes (frequency and duration of nocturnal waking and total sleep-time [diurnal + nocturnal]) at 6 and 12 months postpartum predict early childhood anxiety disorders at 3–4 years of age. Secondary aims examine whether maternal depression, maternal cognitions about infant sleep and APC moderate these relationships. This study is the first, to our knowledge, to investigate whether maternally reported infant sleep outcomes predict specific anxiety disorders in early childhood using a diagnostic measure of mental health. We hypothesised that

1. Maternally reported infant sleep behaviours (higher frequency of nocturnal waking, increased nocturnal wakefulness and lower total sleep-time [diurnal + nocturnal]) will be associated with a higher risk of anxiety disorders diagnosed at 3–4 years of age.
2. Maternal depression and maternal cognitions about infant sleep will moderate this association, such that infant sleep difficulties will be more strongly associated with childhood anxiety disorders for infants whose mothers were depressed during pregnancy or in the postpartum or reported stricter cognitions about attending to an unsettled infant during the night.

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Finally, we were also interested in assessing whether APC would moderate each of these relationships.

2 | METHOD

2.1 | Participants

Data were drawn from the Mercy Pregnancy and Wellbeing Study (MPEWS), a prospective, selected longitudinal pregnancy cohort study. This study sample comprises 349 women recruited at less than 20 weeks of pregnancy with follow-up in the third trimester, and postnatally at birth, 6 and 12 months and 3–4 years. Recruitment included women diagnosed with depression and women on an antidepressant. Ethics approval was obtained from the Mercy Health Human Research Ethics Committee and all participants provided informed and written consent. Published study protocol of the original cohort (Galbally et al., 2017).

2.2 | Procedure

2.2.1 | Infant sleep outcomes

Infant sleep at 6 and 12 months was measured using the 13-item parent-report Brief Infant Sleep Questionnaire (BISQ). The BISQ is validated against actigraphy and daily sleep logs, with high test–retest reliability ($r = 0.81–0.95$; (Sadeh, 2004)). Measures of maternally reported infant sleep were used: average frequency of nocturnal wakes, nocturnal wakefulness (minutes spent awake during the night) and total sleep-time per day (diurnal + nocturnal). Maternal reports of three or more average nocturnal wakes, 60 or more minutes of nocturnal wakefulness and <9 h of total sleep were applied as cut-off values to indicate infant sleep difficulties. These cut-off scores were identified using discriminant function analysis as capable of classifying clinical cases of infant sleep with over 80% accuracy (Sadeh, 2004). Given the challenges of defining infant sleep *problems* (Marinelli et al., 2019), we present the continuous measures derived from the BISQ, as well as cut-points to indicate sleep difficulties.

2.2.2 | Childhood anxiety disorders

Childhood anxiety disorders were assessed at 3–4 years of age using the Preschool Age Psychiatric Assessment (PAPA) (Egger et al., 2006). The PAPA is a structured diagnostic parent interview for children aged 3–8 years that uses algorithms to generate DSM-5 diagnoses based on symptom severity, frequency and impairment. Test–retest reliability and the inter-rater reliability have been established (Egger et al., 2006). We assessed Separation Anxiety Disorder (SAD), Generalised Anxiety Disorder (GAD), Social Phobia (SP) and specific phobias.

2.2.3 | Maternal depression

Diagnosis of past or current maternal depressive disorders was assessed using the Structured Clinical Interview for DSM-IV Clinician Version (SCID-IV-CV) at recruitment and at 6 months postpartum (First et al., 2016). The SCID-IV-CV has excellent reliability and clinical validity (Osório et al., 2019). At recruitment or at 6 months postpartum, 93 (26.6%) women met the criteria for a depressive disorder.

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2.2.4 | Maternal active physical comforting

Settling behaviours were measured using the APC scale of the Parental Interactive Bedtime Behaviour Scale (PIBBS; Morrell & Cortina-Borja, 2002). The PIBBS is a 17-item self-report questionnaire that assesses the use of five strategies for settling. For this study, we use the APC subscale only, which measures how much time a mother spent engaging in APC behaviours relative to other techniques. Moderate internal consistency is reported (Cronbach's $\alpha = 0.71$; Morrell & Cortina-Borja, 2002).

2.2.5 | Maternal cognitions about infant sleep

We applied the three-item Limit Setting subscale of the Maternal Cognitions about Infant Sleep Questionnaire to operationalise maternal cognitions about attending to their child's signalling at night (Morrell, 1999). Higher average limit-setting scores are indicative of a lower maternal threshold for responding to nocturnal infant signalling. These items demonstrated good internal consistency at 6 ($\alpha = 0.81$) and at 12 months ($\alpha = 0.76$) postpartum.

2.2.6 | Covariates

Breastfeeding cessation was collected by maternal self-report at 6 and at 12 months postpartum. Infant birth weight and sex were collected at delivery from medical records.

2.3 | Statistical analyses

To address hypothesis 1, we present the associated risk (*AR*) and risk ratio (*RR*) of developing each of the four anxiety disorders at 3–4 years relative to a comparison group of the sample that did not develop an anxiety disorder. To address hypothesis 2, a series of generalised (log-binomial) linear regression models were estimated, with multiplicative interaction terms between infant sleep outcomes and hypothesised moderators (maternal depression, APC and maternal cognitions) included. In each model, we entered covariates breastfeeding cessation, and infant birth weight and sex. Infant sleep outcomes at 12 months of age and hypothesised moderators were added simultaneously in Block 2, with interaction terms added in a third block. Significant interaction terms were probed by calculating simple effects between infant sleep and child anxiety disorder at 3–4 years of age at meaningful values of the moderators (e.g., mean ± 1 to 2 standard deviation/s dependent on distribution characteristics such as skew). All continuous variables for inclusion in the modelling were standardised (*z*-score transformed). Preliminary data preparation, descriptive and bivariate association statistics were conducted using *SPSS* version 24 (Statistics, 2016) and regression modelling was conducted using *Mplus* 8 (Muthén et al., 2017).

3 | RESULTS

3.1 | Sample characteristics

Maternal demographic and mental health characteristics and infant outcomes at birth are presented in Table 1.

3.2 | Infant sleep outcomes at 6 and 12 months

Descriptive statistics and the proportions of infants whose sleep scores met cut-off criteria for maternally reported sleep difficulties are presented in Table 2. One-quarter of infants were classified as having a maternally

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TABLE 1 Maternal demographic and maternal mental health, and child characteristics ($N = 349$).

Maternal characteristics	*n*, *M*	*%*[a], *SD*
Age at recruitment (*M*, SD)	32.46	4.45
Ethnicity (*n*, %)		
Oceanic/European	311	89.4
Aboriginal and/or Torres Strait Islander Australians	3	0.9
Asian	29	8.3
Middle Eastern	5	1.4
In a married, de facto or otherwise stable relationship (*n*, %)	332	96.0
University degree (*n*, %)	255	73.1
Full-time, part-time or casual employment (*n*, %)	312	91.5
Substance use in pregnancy (*n*, %)		
Smoking	37	10.7
Alcohol consumption	147	42.5
Major depression	93	26.6
Antidepressant use in pregnancy	61	17.5
Infant characteristics at birth		
Male (*n*, %)	199	57.0
Gestational age at delivery, weeks (*M*, SD)	39.46	1.56
Birth weight, kg (*M*, SD)	3419.59	502.16

Abbreviations: M, mean; n, sample with data; SD, standard deviation.
[a]Valid percentage shown.

TABLE 2 Descriptive statistics for measures of infant sleep at 6 and 12 months of age ($N = 349$).

	n	Mdn	IQR	Min	Max	Sleep difficulty[a] *n* (%[b])
6-month sleep						
Nocturnal wakes	314	2.00	1, 3	0.00	8.00	46 (14.6)
Nocturnal wakefulness (minutes)	315	30.00	10.00, 60.00	0.00	360.00	47 (14.9)
Total sleep night (hours)	320	13.50	12.50, 14.75	5.00	19.00	5 (1.6)
Any sleep difficulty[c]	307	-	-	-	-	77 (25.1)
12-month sleep						
Nocturnal wakes	306	1.00	0, 2	0.00	8.00	28 (9.2)
Nocturnal wakefulness (minutes)	295	20.00	2.50, 30.00	0.00	180.00	22 (7.5)
Total sleep-time (hours)	301	13.00	12.00, 14.00	5.33	16.75	5 (1.7)
Any sleep difficulty[c]	289	-	-	-	-	46 (15.9)

Abbreviations: IQR, interquartile range; Max, maximum observed value; Mdn, median; Min, minimum observed value; n, sample with data.
[a]As per Sadeh's (2004) cut-off scores.
[b]Valid percent due to case-wise missing data.
[c]Meeting Sadeh's cut-off score for sleep difficulty in either nocturnal wakes, nocturnal wakefulness or total sleep-time.

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reported sleep difficulty in at least one sleep outcome at 6 months postpartum, reducing to 15.9% at 12 months. Only five mothers reported less than 9 h of total infant sleep per day (diurnal + nocturnal) at both 6 and 12 months postpartum.

3.3 | Childhood anxiety disorders

Forty-four percent of children in the sample ($n = 154$) met the criteria for a DSM-5 anxiety disorder. This comprised 30.4% ($n = 106$) specific phobia, 12.6% ($n = 44$) SAD, 12.4% ($n = 43$) SP, 8.6% ($n = 30$) GAD, 2.6% ($n = 9$) agoraphobia without panic and 0.3% ($n = 1$) panic attacks. There was substantial comorbidity amongst anxiety disorders, with 28.9% ($n = 101$) children diagnosed with one anxiety disorder, followed by 32 (9.2%) who were diagnosed with two anxiety disorders and 21 (6.0%) diagnosed with three or more anxiety disorders.

3.4 | Childhood anxiety disorders and maternally reported infant sleep outcomes

Table 3 presents the rates of infant sleep difficulties by specific anxiety disorders and associated AR and RR of anxiety disorder due to infant sleep difficulty compared to the comparison group. None of the maternal-reported infant sleep difficulties were associated with a higher risk of any of the anxiety disorders at 3–4 years of age. We used continuous sleep outcomes at 12 months to predict the four anxiety disorders in regression modelling to address hypothesis 2.

Distributions of the raw infant sleep outcomes at 6 and 12 months postpartum are presented in Figure 1. Figure 1a,b displays maternally reported infant nocturnal wakes at 6 and 12 months postpartum, respectively. Whilst the box-and-whisker plots for nocturnal wakes at 6 months demonstrate similar IQR for the comparison group compared with each childhood anxiety disorder (Figure 1a), the IQR of nocturnal wakes at 12 months appeared higher for children diagnosed with either social phobia or separation anxiety disorder at 4 years old compared to the comparison group (Figure 1b). However, the observed range of nocturnal wakes was largest for the comparison group at both 6 and 12 months postpartum when compared to all individual anxiety disorders, with infants reported as waking the most frequently in the sample belonging to the comparison group. Figure 1c,d displays maternally reported infant nocturnal wakefulness at 6 and 12 months postpartum, respectively. Although the range reduced relatively consistently across the groups between 6 and 12 months, the IQR for wakefulness at 12 months appears marginally higher for those with separation anxiety and specific phobias. Figures 1e,f display maternally reported infant total sleep at 6 and 12 months postpartum, respectively. Again, although relatively similar at 12 months, the distribution of total sleep hours at 12 months of age was observably lower for children meeting a diagnosis of separation anxiety disorder at 3–4 years old. Supplementary Table I displays zero-order bivariate associations between infant sleep outcomes at 12 months, anxiety disorder symptoms at 3–4 years, the three hypothesised moderators and selected covariates.

Table 4 presents the results for the final four multivariate models (log-binomial regressions) predicting specific anxiety disorders. None of the interaction terms across the child anxiety disorders models were significant, suggesting that maternal depression, APC and maternal cognitions did not significantly moderate the associations between infant sleep at 12 months and anxiety disorders at 3–4 years. Total infant sleep-time at 12 months of age was significantly associated with both GAD and SP. Specifically, the risk of developing GAD or SP at 3–4 years of age was reduced by 42% ($p = 0.001$) and 31% ($p = 0.001$), respectively, for a one standard deviation increase in total sleep-time at 12 months postpartum. Although not significant moderators, maternal depression and APC were each independently associated with significant differences in the risk of developing anxiety disorders at 3–4 years old. Maternal depression was associated with a 3.06-fold risk ($p < 0.001$) and a 2.74-fold risk ($p = 0.013$) in developing SAD and GAD, respectively. Interestingly, a one standard deviation increase in APC was associated with a

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TABLE 3 Rates, attributable risk and relative risk of maternally reported infant sleep difficulties at 6 and 12 months within anxiety disorder diagnoses at 4 years of age, each compared to a group without any disorder at 4 years of age.

	Comparison group ($n = 195$)	Separation anxiety ($n = 44$)			Generalised anxiety ($n = 30$)			Social phobia ($n = 43$)			Specific phobia ($n = 106$)		
Sleep difficulties	***n*** [a] **(%)**	***n* (%)**	**AR**	**RR (95% CI)**	***n* (%)**	**AR**	**RR (95% CI)**	***n* (%)**	**AR**	**RR (95% CI)**	***n* (%)**	**AR**	**RR (95% CI)**
6 months													
Nocturnal wakes	24 (14.0)	7 (18.4)	4.4	1.32 (0.61, 2.84)	5 (17.2)	3.2	1.24 (0.51, 2.98)	6 (15.0)	1.0	1.08 (0.47, 2.46)	16 (16.7)	2.7	1.19 (0.67, 2.14)
Nocturnal wakefulness	27 (15.6)	6 (16.7)	1.1	1.07 (0.48, 2.40)	4 (14.8)	−0.8	0.95 (0.36, 2.50)	5 (15.4)	−0.2	0.99 (0.44, 2.22)	15 (15.6)	0.0	1.00 (0.56, 1.79)
Any difficulty[b]	43 (25.4)	10 (27.8)	2.4	1.09 (0.61, 1.96)	6 (22.2)	3.2	0.87 (0.41, 1.85)	11 (28.9)	3.5	1.14 (0.65, 1.99)	25 (26.9)	1.5	1.06 (0.69, 1.61)
12 months													
Nocturnal wakes	14 (8.2)	4 (11.4)	3.2	1.40 (0.49, 3.99)	0 (0.0)	−8.2	0.21 (0.01, 3.45)	6 (14.6)	6.4	1.79 (0.73, 4.37)	10 (10.8)	2.6	1.31 (0.61, 2.84)
Nocturnal wakefulness	11 (6.8)	2 (5.9)	−0.9	0.86 (0.20, 3.71)	0 (0.0)	−6.8	0.26 (0.02, 4.30)	6 (14.0)	7.2	2.04 (0.80, 5.21)	8 (8.8)	2.0	1.29 (0.54, 3.09)
Any difficulty[b]	23 (14.9)	6 (17.6)	2.7	1.21 (0.53, 2.75)	1 (4.0)	−10.9	0.27 (0.04, 1.95)	10 (25.0)	10.1	1.72 (0.89, 3.31)	17 (18.9)	4.0	1.30 (0.73, 2.30)

Abbreviations: AR, attributable risk, RR, relative risk.

[a]Comparison rate for all attributable and relative risks.

[b]Sleep difficulty on nocturnal wakes, nocturnal wakefulness or total sleep-time less than 9 h, as per Sadeh's (2004) sleep cut-off scores.

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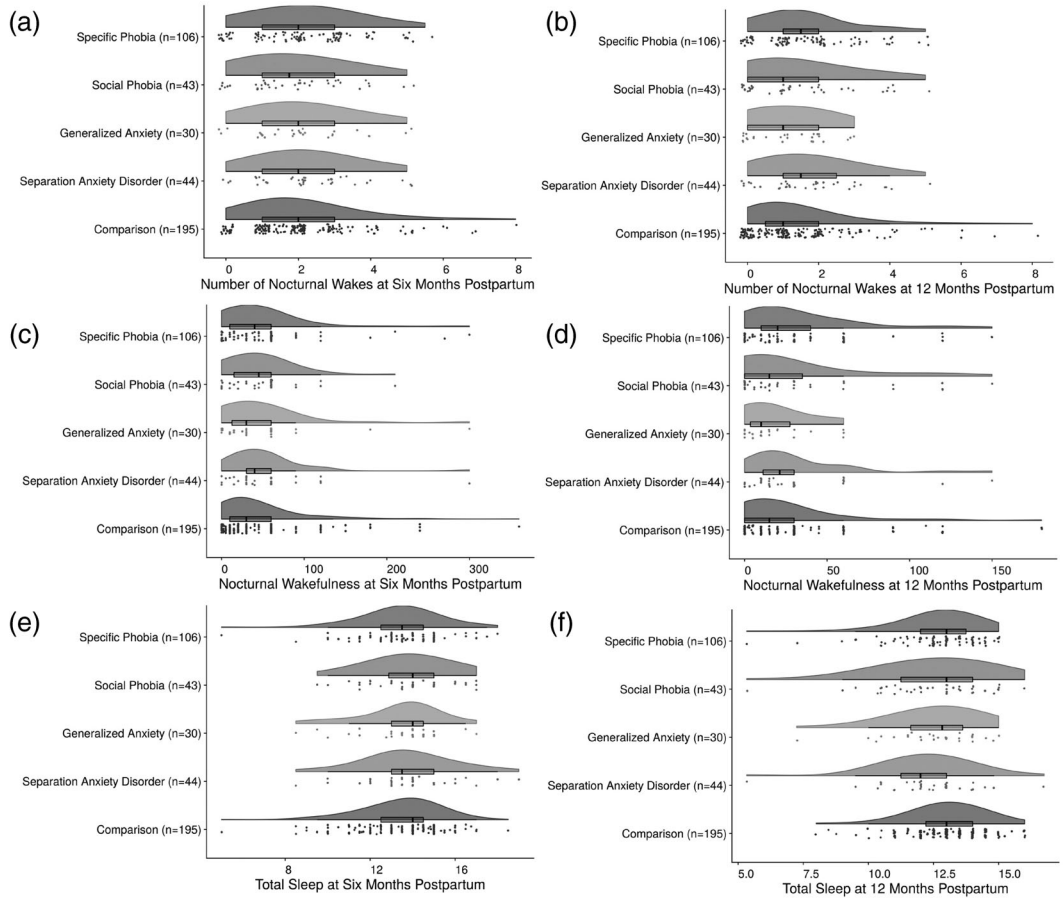

FIGURE 1 Raincloud plots, with embedded box-and-whisker plots (median, IQR, ±1.5*IQR), showing maternally reported infant sleep outcomes at 6 (a, c and e) and 12 months postpartum (b, d and f) by comparison group and specific DSM-5 childhood anxiety disorders.

1.51-fold risk ($p = 0.008$) of developing SAD but a 33% reduction ($p = 0.026$) in the risk of developing SP at 3–4 years of age. None of the variables in blocks 1 and 2 were significant independent predictors of the risk of developing a specific phobia at 3–4 years old.

4 | DISCUSSION

This study investigated in a selected sample of women whether maternally reported infant sleep outcomes at 6 and 12 months postpartum predict anxiety disorders at 3–4 years, and whether maternal depression, maternal cognitions about infant sleep and APC moderate these relationships. We found that maternally reported infant sleep difficulties at 6 and 12 months were not associated with an increased unadjusted risk of developing any of the four anxiety disorders at age 3–4 years. Though multivariate modelling demonstrated that more total sleep at 12 months postpartum was associated with significantly lower adjusted risk of developing GAD and SP at 3–4 years. There was no evidence of maternal depression, APC or maternal cognitions about infant sleep moderating these relationships. Given the increasing emphasis on understanding risk factors for early childhood anxiety (Racine et al., 2021), this study provides a unique examination of any role that infant sleep may play in this context.

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TABLE 4 Results[a] of the multiple generalised linear regression models (log-binomial) using infant sleep outcomes 12 months postpartum to predict DSM-V anxiety disorders at 3–4 years of age.

	Separation anxiety ($N = 175$[b])		Generalised anxiety ($N = 170$[b])		Social phobia ($N = 181$[b])		Specific phobia ($N = 226$[b])	
Model	***B (SE)***	***aRR* (95% CI)**	***B (SE)***	***aRR* (95% CI)**	***B (SE)***	***aRR* (95% CI)**	***B (SE)***	***aRR* (95% CI)**
Intercept	−1.96 (0.29)	0.14 (0.08, 0.25)	−2.55 (0.41)	0.08 (0.04, 0.17)	−1.91 (0.26)	0.15 (0.09, 0.25)	−1.22 (0.15)	0.29 (0.22, 0.40)
Maternal depression	**1.12*** (0.27)**	**3.06 (1.79, 5.24)**	**1.00* (0.40)**	**2.73 (1.24, 6.00)**	−0.18 (0.33)	1.20 (0.63, 2.29)	0.32 (0.19)	1.37 (0.94, 2.00)
Maternal cognitions about infant sleep at 12 months[c]	−0.11 (0.19)	0.89 (0.62, 1.29)	0.05 (0.23)	1.05 (0.67, 1.64)	−0.10 (0.17)	0.90 (0.64, 1.27)	−0.12 (0.09)	0.89 (0.75, 1.06)
Active physical comforting at bedtime at 12 months[c]	**0.41** (0.16)**	**1.51 (1.11, 2.05)**	0.17 (0.23)	1.19 (0.76, 1.87)	**−0.41* (0.18)**	**0.67 (0.47, 0.95)**	−0.03 (0.09)	0.97 (0.82, 1.16)
12-month infant sleep outcome								
Total sleep-time (diurnal + nocturnal)[c]	−0.07 (0.09)	0.93 (0.78, 1.11)	**−0.55** (0.17)**	**0.58 (0.42, 0.81)**	**−0.38** (0.12)**	**0.69 (0.55, 0.86)**	−0.11 (0.06)	0.90 (0.80, 1.01)
Nocturnal wakes[c]	0.26 (0.17)	1.29 (0.93, 1.79)	−0.30 (0.30)	0.74 (0.41, 1.34)	0.01 (0.21)	1.01 (0.66, 1.53)	0.09 (0.10)	1.09 (0.89, 1.33)
Nocturnal wakefulness (minutes)[c]	−0.23 (0.15)	0.79 (0.59, 1.05)	−0.32 (0.28)	0.72 (0.41, 1.27)	−0.004 (0.14)	1.00 (0.76, 1.30)	−0.01 (0.06)	0.99 (0.89, 1.33)

Note: The bolded values represent statistical significance at .05.

Abbreviations: aRR, adjusted risk ratio; CI, confidence interval; SE, standard error.

[a]Results presented from final generalised linear regression models with adjustment for sex (male = 1), birth weight (g) and breastfeeding cessation by 6 months postpartum.

[b]Missing data handled using case-wise omission.

[c]Continuous variables standardised (transformed to *z*-score) prior to entry into modelling.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

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Whilst most infant sleep outcomes were unrelated to early childhood anxiety disorders, the finding that lower total sleep-time at 12 months was associated with the risk of GAD increasing 3.06-fold, and SP 2.74-fold, reflects research on the potential developmental impact of low total sleep-time (Velten-Schurian et al., 2010). Sleep is associated with cognitive functioning that is central to optimal learning (e.g., visual attention; reaction time and working memory; Burke et al., 2015), and child developmental outcomes (Kapsi et al., 2020). However, the frequency and duration of nocturnal wakefulness were unrelated to early childhood anxiety disorders, which differs from previous findings (Cook et al., 2020). That said, the elevated likelihood of anxiety symptoms reported as an outcome in the infant sleep study by Cook et al. (2020) was for children aged 10 years, so until now, this association has not been clear for early childhood. This study provides a unique opportunity to assess a possible predictor of child anxiety at only 3–4 years when early intervention may still be possible. Given the evidence of the role of genetics in anxiety disorders (Ask et al., 2021), identification of any modifiable and targetable outcomes such as infant sleep, is valuable.

The fact that it is total infant sleep-time that was the only sleep outcome with a small but significant effect, and not how that sleep is achieved (i.e., night waking), or even *when* that sleep occurs (i.e., nocturnal or diurnal), is noteworthy given the emphasis by Western models of infant care on continuous overnight sleep (Ball et al., 2019). Over the last three decades, studies assessing the effectiveness of infant sleep interventions in targeting the reduction of infant night waking have been reported (e.g., Hall et al., 2015; Leichman et al., 2020; Skuladottir & Thome, 2003), yet our findings indicate the focus should shift to the total amount of infant sleep across a 24-h period. This is interesting given the emphasis on infants sleeping 'through the night' (Ball, 2020), despite infants often requiring regular overnight feeding, comfort or contact (Rudzik & Ball, 2021).

Given that meta-analysis of 34 studies reported wide variation in sleep duration during infancy, with consistent sleep patterns only beginning to develop at 12 months (Galland et al., 2012), flexibility in the approach around how infant sleep occurs may better reflect the evidence available. Indeed, a systematic review of the effectiveness of behavioural interventions for infant 'sleep problems' indicated insufficient evidence of any long-term effectiveness (Reuter et al., 2020), with increased efficacy observed by targeting maternal expectations about infant sleep using maternal education (Sweeney et al., 2020). Perhaps intervention for nocturnal night waking or nocturnal wakefulness may be parental, with the infant able to access the total sleep that is required where a flexible approach to infant sleep is adopted. For example, an improved understanding of infant sleep architecture may also increase maternal awareness around the application of APC.

Contrary to initial hypotheses, there was no evidence that the relationship between sleep outcomes in infancy and anxiety disorders in early childhood were moderated by maternal depression, APC or maternal cognitions regarding attending to an unsettled infant. Maternal depression was significantly associated with an increased risk of SAD and GAD, which is consistent with previous research by our own and other teams (Bat-Pitault et al., 2017; Galbally et al., 2022). There are other studies that report an association between maternal depression and adverse child mental health outcomes (Goodman et al., 2011; McLean et al., 2018), however, the effect sizes are often small, and measurement of maternal depression can often involve symptomatic assessment only (e.g., Glynn et al., 2018). Consequently, caution is to be exercised in the application of our findings.

Interestingly, higher APC was associated with an increased risk of SAD by 1.51-fold, and a 33% *reduced* risk of SP, but this requires further research. There is evidence of extreme levels of maternal sensitivity; overinvolved parenting and child anxiety (Bayer et al., 2019; Mount et al., 2010), with opportunities for children to regulate fear-related distress or experience exposure to new situations potentially reduced in the context of highly sensitive maternal behaviour. One possibility is that APC may occur more frequently where there is maternal overprotection or extreme sensitivity, despite this, however, less is known regarding APC in the context of infant sleep and diagnosed early child anxiety disorders. There was no evidence to support the emphasis on maternal cognitions in the context of infant sleep and early childhood anxiety, which is interesting given the role of maternal cognitions in parental concerns regarding infant sleep (Tikotzky & Sadeh, 2009).

Findings showed that children of mothers with maternal depression were more than three times as likely to develop SAD at 3–4 years of age, and over two and a half times more likely to develop GAD. This may reflect the

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documented increased risk of child psychopathology for women diagnosed with depression, however, with studies generally reporting small to moderate effect sizes (Stein et al., 2014), this risk is not to be overstated. Similarly, children who experienced one standard deviation increase in APC at 12 months were 1.5 times more likely to develop SAD at 3–4 years, but 33% less likely to develop SP. This supports our proposition that APC is bidirectional – it may be a risk or a protective factor for the child because it can occur in the context of maternally sensitive caregiving.

4.1 | Limitations

Generalisability of the findings may be limited by the predominantly Caucasian and university educated sample, though different cultural groups and ethnicities are represented. All outcomes were maternally reported, and not immune to bias, so shared methods variance may have influenced results. Future research would benefit from objective sleep measurement (e.g., actigraphy; clinically evaluated diagnoses from sleep laboratories). Further limitations include the measurement of APC at 12 months only, reliance on a structured diagnostic parent interview for the assessment of child anxiety, without direct observation of the child and no inclusion of infant temperament. Future research should measure persistent sleep problems and their association with childhood anxiety disorders in an unselected sample, as well as the role of infant temperament on any outcomes (Beekman et al., 2015). The inclusion of temperament reflects the consistent evidence of an association between inhibition and anxiety disorders (Biederman et al., 2001; Schwartz et al., 2015).

4.2 | Conclusions

This study provides limited evidence of a relationship between maternal-reported sleep outcomes in infancy and early childhood anxiety disorders in a sample including women diagnosed with perinatal depression. Except for total sleep at 12 months, infant sleep was unrelated to anxiety disorders at age 3–4 years. Total sleep may be more important at 12 months, rather than how or when that sleep occurs. Night waking may only become a 'problem' when it persists beyond infancy, or when the mother struggles to adapt to their infant's sleep needs (Countermine & Teti, 2010). These findings may be encouraging for women, particularly those diagnosed with perinatal depression, whose infants do not 'sleep through' the night. Results highlight that child anxiety disorders are the outcome of a complex interaction of factors, of which maternal reported sleep outcomes in infancy, may be but a small contributor.

AUTHOR CONTRIBUTIONS

Kelli K. MacMillan: Project administration; supervision; writing – original draft; writing – review and editing. **Declan Bourke:** Writing – original draft; writing – review and editing. **Stuart J. Watson:** Data curation; formal analysis; project administration; supervision; writing – original draft; writing – review and editing. **Andrew J. Lewis:** Conceptualization; funding acquisition; investigation; methodology; supervision; visualization; writing – review and editing. **Douglas M. Teti:** Writing – review and editing. **Helen L. Ball:** Writing – review and editing. **Megan Galbally:** Conceptualization; funding acquisition; investigation; methodology; resources; supervision; visualization; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no competing interests.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

Author elects to not share data.

ETHICS STATEMENT

Ethics approval was obtained from the Mercy Health Human Research Ethics Committee.

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