The prospective relationship between postpartum PTSD and child sleep: A 2-year follow-up study.

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Abbreviations: ABC - Akershus Birth Cohort, BIS - Bergen Insomnia Scale, BISQ - Brief Infant Sleep Questionnaire , CI - Confidence Interval, DSM-5 - Diagnostic and Statistical

Manual of Mental Disorders, Fifth Edition, IES - The Impact of Event Scale, OR - Odds Ratio, PTSD - posttraumatic stress disorder, SD - standard deviation

Contributors' Statements:

Dr. Susan Garthus-Niegel and Dr. Antje Horsch conceptualized and designed the study, performed the statistical analyses, drafted the initial manuscript, and reviewed and revised the manuscript.
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Abstract

Background

The main aim of this study was to examine the prospective impact of maternal postpartum PTSD on several standardized child sleep variables two years postpartum in a large, population-based cohort of mothers. Moreover, we investigated the influence of numerous potential confounding maternal and child factors. Finally, we tested potential reverse temporal associations between child sleep eight weeks postpartum and maternal PTSD symptoms two years postpartum.

Methods

This study is part of the population-based Akershus Birth Cohort, a prospective cohort study at Akershus University Hospital, Norway. Data from the hospital's birth record, from questionnaires at 17 weeks gestation, eight weeks and two years postpartum were used. At two years postpartum, 39% of the original participants could be retained, resulting in a study population of n=1,480. All child sleep variables significantly correlated with postpartum PTSD symptoms were entered into multiple linear regression analyses, adjusting for confounding factors.

Results

Postpartum PTSD symptoms were related to all child sleep variables, except daytime sleep duration. When all significant confounding factors were included into multivariate regression analyses, postpartum PTSD symptoms remained a significant predictor for number and duration of night wakings (β = 0.10 and β = 0.08, respectively), duration of settling time (β =

0.10), and maternal rating of their child's sleep problems (β = 0.12, all p < .01. Child sleep at eight weeks postpartum was not significantly related to maternal sleep two years postpartum when controlling for postpartum PTSD at eight weeks.

Limitations

Child outcomes were based on maternal reporting and might be influenced by maternal mental health.

Conclusions

Our results showed for the first time that maternal postpartum PTSD symptoms were prospectively associated with less favorable child sleep, thus increasing the risk of developmental or behavioral problems through an indirect, but treatable pathway. Early detection and treatment of maternal postpartum PTSD may prevent or improve sleep problems and long-term child development.

Keywords: posttraumatic stress disorder; BISQ; Brief Infant Sleep Questionnaire; anxiety; depression; maternal mental health

Introduction

Following childbirth, approximately 3-6% of mothers develop posttraumatic stress disorder (PTSD), which comprises four symptom clusters (intrusion or re-experiencing, avoidance, negative alterations in mood or cognitions, and increased arousal), that must have lasted at least one month and that significantly impair the mother's functioning (American Psychiatric Association, 2013; Yildiz, Ayers, & Phillips, 2017). Postpartum PTSD may negatively impact the mother-infant relationship, as well as infant behavior and social-emotional and cognitive development (Cook, Ayers, & Horsch, 2017).

In this study, we propose a link between maternal birth-related PTSD and infant sleep, an important area of investigation, since sleep during infancy has been shown to be associated with infant mental health and social-emotional problems (Jansen et al., 2011; Sivertsen et al., 2015). Sleep problems in infants, such as difficulties initiating or maintaining sleep, are commonly reported and tend to be stable during childhood (Hysing et al., 2014). Infant health problems can lead directly to sleep problems (e.g., eczema, recurrent ear infections, asthma, and diabetes) (Brouwer et al., 2005; Camfferman, Kennedy, Gold, Martin, & Lushington, 2010; Koinis-Mitchell et al., 2015; Reutrakul et al., 2016) or through parents' stress (e.g., injuries, hospital admissions) (Woolf, Muscara, Anderson, & McCarthy, 2016). Furthermore, the sleep organization of infants may be influenced by qualitative and quantitative differences in nutrient intakes that depend on the feeding method, but no consensus has been reached so far (Averill, 2008; LIAT et al., 2010). Mothers' mental health problems, such as depression or anxiety are associated with infant sleep problems (Ystrom et al., 2017). Several mechanisms underlying these associations have been proposed. First, the "mother-driven" mechanism proposes that maternal symptoms of anxiety and depression negatively affect the child's nocturnal awakenings, mediated by maternal behaviors such as more intrusive and less effective parenting and family conflict (El-Sheikh, Kelly, Bagley, & Wetter, 2012). Second, a "child-driven" mechanism states that child nocturnal awakenings negatively impact maternal

anxiety and depression (Teti & Crosby, 2012). Third, common underlying mechanisms, such as genetics or environmental stressors may increase the risk of maternal anxiety and depression as well as child nocturnal awakenings (El-Sheikh et al., 2012; McAdams et al., 2014). Evidence exists for each of the pathways, which can also combine to form a reciprocal model (Warren, Howe, Simmens, & Dahl, 2006) (see Figure 1).

Mothers with postpartum PTSD sleep less well (Garthus-Niegel, Ayers, von Soest, Torgersen, & Eberhard-Gran, 2015), but studies addressing the relationship between maternal PTSD and child sleep are scarce. The underlying mechanisms for this proposed association may be similar to those described for maternal anxiety and depression. This study firstly aimed to examine the prospective impact of maternal postpartum PTSD on several important and standardized child sleep variables in a large, population-based cohort of mothers at two years postpartum. Secondly, we investigated the influence of numerous potential confounding maternal and child factors. Finally, we tested potential reverse temporal associations between PTSD symptoms at two years postpartum and child sleep eight weeks postpartum.

Methods

Design and study population

Data were derived from the Norwegian Akershus Birth Cohort (ABC). The ABC study is a large population-based prospective cohort study, which targeted all women scheduled to give birth at Akershus University Hospital, Norway, serving approximately 350,000 people from both urban and rural areas. Between November 2008 and April 2010, women were recruited for the study during their routine fetal ultrasound examination, at 17 weeks gestation and asked to complete questionnaires at 17 weeks gestation, 32 weeks gestation, eight weeks postpartum, and two years postpartum. Of the eligible women (i.e., those able to complete a questionnaire in Norwegian), 80% (n = 3,752) agreed to participate and returned the first questionnaire. The number of eligible women dropped somewhat during the study, because

some had moved or were withdrawn from the study due to severe birth complications. Response rates were 81% (2,936 out of 3,621 eligible women), 79% (2,217 out of 2,806), and 73% (1,480 out of 2,019) respectively. Detailed information about response and dropout rates are presented in Figure 2.

A total of 1,480 women had data in the birth records, completed the questionnaires collected at 17 weeks gestation and eight weeks and two years postpartum, and thus were included in the analyses. As less than 50% of the original participants were retained at the last measurement point, we performed attrition analyses, which showed that women with more than 12 years of education (*Odds Ratio (OR)* 0.57, 95% *Confidence interval (CI)* 0.49-0.66, $p < .001$) were less likely to drop out than women with fewer years of education. Also, when using a continuous measure of age, older age was related to less drop out (*OR* 0.97, 95% *CI* 0.95-.98, $p < .001$). Women with symptoms of depression (*OR* 1.05, 95% *CI* 1.02-1.07, $p < .001$) were somewhat more likely to drop out. Importantly, symptoms of anxiety and PTSD were not significantly related to dropout ($p > .05$).

Ethical considerations

The ABC study obtained ethical approval from the Regional Committees for Medical and Health Research Ethics (approval number S-08013a). According to the Norwegian Health Research Act, the committees evaluate whether health research is conducted in accordance to common ethical standards and Norwegian data protection regulations. All participants provided written informed consent.

Measures

Child sleep: At eight weeks postpartum, mothers were asked about the number of *night wakings* of their child (i.e., how often their child wakes up during the night), with response options "4" = 3 or more times each night, "3" = 1-2 times each night, "2" = some nights per

week, and "1" = less frequently) and *settling time* (i.e., how fast the child calms down/falls asleep again after feeding, with response options "4" = after more than 30 minutes, "3" = within 15-30 minutes, "2" = within 15 minutes, and "1" = right away). At two years postpartum, the Brief Infant Sleep Questionnaire (BISQ) (Sadeh, 2004) was used to assess different domains of child sleep: 1) *nocturnal sleep duration* (between 7 p.m. and 7 a.m.); 2) *daytime sleep duration* (between 7 a.m. and 7 p.m.); 3) *total sleep duration* ; 4) number of *night wakings*; 5) *duration of wakefulness* during nighttime (between 10 p.m. and 6 a.m.); 6) *settling time* (latency to falling asleep for the night); 7) whether the mother considers her *child's sleep to be a problem*. Response options range from "a very serious problem", "a small problem", to "not a problem at all", and mothers were instructed to refer to their child's sleep during the past week. The BISQ has demonstrated good psychometric properties as a screening tool for clinical and research purposes in infants and toddlers (0-30 months) (Sadeh, 2004).

Postpartum PTSD: The Impact of Event Scale (IES) (Horowitz, Wilner, & Alvarez, 1979) was used to measure *PTSD symptoms* at both eight weeks and two years postpartum. The scale measures *symptoms of intrusion* (7 items) and *avoidance* (8 items) and has four response categories (0 = not at all, 1 = rarely, 3 = sometimes, and 5 = often). Sum scores for the overall scale were computed (range 0-75); higher scores reflect a higher degree of post-traumatic stress, and a score above 34 indicates PTSD to be likely present. All participants were asked to complete the scale, and participants were specifically instructed to report PTSD symptoms that were experienced as a result of childbirth. The IES has been validated in postpartum women (Olde, Kleber, van der Hart, & Pop, 2006). Reliability in the present study was $\alpha = .84$.

Confounders for mother-driven child sleep problems

At 8 weeks postpartum, mothers completed several questionnaires:

Symptoms of depression during the past week were measured using the Edinburgh Postnatal Depression Scale (Cox, Holden, & Sagovsky, 1987), which is a 10-item self-rating scale, with four response categories ranging from 0 to 3; thus, the total scores can range from 0 to 30. Higher scores reflect higher levels of depression; reliability was $\alpha = .85$.

Anxiety symptoms during the previous week were evaluated with the 10-item anxiety scale of the Hopkins Symptom Checklist , which has four response categories ranging from 1 to 4, with higher scores indicating higher levels of anxiety (Nettelbladt, Hansson, Stefansson, Borgquist, & Nordstrom, 1993). Reliability was $\alpha = .78$.

Prior PTSD symptoms were assessed at pregnancy week 17. The women in our study reported whether at any time in their life they had been involved in or had experienced a dramatic or terrifying event. If this was the case, they reported whether they had suffered from eight potential symptoms related to that event during the last month. The symptoms were based on questions included in the Mini-International Neuropsychiatric Interview, which is designed for epidemiological studies and clinical trials. The Mini-International Neuropsychiatric Interview is a short structured clinical interview which enables researchers to make diagnoses of psychiatric disorders according to DSM-IV or ICD- 10 (Sheehan et al., 1998). We measured symptoms as follows: “During the last month I… (1) “re-experienced the event (e.g., in dreams, nightmares, intense memories, or flashbacks)”, (2) “avoided thinking or talking about the event”, (3) “had problems remembering the event”, (4) “felt distant”, (5) “had problems sleeping”, (6) “had problems concentrating”, (7) “have been nervous”, and (8) “ have been considerably disturbed by the event in my work and in social activities”. Depending on whether the symptom was present, a score was given or not. This resulted in a symptom score ranging from 0 (no symptoms) to 8 (maximum number of symptoms).

Insomnia symptoms were assessed using the Bergen Insomnia Scale (BIS) (Pallesen et al., 2008). This questionnaire comprises six items; the first four pertain to nighttime factors

and correspond to DSM criteria A for insomnia (American Psychiatric Association, 2013): (1) sleep onset delayed more than 30 minutes, (2) waking up for more than 30 minutes during the night, (3) waking up more than 30 minutes earlier than desired without managing to fall asleep again, and (4) not feeling adequately rested after sleep. The last two items assess level of daytime impairment (affecting work/studies or personal life) due to (5) sleepiness and/or (6) dissatisfaction with sleep, corresponding to criterion B (American Psychiatric Association, 2013). The BIS has been validated against other self-reporting scales as well as polysomnographic data (Pallesen et al., 2008). Reliability was good with $\alpha = .73$.

From the hospital's birth records, we obtained information on *maternal age, maternal education* ("1" > 12 years of education and "0" ≤ 12 years of education), and *parity* (nulliparous "0" or parous "1"). Moreover, the birth record provided information about *obstetric complications*, and a sum score of complications was computed, ranging from 0 (no labor complications) to 11 (presence of 11 labor complications. Labor complications included unplanned instrumental delivery, placental abruption, shoulder dystocia, eclampsia, maternal infection during labor, active phase of labor > 12 hours, vaginal tears (degrees 3 and 4), blood loss ≥ 1000 ml, umbilical cord complications, intrapartum asphyxia, and Apgar score at 5 minutes < 7, not due to intrapartum asphyxia.

Mothers reported at two years postpartum, whether they had *breastfed* when their child was 21-24 months old, and whether they were *employed*, with the response options no paid employment (0), part-time employment (between 1-36 h/week) (1), and full-time employment (2).

Confounders for child-driven child sleep problems

Information regarding *child gender, birth weight*, and *prematurity* was retrieved from the hospital's birth records.

At eight weeks postpartum, *difficult infant temperament* was measured with a 10-item adapted version of the "Fussy/Difficult" Subscale of the Infant Characteristics Questionnaire (Bates, Freeland, & Lounsbury, 1979). Mothers rated their infants' usual mood and temperament on a 7-point scale, with higher scores reflecting greater infant difficultness. Reliability was $\alpha = .83$.

Child health problems were assessed at age two and based on maternal reporting. Mothers were asked whether their child has had any of the following diseases or health problems ("no", "yes, has had previously", or "yes, has currently"): (1) eczema (32.9% of children affected), (2) asthma (12.5%), (3) recurring ear infection (17%), (4) food allergy/intolerance (9.2%), (5) insufficient weight gain (11.4%), (6) excessive weight gain (1.7%), (7) nutritional deficiencies (3.0%), (8) diabetes (0.1%), (9) injuries or accidents (6.2%), and (10) others (8.9%). Each health problem was treated as a dichotomous variable depending on whether or not it was present currently and/or previously. Child health problems were then coded as "0" (no health problem) "1" (one health problem currently and/or previously), or "2" (two or more health problems currently and/or previously).

Data analysis

As a measure of standardized effect size, bivariate correlations of all child sleep variables at two years with postpartum PTSD symptoms at eight weeks and with the potential confounding factors were estimated. Child sleep variables that were significantly correlated with PTSD symptoms eight weeks postpartum were entered one by one into linear regression analyses as outcome variables. In the multiple regression analyses, PTSD symptoms eight weeks postpartum was entered as predictor and we adjusted for those confounding factors that also were significantly associated with the respective child sleep variables in the bivariate analyses. Moreover, to examine for potential reverse temporal associations, we conducted multiple linear regression analyses with PTSD symptoms two years postpartum as outcome

variable and child sleep eight weeks postpartum as predictor. We also included PTSD symptoms eight weeks postpartum as covariate to examine whether child sleep at eight week postpartum could account for changes in postpartum PTSD.

To account for potential non-normality, bias corrected and accelerated confidence interval for all regression coefficients were estimated by means of bootstrapping with 5,000 bootstrapping samples. Level of significance was set at $p < .05$. The statistical package IBM SPSS 24 was used for all analyses.

Results

Sample characteristics

The children's mean birth weight was 3,545 grams (*standard deviation (SD)* = 533 grams), and 6.1% were born premature. The sample had fewer girls (48%) than boys. At two years postpartum, 41% of mothers reported no current or past children health problems, 33% one health problem, and 26% two or more health problems.

At eight weeks postpartum, most children woke up several times each night (36% of the children 1-2 times each night and 58% woke up 3 or more times each night). Regarding settling time eight weeks postpartum, 36% of the children calmed down right away, while 32% calmed down within 15 minutes, 24% within 15-30 minutes, and 8% needed more than 30 minutes to calm down/fall asleep again after feeding. At two years postpartum, mean total child sleep duration was 12 hours 8 minutes (see Table 1). More than half the children (54%) were reported to have 1-2 night awakenings, 39% were reported to not wake up during nights. Mean duration of wakefulness of children waking up at night was 13 minutes. Mean settling time to fall asleep in the evening was 22 minutes. Mothers reported sleep problems as small in 24.5% of the children, and as very serious in 2.4%.

Mean maternal age at birth was 31.7 years (*SD* =4.5) (see Table 1); 98% were married or living with a partner, and a majority of the sample (73%) had an educational level beyond

high school. Just over half (52%) reported that this was their first child. Mode of delivery was distributed as follows: vaginal delivery (74.2%), assisted vaginal delivery (10.7%), elective cesarean section (6.4%), and emergency cesarean section (8.7%). Two years postpartum,4.2% of the women still breastfed their children.

At eight weeks postpartum, 2% of women had probable postpartum PTSD (scores above 34). The mean IES score was 7.01 (*SD* = 8.37); mean scores for the subscales intrusion and avoidance were 4.39 (*SD*=4.96) and 2.53 (*SD* = 4.11), respectively. Two years postpartum, 1.2% of women had probable postpartum PTSD. The mean IES score at two years postpartum was 5.41 (*SD* = 7.70); mean scores for the subscales intrusion and avoidance were 3.45 (*SD*=4.48) and 1.89 (*SD* = 3.81), respectively.

Associations with child sleep two years postpartum

Maternal postpartum PTSD symptoms eight weeks after birth were significantly associated with all night-time child sleep variables two years postpartum, i.e., *nocturnal sleep duration* (r = -0.07, $p < .01$), *total sleep duration* (r = -0.06, $p < .05$), number of *night wakings* (r = 0.12, $p < .001$), *duration of wakefulness* (r = 0.10, $p < .001$), *settling time* (r = 0.13, $p < .001$), and perceived *child sleep problems* (r = 0.13, $p < .001$), but not *daytime sleep duration*. Depression and anxiety symptoms as well as difficult infant temperament were similarly prospectively related to the same child sleep variables (see Table 2). Other confounding variables related to some of the child sleep variables were prior PTSD symptoms, maternal insomnia symptoms and old age, obstetric complications, breastfeeding, child's gender, birth weight, and child's health problems (Table 2). Further, regarding the prospective relationship between child sleep from eight weeks to two years postpartum, number of night wakings at eight weeks postpartum was significantly related to number of night wakings at two years postpartum (r = 0.17, $p < .001$) as well as duration of wakefulness (r = 0.14, $p < .001$) and perceived child sleep problems two years postpartum (r = 0.14, $p < .001$). Settling time at

eight weeks postpartum was significantly associated with number of night wakings (r = 0.14, p < .001), duration of wakefulness (r = 0.09, p < .001), settling time (r = 0.09, p < .001), and perceived child sleep problems at two years postpartum (r = 0.12, p < .001).

Next, postpartum PTSD eight weeks after birth was entered together with all significant confounding factors into multiple linear regressions. When including *nocturnal sleep duration* as outcome variable, postpartum PTSD symptoms were no longer a significant predictor (β = -0.03). Of the included variables, only anxiety symptoms (β = -0.09) and difficult infant temperament (β = -0.06) remained significantly associated. Similarly, postpartum PTSD symptoms were no longer significantly associated (β = -0.04) with *total sleep duration*; only anxiety symptoms (β = -0.08) remained as significant predictor in the regression model. Regarding *night wakings*, postpartum PTSD symptoms (β = 0.11), maternal insomnia symptoms (β = 0.08), age (β = 0.10), breastfeeding (β = 0.07), child birth weight (β = -0.06), as well as number of night wakings (β = 0.13) and settling time (β = 0.07) at eight weeks postpartum were significant predictors in the final model. *Duration of wakefulness* was explained by postpartum PTSD symptoms (β = 0.09), anxiety symptoms (β = 0.11), maternal age (β = 0.12), breastfeeding (β = 0.06), and number of night wakings at eight weeks postpartum (β = 0.11). Regarding *settling time*, postpartum PTSD symptoms (β = 0.09), anxiety symptoms (β = 0.08), maternal age (β = 0.08), and difficult infant temperament (β = 0.08) remained as significant predictors in the regression model. Finally, whether the mother considered her *child´s sleep* as *problematic* was predicted by postpartum PTSD symptoms (β = 0.12), maternal age (β = 0.11), breastfeeding (β = 0.09), difficult infant temperament (β = 0.12), child health problems (β = 0.09), and number of night wakings at eight weeks postpartum (β = 0.10). (see Table 3).

Associations with postpartum PTSD two years after birth

Finally, we examined potential reverse temporal associations between child sleep and postpartum PTSD. More specifically, we correlated child sleep variables eight weeks postpartum with PTSD two years postpartum. Correlation analyses showed that duration of wakefulness ($r = 0.11$, $p < .001$) but not number of night waking ($r = 0.03$, $p = .26$) of the child at eight weeks was significantly related to PTSD two years postpartum. Further, we conducted multiple linear regression analyses with postpartum PTSD two years after birth as outcome variable and duration of wakefulness as predictor while controlling for postpartum PTSD eight weeks after birth. Results showed duration of wakefulness not any longer to be related to subsequent PTSD (B = 0.27, β = 0.03, 95% CI: -0.06; 0.59).

Discussion

This prospective study examined the impact of maternal postpartum PTSD symptoms on several important and standardized child sleep variables in a large, population-based cohort of mothers at two years postpartum while considering the influence of numerous potential confounding maternal and child factors. Results showed for the first time that maternal postpartum PTSD symptoms at eight weeks were significantly associated with less favorable child sleep at two years. Maternal variables related to some of the child sleep variables were anxiety and depression symptoms at eight weeks postpartum, insomnia symptoms at eight weeks postpartum as well, and maternal age, as well as obstetric complications and breastfeeding. Child variables related to child sleep were gender (with girls sleeping less during the day) and children with health problems having an increased settling time in the evening and more perceived sleep problems. When all significant confounding factors were included into multiple linear regression analyses, postpartum PTSD symptoms remained a significant predictor for number and duration of night wakings, duration of settling time, and maternal rating of their child's sleep problems. Finally, duration of wakefulness of the child at

eight weeks was significantly related to maternal PTSD two years postpartum but this effect disappeared when controlling for postpartum PTSD at eight weeks.

Our main results align with a "mother-driven" mechanism (Ystrom et al., 2017). Evidence shows that mothers with PTSD report more parenting stress and less effective parenting (Ee, Kleber, & Jongmans, 2016). An important factor in this "mother-driven" mechanism may be cortisol, a stress hormone shown to be altered in mothers with PTSD (Schechter et al., 2004). Recent studies report that maternal PTSD alters the child's cortisol levels (Cordero et al., 2017), which in turn induce sleep problems (Saridjan et al., 2017). Furthermore, maternal PTSD symptoms resulting in impaired functioning and subjective distress have been linked to less optimal mother-infant relationships (Muller-Nix et al., 2004). Mothers with PTSD also show impaired interpretation of the child's emotions and, therefore less sensitive parenting (Schechter et al., 2015), resulting in less efficient support of the child's self-regulatory experiences (Blandon, Calkins, Keane, & O'Brien, 2008), which could interfere with the self-soothing skills of the infant (Ystrom et al., 2017). Indeed, the link between parental behavior and frequent night waking is already known (Teti & Crosby, 2012). Therefore, maternal mental health may influence the child's regulation through distortions in the mother-infant relationship, thus affecting child sleep.

It is worth noting that, contrary to common belief, the reported children's health problems during the first two years of life were not directly associated with major sleep problems.

Finally, our results did not lend support to "child-driven" mechanisms: Even though one aspect of child sleep problems eight weeks postpartum (duration of wakefulness) showed a prospective associations with postpartum PTSD, this association disappeared when controlling for postpartum PTSD at eight weeks. This finding indicate that the association between child sleep problems and subsequent maternal PTSD is not a causal effect, but rather

a result of an already existing correlation between child sleep problems and maternal PTSD eight weeks postpartum.

Limitations

Despite the inclusion of important maternal and child confounders in the analyses and the use of a validated questionnaire to assess different child sleep outcomes, this study has some limitations. We acknowledge as a major limitation that almost all measures are based on maternal reporting. Evidence shows that maternal mental health symptoms may bias mothers' ratings of child psychopathology (see De Los Reyes and Kazdin (2005), for a review). However, frequency and duration of night awakenings have been used previously to characterize child sleep disorders (Warren et al., 2006). Moreover, even though frequency and duration of night awakenings have been used previously to characterize child sleep disorders (Warren et al., 2006), and studies show that such variables can be accurately reported by parents, it has also been reported that parents might underreport awakenings (Sadeh, 1996). Thus, it would have been useful to examine the accuracy of maternal report by corroborating them with data from other sources, such as hospital register data or observational data, including objective sleep measures by using actigraphs. However, the present dataset did not allow for such tests. In addition, child sleep was measured less extensively at eight weeks postpartum than at two years postpartum, and the non-findings concerning reverse causal directions have thus to be interpreted with some caution. As another limitation, the clinical significance of the findings may be questioned as most prospective associations in multiple regression models showed rather small effect sizes. Still, we regard our results as potentially important for clinical practice because we could show that postpartum PTSD symptoms were prospectively associated with less favorable child sleep even over a long period of time such as almost two years and even after controlling for a substantial number of potential covariates.

Finally, the father's role in children's sleep should be examined in detail. For example, the effect of maternal mental health problems may be buffered in families where fathers actively help the child to develop self-soothing capacities. In contrast, the effects of maternal PTSD on child problems may aggravate in families where fathers experience themselves mental health problems.

Conclusions

Our findings have important clinical implications. Mental health problems in mothers have been shown to be associated with adverse developmental and behavioral outcomes in children (Cook et al., 2017). One of the mechanisms is through altered mother-child relationships, adverse feedback, and less efficient support of the child's self-regulatory experiences. Our study shows that maternal PTSD is directly related to less optimal child sleep, thus increasing the risk of developmental or behavioral problems through an indirect, but treatable pathway. Likewise, child sleep problems can maintain maternal PTSD or other psychiatric disorders. Future research should thus address early interventions to treat child sleep problems as important maintaining factor of maternal PTSD, as well as early intervention for maternal PTSD to protect child sleep and development.

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Table 1. Demographic Characteristics of the Study Sample (*n* = 1,480[a])

Characteristics *(time point measured, range)*	Number (%)	Mean (*SD*)
Child sleep (2 years postpartum)		
Nocturnal sleep duration *(hours)*		10.82 (1.34)
Daytime sleep duration *(hours)*		1.50 (0.52)
Total sleep duration *(hours)*		12.14 (1.89)
Number night wakings		0.94 (1.05)
Duration wakefulness *(minutes)*		12.95 (22.53)
Settling time *(minutes)*		21.51 (19.90)
Perceived sleep problems		
Very serious problem	35 (2.4%)	
Small problem	356 (24.5%)	
No problem	1,064 (73.1%)	
Postpartum PTSD[1] (8 weeks postpartum)		
PTSD[1] symptoms (sum scores, range 0-65)		7.01 (8.37)
Postpartum PTSD[1] (2 years postpartum)		
PTSD[1] symptoms (sum scores, range 0-71)		5.41 (7.70)
Maternal factors		
Depression symptoms *(8 weeks postpartum; sum scores, range 0-25)*		4.38 (4.09)
Anxiety symptoms *(8 weeks postpartum; sum scores, range 10-40)*		11.92 (2.63)
Prior PTSD symptoms *(pregnancy week 17; sum scores, range 0-8)*		0.31 (0.84)
Insomnia symptoms *(8 weeks postpartum; sum scores, range 0-42)*		15.40 (8.87)
Age *(at birth; years, range 19-46)*		31.65 (4.50)
Educational level *(at birth)*		
>12	1,026 (72.5)	
≤12	389 (27.5)	
Paid employment *(2 years postpartum)*		
Full-time employment	807 (61.7)	
Part-time employment	456 (34.9)	
No employment	45 (3.4)	
Parity *(pregnancy week 17)*		
Primiparous	766 (51.8)	
Multiparous	714 (48.2)	
Obstetric complications[b] *(at birth)*		
≥2	161 (10.9)	
1	352 (23.8)	
0	967 (65.3)	
Breastfeeding *(2 years postpartum)*		
Yes	62 (4.2)	
No	1,418 (95.8)	
Child factors		
Sex *(at birth)*		
Female	706 (48)	
Male	764 (52)	
Birth weight (*at birth; grams, range 1,050-5,580)*		3,545 (533)
Premature birth *(at birth)*		
Yes	89 (6.1)	
No	1,381 (93.9)	
Difficult infant temperament *(8 weeks postpartum; sum scores, range 10-64)*		25.72 (9.15)
Health problems[c] *(8 weeks postpartum)*		
≥2	372 (25.9)	
1	477 (33.2)	
0	589 (41.0)	
Child sleep (8 weeks postpartum)		
Number night wakings		3.26 (0.68)
Settling time		2.04 (0.96)

[a]Due to missing values on some of the items *n* varied between 1,065 (daytime sleep duration) and 1,480.

[b]Potential complications: (1) unplanned instrumental delivery, (2) placental abruption, (3) shoulder dystocia, (4) eclampsia during labor, (5) maternal infection during labor, (6) long labor duration, (7) severe vaginal tears (8) extensive blood, (9) umbilical cord complications, (10) intrapartum asphyxia, and (11) low neonate Apgar score at 5 minutes.

[c]Potential health problems: (1) reduced hearing, (2) reduced vision, (3) eczema, (4) asthma, (5) respiratory syncytial virus, (6) bronchiolitis, (7) urinary tract infection, (8) recurring ear infection, (9) food allergy/intolerance, (10) insufficient weight gain, (11) excessive weight gain, (12) nutritional deficiencies, (13) diabetes, (14) injuries or accidents, and (15) others.

[1]Posttraumatic stress disorder

Table 2. Bivariate Pearson Correlations with All Child Sleep Variables Two Years Postpartum

	Nocturnal sleep duration	Daytime sleep duration	Total sleep duration	Number night wakings	Duration wakefulness	Settling time	Perceived child sleep problems
Postpartum PTSD[1] (8 weeks postpartum)							
PTSD[1] symptoms	**-0.07****	0.03	**-0.06***	**0.12*****	**0.10*****	**0.13*****	**0.13*****
Postpartum PTSD[1] (2 years postpartum)							
PTSD[1] symptoms	**-0.07***	0.04	**-0.05***	**0.11*****	**0.08****	**0.10*****	**0.08*****
Maternal factors							
Depression symptoms *(8 weeks postpartum)*	**-0.10*****	0.02	**-0.07***	**0.09*****	**0.09****	**0.10*****	**0.13*****
Anxiety symptoms *(8 weeks postpartum)*	**-0.13*****	0.02	**-0.09*****	**0.06***	**0.12*****	**0.11*****	**0.11*****
Prior PTSD symptoms *(pregnancy week 17)*	-0.01	0.05	0.01	0.02	**0.08****	0.04	0.03
Insomnia symptoms *(8 weeks postpartum)*	-0.05	0.02	-0.04	**0.17*****	**0.13*****	**0.08****	**0.15*****
Age *(years, at birth)*	-0.05	0.06	-0.01	**0.09*****	**0.10*****	**0.06***	**0.10*****
Educational level *(at birth)*	0.02	-0.01	0.01	0.01	-0.05	0.01	0.01
Paid employment *(2 years postpartum)*	-0.01	0.02	0.02	-0.02	-0.04	-0.05	-0.02
Parity *(pregnancy week 17)*	0.01	-0.03	0.02	0.04	0.01	-0.04	0.02
Obstetric complications *(at birth)*	0.02	**0.07***	0.02	-0.00	-0.01	0.04	0.01
Breastfeeding *(2 years postpartum)*	-0.04	0.05	-0.03	**0.08****	**0.09*****	0.00	**0.09****
Child factors							
Sex *(female, at birth)*	0.05	**-0.08****	-0.00	-0.03	-0.01	0.01	-0.02
Birth weight *(at birth)*	0.01	-0.01	-0.01	**-0.06***	-0.01	-0.03	-0.03
Premature birth *(at birth)*	-0.01	-0.02	-0.02	0.03	0.01	0.03	0.04
Difficult infant temperament *(8 weeks postpartum)*	**-0.09****	0.03	**-0.07****	**0.09****	**0.08****	**0.10*****	**0.17*****
Health problems *(2 years postpartum)*	-0.04	0.06	0.00	**0.06***	0.05	**0.06***	**0.10*****
Child sleep (8 weeks postpartum)							
Number night wakings	-0.04	0.02	-0.02	**0.17*****	**0.14*****	0.02	**0.14*****
Settling time	-0.03	0.03	0.00	**0.14*****	**0.09*****	**0.09*****	**0.12*****

*p <.05, **p<.01, ***p <.001; [1]Posttraumatic stress disorder

Table 3. Results of Multiple Linear Regression Analyses for Variables Predicting Child Sleep Two Years Postpartum

	Nocturnal sleep duration			Total sleep duration			Number night wakings			Duration wakefulness			Settling time			Perceived child sleep problems		
	B	β	95% CI	B	β	95% CI	B	β	95% CI	B	β	95% CI	B	β	95% CI	B	β	95% CI
PTSD[1] symptoms *(8 weeks postpartum)*	-0.01	-0.03	-0.02; 0.01	-0.01	-0.04	-0.03; 0.01	**0.01**	**0.11**	**0.01; 0.02**	**0.23**	**0.09**	**0.07; 0.40**	**0.23**	**0.09**	**0.07;0.39**	**0.01**	**0.12**	**0.00; 0.01**
Maternal factors																		
Depression symptoms *(8 weeks postpartum)*	-0.01	-0.02	-0.04; 0.02	0.01	0.01	-0.03; 0.04	0.00	-0.01	-0.02; 0.02	-0.40	-0.07	-0.80; 0.01	-0.09	-0.02	-0.52;0.34	0.00	0.00	-0.01; 0.01
Anxiety symptoms *(8 weeks postpartum)*	**-0.05**	**-0.09**	**-0.10; 0.00**	**-0.06**	**-0.08**	**-0.12; 0.00**	0.00	0.00	-0.03; 0.03	**0.94**	**0. 11**	**0.26; 1.78**	**0.58**	**0.08**	**0.04; 1.22**	0.01	0.03	-0.01; 0.02
Prior PTSD symptoms *(pregnancy week 17)*										1.15	0.04	-1.03; 3.61						
Insomnia symptoms *(8 weeks postpartum)*							**0.01**	**0.08**	**0.00; 0.02**	0.06	0.02	-0.10; 0.21	-0.01	0.00	-0.16; 0.15	0.00	0.02	0.00; 0.01
Age *(years, at birth)*							**0.02**	**0.10**	**0.01; 0.04**	**0.61**	**0.12**	**0.32; 0.90**	**0.37**	**0.08**	**0.10; 0.64**	**0.01**	**0.11**	**0.01; 0.02**
Educational level *(at birth)*																		
Paid employment *(2 years postpartum)*																		
Parity *(pregnancy week 17)*																		
Obstetric complications *(at birth)*																		
Breastfeeding *(2 years postpartum)*							**0.36**	**0.07**	**0.07; 0.65**	**6.96**	**0.06**	**0.95; 12.90**				**0.22**	**0.09**	**0.06; 0.38**
Child factors																		
Sex *(female, at birth)*																		
Birth weight *(at birth)*							**0.00**	**-0.06**	**0.00; 0,00**									
Premature birth *(at birth)*																		
Difficult infant temperament *(8 weeks postpartum)*	**-0.01**	**-0.06**	**-0.02; 0.00**	-0.01	-0.05	-0.02; 0.00	0.00	-0.01	-0.01; 0.01	0.11	0.05	-0.05; 0.27	**0.18**	**0.08**	**0.04; 0.34**	**0.01**	**0.12**	**0.00; 0.01**
Health problems *(2 years postpartum)*							0.06	0.04	-0.02; 0.13				0.89	0.04	-0.52; 2.26	**0.06**	**0.09**	**0.02; 0.09**
Child sleep (8 weeks postpartum)																		
Number night wakings							**0.20**	**0.13**	**0.12; 0.29**	**3.75**	**0.11**	**1.99; 5.55**				**0.08**	**0.10**	**0.04; 0.12**
Settling time							**0.08**	**0.07**	**0.01; 0.15**	0.69	0.03	-0.63;2.05	0.65	0.03	-0.71; 2.03	0.02	0.03	-0.02; 0.05
R^2	0.02			0.01			0.08			0.06			0.04			0.10		

B = unstandardized regression coefficient; β = standardized regression coefficient; 95% CI = 95% bias corrected and accelerated confidence intervals of unstandardized regression coefficient as estimated by means of bootstrapping. Bold regression coefficients are significantly different from 0 ($p < .05$); [1]Posttraumatic stress disorder