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Research paper

Insomnia late in pregnancy is associated with perinatal anxiety: A longitudinal cohort study

Rannveig S. Osnes[a,b,*], John Olav Roaldset[a,b,c], Turid Follestad[d], Malin Eberhard-Gran[e,f,g]

[a] Department of Psychiatry, Ålesund Hospital, Møre & Romsdal Health Trust, Ålesund, Norway
[b] Department of Mental Health, Faculty of Medicine and Health Sciences, Norwegian University of Science and Technology, Trondheim, Norway
[c] Centre for Research and Education in Forensic Psychiatry, Oslo University Hospital, Oslo, Norway
[d] Department of Public Health and Nursing, Faculty of Medicine and Health Sciences, Norwegian University of Science and Technology, Trondheim, Norway
[e] HØKH, Research Unit, Akershus University Hospital, Lørenskog, Norway
[f] Institute of Clinical Medicine, Campus Ahus, University of Oslo, Lørenskog, Norway
[g] Department for Infant Mental Health, Regional Center for Child and Adolescent Mental Health, Eastern and Southern Norway, Oslo, Norway

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ABSTRACT

Background: Postpartum anxiety (PPA) affects a substantial number of women. Despite increasing recognition of PPA, few studies have focused on perinatal anxiety and potential PPA triggers. Here we aimed to estimate the prevalence of perinatal anxiety disorders, and to explore the association between insomnia during late pregnancy and anxiety before and after childbirth.

Methods: This study was part of the large population-based Akershus Birth Cohort. We analyzed data from the hospital's birth records and questionnaire responses from pregnancy weeks 17 and 32 and postpartum week 8 (n = 1563). Perinatal anxiety symptoms were measured using the Hopkins Symptom Check List. Anxiety disorder measurements were based on questions from the Mini-International Neuropsychiatric Interview. Insomnia was measured using the Bergen Insomnia Scale.

Results: Among perinatal women, 10% reported symptoms of at least one anxiety disorder. The observed prevalence of obsessive-compulsive disorder was higher after delivery (4.2%) than during pregnancy (2.5%). Multiple regression analysis, with adjustment for several psychosocial and reproductive variables, indicated that insomnia during pregnancy was significantly associated with postpartum anxiety symptoms. However, this association was markedly weakened when depression variables were included in the analysis, indicating that gestational insomnia may also be a marker for a mood disorder.

Limitations: Immigrant and single women were underrepresented in our sample.

Conclusions: Our results suggest that anxiety disorders are prevalent during the perinatal period. Moreover, insomnia during pregnancy is associated with perinatal anxiety. Health professionals should be aware that women with gestational insomnia may have an increased risk of mood and anxiety disorders.

1. Introduction

For most new mothers, the period after childbirth is characterized by positive emotions and expectations. However, the postpartum period can also be filled with negative feelings. Research on perinatal mental disorders has largely focused on depression, particularly postpartum depression (PPD) (Fisher et al., 2016; Mann et al., 2010; Milgrom et al., 2008; Wynter et al., 2013). Considerably less attention has been dedicated to women who suffer from postpartum anxiety (PPA) (Farr et al., 2014; O'Hara and Wisner, 2014). However, in recent years, PPA has become increasingly recognized as an important issue (Field, 2018), as it can reportedly disrupt the mother–infant attachment (Dawson et al., 2000; Pires et al., 2010) and have negative implications for children's health outcomes (Glasheen et al., 2010). Mothers with PPA breastfeed less than women without anxiety (Fallon et al., 2016a), potentially leading to adverse effects for their infants (Rollins et al., 2016; Verduci et al., 2014; Victora et al., 2016). PPA is also associated with low self-confidence (Reck et al., 2012) and fatigue (Taylor and Johnson, 2013), and may influence the mother's relationship with the infant's other parent (Hoffman et al., 2017; Wenzel et al., 2005). Moreover, compared to women with PPD, women with PPA are less likely to seek professional help (Woolhouse et al., 2009). Based on these consequences, two

* Corresponding author at: Department of Psychiatry, Ålesund Hospital, P.O. Box 1600, N-6026 Ålesund, Norway.
E-mail address: rannveig.storaune.osnes@helse-mr.no (R.S. Osnes).

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recent reviews highlight the need for more research on PPA (Ali, 2018; Goodman et al., 2016).

Anxiety can be conceptualized as symptoms of tension, worry, and unease; however, anxiety is also defined as a disorder divided into diagnostic categories (American Psychiatric Association, 2000). Estimates of anxiety disorder prevalence vary from 2.6–39% during pregnancy (Goodman et al., 2014; Leach et al., 2017), and from 3 to 43% during the postpartum period (Glasheen et al., 2010; Goodman et al., 2016). These different studies vary with regards to anxiety measures, assessment time-points, and study samples.

Data from non-perinatal populations suggest that insomnia can be a risk factor for development of psychiatric disorders, including anxiety (Baglioni et al., 2011a,b; Baglioni and Riemann, 2012; Breslau et al., 1996; Buysse et al., 2008; Chang et al., 1997; Neckelmann et al., 2007; Pigeon et al., 2017), and indicate that insomnia has a bidirectional association with depression and anxiety (Alvaro et al., 2017; Jansson-Fröjmark and Lindblom, 2008; Sivertsen et al., 2012). Thus, it is conceivable that insomnia during pregnancy may be associated with a higher likelihood of PPA development. Insomnia is characterized by difficulty initiating or maintaining sleep, and poor sleep quality, with accompanying distress and functional impairments (American Psychiatric Association, 2000; Reichner, 2015). Insomnia is twice as prevalent in women as in men, and can present independently or co-occur with other psychiatric disorders (Morin and Benca, 2012). Insomnia is reported by 5–38% of women during early pregnancy (Facco et al., 2010; Okun et al., 2015, 2013), and the prevalence rapidly increases to up to 60% towards the end of pregnancy (Dørheim et al., 2014). Few studies have explored the association between insomnia and PPA, and most of these studies suffer from small sample sizes (Coo Calcagni et al., 2012; Polo-Kantola et al., 2017), cross-sectional design (Swanson et al., 2011), or limited availability of data regarding covariates (Bei et al., 2008; Cook et al., 2018; Glasheen et al., 2010; Lawson et al., 2015).

In the present study, we aimed to estimate the prevalence of anxiety symptoms, according to the DSM-IV-TR diagnostic criteria, during pregnancy and after childbirth, and to explore the association between insomnia during late pregnancy and anxiety before and after childbirth. We hypothesized that insomnia during late pregnancy would be a predictor of PPA. We also made adjustment for other potential risk factors (Furtado et al., 2018). This study was performed in a large population-based cohort of pregnant women who were followed-up until eight weeks postpartum.

2. Material and methods

2.1. Design and study population

The present study is part of the Akershus Birth Cohort (ABC) Study, which is a prospective cohort study targeting all women who were scheduled to deliver at Akershus University Hospital (Ahus) in Norway during the study period. In that time, the hospital served a population of about 400,000 people, from both urban and rural settings, and an average of 3500 women gave birth each year.

The public antenatal care program in Norway includes a routine ultrasound examination, free of charge, at gestational week 17. From November 2008 to April 2010, a total of 4814 women who came for this examination at the hospital were invited to participate in the study. The women were invited if they could answer a questionnaire in Norwegian. Women who were at least 18 years of age and gave written consent to participate were included in the study (n = 4662). Our final study sample comprised 1563 women who returned all three questionnaires, and who submitted data regarding all of the variables included in our primary analyses. This subset represented 42% of the women who returned the first questionnaire. Fig. 1 presents the study population. The ABC Study was approved by the Regional Committees for Medical and Health Research Ethics (approval number S-08013a).

2.2. Procedure

Data were collected using three self-completed questionnaires at pregnancy week 17 (Q1), pregnancy week 32 (Q2), and 8 weeks postpartum (Q3). Thereafter, the data were linked to the medical birth records. Fig. 2 illustrates the study procedure.

2.3. Measures

2.3.1. Sleep measures

In Q2 and Q3, participants completed the Bergen Insomnia Scale (BIS), which includes six items that correspond to the DSM-IV-TR diagnostic criteria for insomnia (American Psychiatric Association, 2000). Each item is given a score of between 0 and 7, reflecting the frequency of various insomnia symptoms in terms of days per week during the last month. The first four items assess sleep impairment according to DSM-IV-TR criterion A for insomnia. The last two items measure daytime sleepiness or tiredness and dissatisfaction with sleep according to DSM-IV-TR criterion B for insomnia. The BIS provides both a total score on a continuous scale, as well as a dichotomous score that corresponds to the DSM-IV-TR criteria for the presence or absence of insomnia. The BIS shows good psychometric properties (Pallesen et al., 2008). Although the BIS has not been validated to characterize sleep problems during pregnancy, it has been used in several studies involving surveys of pregnant women (Dørheim et al., 2014; Sivertsen et al., 2017, 2015).

2.3.2. Anxiety measures

As part of Q2 and Q3, patients completed the anxiety dimension SCL-A (i.e., the first ten items) from the Hopkins Symptom Check List-25 (SCL-25), which measures anxiety symptoms during the last week (Derogatis et al., 1974). Each item is given a score ranging from 1, indicating “not at all”, to 4, indicating “extremely”. An SCL-A score of $\geq$18 was considered to indicate anxiety (Eberhard-Gran et al., 2003; Harris et al., 2017; Mathiesen et al., 1999; Nettelbladt et al., 1993; Nordeng et al., 2012; Rognmo et al., 2016; Storksen et al., 2012; Størksen et al., 2015). The Norwegian version of the SCL-25 has been validated against the ICD-10 criteria for anxiety and depression (Sandanger et al., 1998), and is widely used in population-based surveys in Norway (Statistics Norway, 2011). The SCL-A shows good psychometric properties and reliable construct measuring (Veijola et al., 2003).

Anxiety disorder categories (later referred to as MINI-anxiety categories) were assessed in Q1, Q2, and Q3. These comprised an extensive battery of self-administered questions based on the Mini-International Neuropsychiatric Interview (MINI). The MINI is a short structured clinical interview designed for use in epidemiological studies and clinical trials. The MINI enables researchers to diagnose psychiatric disorders according to DSM-IV-TR or ICD-10 categories (Sheehan et al., 1998). The participants’ answers were coded according to DSM-IV-TR diagnostic criteria for the following anxiety categories: generalized anxiety disorder (GAD), panic disorder, agoraphobia, specific phobia, social phobia, obsessive-compulsive disorder (OCD), and post-traumatic stress disorder (PTSD) (American Psychiatric Association, 2000; Garthus-Niegel et al., 2013). The GAD duration criterion was relaxed to one month. Panic disorder and agoraphobia were coded as two separate categories. We measured the prevalence of the MINI-anxiety categories in Q1, Q2, and Q3—except for OCD and PTSD, which were assessed only in Q1 and Q3. Additionally, we created a dichotomous anxiety variable, defined as having symptoms of at least one MINI-anxiety category ($\geq$1 MINI-anxiety category).

2.3.3. Depression measures

The Edinburgh Postnatal Depression Scale (EPDS), a 10-item scale that measures depressive symptoms during the previous week (Cox and Sagovsky, 1987), was included in Q2 and Q3. Each item is scored from 0 to 3, and a higher summed score indicates more severe

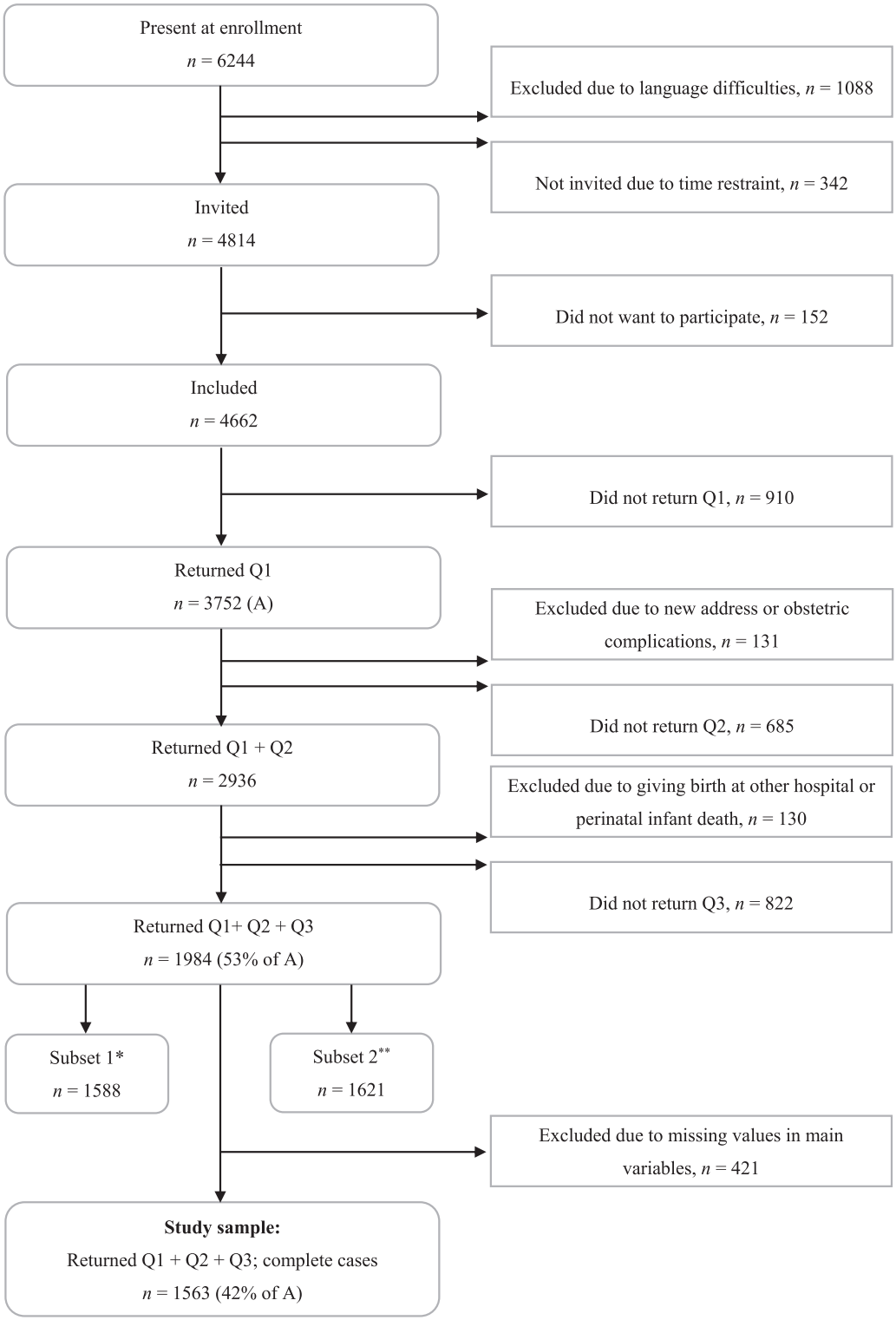


Fig. 1. The Akershus Birth Cohort: overview of inclusion, response rates, and the study sample. Note that the sample sizes may deviate somewhat from previous publications based on this material due to small changes in the latest quality-assured data file released for research. Abbreviations: Q1: Questionnaire 1 in pregnancy week 17; Q2: Questionnaire 2 in pregnancy week 32; Q3: Questionnaire 3 in postpartum week 8. *Subset 1: missing values only in the MINI-anxiety category measures; **Subset 2: missing values only in the SCL-A anxiety scale.

symptomatology. Two of the items in the EPDS measure anxiety symptoms. The EPDS was developed to screen for postpartum depression, but also shows good psychometric properties during pregnancy (Bunevicius et al., 2009) and is validated for use among pregnant women (Bergink et al., 2011).

In Q1, participants completed the Lifetime Major Depression Scale, which measures previous depression based on DSM-IV criteria (Kendler et al., 1993). Yes/no responses are given for five items relating to sadness, appetite change, lack of energy, self-blame, and poor concentration. Previous depression was defined as having had a minimum of three symptoms simultaneously for at least two coherent weeks. The scale shows high reliability for assessing lifetime history of major

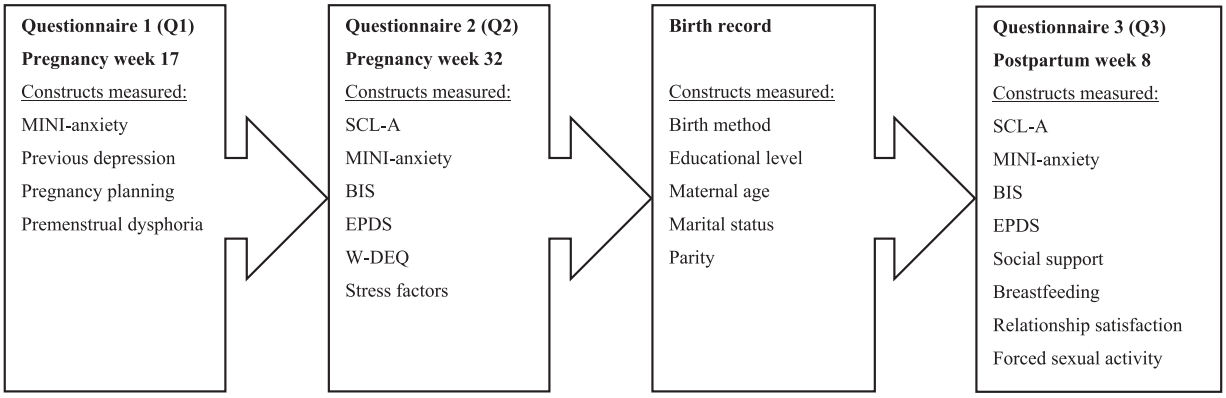


Fig. 2. The Akershus Birth Cohort: overview of the study procedure. Abbreviations: MINI-anxiety: Anxiety categories measured using questions based on the Mini-International Neuropsychiatric Interview (MINI); SCL-A: Anxiety scale from the Hopkins Symptom Check List; BIS: Bergen Insomnia Scale; EPDS: Edinburgh Postnatal Depression Scale; W-DEQ: Wijma Delivery Expectancy/Experience Questionnaire version A.

depression (Kendler et al., 1993).

2.3.4. Reproductive measures

In Q1, participants were asked whether the pregnancy was planned ("yes" or "no"), and whether they normally felt depressed or irritable before menstruating and if these emotions went away after the menstruation started (answers of "yes" indicated the presence of premenstrual dysphoria). In Q2, participants completed the Wijma Delivery Expectancy/Experience Questionnaire version A (W-DEQ), which measures fear of childbirth. It comprises 33 items, each of which is scored from 0 to 5. A higher summed score indicates more symptoms (Garthus-Niegel et al., 2011; Wijma et al., 1998). In Q3, participants were asked "Do you currently breastfeed?", which could be answered as "yes" (exclusively or partly) or "no" (stopped or never breastfed). Data regarding emergency and elective cesarean sections were retrieved from medical birth records.

2.3.5. Psychosocial measures

Q3 included the Relationship Satisfaction Scale, which is a 10-item, modified and shortened version of the Mehrabian´s Marital Satisfaction Scale (Blum and Mehrabian, 1999). The items assess: closeness, problems, happiness, responsiveness, plans for quitting, satisfaction, disagreements, being lucky with partner, views on child-rearing, and thoughts regarding partner's satisfaction. Each item is scored from 1 to 4, with a greater summed score indicating lower relationship satisfaction. This scale has been used in previous Norwegian studies (Røsand et al., 2012, 2011).

The Oslo Social Support Scale (OSS-3) was also part of Q3. The OSS-3 includes three items that measure one's number of close and reliable persons (score 1–4), the interest and concern shown by others (score 1–5), and one's access to practical help from neighbors (score 1–5). A score of ≤ 8 indicates low social support (Størksen et al., 2015). The OSS-3 has been used in several prior studies (Bøen et al., 2012, 2010; Dalgard et al., 2006).

In Q2, we measured stress factors within the last year based on ten items selected from existing life event scales (Coddington, 1972; Swearingen and Cohen, 1985). The ten items include separation or divorce; severe problems in relationship; conflicts with family members, friends, or neighbors; problems at work or education place; economic issues; severe illness or injury oneself; severe illness or injury among close family members; traffic accident, fire, or theft; loss of a close relative; and other difficulties. The items were scored as 1, indicating not so difficult; 2, indicating difficult; or 3, indicating very difficult (Coddington, 1972).

In Q3, previous forced sexual activity was measured using an adapted version of the Abuse Assessment Screen (Soeken et al., 1998). Specifically, participants were asked "Have you ever, as an adult, been coerced or forced into sexual activities?". The answers were coded as yes ("exercised power," "yes coerced," or "yes, raped") or no ("no, never").

From hospital birth records, we retrieved sociodemographic factors, including maternal age at the time of delivery, marital status (married/cohabitating or single), parity (primipara or multipara), and educational level.

2.4. Statistical analyses

Continuous data are presented as mean and standard deviation for normally distributed data, and as median with 25th and 75th percentiles for non-normally distributed data. Data were assessed for normal distribution by visual inspection of Q-Q plots. Due to the large sample size, *t*-tests were used to analyze between-group differences in both normally and non-normally distributed data. Categorical data are presented as frequency and percentage, and differences in proportions were examined using the Chi-square test. Paired-samples *t*-tests were used to test differences in mean scores of the SCL-A, the EPDS and the BIS before versus after delivery. Cronbach's alpha values were calculated to test the internal validity of psychometric scales.

Multiple regression analyses were performed to test for associations of PPA with insomnia, depression and anxiety scores, and reproductive and psychosocial variables. In addition to the BIS on a continuous or dichotomous scale, previously identified risk factors for PPA and insomnia, as well as variables found to be associated ($p < 0.100$) with insomnia in Q2 (Table 2), were included as covariates in the regression analyses. The SCL-A was analyzed both as a continuous variable using linear regression, and as a binary variable (after dichotomization) using logistic regression. The SCL-A distribution was positively skewed, and the variable was first adjusted to range from 1, and then log-transformed before linear regression analysis. Spearman´s rho (r_s) was used for measuring the bivariate correlation between non-normally distributed continuous variables. Additionally, the Pearson correlation coefficient and Kendall's tau-b were determined to evaluate bivariate correlations among independent variables, with the aim of ensuring that they were not too highly correlated to be jointly entered into multiple regression. The variance inflation factor (VIF) was also used to rule out multicollinearity. Multiple logistic regressions were conducted for the dichotomous dependent anxiety variables SCL-A and the ≥ 1 MINI-anxiety category.

The significance level was set to 0.05. Data analyses were performed using the SPSS statistical software package, version 23 (SPSS Inc., Chicago, IL, USA).

Table 1
Sociodemographic and birth outcome characteristics of the study sample, and variables from the Medical Birth Registry of Norway in the year 2009.

Characteristics	Study sample, n = 1563 n (%) or mean ± SD	Medical Birth Registry of Norway Year 2009, n = 61 893 n (%) or mean
Maternal age	31.3 ± 4.6[a]	30.2
Educational level		
lower secondary school	45 (2.9)	
upper secondary school	444 (28.4)	
higher education (>12 years)	1074 (68.7)	
Married/cohabitating	1542 (98.7)	55,959 (90.4)
Primiparous (including this pregnancy)	769 (49.2)	26,410 (42.7)
Single births	1544 (98.8)	
Twin births	19 (1.2)	
Pregnancy was planned	1327 (84.9)	
Smoking	106 (6.8)	4 341 (8.2)[b]
Emergency cesarean section	142 (9.1)	6 248 (10.1)
Elective cesarean section	79 (5.1)	3 897 (6.3)

[a] Age ranged from 18.9 to 45.5 years.
[b] Out of 52,669 with available data on this variable.

3. Results

3.1. Sample characteristics

Our final study sample comprised 1563 women. Table 1 presents their sociodemographic characteristics and birth outcomes, as well as variables from the Medical Birth Registry of Norway (Norwegian Institute of Public Health, 2009). A total of 421 women were excluded due to missing values in the variables used in our primary analyses (Fig. 1). Compared to those excluded, the women in our study sample had experienced significantly less stress [mean, 1.58 (SD, 2.6) vs. mean, 2.12 (SD, 3.2); $p < 0.001$], and fewer had previously experienced depression (32.6% vs. 38.9%; $p = 0.025$). A total of 1768 women dropped out of the ABC study after returning Q1. Compared to those who completed all three questionnaires (Q1 + Q2 + Q3, $n = 1984$), the women who dropped out after Q1 had significantly higher scores for depression [mean, 5.02 (SD, 4.5) vs. mean, 4.2 (SD, 3.9); $p < 0.001$] and anxiety symptoms [mean, 13.3 (SD, 3.4) vs. mean, 12.9 (SD, 2.9); $p < 0.001$] in Q1, and were significantly younger at time of delivery [mean, 30.5 years (SD, 5.0 years) vs. mean, 31.3 years (SD, 4.6 years); $p < 0.001$] (Fig. 1).

3.2. Prevalence

The prevalence of reporting symptoms in ≥1 MINI-anxiety category was 10.4% in Q1 and 10.0% in Q3. Fig. 3 shows the prevalence of symptoms in the MINI-anxiety categories. Anxiety, as measured with a cut-off of 18 on the SCL-A, was present among 8.1% ($n = 127$) in Q2, and 4.4% ($n = 68$) in Q3. From Q2 to Q3, the SCL-A score showed a mean decrease of 0.75 (95% CI, 0.62–0.88; $p < 0.001$). Cronbach's alpha for the SCL-A was 0.77 in Q2 and 0.78 in Q3.

In Q2, 4.2% ($n = 66$) of the women had comorbid depression and anxiety symptoms, defined as EPDS score ≥12, and SCL-A score ≥18. Thus, 58% of the depressed women in Q2 had additional anxiety symptoms, and 52% of those with anxiety symptoms had accompanying depression. In Q3, 2.9% ($n = 45$) of the women had comorbid depression and anxiety symptoms, affecting 41% of those with depression (EPDS ≥ 12) and 66% of those with anxiety (SCL-**A** ≥ 18). Furthermore, 3.1% ($n = 49$) had comorbid depression and anxiety as measured by ≥1 MINI-anxiety category in Q3. A strong positive correlation was found between SCL-A and EPDS in both Q2 ($r_s = 0.63$; $p < 0.001$) and Q3 ($r_s = 58$; $p < 0.001$). EPDS score showed a mean decrease of 0.34 from Q2 to Q3 (95% CI, 0.15–0.53; $p = 0.001$).

Table 2 presents a comparison of the women with insomnia ($n = 965$) and the women without insomnia ($n = 598$) as measured in pregnancy week 32 (Q2). The women in the insomnia group had significantly higher scores for perinatal anxiety and depression, fear of childbirth, relationship dissatisfaction, and stress factors. They had significantly more often experienced premenstrual dysphoria, forced sexual activity, and low social support than had the women in the non-insomnia group. From pregnancy week 32 to postpartum week 8, insomnia score showed a mean decrease of 2.0 (95% CI, 1.4–2.5; $p < 0.001$). A medium positive correlation was found between BIS and SCL-A in Q2 ($r_s = 0.32$; $p < 0.001$) and between BIS in Q2 and SCL-A in Q3 ($r_s = 0.35$; $p < 0.001$). Cronbach's alpha for the BIS in Q2 was 0.85.

3.3. Regression analyses

Table 3 shows the results of the primary analysis, i.e., for multiple linear regression with the log-transformed SCL-A measured in Q3 as the dependent variable. The dichotomous insomnia variable was a significant risk factor for PPA, both with adjustment for the depression variables ($p = 0.044$), and when the depression variables were not included as covariates ($p = 0.005$). On the other hand, the continuous insomnia variable was a significant risk factor for PPA only without adjustment for the depression variables ($p = 0.008$). The following variables also represented statistically significant risk factors for PPA development: history of depression; anxiety and depression during pregnancy; relationship dissatisfaction; having experienced stress factors during the last year; and previously experienced forced sexual activity. Earlier premenstrual dysphoria was only a significant risk factor when not adjusting for depression.

A normal approximation was found to be reasonable for the distributions of the residuals from the multiple linear regression analyses. All bivariate correlation values among the independent variables were <0.7. Results from multiple logistic regression analyses for the dichotomous SCL-A variable and the ≥1 MINI-anxiety category measure in Q3 are shown in Supplementary Table S1 and Table S2, respectively. Multiple regression analysis was not performed for each of the different MINI-anxiety categories due to low frequencies for some categories.

We also performed supplementary regression analyses in two participant subsets: subset 1 ($n = 1588$), including women missing values in the ≥1 MINI-anxiety category; and subset 2 ($n = 1621$), including women missing values for the SCL-A. The results did not substantially differ from the results in the main study sample.

4. Discussion

4.1. Main findings

In the study cohort of 1563 pregnant and postpartum women, 10% reported symptoms of at least one anxiety disorder. Our results further revealed an association between gestational insomnia and an increased risk of anxiety during pregnancy and postpartum. The dichotomous insomnia variable remained significantly associated with postpartum anxiety when depression variables were included in the primary analyses, while the continuous insomnia variable did not. Thus, clinical gestational insomnia, as measured by a positive score on the dichotomous variable, may be an independent predictor of developing anxiety symptoms following delivery. However, the p-value (0.044) was quite close to our selected significance level ($p = 0.05$), and what may be more clinically important is that insomnia could be a helpful marker for depression and anxiety (being a potential symptom or confounder), which in turn are strong predictors of postpartum anxiety.

An Australian interview study of 1095 women from the general population shows an anxiety prevalence of 8.0%, according to the DSM-IV-TR definition (Williams et al., 2010). A similar prevalence estimate

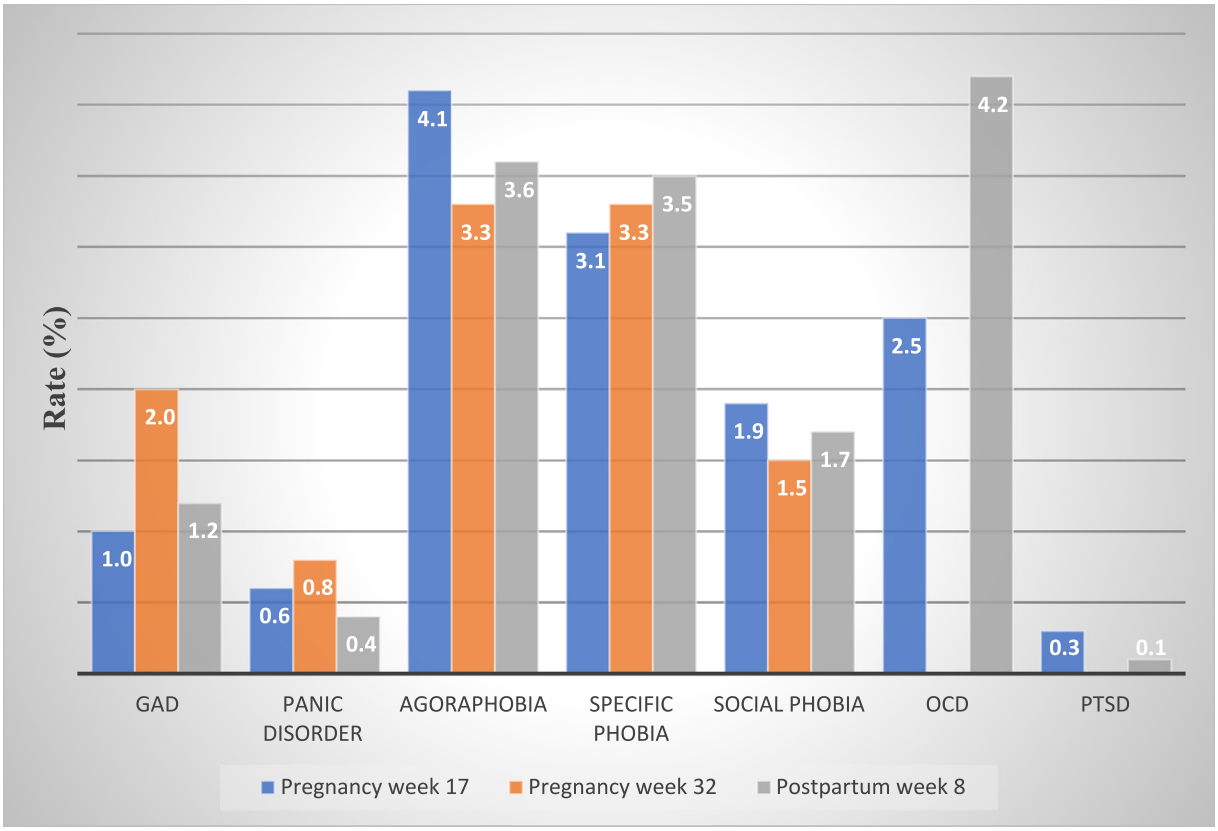


Fig. 3. Prevalence of symptoms in the anxiety categories, as measured by questions based on the Mini-International Neuropsychiatric Interview (MINI). Abbreviations: GAD: Generalized Anxiety Disorder; OCD: Obsessive-Compulsive Disorder; PTSD: Post-Traumatic Stress Disorder. OCD and PTSD were not measured in pregnancy week 32.

is reported in a meta-analysis including 58 interview studies of postpartum women (Goodman et al., 2016). Our present results indicated a slightly higher occurrence of anxiety disorders among perinatal women. However, this disparity in prevalence must be interpreted cautiously since our study and prior studies show considerable heterogeneity with regards to measurement instruments, definition of anxiety, and study design. Furthermore, it is difficult to achieve a true meta-analytic approach that has weighted results from each study on the basis of uniform study design.

In our present study, the prevalence and mean scores of anxiety symptoms as measured by the SCL-A were higher during pregnancy compared to after delivery, which is in agreement with earlier studies (Coo Calcagni et al., 2012; Engle et al., 1990; Figueiredo and Conde, 2011; Najman et al., 1991; Tham et al., 2016). This may be explained by comorbidity of such anxiety symptoms with fear of childbirth or other pregnancy-related anxiety (Rubertsson et al., 2014). In contrast, the prevalence of anxiety disorders as measured by the ≥1 MINI-anxiety category showed smaller differences between pregnancy and the postpartum period, indicating that traits of some anxiety categories may make them less altered by an event such as childbirth. Following childbirth, 3% of the women experienced comorbid anxiety and depression, which is in accordance with previous findings (Matthey et al., 2003; Reck et al., 2008).

Among the categories of anxiety on MINI, OCD alone demonstrated a clearly higher proportion of cases following childbirth than during pregnancy, rising from 2.5% in week 17 of gestation to 4.2% in week 8 postpartum. Retrospective studies also show worsening of OCD symptoms after childbirth (Labad et al., 2005; Vulink et al., 2006; Williams and Koran, 1997). Fairbrother and Abramowitz (2007) proposed a cognitive behavioral hypothesis for the increased postpartum OCD rates, where the childbirth and new role as a parent evokes a sudden increase in the perception of threat and sense of responsibility to prevent harm. Also, biological hypotheses have been proposed, for example, that the rapid changes of estrogen and progesterone cause dysregulation of serotonin functioning (serotonin hypothesis of OCD) (Abramowitz et al., 2003), and that increased concentrations of oxytocin trigger thoughts about harm coming to the baby (Fairbrother and Abramowitz, 2016).

Our postpartum PTSD prevalence of 0.1% was much lower than the 4% rate found in a recent meta-analysis (Yildiz et al., 2017), but similar to the prevalence in a study using diagnostic interviews (Navarro et al., 2008). One reason could be our conservative PTSD measure that accords to DSM-IV-TR, as opposed to instruments that measure recent or childbirth-specific traumatic experiences and reactions to those (Callahan and Hynan, 2002; De Schepper et al., 2016; Yildiz et al., 2017).

Few longitudinal studies have explored the association between insomnia during late pregnancy and postpartum anxiety. One study conducted among 313 women in Singapore reports no association between poor subjective sleep quality during pregnancy and postpartum anxiety (Tham et al., 2016). However, the lack of significant association may be explained by methodological limitations, such as low statistical power and insufficient control for confounding variables.

Previously experienced forced sexual activity was a significant risk factor for PPA development. The reason may be that childbirth could function as a re-traumatization of previous sexual abuse that, in turn, may exacerbate posttraumatic stress (Lev-Wiesel et al., 2009). Interestingly, fear of childbirth was not a PPA risk factor, suggesting that this was primarily related to the specific event of delivery and not to anxiety in a broader context.

Table 2
Comparison between the insomnia group and the non-insomnia group. The grouping is based on insomnia measures in pregnancy week 32 (Q2).

Variable (time point)	Insomnia, $N = 965$ (61.7%) n (%) or mean ± SD/median (25–75 perc.)	Non-insomnia, $N = 598$ (38.3%) n (%) or mean ± SD/median (25–75 perc.)	p value
Previous depression	375 (38.9)	134 (22.4)	<0.001[b]
Depression (Q2)	5.8 ± 4.4 5.0 (2.0–8.0)	3.3 ± 3.0 3.0 (1.0–5.0)	<0.001[c]
Depression (Q3)	5.1 ± 4.4 4.0 (2.0–7.0)	3.5 ± 3.3 3.0 (1.0–5.0)	<0.001[c]
Anxiety SCL-A (Q2)	13.3 ± 3.3 12.0 (11.0–15.0)	11.8 ± 2.1 11.0 (10.0–13.0)	<0.001[c]
Anxiety SCL-A (Q3)	12.4 ± 2.9 12.0 (10.0–13.0)	11.3 ± 1.8 11.0 (10.0–12.0)	<0.001[c]
≥1 MINI-anxiety category[a] (Q1)	119 (12.3)	44 (7.4)	0.002[b]
≥1 MINI-anxiety category[a] (Q3)	117 (12.1)	40 (6.7)	0.001[b]
Fear of childbirth	59.0 ± 20.3 58.0 (45.0–72.0)	53.4 ± 17.9 53.0 (41.8–64.0)	<0.001[c]
Higher education (>12 years)	653 (67.7)	421 (70.4)	0.282[b]
Maternal age	31.2 ± 4.6 31.1 (28.0–34.4)	31.3 ± 4.7 31.3 (28.0–34.6)	0.651[c]
Stress factors in last year	1.8 ± 2.8 0.0 (0.0–3.0)	1.2 ± 2.1 0.0 (0.0–2.0)	<0.001[c]
Multiparous	503 (52.1)	291 (48.7)	0.201[b]
Relationship dissatisfaction	15.4 ± 5.1 14.0 (11.0–18.5)	13.9 ± 4.4 13.0 (10.0–16.0)	<0.001[c]
Low social support	112 (11.6)	35 (5.9)	<0.001[b]
Planned pregnancy	806 (83.5)	521 (87.1)	0.063[b]
Previous forced sexual activity	185 (19.2)	77 (12.9)	0.002[b]
Premenstrual dysphoria	251 (26.0)	92 (15.4)	<0.001[b]
Emergency cesarean section	87 (9.0)	55 (9.2)	0.975[b]
Elective cesarean section	53 (5.5)	26 (4.3)	0.376[b]
Breastfeeding	844 (87.5)	543 (90.8)	0.051[b]

Abbreviations: perc.: Percentile; Q1: Questionnaire 1 in pregnancy week 17; Q2: Questionnaire 2 in pregnancy week 32; Q3: Questionnaire 3 in postpartum week 8; SCL-A: The anxiety scale from the Hopkins Symptom Check List.

[a] Anxiety categories measured using questions based on the Mini-International Neuropsychiatric Interview (MINI).

[b] Chi-square test.

[c] t-test.

4.2. Strengths and limitations

The present study had several strengths. To our knowledge, it is the only longitudinal population-based study to both examine the impact of insomnia during late pregnancy on PPA and explore the prevalence of anxiety disorder symptoms throughout the perinatal period. In contrast to earlier studies of PPA, here we were able to adjust for a range of known possible confounding factors (Glasheen et al., 2010). Our study had a large sample size, and targeted women who attended a routine examination that is undergone by most pregnant women in Norway, indicating low selection bias in the first wave. Moreover, the presently used self-report sleep measure (BIS) reportedly corresponds well with objective sleep measures, including polysomnography (PSG) (Pallesen et al., 2008).

Our study also had several methodological limitations. First, data on anxiety symptoms were based on self-reported instruments rather than clinical evaluation or other objective measures. The women's clinical records did not provide any information regarding these exact domains, which otherwise would have reduced potential bias in observer ratings. Additionally, we did not retrieve information about insomnia or anxiety symptoms prior to the index pregnancy; therefore, it is difficult to say whether positive scores represented incidence or recurrence. The study is also restricted to the early postpartum period. Hence, anxiety symptoms could subside throughout the first postpartum year (Adewuya and Afolabi, 2005).

To date, there is no consensus regarding which instruments should be used to measure perinatal anxiety (Meades and Ayers, 2011). In contrast, the EPDS is by far the most common tool used to measure perinatal depression (Cox, 2017; Gibson et al., 2009; Milgrom and Gemmill, 2014). The diversity of anxiety measures, including those used in our present study, makes comparisons among results less reliable, as do inter-study variations in anxiety definitions, cut-off scores, measurement time-points, study populations, and origins (Field, 2018). It is also possible that general anxiety measures do not optimally capture anxiety characteristics that occur during the perinatal period (Blackmore et al., 2016; Fallon et al., 2016b). Furthermore, there have been changes in the anxiety disorder categorization in DSM-V (American Psychiatric Association, 2013a)—OCD, the MINI-anxiety category most prevalent in postpartum week 8 in our study, has been removed from the anxiety disorder chapter and placed in a new category. Still, the position of OCD in the chapter following the anxiety disorder chapter reflects the close relationship between these conditions (American Psychiatric Association, 2013b). Notably, the ABC study was conducted prior to these changes, and the DSM-IV-TR is still widely used in research.

The generalizability of our present findings is limited because our cohort included only Norwegian-speaking women. Immigrants representing other ethnic groups may experience different risk factors in pregnancy, and have different prevalence of perinatal mood and anxiety disorders (Liu et al., 2016; Rubertsson et al., 2014). Moreover, immigration itself could be a risk factor (Falah-Hassani et al., 2016). Notably, the psychiatric illness burden co-occurring with insomnia reportedly differs among people of various racial backgrounds (Kalmbach et al., 2016). There is also reason to believe that the women in our study were somewhat more resourceful than the general birthing population in Norway. Younger women and single women were underrepresented, and those who dropped out of the study had significantly higher levels of depression and stress compared to those who remained. Consequently, the estimated association between insomnia and mental health measures may have been underestimated due to selective attrition.

4.3. Implications

PPA may have serious health consequences, especially for the infant. Therefore, healthcare providers should be aware of the frequent occurrence of anxiety disorders among pregnant and postpartum women. This high prevalence may warrant the implementation of screening procedures to detect anxiety along with the existing procedures for depression screening (Yawn et al., 2015). However, there remains a need for a consensus regarding the best instruments to detect perinatal anxiety, and whether these instruments should measure general anxiety symptoms, diagnostic anxiety categories or pregnancy-related and postpartum-specific anxiety (Somerville et al., 2015).

Healthcare professionals should be especially aware of the increased risk of OCD symptoms among postpartum women. Women with postpartum OCD often have aggressive, ego-dystonic intrusive thoughts concerning the newborn, and, therefore, might be reluctant to tell others about them due to shame or fear of reprisals (Brandes et al., 2004). When examining OCD symptoms, it is therefore important to normalize such experiences to make the woman feel safe enough to disclose symptoms (Fairbrother and Abramowitz, 2016). Further, it is essential to distinguish the obsessions of OCD from psychotic symptoms (McGuinness et al., 2011).

Our present observation of a significant association between insomnia in late pregnancy and perinatal anxiety may help healthcare

Table 3
Results from multiple linear regression analyses with anxiety measured by the log-transformed SCL-A during postpartum week 8 (Q3) as the dependent variable (n = 1563).

Variables	Model 1 Estimate (95% CI)	p value	Model 2 Estimate (95% CI)	p value	Model 3 Estimate (95% CI)	p value	Model 4 Estimate (95% CI)	p value
Insomnia continuous AP[a]	0.002 (−0.001–0.005)	0.125			0.004 (0.001–0.007)	0.008		
Insomnia dichotomous AP			0.062 (0.002–0.123)	0.044			0.088 (0.027–0.149)	0.005
Previous depression	0.197 (0.131–0.263)	<0.001	0.198 (0.132–0.264)	<0.001				
Depression AP	0.017 (0.007–0.027)	0.001	0.017 (0.007–0.027)	0.001				
Anxiety[b] AP	0.358 (0.309–0.407)	<0.001	0.357 (0.308–0.406)	<0.001	0.424 (0.381–0.467)	<0.001	0.425 (0.382–0.467)	<0.001
Fear of childbirth AP	−0.001 (−0.002–0.001)	0.532	0.000 (−0.002–0.001)	0.578	0.000 (−0.001–0.002)	0.711	0.000 (−0.001–0.002)	0.606
Higher education	−0.043 (−0.108–0.021)	0.186	−0.044 (−0.108–0.021)	0.183	−0.045 (−0.110–0.020)	0.176	−0.045 (−0.110–0.020)	0.175
Maternal age	−0.007 (−0.014–0.000)	0.055	−0.007 (−0.014–0.000)	0.057	−0.005 (−0.012–0.002)	0.143	−0.005 (−0.012–0.002)	0.147
Stress factors in last year	0.017 (0.005–0.029)	0.004	0.018 (0.006–0.030)	0.004	0.024 (0.012–0.036)	<0.001	0.025 (0.013–0.037)	<0.001
Multiparity	−0.045 (−0.109–0.019)	0.164	−0.045 (−0.109–0.019)	0.166	−0.042 (−0.106–0.023)	0.202	−0.041 (−0.105–0.024)	0.214
Relationship dissatisfaction	0.015 (0.009–0.022)	<0.001	0.015 (0.009–0.021)	<0.001	0.017 (0.011–0.024)	<0.001	0.017 (0.010–0.023)	<0.001
Low social support	0.023 (−0.079–0.125)	0.659	0.026 (−0.076–0.128)	0.622	0.036 (−0.068–0.140)	0.498	0.041 (−0.063–0.145)	0.438
Planned pregnancy	0.057 (−0.024–0.138)	0.167	0.057 (−0.024–0.137)	0.169	0.056 (−0.026–0.138)	0.180	0.055 (−0.027–0.137)	0.188
Previous forced sexual activity	0.100 (0.021–0.178)	0.013	0.102 (0.023–0.180)	0.011	0.137 (0.057–0.216)	0.001	0.141 (0.062–0.220)	<0.001
Premenstrual dysphoria	0.045 (−0.026–0.115)	0.215	0.043 (−0.027–0.114)	0.228	0.085 (0.014–0.155)	0.018	0.084 (0.014–0.155)	0.019
Emergency cesarean section	−0.075 (−0.175–0.024)	0.138	−0.075 (−0.175–0.024)	0.139	−0.093 (−0.194–0.008)	0.072	−0.092 (−0.194–0.009)	0.073
Elective cesarean section	−0.005 (−0.134–0.125)	0.941	−0.005 (−0.135–0.124)	0.938	0.012 (−0.120–0.143)	0.860	0.012 (−0.120–0.143)	0.863
Breastfeeding	−0.059 (−0.150–0.032)	0.206	−0.059 (−0.150–0.032)	0.200	−0.062 (−0.155–0.030)	0.186	−0.064 (−0.157–0.028)	0.171

Model 1: Insomnia measured by the continuous Bergen Insomnia Scale (BIS). Depression measures are included in the model. **Model 2**: Insomnia measured by the dichotomous BIS. Depression measures are included in the model. **Model 3**: Insomnia measured by the continuous BIS. Depression measures are excluded from the model. **Model 4**: Insomnia measured by the dichotomous BIS. Depression measures are excluded from the model.

[a] AP: Antepartum in pregnancy week 32.

[b] Anxiety measured by the log-transformed SCL-A, the anxiety scale from the Hopkins Symptom Check List.

workers identify women with anxiety and mood disorders who require extra care. Reporting insomnia symptoms may not feel stigmatizing for the anxious or depressed woman, and screening for insomnia in pregnancy could thus represent an effective strategy for detecting anxiety and mood disorders. Furthermore, insomnia is a disorder for which there are effective non-pharmacological treatment methods, and cognitive behavioral therapy for insomnia (CBT-i) is the commonly recommended first-line treatment (Trauer et al., 2015). CBT-i has been shown to be safe and effective for pregnant women (Manber et al., 2018), and it may represent a low-cost strategy for preventing perinatal anxiety and mood disorders, but further research is required on this topic. Also, a possible bidirectional effect between perinatal insomnia and anxiety should be studied.

Healthcare providers should be aware of the vulnerability to develop postpartum anxiety symptoms among women with a history of sexual abuse.

5. Conclusion

The results of this study reveal a high prevalence of anxiety disorders during the perinatal period. Our findings also indicate that gestational insomnia may be a helpful marker in detecting perinatal women with anxiety. Notably, insomnia may reflect underlying depression, and depression during pregnancy is a strong risk factor for postpartum anxiety. Thus, the association between insomnia during pregnancy and PPA must be further explored. Future research should also examine the extent to which treatment of anxiety, depression and insomnia in pregnancy may help prevent the development of postpartum anxiety.

Contributors' statements

Rannveig S. Osnes performed statistical analyses and drafted the manuscript. John Olav Roaldset interpreted data and critically reviewed the manuscript. Turid Follestad supervised statistical analyses, interpreted data, and critically reviewed the manuscript. Malin Eberhard-Gran is the project manager of the ABC study, and she interpreted data and critically reviewed the manuscript. All authors approved the final manuscript as submitted.

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Conflict of interest

There are no conflicts of interest.

Declaration of interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in

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