Prenatal work stress is associated with prenatal and postnatal depression and anxiety: Findings from the Norwegian Mother, Father and Child Cohort Study (MoBa)

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A B S T R A C T

Background: An emerging body of research suggests that stress experienced in the workplace can have detrimental impacts on maternal mental health, including greater risk of postnatal depression. However, few longitudinal studies have examined these associations during the perinatal period. The objective of this study was to examine the associations between prenatal work stress and subsequent depression and anxiety.
Methods: This study is based on the Norwegian Mother, Father and Child Cohort Study (MoBa), and included 77,999 employed women recruited between 1999 and 2008. The exposure variable was prenatal work stress measured at 17 weeks' gestation, using an 8-item scale examining factors including autonomy, working relationships, and work enjoyment. Outcomes included depression and anxiety at 30 weeks' gestation and 6 months postpartum, measured using the Symptom Checklist-8. Analyses comprised of unadjusted and adjusted logistic regressions.
Results: After covariate adjustment, prenatal work stress was associated with depression and anxiety at 30 weeks' gestation (OR = 1.33, 95% CI: 1.19–1.49), and 6 months postpartum (OR = 1.44, 95% CI: 1.28–1.61). Most associations remained after adjustment for additional work-related variables and maternity leave.
Limitations: Work stress was measured once during pregnancy, thus variation of associations by trimester could not be investigated. Findings are reported for a sample with high socioeconomic status, and may not generalize to other populations.
Conclusions: Women dealing with work stress during pregnancy are more likely to experience subsequent depression and anxiety. Findings can inform the development of workplace strategies to support the mental health of expecting and new mothers.

1. Introduction

Both prenatal and postnatal depression are common, with research suggesting that the prevalence of depression during pregnancy ranges from 6.4% to 12.0% depending on trimester and method of assessment, and may be as high as 19.9% in the postnatal period (Bennett et al., 2004; Cena et al., 2021; Gavin et al., 2005; Hahn-Holbrook et al., 2018).

Prenatal and postnatal depression are associated with a range of negative outcomes, including preterm delivery, impaired mother-child bonding, and mental disorders in offspring (Accortt et al., 2015; Dubber et al., 2015; Plant et al., 2015). Given these detrimental impacts of prenatal and postnatal depression on maternal-child health, identifying factors that influence risk of depression onset during and after pregnancy is important in reducing its potential burden.

In the past several decades, women have also represented a growing segment of the workforce – data from several countries suggests that women's participation rates in the labor force are now nearly equivalent to those of men (Ortiz-Ospina et al., 2018). In turn, employment can impart substantial impacts on women's health and wellbeing (Cooklin et al., 2011; Gjerdingen et al., 2014). Generally, employment confers protective effects on overall wellbeing relative to unemployment, via improved financial security, social connections, and personal fulfillment (Stansfeld and Candy, 2006). However, the protective impacts of employment often depend on whether or not the workplace exhibits positive characteristics, including autonomy, flexible schedules, supportive colleagues, generous leave policies, and low occupational strain (Grice et al., 2007; Nichols and Roux, 2004). Furthermore, negative aspects of the workplace, including nonstandard work schedules (i.e., irregular shifts, night work, or casual work), precarious employment, lower job flexibility, high physical strain, and high intensity (e.g., demanding work and/or long working hours) can have detrimental impacts on mental health and wellbeing outcomes including greater risk towards depression, and lower family and job satisfaction (Dagher et al., 2011; Frye and Breaugh, 2004).

Maintaining a balance between work and family life can be a struggle for many women, and this stress can negatively impact their mental health (Grice et al., 2007). A growing number of studies have reported that higher work-related stress, low job satisfaction, and unsupportive working environments have been associated with higher symptoms of depression and anxiety among postpartum women (Dagher et al., 2011; Killien et al., 2001; McGovern et al., 2007; Schwab-Reese et al., 2017; Shepherd-Banigan et al., 2016); these relationships may be mediated by factors including increased work-family conflict (Frye and Breaugh, 2004). Taken together, this research highlights the potential impact of work-related stress on maternal mental health and wellbeing. However, much of the literature that examines the impacts of work-related stress and other workplace characteristics on risk of depression in expecting or new mothers has been done in cross-sectional or smaller samples (McGovern et al., 2007; Shepherd-Banigan et al., 2016). In addition, no large-scale, prospective studies, to our knowledge, have examined the relations between work-related stressors and subsequent symptoms of depression in the prenatal period. Given the potential burden of perinatal depression on the long-term mental health and wellbeing of both mothers and their children, this calls for additional research into these associations.

2. Study aims

To address the dearth of research in this area, we utilized data from a large, longitudinal cohort sample with available information on prenatal work stress and several workplace characteristics, symptoms of prenatal and postnatal maternal depression and anxiety, and several potential confounding variables. The primary aim of this study was to examine the associations between prenatal work stress, measured at 17 weeks' gestation, and prenatal and postnatal depression and anxiety, measured at 30 weeks' gestation and at six months postpartum, respectively. Secondarily, we sought to examine additional work-related stressors, including physical work strains, working more than one job, and nonstandard work schedules (i.e., shift or night work), and their associations with subsequent depression and anxiety.

3. Methods

3.1. Sample

The current study utilizes data from the Norwegian Mother, Father and Child Cohort Study (MoBa), a population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health (Magnus et al., 2016). Participants were recruited from across Norway between 1999 and 2008, and 41% of pregnant women consented to participation.

The cohort now includes over 114,500 children, 95,200 mothers and 75,200 fathers. Maternal questionnaire response rates at the 17 weeks' gestation, 30 weeks' gestation, 6 months postpartum were 94.9%, 87.0%, and 76.7%, respectively (Magnus et al., 2016). The current study is based on version 12 of the quality-assured data files released for research in 2020. The establishment of MoBa and initial data collection was based on a license from the Norwegian Data Protection Agency and approval from The Regional Committees for Medical and Health Research Ethics. The MoBa cohort is now based on regulations related to the Norwegian Health Registry Act. The current study was approved by The Regional Committees for Medical and Health Research Ethics (#2013/2061). The sample for the current study comprises 77,999 women enrolled in MoBa for the first time (repeated pregnancies were not included), who reported being employed in public or private sectors at 17 weeks' gestation, and had available data on work-related stress measures.

4. Measures

4.1. Prenatal work stress

Work stress was measured at 17 weeks' gestation using an 8-item scale created for the MoBa study. Items examined several components of work-related stress: physical strains ("I have physically heavy work"), nature of work ("My work is very monotonous", "My work demands a lot of me" and "My work is very stressful"), enjoyment and fulfillment ("I enjoy my work" and "I learn a lot at work"), working environment ("There is a good team spirit at my place of work"), and autonomy ("I am able to decide how my work is to be carried out"). Respondents were presented with four response options for each item, including "Agree", "Agree mostly", "Disagree mostly", and "Disagree". Positive statements were reverse coded, and scores were summed and divided by the total number of items to generate mean scores of work stress, whereby higher scores represented higher levels of work stress (Magnus et al., 2018). Items from the work stress scale have been examined in prior MoBa research, demonstrating associations with objective work-related measures including duration of sickness absence and probability of returning to work (Kristensen et al., 2008).

4.2. Depression and anxiety

Symptoms of depression and anxiety were examined at 17 weeks' gestation, 30 weeks' gestation, and 6 months postpartum using the short 5-item (17 weeks; SCL-5) and 8-item (30 weeks, 6 months; SCL-8) versions of the Hopkins Symptom Checklist-25 (SCL-25), translated into Norwegian (Strand et al., 2003). The SCL-25 has been validated as a screening instrument for depression in several populations (Nettelbladt et al., 1993; Sandanger et al., 1998), and SCL-5 and SCL-8 scores are highly correlated with SCL-25 scores ($r's$ = 0.92 and 0.94, respectively) (Strand et al., 2003; Tambs and Moum, 1993). Participants rated their experience of each symptom during the past two weeks on a Likert scale ranging from 1 ("not bothered") to 4 ("very bothered"). Scores on each item were summed, and the total was divided by the total number of items to generate mean scores of depressive and anxiety symptoms. A mean score of greater than 2.0 was used as a cut-off to construct a dichotomous measure indicating the presence of depression and anxiety; this cut-off has been validated for both the SCL-5 and SCL-8 scales (Strand et al., 2003).

At 6 months postpartum, depressive symptoms were also examined using a validated 6-item Norwegian version of the Edinburgh Postnatal Depression Scale (EPDS) (Berle et al., 2003; Cox et al., 1987). Participants indicated whether they had experienced each symptom during the past two weeks on a Likert scale ranging from 0 ("no, never") to 3 ("yes, almost all the time"), and scores were generated by summing item scores. A score of ≥ 7 was used as a cut-off to construct a dichotomous measure indicating presence of moderate to severe depression; this

cut-off score has been well-validated (Cox et al., 1987; Eberhard-Gran et al., 2001), and utilized in other MoBa studies (Solberg et al., 2011).

4.3. Additional work variables

Physical work stress. Physical stress at work was measured at 17 weeks' gestation, using a 7-item scale developed for the MoBa cohort examining physical strains in the work environment (Magnus et al., 2016); statements included "Do you work walking or standing?", "Are you subjected to a lot of uncomfortable background noise?" and "Do you have to turn and bend many times in the course of an hour?". Respondents could select one of four response items for each statement, including "Yes, every day more than half of the working day"; "Yes, every day less than half of the working day", "Yes, periodically but not daily", and "Seldom or never". Items were summed and divided by the total number of items to generate mean scores of physical work stress, whereby higher scores represented higher physical work stress.

Working hours and stability of working conditions. At 17 weeks' gestation, respondents were asked to indicate how many hours they worked per week, when their working hours were (e.g., permanent night work, day or night shift work/rotations), and whether they worked more than one job (with or without salary) when they became pregnant. At 30 weeks' gestation, respondents were also asked to indicate whether they maintained the same working conditions as reported at 17 weeks. Dichotomous variables were constructed to characterize respondents who reported working nights, being employed in shift work, working more than one job, and who maintained the same working conditions from 17 to 30 weeks' gestation. Working hours per week were collapsed into four categories: ≤22.5 h, 22.6–30 h, 30.1–37.5 h, and ≥ 37.6 h (Kristensen et al., 2008).

4.4. Covariates

A number of covariates known or theorized to influence prenatal work stress, depression and anxiety were adjusted for in analyses. Sociodemographic covariates included: civil status (i.e., married, partnered, or single); number of hours worked per week; low household income (below 300,000 NOK per year); need for the mother's income. Psychosocial covariates included: smoking during pregnancy (yes or no); alcohol use during pregnancy (never, 1–3 times per month or less, and 1+ times per week); social support (mean of three items examining availability of support outside of the marital relationship, social interactions, and loneliness); number of adverse life events in the prior 12 months (e.g., financial problems, illness, or injury or death of someone close to the respondent); ability to cope with unexpected bills; and ability to cope with running expenses (e.g., food, rent). All covariates were measured at 17 weeks' gestation with the exception of adverse life events, which was measured at 30 weeks' gestation and six months postpartum; and ability to cope with unexpected bills and running expenses, which were measured at six months postpartum.

4.5. Statistical analyses

Analyses were completed using Stata version 14 (StataCorp, College Station, TX). Demographic characteristics were reported for the full sample using means and standard deviations, or frequencies. Logistic regressions were conducted to examine the relationships between prenatal work stress at 17 weeks, and depression and anxiety at 30 weeks' gestation and 6 months postpartum, and moderate to severe depression at 6 months postpartum. Unadjusted associations were first examined. Next, models were adjusted for covariates in two steps – first, adjustment was made for baseline depression and anxiety at 17 weeks' gestation, and demographic factors (maternal age, marital status, education, need for maternal income, and household income); and second, additional adjustment was made for lifestyle factors (alcohol use, smoking), social support, adverse life events, and additional financial strains (for

outcomes measured at six months postpartum). Associations between additional work variables measured at 17 weeks (physical strains, shift or night work, working more than one job) and depression and anxiety at 30 weeks' gestation and 6 months postpartum, and moderate to severe depression at 6 months postpartum were also examined in unadjusted and adjusted logistic regression models. Sensitivity analyses comprised the examination of associations between prenatal work stress and subsequent depression and anxiety with additional adjustment for type of work and working more than one job; adjustment for physical work strains; restricting to women who reported the same working conditions from 17 to 30 weeks' gestation; stratifying analyses by parity (i.e., first-time mothers and mothers with one or more child); adding self-employed mothers to the sample; stratifying analyses by working hours at 17 weeks' gestation; excluding women who exceeded the cut-off for clinically significant depression and anxiety at baseline (17 weeks' gestation); and adjusting for maternity leave duration at 6 months postpartum. To account for missing data on covariates and outcome variables (see Supplementary Table 1), multiple imputation was conducted using chained equation procedures, and results were pooled across 10 imputed datasets.

5. Results

Descriptive characteristics of the sample at baseline (17 weeks' gestation) are summarized in Table 1. The majority of women included in the sample were married or cohabiting, had some level of post-secondary education, had a higher household income, and worked at least 30 h per week at 17 weeks' gestation. Approximately 5% of women experienced depression or anxiety (exceeding a cut-off of 2.0 or greater on the SCL-5) at baseline (17 weeks' gestation).

Results of logistic regressions for associations between prenatal work stress and depression and anxiety at 30 weeks' gestation and six months

Table 1
Baseline characteristics of the study sample.

Characteristic	Mean ± SD or n (%)
Maternal age	30.17 ± 4.25
Parity	
0	36,423 (46.70)
1+	41,576 (53.30)
Marital status	
Married	38,266 (49.06)
Cohabiting	38,033 (48.76)
Single	1700 (2.18)
Maternal education	
> High school	61,438 (78.81)
High school and below	16,531 (21.19)
Household Income	
≥ 300,000 NOK	58,057 (74.43)
< 300,000 NOK	19.942 (25.57)
Can manage without maternal income (no)	34,826 (44.65)
Working hours at 17 weeks	
0–22.5	12,618 (16.18)
22.6–30.0	10,027 (12.86)
30.0–37.5	41,398 (53.08)
37.6+	13,956 (17.89)
Additional job (yes)	9155 (11.74)
Shift work (yes)	16,894 (21.66)
Depression and anxiety, 17 weeks (SCL-5 score ≥ 2.0)	4159 (5.33)
Smoking	
None	54,440 (69.80)
Sometimes	9174 (11.76)
Daily	14,385 (18.44)
Alcohol use	
None	67,864 (87.01)
1–3 drinks per month	9683 (12.41)
1+ drinks per week	452 (0.58)

Note. The sample size was $n = 77,999$. NOK = Norwegian krone, SCL-5 = Hopkins Symptom Checklist 5. Descriptive characteristics calculated using imputed data.

postpartum, and moderate to severe depression at six months postpartum are summarized in Tables 2–4. At 30 weeks' gestation, prenatal work stress was positively associated with depression and anxiety after adjustment for baseline depression and anxiety, demographic and lifestyle factors, social support, and adverse events (OR = 1.33, 95% CI: 1.19 – 1.49). These associations persisted in the postpartum period for depression and anxiety measured at six months postpartum after further adjustment for additional adverse events and financial variables (OR = 1.44, 95% CI: 1.28–1.61). Higher prenatal work stress was also associated with higher odds of moderate-severe depression at six months postpartum after covariate adjustment (OR = 1.41, 95% CI: 1.32–1.50).

Results of logistic regressions for associations between remaining work-related stressors and depression and anxiety at 30 weeks' gestation and six months postpartum, and moderate to severe depression at six months postpartum are also summarized in Tables 2–4. After covariate adjustment, higher physical work stress was associated with increased depression and anxiety at both 30 weeks' gestation (OR = 1.16, 95% CI: 1.08–1.24) and six months postpartum (OR = 1.08, 95% CI: 1.01–1.17), as well as moderate-severe depression at six months postpartum (OR: 1.16, 95% CI: 1.11–1.22). Prior to covariate adjustment, working nights was not associated with subsequent depression and anxiety; however, after complete covariate adjustment, working nights was associated with lower odds of depression and anxiety (OR: 0.68, 95% CI: 0.48–0.96), and moderate-severe depression at 6 months postpartum (OR: 0.83, 95% CI: 0.70–0.98). Associations between shift work and subsequent depression and anxiety were not statistically significant.

Results of sensitivity analyses are highlighted in Supplementary Table 2. After adjustment for nonstandard work schedules and additional employment, as well as restriction of the sample to women reporting consistent working conditions between 17 and 30 weeks' gestation, associations between prenatal work stress and depression and anxiety were marginally strengthened at both 30 weeks' gestation and 6 months postpartum. Adjustment for physical work stress significantly attenuated the associations between prenatal work stress and depression and anxiety at 30 weeks' postpartum, and slightly attenuated associations at 6 months postpartum. The addition of self-employed mothers to the sample had little impact on strength of associations. Removing mothers reporting clinically significant depression or anxiety (i.e., above the SCL-5 cut-off) at 17 weeks' gestation, and adjusting for maternity leave status at six months postpartum marginally attenuated associations between prenatal work stress and depression and anxiety. After stratifying analyses by parity, the associations between prenatal work stress and depression and anxiety appeared stronger among first-time mothers; however, tests of the interactions between parity and work stress were not statistically significant ($p = .12 - 0.18$). Stratification by working hours reported at 17 weeks' gestation did not suggest a clear dose-response association between prenatal work stress and subsequent

Table 2
Logistic regression results for relationship between work-related stressors and depression/anxiety (SCL-8) at 30 weeks' gestation.

Predictor	Step 1 (OR, 95% CI)	Step 2 (OR, 95% CI)	Step 3 (OR, 95% CI)
Prenatal work stress	3.42 (3.14–3.73)	1.81 (1.63–2.00)	1.33 (1.19–1.49)
Prenatal physical strains scale	1.69 (1.59–1.80)	1.25 (1.17–1.34)	1.16 (1.08–1.24)
Shift work	1.00 (0.91–1.10)	0.99 (0.89–1.09)	0.98 (0.88–1.08)
Night work	1.01 (0.80–1.29)	0.90 (0.69–1.17)	0.88 (0.67–1.17)
Second job	1.31 (1.17–1.47)	1.06 (0.93–1.20)	0.96 (0.84–1.09)

Note. SCL-8 = Hopkins Symptom Checklist 8, OR = odds ratio, CI = confidence interval. Model 1 presents unadjusted associations. Model 2 presents associations adjusted for depression/anxiety at 17 weeks' gestation, maternal age, marital status, maternal education, working hours at 17 weeks' gestation, household income, and need for mother's income. Model 3 presents associations adjusted for covariates in Model 2, as well as maternal smoking, maternal alcohol use, maternal social support, and adverse events at 30 weeks' gestation.

Table 3
Logistic regression results for relationship between work-related stressors and depression/anxiety (SCL-8) at 6 months postpartum.

Predictor	Step 1 (OR, 95% CI)	Step 2 (OR, 95% CI)	Step 3 (OR, 95% CI)
Prenatal work stress	3.38 (3.09–3.70)	2.03 (1.83–2.25)	1.44 (1.28–1.61)
Prenatal physical strains scale	1.59 (1.50–1.70)	1.22 (1.14–1.31)	1.08 (1.01–1.17)
Shift work	1.01 (0.91–1.12)	0.98 (0.88–1.10)	0.95 (0.84–1.07)
Night work	0.89 (0.68–1.19)	0.74 (0.55–1.00)	0.68 (0.48–0.96)
Second job	1.36 (1.22–1.52)	1.15 (1.01–1.30)	0.99 (0.87–1.13)

Note. SCL-8 = Hopkins Symptom Checklist 8, OR = odds ratio, CI = confidence interval. Model 1 presents unadjusted associations. Model 2 presents associations adjusted for depression/anxiety at 17 weeks' gestation, maternal age, marital status, maternal education, working hours at 17 weeks' gestation, household income, and need for mother's income. Model 3 presents associations adjusted for covariates in Model 2, as well as maternal smoking, maternal alcohol use, maternal social support, and adverse events at 30 weeks' gestation and 6 months postpartum, difficulties coping with unexpected bills at 6 months postpartum, and difficulties coping with running expenses at 6 months postpartum.

Table 4
Logistic regression results for relationship between work-related stressors and depression (EPDS) at 6 months postpartum.

Predictor	Step 1 (OR, 95% CI)	Step 2 (OR, 95% CI)	Step 3 (OR, 95% CI)
Prenatal work stress	2.47 (2.34–2.61)	1.86 (1.75–1.97)	1.41 (1.32–1.50)
Prenatal physical strains scale	1.47 (1.42–1.52)	1.26 (1.21–1.32)	1.16 (1.11–1.22)
Shift work	1.07 (1.02–1.13)	1.05 (0.99–1.10)	1.03 (0.97–1.09)
Night work	0.97 (0.84–1.13)	0.85 (0.72–1.00)	0.83 (0.70–0.98)
Second job	1.27 (1.19–1.35)	1.14 (1.06–1.23)	1.03 (0.96–1.12)

Note. EPDS = Edinburgh Postnatal Depression Scale, OR = odds ratio, CI = confidence interval. Model 1 presents unadjusted associations. Model 2 presents associations adjusted for depression/anxiety at 17 weeks' gestation, maternal age, marital status, maternal education, working hours at 17 weeks' gestation, household income, and need for mother's income. Model 3 presents associations adjusted for covariates in Model 2, as well as maternal smoking, maternal alcohol use, maternal social support, and adverse events at 30 weeks' gestation and 6 months postpartum, difficulties coping with unexpected bills, and difficulties coping with running expenses.

symptoms of depression and anxiety at 30 weeks' gestation or six months postpartum as working hours increased.

6. Discussion

This study of 77,999 women examined the associations between prenatal work stress and depression and anxiety both later in pregnancy and in the postpartum period. Our findings demonstrate that experiencing higher prenatal work stress is associated with increased odds of depression and anxiety both later in pregnancy and in the postpartum period. These associations largely persisted after adjustment for baseline depression and anxiety and a number of potential confounding variables, and after conducting several sensitivity analyses.

Our findings are consistent with studies that have demonstrated relationships between work-related stressors and risk of depression in the prenatal and postnatal periods. In the prenatal period, cross-sectional research has reported associations between workplace adversity, job strain and symptoms of depression (Cooklin et al., 2007; Tsai, 2019). Postnatally, a number of cross-sectional studies have reported relationships between work-related stressors including job quality, psychological demands, and lower perceived control, and symptoms of depression (Dagher et al., 2009; Tsai, 2019). In addition, a growing number of longitudinal studies have examined the impacts of work-related stressors on postpartum depression risk. For example,

studies have demonstrated relationships between higher total workload and higher work stress, and an increased risk of postnatal depression (Dagher et al., 2011; Shepherd-Banigan et al., 2016). Our study adds to this body of evidence, and to our knowledge, represents the first prospective study to consider the impacts of work-related stress beyond employment status on risk of prenatal depression and anxiety.

We further explored the impacts of other work-related stressors on prenatal and postnatal depression and anxiety, and our findings demonstrated associations between physical work stress and subsequent depression and anxiety. The role of physical work stress and working multiple jobs on prenatal and postnatal depression risk appears to be unexplored in the broader literature. However, studies examining the impacts of nonstandard work schedules on maternal risk of depression present mixed findings. Some research has reported associations between regular and irregular shift and night work schedules and risk of postnatal depression (Grzywacz et al., 2016; Zhao et al., 2020); a potential limitation of these studies is that they do not account for or examine work-related stress. By comparison, longitudinal research by Shepherd-Banigan et al. (2016), and Hammer et al. (2019) did not report associations between work schedules and night work, respectively, and postnatal depression. The variability of findings regarding the impacts of nonstandard work schedules on risk of maternal depression, as well as a lack of examination into the impacts of physical work stress and working more than one job, suggests that these factors may benefit from continued investigation.

Findings from the current study can inform the development of prevention and intervention strategies in the workplace to potentially mitigate the impacts of prenatal work stress, and work stress experienced by employees more broadly. For example, targeting components of stressful work, including high job demands, a lack of "team spirit", and a lack of control – items which were included in our work stress measure – may be of interest. To date, moderate evidence supports the implementation of prevention strategies in the workplace that increase employee control and promote supportive workplace environments to reduce levels of occupational stress (Egan et al., 2007; Osilla et al., 2012), and emerging evidence also suggests that resilience training may positively impact reported levels of occupational stress (Egan et al., 2007). A wider range of studies have also demonstrated positive impacts of cognitive behavioural techniques to manage stress on measured levels of occupational stress in general population samples (Joyce et al., 2016); reducing levels of work-related stress can, in turn, prevent the onset or minimize the degree of depressive and anxious symptoms experienced in employees (Joyce et al., 2016). Evidence supporting the effectiveness of broad interventions for depression and anxiety symptoms in the workplace is mixed; however, there is some support for the individual delivery of cognitive behavioural interventions for employees dealing with poor mental health (Furlan et al., 2012). However, no studies, to our knowledge, have examined the impact of these prevention strategies in samples of pregnant employees; this is a clear evidence gap given the growing number of working mothers in the labor force, and is thus an area that would benefit from further inquiry.

6.1. Limitations and strengths

The current study has a number of limitations. First, findings may not generalize to working mothers in other countries, given that the division of unpaid labor in two-parent households is relatively equitable in Norway, and parental leave policies allow for both mothers and their partners to take extended time off after the birth of their child. This is reflected in our study sample, where the majority (96%) of women reported being on maternity leave six months after birth. Furthermore, the majority (>99%) of MoBa participants are of Norwegian decent and most participants are of higher socioeconomic status; thus, our findings may also not generalize to working mothers residing in regions with greater socioeconomic or ethnic diversity. Second, since data was not available on unpaid household work during pregnancy, we cannot

ascertain how cumulative workload (i.e., paid and unpaid work undertaken by mothers) may influence the observed associations. Third, mothers included in the sample were recruited over a 10-year period (1999 to 2008) where workplace environments may have experienced substantial structural changes due to technology, globalization, and /or shifts towards alternative working environments. These changes may influence how stress is experienced in the workplace, impacting generalizability of these findings. Fourth, moderate attrition occurred during the study follow-up period, which may lead to bias in the reported associations. However, attrition analyses completed in the MoBa cohort suggest that participant attrition largely impacts prevalence estimates, and thus may not substantially bias exposure-outcome associations (Nilsen et al., 2009). Fifth, the work stress scale included in the 17 week questionnaire was developed for the MoBa cohort, and has yet to be validated in other samples; given that work stress was only measured at 17 weeks' gestation, we also could not ascertain whether associations differed depending on timing of assessment during pregnancy. Finally, detailed data on important factors that may be associated with high-stress work, including employment in precarious positions, was not collected, which can lead to residual confounding of the observed associations.

The current study also has several strengths. We utilized data from a prospective cohort sample with a large sample size, which allowed for the examination of associations between prenatal work stress and subsequent depression and anxiety with adjustment for several confounding variables. We were also able to include information on a number of important work-related variables, which allowed for the ability to conduct additional analyses to better elucidate the role of prenatal work stress on later risk of depression and anxiety.

7. Conclusions

Pregnancy is often a stressful time for many expecting mothers, and the added impacts of work-related stress can amplify their risk towards poorer mental health. Our findings provide longitudinal evidence supporting associations between prenatal work stress and subsequent prenatal and postnatal depression and anxiety. As a result, targeting work stress early in pregnancy may minimize risk towards future stress and depression. Employers, partners, and other available social supports can help pregnant women and new mothers mitigate the impacts of work-related stress by promoting supportive workplace cultures, balancing unpaid work between family members, and alleviating other potential sources of stress. Given a dearth of research to date, studies examining the effectiveness of workplace interventions designed to reduce levels of occupational stress and symptoms of depression in pregnant women and working mothers represent an important area of future inquiry.

CRediT authorship contribution statement

Zahra M. Clayborne: Visualization, Formal analysis, Investigation, Writing – original draft. **Ian Colman:** Supervision, Visualization, Investigation, Writing – original draft. **Mila Kingsbury:** Visualization, Investigation. **Fartein Ask Torvik:** Visualization, Investigation. **Kristin Gustavson:** Visualization, Investigation. **Wendy Nilsen:** Funding acquisition, Supervision, Visualization, Investigation, Writing – original draft.

Declaration of Competing Interest

The authors have no conflicts to declare.

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families in Norway who take part in this on-going cohort study. The consent given by the participants does not allow for storage of data on an individual level in repositories or journals. Researchers who want access to data sets for replication should submit an application to www.hel-sedata.no. Access to data sets requires approval from The Regional Committee for Medical and Health Research Ethics in Norway and an agreement with MoBa.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2021.11.024.

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