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Patterns of peripartum depression and anxiety during the pre-vaccine COVID-19 pandemic

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Abstract

Background Pregnant people are vulnerable to new or worsening mental health conditions. This study aims to describe prevalence and course of depression and anxiety symptoms in pregnancy during the pre-vaccine COVID-19 pandemic.

Methods This is a prospective cohort study of pregnant individuals with known or suspected COVID-19. Participants completed Edinburgh Postnatal Depression Scale (EPDS) and Generalized-Anxiety Disorder-7 (GAD-7) questionnaires, screening tools for depression and anxiety, at 34weeks gestational age, 6-8weeks postpartum, and 6months postpartum. Prevalence of elevated depressive and anxiety symptoms at each visit was described. Univariable logistic regression analysis was used to determine the association between demographic and clinical factors and those with elevated depression or anxiety symptoms.

Results 317 participants were included. The prevalence of elevated antepartum depression symptoms was 14.6%, 10.3%, and 20.6% at 34weeks gestational age, 6-8weeks postpartum, and 6months postpartum, respectively. The rate of elevated anxiety symptoms was 15.1%, 10.0%, and 17.3% at 34weeks gestational age, 6-8weeks postpartum, and 6months postpartum, respectively. A prior history of depression and/or anxiety (p 's < 0.03), as well as higher EPDS and GAD-7 scores at enrollment (p 's < 0.04) associated with elevated depression and anxiety symptoms throughout pregnancy and the postpartum period. Quarantining during pregnancy was associated with elevated anxiety symptoms at 34weeks gestational age in univariate ($P=0.027$) analyses. COVID-19 diagnosis and hospitalization were not associated with elevated depression or anxiety symptoms.

Conclusions Elevated depression and anxiety symptoms were prevalent throughout pregnancy and the postpartum period, particularly in those with prior depression and/or anxiety and who quarantined. Strategies that target social isolation may mitigate potential adverse consequences for pregnant people, and continued vigilance in recognition of depression and anxiety in pregnancy should be considered.

Keywords Pregnancy, COVID-19, Depression, Anxiety, Maternal mental health

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Introduction

The COVID-19 pandemic has provoked significant fear, uncertainty, and stigma in the perinatal population. Implementation of measures intended to curb the spread of the virus such as social and physical distancing, travel bans, and lockdowns have engendered unprecedented isolation [1]. The prevalence of anxiety and depressive symptoms were found to be increased during previous infectious disease outbreaks [2, 3], including among pregnant people [4]. During the peripartum period women are especially vulnerable to experiencing the onset or relapse of psychiatric disorders [5]. Whereas the prevalence of depression and anxiety is 3–5% in the general population [6], an estimated 13–23% of women suffer from depression or anxiety during pregnancy and postpartum [7, 8], up to 9% incidence of comorbid depressive and anxiety symptoms [9]. Untreated antenatal depression and anxiety have both been associated with adverse perinatal outcomes such as preterm delivery and low birth weight [10, 11], as well as impaired mother-infant bonding and delayed childhood cognitive/emotional development [12–14].

To date, data has been unclear on whether, in the context of the COVID-19 pandemic, pregnant and postpartum individuals experience more depression and anxiety symptoms [15–19]. Hessami et al. showed that perinatal anxiety scores were higher during the COVID-19 pandemic among peripartum individuals and that peripartum individuals had higher pooled validated depression scores during the pandemic compared to pre-pandemic, but the difference was not significant [20]. A more recent meta-analysis by Shorey et al. suggested a higher prevalence of depressive symptoms in the antepartum period during COVID-19, but no difference in the prevalence of depressive symptoms in the postpartum period [21]. One small case series of 14 pregnant women with laboratory-confirmed SARS-CoV-2 infection reported similar levels of depression and anxiety compared to 14 matched non-infected pregnant women [22]. Pregnant people may be in even higher need of preventive mental health interventions during the COVID-19 pandemic. We describe the prevalence of depressive and anxiety symptoms among pregnant people with known or suspected COVID-19 throughout the peripartum period.

Methods

PRIORITY (Pregnancy CoRonavirus Outcomes RegIs-TrY) is a prospective cohort study of pregnant or recently pregnant people with known or suspected COVID-19 infection. Participants were recruited nationwide between March 2020 and October 2020 through outreach by professional societies, community organizations, traditional media, and social media. Eligible participants were ≥ 13 years old, spoke any language, pregnant or

within 6 weeks of pregnancy, and under investigation for COVID-19 infection or had confirmed COVID-19 diagnosis. Participants were provider-referred or self-referred. Informed consent was obtained from each individual participant in accordance with study protocols approved by the University of California, San Francisco (UCSF) and the University of California, Los Angeles (UCLA) Institutional Review Boards (IRB) (UCSF IRB# 20-30410, UCLA IRB# 20-000579). PRIORITY follow up is ongoing; for this manuscript, we report data available through August 18, 2021.

Baseline demographic and clinical characteristics were collected at the time of enrollment through online surveys and electronic medical record review. Demographic characteristics included race/ethnicity, region of residence (Midwest, Northeast, South, West), language, sexual orientation, relationship status, employment status, and annual income. Clinical characteristics included age, BMI, substance use history, medical history, gestational age, obstetric history, antepartum/intrapartum complications, neonatal outcomes, COVID-19 diagnosis, and COVID-19-related hospitalization. Self-report of SARS-CoV-2 diagnosis was adjudicated with viral test results on a subsample of 140 participants; 138 (98.6%) were concordant with self-report [23].

Participants completed online questionnaires about their health, pregnancy history, COVID-19 diagnosis, and quarantine practices at enrollment, weekly for 4 weeks, and then at multiple time points throughout pregnancy and postpartum. These questionnaires also included Edinburgh Postnatal Depression Scale (EPDS) and Generalized Anxiety Disorder-7 (GAD-7). For this analysis, we selected PRIORITY participants who enrolled while pregnant < 24 weeks gestation and completed the EPDS and GAD-7 at least once antepartum (24 weeks and/or 34 weeks gestational age) and once postpartum (6–8 weeks postpartum and/or 6 months postpartum). Depressive symptoms were assessed using the EPDS. “Elevated depressive symptoms” was defined as an EPDS score of ≥ 13 , which yielded a sensitivity of 88% and specificity of 93% postpartum for probable cases of major and minor depression [24], and the same cutoff has also been validated for use during pregnancy [25]. Anxiety symptoms were assessed using the GAD-7 scale. “Elevated anxiety symptoms” was defined as GAD-7 score of ≥ 10 , which yielded a sensitivity of 89% and specificity of 82% for generalized anxiety disorder independently diagnosed by mental health professionals [26], with good reliability and construct validity in pregnancy and the postpartum period [27]. Severity of depression or anxiety symptoms was measured using the quantitative score of EPDS or GAD-7, respectively. Those with higher scores on EPDS or GAD-7 were interpreted as having more severe depression or anxiety symptoms.

Statistical analysis was performed using SAS version 9.4, R version 3.6.2, and Stata 15. Descriptive statistics were used to summarize baseline demographic and clinical characteristics for the total study population and COVID-19 positive subgroup. The prevalence of elevated depression and anxiety symptoms were reported at 24weeks gestation, 34weeks' gestation, 6-8weeks postpartum, and 6 months postpartum. Severity of depression and anxiety symptoms throughout pregnancy and postpartum were approximated using the mean EPDS scores and GAD-7 scores. Repeated measures linear and logistic regression models were used to examine change in prevalence and severity of depression and anxiety symptoms over time; time point was treated as a categorical fixed effect and random intercepts were included for each subject to account for the correlation of the repeated measures. Univariable logistic regression analysis was used to determine the association between demographic and clinical factors and elevated depression or anxiety symptoms at 34 weeks' gestation, 6-8weeks postpartum, and 6 months postpartum. Maternal demographic variables of age, parity, region of residence, relationship status, employment status, and annual income were considered in a multivariable logistic regression model. We calculated summary statistics and 95% confidence intervals (CI). Statistical significance was set at *P*-value of 0.05.

Results

Of 1,336 PRIORITY participants, 317 enrolled prior to 24weeks gestation and completed questionnaires both in the antepartum and postpartum period and thus were included in the study (Fig. 1). Among the 317 individuals with completed questionnaires, 247 tested positive for SARS-CoV-2, and 40 were negative.

Mean maternal age of the sample was 31.5 (standard deviation [SD] 4.91) with 41.0% being nulliparous (Table 1). Mean weeks of gestation was 17.1 (SD 5.43) at enrollment and 38.6 (SD 2.82) at birth. Nearly all pregnancies were singleton (99.0%) and resulted in livebirths (98.7%). Two individuals (1.5%) reported having considered an abortion. Most of the cohort (62.8%) identified as White and 27.8% identified as Hispanic/Latinx, living in the Midwest (17.3%), the Northeast (28.1%), the South (25.8%), and the West (30.7%). Notably, 47.0% reported an annual income of more than \$100,000. In this cohort, 26.5% reported a history of depression, anxiety, or both. Other pre-pregnancy medical comorbidities were reported by 30.9% of the cohort. Only 2.2% of the participants were hospitalized at time of enrollment, but more than half (60.9%) self-reported they were in quarantine at time of enrollment. Demographic and clinical characteristics for participants who tested positive for SARS-CoV-2 infection are also presented in Table 1.

In this peripartum cohort, rate of elevated depression and anxiety symptoms as defined by validated cutoffs of

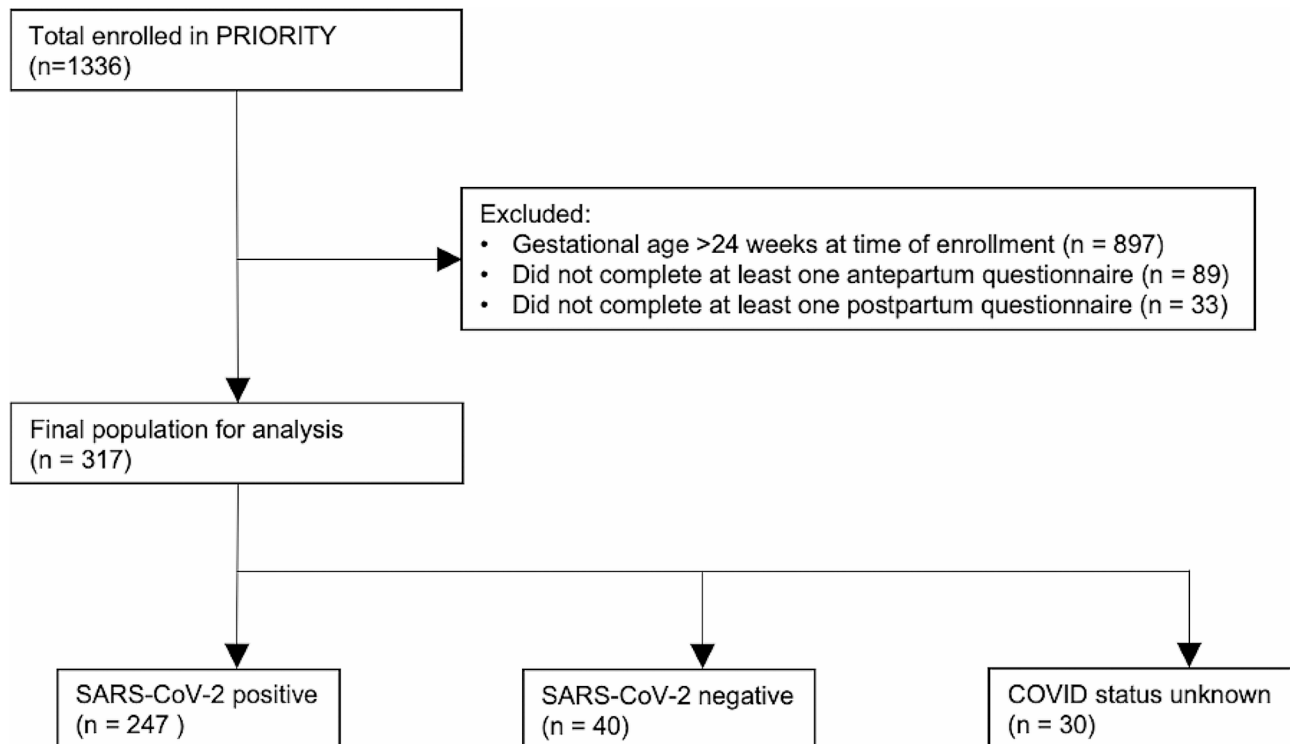


Fig. 1 Diagram representing the selection of final study population and associated COVID-19 diagnoses

Table 1 Demographic and clinical characteristics of study participants

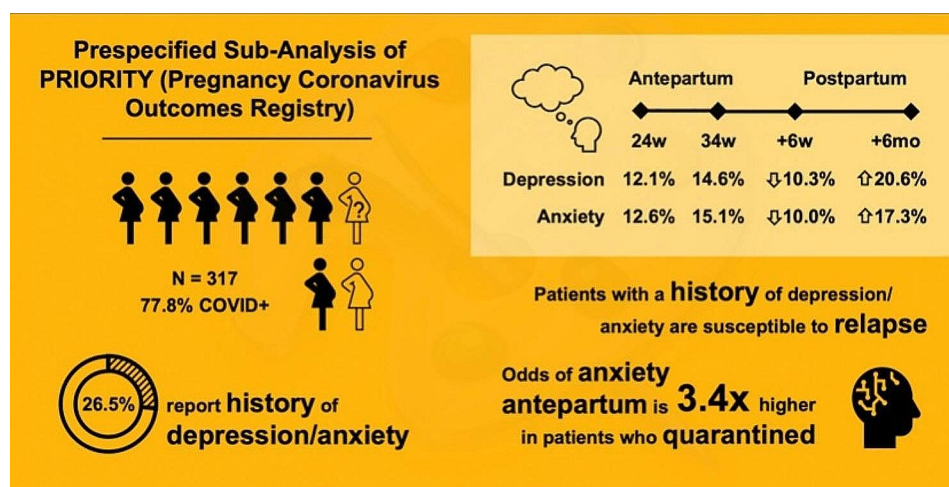
Characteristics	All participants	COVID+ Subgroup
Age (years; mean \pm SD (n))	31.5 \pm 4.91 (n = 316)	31.3 \pm 4.83 (n = 246)
Gestational age at enrollment (weeks; mean \pm SD)	17.1 \pm 5.43 (n = 317)	17.2 \pm 5.44 (n = 247)
<i>Race/Ethnicity</i>		
Asian	22 (6.9%)	13 (5.4%)
Black	23 (7.3%)	19 (7.7%)
Hispanic/Latinx	88 (27.8%)	77 (31.2%)
White	199 (62.8%)	149 (60.3%)
Other	8 (12.8%)	7 (2.8%)
<i>Language</i>		
English	297 (94.3%)	228 (93.1%)
Spanish	17 (5.4%)	16 (6.5%)
Other	1 (0.3%)	1 (0.4%)
<i>Region of country</i>		
Midwest	53 (17.3%)	43 (17.9%)
Northeast	80 (26.1%)	63 (26.3%)
South	79 (25.8%)	67 (27.9%)
West	94 (30.7%)	67 (27.9%)
<i>Employment status</i>		
Full time paid employment	223 (70.3%)	173 (70.0%)
Homemaker, childcare provider, or both (unpaid)	26 (8.2%)	21 (8.5%)
Part time employment or seeking employment	39 (12.3%)	30 (12.1%)
Healthcare worker or direct patient care	99 (31.2%)	83 (33.6%)
<i>Annual income (\$)</i>		
Less than 25,000	24 (7.6%)	18 (7.03%)
25,000–50,000	46 (14.5%)	40 (16.2%)
50,000–100,000	88 (27.8%)	69 (27.9%)
More than 100,000	149 (47.0%)	112 (45.3%)
In a significant relationship (including marriage or domestic partner)	299 (94.3%)	236 (95.6%)
Heterosexual or straight	305 (96.2%)	237 (96.0%)
<i>Medical history</i>		
No pre-existing conditions	85 (26.8%)	71 (28.7%)
Medical co-morbidities	98 (30.9%)	74 (30.0%)
Mental health co-morbidities	84 (26.5%)	60 (24.3%)
Tobacco, alcohol, and/or marijuana use	16 (5.0%)	7 (2.8%)
<i>Body mass index</i>		
Less than 25	142 (45.5%)	102 (42.1%)
25–30	93 (29.8%)	69 (28.5%)
30 or higher	77 (24.7%)	71 (29.3%)
Nulliparity	130 (41.0%)	101 (40.9%)
IVF pregnancy	32 (10.1%)	27 (10.9%)
<i>Antepartum complications</i>		
Gestational diabetes	23 (7.4%)	19 (7.9%)
Hypertensive disease of pregnancy	38 (12.3%)	32 (13.3%)
Oligo/polyhydramnios or PPRM	26 (8.4%)	18 (7.5%)
Other	34 (11.0%)	24 (10.0%)
Intrapartum complications	71 (22.6%)	51 (20.8%)
Gestational age at delivery (weeks; mean \pm SD)	38.6 \pm 2.82 (n = 314)	38.5 \pm 3.09 (n = 245)
<i>Pregnancy outcome</i>		
Live birth of an infant	310 (98.7%)	241 (98.4%)
Abortion	2 (0.6%)	2 (0.8%)
Miscarriage	1 (0.3%)	1 (0.4%)
Death of an infant > 20 weeks	1 (0.3%)	1 (0.4%)
NICU admission	40 (12.6%)	29 (11.7%)

Table 1 (continued)

Characteristics	All participants	COVID+ Subgroup
Infant "roomed in" after delivery	268 (84.5%)	208 (84.2%)
Hospitalized at enrollment	7 (2.2%)	7 (2.8%)
Quarantined at enrollment	193 (60.9%)	165 (66.8%)

Table 2 Prevalence of peripartum depressive and anxiety symptoms across the antepartum and postpartum periods. GA=gestational age

	24 week GA	34 week GA	6–8 weeks postpartum	6 months postpartum	P-value
<i>EPDS score: mean, SD (n)</i>					
All participants	7.06 ± 4.73 (174)	7.24 ± 4.89 (301)	5.79 ± 5.01 (310)	7.45 ± 5.11 (243)	< 0.0001
COVID + subgroup	6.82 ± 4.92 (130)	6.95 ± 4.84 (235)	5.55 ± 4.96 (241)	7.29 ± 5.16 (189)	< 0.0001
<i>EPDS score: median (range)</i>					
All participants	7 (0.0–20)	7 (0.0–21)	5 (0.0–25)	6 (0.0–25)	--
COVID + subgroup	6.5 (0.0–20)	6 (0.0–20)	5 (0.0–25)	7 (0.0–20)	--
<i>Symptomatic Depression: n (%)</i>					
All participants	21 (12.1%)	44 (14.6%)	32 (10.3%)	50 (20.6%)	0.0026
COVID + subgroup	13 (10.0%)	32 (13.6%)	20 (8.3%)	37 (19.6%)	0.0009
<i>GAD-7 score: mean, SD (n)</i>					
All participants	4.63 ± 4.03 (174)	5.07 ± 4.49 (298)	3.93 ± 4.44 (309)	5.16 ± 5 (243)	< 0.0001
COVID + subgroup	4.59 ± 4.2 (130)	4.97 ± 4.63 (233)	3.66 ± 4.33 (240)	5.06 ± 5.07 (189)	< 0.0001
<i>GAD-7 score: median (range)</i>					
All participants	4 (0.0–19)	4 (0.0–21)	3 (0.0–21)	4 (0.0–21)	--
COVID + subgroup	4 (0.0–19)	4 (0.0–21)	2 (0.0–21)	4 (0.0–21)	--
<i>GAD score ≥ 10: n (%)</i>					
All participants	22 (12.6%)	45 (15.1%)	31 (10.0%)	42 (17.3%)	0.014
COVID + subgroup	17 (13.1%)	36 (15.5%)	22 (9.2%)	33 (17.5%)	0.0056
<i>Comorbid depression/anxiety: n (%)</i>					
All participants	28 (16.1%)	62 (20.6%)	42 (13.5%)	64 (26.3%)	< 0.0001
COVID + subgroup	19 (14.6%)	45 (19.1%)	29 (12.0%)	49 (25.9%)	< 0.0001

**Fig. 2** Summary of key study results: COVID-19 positivity rate among study participants, prevalence of a prior history of depression and anxiety, prevalence of symptomatic depression and anxiety throughout the perinatal period, and the relationship between anxiety and quarantine practices

EPDS and GAD-7 scores was lowest at 6-8weeks postpartum and highest at 6months postpartum (Table 2). The prevalence of elevated depression symptoms during the antepartum period was 12.1% (95% CI: 7.6–17.9%) at 24 weeks gestational age and 14.6% (95% CI: 10.8–19.1%)

at 34 weeks. Rate of elevated depression symptoms was lower (10.3%, 95% CI: 7.2–14.3%) at 6-8weeks postpartum, and increased (20.6%, 95% CI: 15.7–26.2%) by 6 months postpartum (Fig. 2). For elevated anxiety symptoms during the antepartum period, the prevalence

was 12.6% (95% CI: 8.1–18.5%) at 24 weeks and 15.1% (95% CI: 11.2–19.7%) at 34 weeks. Similarly, the rate of elevated anxiety symptoms was lower (10.0%, 95% CI: 6.9–13.9%) at 6–8 weeks postpartum and rose again to 17.3% (95% CI: 12.7–22.6%) by 6 months postpartum (Fig. 2). At 24 weeks, 16.1% (95% CI: 11.0–22.4%) of the cohort met criteria for both elevated depression and anxiety symptoms. 20.6% of participants had comorbid (past medical history of) depression and/or anxiety (95% CI: 16.2–25.6%) at 34 weeks, 13.5% (95% CI: 9.9–17.9%) at 6–8 weeks postpartum, and 26.3% (95% CI: 20.9–32.3%) at 6 months postpartum.

The results of univariable logistic regression analyses examining the association of demographic and clinical factors with elevated depression symptoms are presented in Supplemental Table 1A. A prior history of depression and/or anxiety, as well as higher EPDS and GAD-7 scores at enrollment were significantly associated with elevated depression symptoms at 34 weeks gestation, 6–8 weeks postpartum, and 6 months postpartum. At 6–8 weeks postpartum, increasing age was protective for elevated depression symptoms (OR 0.92, 95% CI 0.85–0.99, $P=0.021$). In the multiple logistic regression analyses (Supplemental Table 2A), prior history of depression and/or anxiety was associated with increased odds of elevated depression symptoms at 34 weeks' gestation (OR 6.8, 95% CI 2.9–15.7, $P<0.0001$), 6–8 weeks postpartum (OR 8.5, 95% CI 3.1–23.1, $P<0.0001$), and 6 months postpartum (OR 2.4, 95% CI 1.1–5.2, $P=0.03$). Higher GAD-7 score at enrollment was associated with increased odds of elevated depression symptoms at 34 weeks (OR 1.4, 95% CI 1.14–1.7, $P=0.001$) and at 6–8 weeks postpartum (OR 1.2, 95% CI 1.0–1.4, $P=0.026$), but not at 6 months postpartum. Higher EPDS score at enrollment was significantly associated with 1.6-fold increased odds of elevated depression symptoms only at 34 weeks' gestation (OR 1.6, 95% CI 1.2–2.1, $P=0.002$). At 34 weeks' gestation, hypertensive disease of pregnancy (OR 3.2, 95% CI 1.1–8.9, $P=0.028$) and "Other" antepartum complications (OR 3.5, 95% CI 1.1–11.0, $P=0.034$) were both associated with approximately three-fold increased odds of elevated depression symptoms.

Similar univariate logistic regression analyses were conducted for peripartum anxiety. The findings are summarized in Supplemental Table 1B. Elevated anxiety symptoms at 34 weeks' gestation and postpartum time points was associated with a prior history of depression and/or anxiety and higher enrollment EPDS and GAD-7 scores. Antepartum complications ($P=0.003$) predicted elevated anxiety symptoms at 34 weeks. Hispanic/Latinx identity was significantly associated with elevated anxiety symptoms at 6–8 weeks postpartum (OR 2.6, 95% CI 1.2–5.9, $P=0.019$). Both employment status ($P=0.034$) and annual income ($P=0.043$) were associated with

increased odds of elevated anxiety symptoms at 6 months postpartum. For the multivariate analyses (Supplemental Table 2B), prior history of depression and/or anxiety was associated with increased odds of elevated anxiety symptoms at 34 weeks' gestation (OR 4.0, 95% CI 1.9–8.6, $P=0.0003$), 6–8 weeks postpartum (OR 10.4, 95% CI 3.5–31.0, $P<0.0001$), and 6 months postpartum (OR 3.7, 95% CI 1.6–8.8, $P=0.002$). Higher GAD-7 at enrollment was also associated with increased odds of elevated anxiety symptoms at all time points (at 34 weeks' gestation: OR 1.8, 95% CI 1.3–2.3, $P<0.0001$; at 6–8 weeks postpartum: OR 1.3, 95% CI 1.0–1.6, $P=0.018$; and at 6 months postpartum: OR 1.5, 95% CI 1.1–1.9, $P=0.005$). Higher EPDS score at enrollment was significantly associated with increased odds of elevated anxiety symptoms at 34 weeks' gestation (OR 1.5, 95% CI 1.2–1.9, $P<0.0001$) and 6 months postpartum (OR 1.3, 95% CI 1.0–1.6, $P=0.024$), but not at 6–8 weeks postpartum. Additionally at 34 weeks' gestation, antepartum complications of gestational diabetes (OR 4.0, 95% CI 1.3–12.7, $P=0.019$), hypertensive disease of pregnancy (OR 3.2, 95% CI 1.1–9.0, $P=0.028$) and "Other" antepartum complications (OR 3.7, 95% CI 1.3–10.6, $P=0.014$) were associated with approximately 3–4 fold increased odds of elevated anxiety symptoms.

Pandemic-specific factors such as COVID positive status, hospitalization, observation of quarantine did not predict elevated depression symptoms in the univariate (Supplemental Table 1A) or multivariate (Supplemental Table 2A) analyses. Interestingly, quarantine for COVID at present was associated with significantly increased odds of elevated anxiety symptoms at 34 weeks gestation in both the univariate analysis (OR 2.5, 95% CI 1.1–5.6, $P=0.027$) and the multivariate analysis (OR 2.7, 95% CI 1.0–7.1, $P=0.040$). At 6–8 weeks postpartum, the association between anxiety and quarantine practices were not significant in the univariate analysis. However, multivariate analyses adjusting for maternal demographic variables, elevated anxiety symptoms was predicted by both quarantine at enrollment (OR 3.1, 95% CI 1.1–8.7, $P=0.04$) and quarantine at present (OR 3.5, 95% CI 1.1–10.1 $P=0.03$) at 6–8 weeks postpartum.

Discussion

Clinical implications

Elevated depression and anxiety symptoms were prevalent throughout pregnancy and postpartum during the COVID-19 pandemic, irrespective of patient SARS-CoV-2 status. Participants who had a history of depression and/or anxiety, as well as those with higher baseline EPDS and GAD-7 scores, were more susceptible to elevated depression and anxiety symptoms during pregnancy and postpartum. Participants who quarantined during pregnancy had higher odds of

elevated anxiety symptoms antepartum but not postpartum. On the other hand, those who quarantined during pregnancy did not have increased prevalence of depression. Interestingly, unlike findings in the general population, our participants who tested positive for COVID-19 during pregnancy or were hospitalized during their pregnancy were not more likely to report elevated depression and anxiety symptoms, though our analyses may be underpowered [28]. We describe the prevalence of elevated depression and anxiety symptoms among pregnant patients throughout the peripartum period, including those with confirmed SARS-CoV-2 infections, and identify risk factors associated with peripartum depression and anxiety during the COVID-19 pandemic.

In our study, the prevalence of elevated depression and anxiety symptoms across the peripartum period ranged between 10% and 20%. This is comparable to pre-pandemic rates of peripartum depression and anxiety based on meta-analyses [7, 8]; but lower than published rates of peripartum depression and anxiety during the COVID-19 pandemic [29]. The difference may be partially attributable to differences in EPDS cut-offs for clinical significance. Wu et al. reported 29.6% prevalence of peripartum depression as defined by EPDS score ≥ 10 , but subgroup analysis showed 13.9% had EPDS score ≥ 13 , which was aligned with our findings. Nevertheless, in a meta-analysis of eight studies by Hessami et al., the overall mean EPDS score during the pandemic was 9.84, and in our cohort the mean EPDS score was between 5.79 at 6–8 weeks postpartum and 7.45 at 6 months postpartum, lower than those reported in the meta-analysis [18, 20]. With regards to anxiety, pooled prevalence for perinatal anxiety across four studies was 50% in a meta-analysis by Shorey et al., noting high heterogeneity between studies [21]. Our cohort may have lower reported rates of elevated depression and anxiety symptoms compared to Hessami et al. and Shorey et al. because we looked prospectively at the prevalence of depression or anxiety symptoms at specific antepartum and postpartum timepoints, not just at any point during the peripartum period. Our cohort includes participants enrolled between March and October 2020, while Hessami et al. looked at participants in February 2020. It is possible that participants enrolled later in the pandemic may have lower rates of depression and anxiety symptoms, than those at the beginning of the pandemic. In the general population, mental health conditions such as depression and anxiety did decrease as the pandemic progressed [30–33]. Since our cohort included participants enrolled at later time points compared to Hessami et al. it is expected that we would have lower rates of reported depression and anxiety symptoms.

Our study found that the prevalence of both elevated depression and anxiety symptoms increased with

gestational age during pregnancy, decreased at 6–8 weeks postpartum, and peaked by 6 months postpartum. In a meta-analysis published pre-pandemic, depression was more prevalent as pregnancy continued, finding that the average prevalence of depression in the first trimester of pregnancy was 7.4% and increased to 12.0–12.8% by the second or third trimester [34].

Research implications

Given the impact of depression and anxiety on maternal and neonatal health outcomes, it is imperative for clinicians to identify which pregnant patients are at highest risk for developing depression and anxiety during the COVID-19 pandemic. Our study found that participants at the highest risk for depression and anxiety symptoms during the COVID-19 pandemic included those with a prior history of depression and/or anxiety, observing quarantine, or of Hispanic/Latinx identity. In our cohort, those with prior depression and/or anxiety or those with higher baseline EPDS and GAD-7 scores were more likely to have elevated depression and anxiety symptoms at all antepartum and postpartum timepoints. Prior depression and/or anxiety are well-known risk factors for major depressive disorder with peripartum onset, and the COVID-19 pandemic may contribute further to peripartum depression and anxiety. Moyer et al. found that pregnant individuals with a history of depression or anxiety pre-pandemic were most likely to experience the largest increases in anxiety during the COVID-19 pandemic [35]. This finding is also seen in the general population. Numerous studies have shown that in the general population, those with pre-existing mental health conditions similarly reported higher rates of depression or anxiety during the COVID-19 pandemic [32, 36–38]. Furthermore, our participants who quarantined during pregnancy had higher rates of elevated anxiety symptoms, but not depression, in the antepartum period. Pregnant patients who felt feelings of isolation had increased rates of symptomatic depression and anxiety and those with better perceived social support actually had lower rates of depression and anxiety [39]. Sommerland et al. found that in 71,117 UK-dwelling participants, those with daily face-to-face or phone/video contact were less likely to report depressive symptoms compared to participants with little social contact, yet this is a non-pregnant population, unlike our study [36]. Our study findings emphasize that in pregnant people with known or suspected COVID-19 pre-existing mental health conditions and/or social isolation are important risk factors for development elevated depression and anxiety symptoms throughout the peripartum course during the pre-vaccine COVID-19 pandemic. The impact on telehealth during COVID-19 should be explored and how this could modify maternal health and/or attenuate risk factors. Thus, it is imperative

for health care providers to ask about mental health history in the obstetrics space to identify those at greatest risk for peripartum depression and anxiety.

In our cohort, Hispanic or Latina identity was significantly associated with increased likelihood of elevated anxiety symptoms at 6–8 weeks postpartum. Birthing persons of color have higher rates of postpartum mental health conditions, but are often under screened and under counseled, compared to White persons [40, 41]. Specifically, in a study by Declercq et al., only 18.3% of Latina participants with prenatal depressive symptoms were counseled prenatally on postpartum depression compared to 43.4% of White participants [41]. With racial/ethnic inequities related to mental health screening and access to mental health services among birthing people, our study emphasizes the necessity to screen and counsel all participants for anxiety in antepartum and postpartum period.

Strength and limitations

Our study does have limitations. We defined elevated depression and anxiety symptoms using EPDS and GAD-7 cut-off scores, not provider-validated clinical diagnoses. EPDS and GAD-7 are validated screening tools frequently used to screen for depression and anxiety in both the research and clinical settings. Past validation studies estimate the sensitivity of EPDS ranging between 65 and 100% and specificity between 49 and 100% [42] and estimate the GAD-7 as having a sensitivity of 89% and specificity of 82% [43]. Although EPDS and GAD-7 are validated screening tools for depression or anxiety, especially for research purposes, they are not diagnostic and thus we may not have accurately identified all participants with clinically significant anxiety/depression in our study. EPDS and GAD-7 do not directly investigate pregnancy-related depression and anxiety. Pregnancy-specific anxiety is a better predictor of poorer birth outcomes compared to general anxiety [21]. Understanding how concerns surrounding childbirth, infant health, and parenting concerns during the COVID-19 pandemic and how they contribute to anxiety and depression experienced during the peripartum period need further exploration, particularly if they impact maternal/neonatal birthing outcomes. We also had challenges establishing a baseline mental health assessment, as participants did not complete the EPDS and GAD-7 pre-pandemic. As such were unable to investigate precisely how the COVID-19 pandemic, including length of hospitalization and visitor policies directly impacted our participants' mental health. Our study was also limited by the fact that we did not consider how treatment with antidepressants, anxiolytics, and/or psychotherapy may change participants EPDS or GAD-7 scores. Participants treated with antidepressants and anxiolytics possibly have lower EPDS

and GAD-7 and as such, might not have been categorized into “symptomatic” depression or anxiety subgroups. Going forward, we hope to gather this information for future studies.

Conclusions

Elevated depressive and anxiety symptoms were prevalent throughout pregnancy and the postpartum period, particularly in those with a prior history of depression and/or anxiety. Having COVID-19 did not increase one's risk for elevated depression/anxiety symptoms. Instead, individuals who quarantined during pregnancy were more likely to experience antepartum anxiety. Our study findings emphasize that in pregnant people with known or suspected COVID-19 pre-existing mental health conditions and/or social isolation are important risk factors for development elevated depression and anxiety symptoms throughout the peripartum course during the pre-vaccine COVID-19 pandemic. Thus, strategies that identify social isolation may mitigate potential adverse consequences for pregnant people, and continued vigilance in recognition of depression and anxiety in pregnancy is imperative.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12884-024-06518-8>.

Supplementary Table 1A

Supplementary Table 1B

Supplementary Table 2A

Supplementary Table 2B

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Author contributions

MA and LX performed data collection, data interpretation, and were major contributors in manuscript writing. YA played a significant role in study design, statistical analyses, and manuscript writing. IA, WJB, SG, VF, VJ, MR, and DK analyzed and interpreted patient data and performed significant manuscript revision. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All study protocols were performed in accordance with the guidelines of the Declaration of Helsinki. Ethical approval was obtained by the University of California, San Francisco (UCSF) and the University of California, Los Angeles (UCLA) Institutional Review Boards (IRB) (UCSF IRB# 20-30410, UCLA IRB# 20-000579). Informed consent was obtained from each individual participant in accordance with study protocols approved by the University of California, San Francisco and the University of California, Los Angeles Institutional Review Boards (UCSF IRB# 20-30410, UCLA IRB# 20-000579).

Consent for publication

not applicable.

Competing interests

The authors declare no competing interests.

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References

- Galea S, Merchant RM, Lurie N. The Mental Health consequences of COVID-19 and physical distancing: the need for Prevention and early intervention. *JAMA Intern Med*. 2020;180(6):817–8. <https://doi.org/10.1001/jamainternmed.2020.1562>.
- Hawryluck L, Gold WL, Robinson S, Pogorski S, Galea S, Styrar R. Psychological Effects of Quarantine for SARS. 10, 2004.
- Wu KK, Chan SK, Ma TM. Posttraumatic stress, anxiety, and depression in survivors of severe acute respiratory syndrome (SARS). *J Trauma Stress*. 2005;18(1):39–42. <https://doi.org/10.1002/jts.20004>.
- Brooks SK, Weston D, Greenberg N. Psychological impact of infectious disease outbreaks on pregnant women: rapid evidence review. *Public Health*. 2020;189:26–36. <https://doi.org/10.1016/j.puhe.2020.09.006>.
- Burt VK, Stein K. Epidemiology of depression throughout the female life cycle. *J Clin Psychiatry*. 2002;63(Suppl 7):9–15.
- Depression and Other Common Mental Disorders: Global Health Estimates. 2017.
- Woody CA, Ferrari AJ, Siskind DJ, Whiteford HA, Harris MG. A systematic review and meta-regression of the prevalence and incidence of perinatal depression. *J Affect Disord*. 2017;219:86–92. <https://doi.org/10.1016/j.jad.2017.05.003>.
- Dennis C-L, Falah-Hassani K, Shiri R. Prevalence of antenatal and postnatal anxiety: systematic review and meta-analysis. *Br J Psychiatry*. 2017;210(5):315–23. <https://doi.org/10.1192/bjp.bp.116.187179>.
- Falah-Hassani K, Shiri R, Dennis C-L. The prevalence of antenatal and postnatal co-morbid anxiety and depression: a meta-analysis. *Psychol Med*. 2017;47(12):2041–53. <https://doi.org/10.1017/S0033291717000617>.
- Grigoriadis S, Graves L, Peer M, et al. Maternal anxiety during pregnancy and the Association with adverse perinatal outcomes: systematic review and Meta-analysis. *J Clin Psychiatry*. 2018;79(5). <https://doi.org/10.4088/JCP.17r12011>.
- Stein A, Pearson RM, Goodman SH, et al. Effects of perinatal mental disorders on the fetus and child. *Lancet* (London England). 2014;384(9956):1800–19. [https://doi.org/10.1016/S0140-6736\(14\)61277-0](https://doi.org/10.1016/S0140-6736(14)61277-0).
- Glover V. Prenatal stress and its effects on the fetus and the child: possible underlying biological mechanisms. *Adv Neurobiol*. 2015;10:269–83. https://doi.org/10.1007/978-1-4939-1372-5_13.
- Rogers A, Obst S, Teague SJ, et al. Association between maternal perinatal depression and anxiety and child and adolescent development: a Meta-analysis. *JAMA Pediatr*. 2020;174(11):1082–92. <https://doi.org/10.1001/jamapediatrics.2020.2910>.
- Preis H, Mahaffey B, Pati S, Heiselman C, Lobel M. Adverse perinatal outcomes predicted by prenatal maternal stress among U.S. women at the COVID-19 pandemic onset. *Ann Behav Med*. 2021;55(3):179–91. <https://doi.org/10.1093/abm/kaab005>.
- Sade S, Sheiner E, Wainstock T, et al. Risk for depressive symptoms among hospitalized women in high-risk pregnancy units during the COVID-19 pandemic. *J Clin Med*. 2020;9(8). <https://doi.org/10.3390/jcm9082449>.
- Pariante G, Wissotzky Broder O, Sheiner E, et al. Risk for probable postpartum depression among women during the COVID-19 pandemic. *Arch Womens Ment Health*. 2020;23(6):767–73. <https://doi.org/10.1007/s00737-020-01075-3>.
- Zanardo V, Manghina V, Giliberti L, Vettore M, Severino L, Straface G. Psychological impact of COVID-19 quarantine measures in northeastern Italy on mothers in the immediate postpartum period. *Int J Gynaecol Obstet*. 2020;150(2):184–8. <https://doi.org/10.1002/ijgo.13249>.
- Wu Y, Zhang C, Liu H, et al. Perinatal depressive and anxiety symptoms of pregnant women during the coronavirus disease 2019 outbreak in China. *Am J Obstet Gynecol*. 2020;223(2):240e. 1–240.e9.
- Suzuki S. Psychological status of postpartum women under the COVID-19 pandemic in Japan. *J Matern Neonatal Med off J Eur Assoc Perinat Med Fed Asia Ocean Perinat Soc Int Soc Perinat Obstet* May 2020:1–3. <https://doi.org/10.1080/14767058.2020.1763949>.
- Hessami K, Romanelli C, Chirrazzi M, Cozzolino M. COVID-19 pandemic and maternal mental health: a systematic review and meta-analysis. *J Matern Neonatal Med off J Eur Assoc Perinat Med Fed Asia Ocean Perinat Soc Int Soc Perinat Obstet* November 2020:1–8. <https://doi.org/10.1080/14767058.2020.1843155>.
- Shorey SY, Ng ED, Chee CYI. Anxiety and depressive symptoms of women in the perinatal period during the COVID-19 pandemic: a systematic review and meta-analysis. *Scand J Public Health*. 2021;49(7):730–40. <https://doi.org/10.1177/14034948211011793>.
- Kotabagi P, Nauta M, Fortune L, Yoong W. COVID-19 positive mothers are not more anxious or depressed than non COVID pregnant women during the pandemic: a pilot case-control comparison. *Eur J Obstet Gynecol Reprod Biol*. 2020;252:615–6. <https://doi.org/10.1016/j.ejogrb.2020.07.037>.
- Afshar Y, Gaw SL, Flaherman VJ, et al. Clinical presentation of Coronavirus Disease 2019 (COVID-19) in pregnant and recently pregnant people. *Obstet Gynecol*. 2020;136(6):1117–25. <https://doi.org/10.1097/AOG.0000000000004178>.
- Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression. Development of the 10-item Edinburgh postnatal depression scale. *Br J Psychiatry*. 1987;150:782–6. <https://doi.org/10.1192/bjp.150.6.782>.
- Murray D, Cox JL. Screening for depression during pregnancy with the Edinburgh depression scale (EDDS). *J Reprod Infant Psychol*. 1990;8(2):99–107. <https://doi.org/10.1080/02646839008403615>.
- Spitzer RL, Kroenke K, Williams JBW, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med*. 2006;166(10):1092–7. <https://doi.org/10.1001/ARCHINTE.166.10.1092>.
- Simpson W, Glazer M, Michalski N, Steiner M, Frey BN. Comparative efficacy of the generalized anxiety disorder 7-item scale and the Edinburgh postnatal depression scale as screening tools for generalized anxiety disorder in pregnancy and the postpartum period. *Can J Psychiatry*. 2014;59(8):434–40. <https://doi.org/10.1177/070674371405900806>.
- Xie Y, Xu E, Al-Aly Z. Risks of mental health outcomes in people with covid-19: cohort study. *BMJ*. 2022;376:e068993. <https://doi.org/10.1136/bmj-2021-068993>.

29. Preis H, Mahaffey B, Heiselman C, Lobel M. Pandemic-related pregnancy stress and anxiety among women pregnant during the coronavirus disease 2019 pandemic. *Am J Obstet Gynecol MFM*. 2020;2(3):100155. <https://doi.org/10.1016/j.ajogmf.2020.100155>.
30. Wang C, Pan R, Wan X, et al. A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain Behav Immun*. 2020;87:40–8. <https://doi.org/10.1016/j.bbi.2020.04.028>.
31. Hyland P, Shevlin M, Murphy J, et al. A longitudinal assessment of depression and anxiety in the Republic of Ireland before and during the COVID-19 pandemic. *Psychiatry Res*. 2021;300:113905. <https://doi.org/10.1016/j.psychres.2021.113905>.
32. Fancourt D, Steptoe A, Bu F. Trajectories of depression and anxiety during enforced isolation due to COVID-19: longitudinal analyses of 59,318 adults in the UK with and without diagnosed mental illness. *medRxiv* January. 2020. 2020.06.03.20120923.
33. Robinson E, Sutin AR, Daly M, Jones A. A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic. *medRxiv* January 2021:2021.03.04.21252921. <https://doi.org/10.1101/2021.03.04.21252921>.
34. Bennett HA, Einarson A, Taddio A, Koren G, Einarson TR. Prevalence of depression during pregnancy: systematic review. *Obstet Gynecol*. 2004;103(4):698–709. <https://doi.org/10.1097/01.AOG.0000116689.75396.5f>.
35. Moyer CA, Compton SD, Kaselitz E, Muzik M. Pregnancy-related anxiety during COVID-19: a nationwide survey of 2740 pregnant women. *Arch Womens Ment Health*. 2020;23(6):757–65. <https://doi.org/10.1007/s00737-020-01073-5>.
36. Sommerlad A, Marston L, Huntley J et al. Social relationships and depression during the COVID-19 lockdown: longitudinal analysis of the COVID-19 Social Study. *Psychol Med* January 2021:1–10. <https://doi.org/10.1017/S0033291721000039>.
37. Kwong ASF, Pearson RM, Adams MJ et al. Mental health before and during the COVID-19 pandemic in two longitudinal UK population cohorts. *Br J Psychiatry* November 2020:1–10. <https://doi.org/10.1192/bjp.2020.242>.
38. Généréux M, Schluter PJ, Landaverde E, et al. The evolution in anxiety and depression with the progression of the pandemic in adult populations from eight countries and four continents. *Int J Environ Res Public Health*. 2021;18(9). <https://doi.org/10.3390/ijerph18094845>.
39. Lebel C, MacKinnon A, Bagshawe M, Tomfohr-Madsen L, Giesbrecht G. Corrigendum to elevated depression and anxiety symptoms among pregnant individuals during the COVID-19 pandemic *Journal of affective disorders* 277 (2020) 5–13. *J Affect Disord*. 2021;279:377–379. <https://doi.org/10.1016/j.jad.2020.10.012>.
40. Pao C, Guintivano J, Santos H, Meltzer-Brody S. Postpartum depression and social support in a racially and ethnically diverse population of women. *Arch Womens Ment Health*. 2019;22(1):105–14. <https://doi.org/10.1007/s00737-018-0882-6>.
41. Declercq E, Feinberg E, Belanoff C. Racial inequities in the course of treating perinatal mental health challenges: results from listening to mothers in California. *Birth* August. 2021. <https://doi.org/10.1111/birt.12584>.
42. Eberhard-Gran M, Eskild A, Tambs K, Opjordsmoen S, Samuelsen SO. Review of validation studies of the Edinburgh postnatal depression scale. *Acta Psychiatr Scand*. 2001;104(4):243–9. <https://doi.org/10.1034/j.1600-0447.2001.00187.x>.
43. Löwe B, Decker O, Müller S, et al. Validation and standardization of the generalized anxiety disorder screener (GAD-7) in the general population. *Med Care*. 2008;46(3):266–74. <https://doi.org/10.1097/MLR.0b013e318160d093>.

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