



# Pregnancy-related anxiety during COVID-19: a nationwide survey of 2740 pregnant women

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## Abstract

The aim of this study is to explore the impact of the COVID-19 pandemic on pregnant women's anxiety and identify factors most strongly associated with greater changes in anxiety. An anonymous, online, survey of pregnant women (distributed April 3–24, 2020) included a modified pregnancy-related anxiety scale (PRAS) reflecting respondents' perception of pregnancy anxiety before COVID-19 and a current assessment of pregnancy-related anxiety. The difference between these scores was used as the outcome variable. Data were analyzed using bivariate and multivariate linear regression analyses. Two thousand seven hundred forty pregnant women from 47 states completed the survey. 25.8% ( $N = 706$ ) stopped in-person visits, 15.2% used video visits ( $N = 415$ ), and 31.8% ( $N = 817$ ) used phone visits for prenatal care as a result of COVID-19. Those planning a hospital birth dropped from 2641 (96.4%) to 2400 (87.7%) following COVID-19. More than half of women reported increased stress about food running out (59.2%,  $N = 1622$ ), losing a job or household income (63.7%,  $N = 1745$ ), or loss of childcare (56.3%,  $N = 1543$ ). More than a third reported increasing stress about conflict between household members (37.5%,  $N = 1028$ ), and 93% ( $N = 2556$ ) reported increased stress about getting infected with COVID-19. Slightly less than half of respondents (either selves or family members) were healthcare workers (41.4%,  $N = 1133$ ) or worked in essential services (45.5%,  $N = 1246$ ). In multivariate analysis, those reporting higher agreement with COVID-19-related stressors had greater changes in pre- to post-COVID-19 pregnancy-related anxiety. The COVID-19 pandemic is profoundly affecting pregnant women's mental health, and factors independent of pregnancy appear to be driving changes in pregnancy-specific anxiety.

**Keywords** Perinatal anxiety · Perinatal mental health · Maternal mental health · Pregnancy

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## Condensation

An online survey of nearly 3000 pregnant women in April 2020 finds high levels of pregnancy-related anxiety, driven in large part by COVID-19-related fears.

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## Introduction

Researchers have been racing to understand the impact of SARS-CoV-2 and the disease it causes, COVID-19, on the pregnant woman and fetus. Early publications focus on understanding incidence and severity during pregnancy, based on limited COVID-19 data and data from other coronaviruses (Rasmussen et al. 2020). In a recent study conducted in New York City, the authors reported that pregnant women were not at an elevated risk for severe disease (Schwartz 2020), and the majority of pregnant women who tested positive for COVID-19 in the same city were asymptomatic (Breslin et al. 2020). Thus hospital systems are dealing with the potential of asymptomatic pregnant women spreading SARS-CoV-2 and the resulting disease of COVID-19 to healthcare providers, other women, and support people during labor. Some institutions are conducting universal testing (Sutton et al. 2020) or have instituted strict policies regarding labor companions. Two hospitals in New York, including New York Presbyterian (NYP), banned all birthing partners for a time (Caron and Van Syckle 2020). Although some of those

restrictions were lifted for the time during labor, visitors were not permitted in postpartum wards (NYP 2020). Such a rapidly changing context and the high degree of uncertainty surrounding what women might face during the birth process may lead to increased anxiety among pregnant women about their labor and delivery, a time of already increased stress.

The impact of the COVID-19 pandemic on pregnancy-related anxiety has yet to be systematically studied. Saccone et al. (2020) published a small study of 100 pregnant women in Italy, in which more than half rated the psychological impact of COVID-19 as severe, and two-thirds were more anxious than normal (Saccone et al. 2020). However, the study design did not include a deeper exploration of what aspects of the COVID-19 outbreak were driving increased anxiety. A study in China which explored the risk and protective factors for COVID-19-related anxiety in the general population (Wang et al. 2020) did not evaluate specific pregnancy-related concerns.

This research was designed to explore the impact of the COVID-19 pandemic on pregnant women's anxiety, as well as to identify the factors that were most strongly associated with a greater increase in anxiety.

## Materials and methods

### Study design

TA cross-sectional study of pregnant women conducted anonymously via a survey distributed on Facebook, Twitter, and pregnancy-related peer and professional communities from April 3–24, 2020.

### Setting

English-language online survey open to any pregnant woman, regardless of geographic location.

### Participants

Self-identified pregnant women able to complete an online survey in English, recruited via Facebook and Twitter, including pregnancy-specific Facebook groups and snowball sampling among pregnant respondents. The survey link was also shared with pregnancy-specific professional communities for distribution through their networks of pregnant women. We sought additional gatekeepers in rural, urban, minority, and low-income populations, asking them to circulate the survey link within their networks.

### Data sources/measurement

The survey was developed using an iterative process with expert review, including previously used demographic and health

questions and a modification of the pregnancy-related anxiety scale (PRAS) (Rini et al. 1999). The survey was formatted for use in Qualtrics© and assessed demographic and pregnancy-related factors, anxiety, and psychosocial risk factors.

### Demographic and pregnancy-related measures

The survey included basic demographic questions, pregnancy-related background questions, and questions regarding the impact of COVID-19 on utilization of prenatal care and intentions for delivery location (see Table 1).

### Anxiety measures

>Anxiety was measured in several ways. First, we used a 10-point visual analog scale (VAS) to assess anxiety about being pregnant during the COVID-19 pandemic (Williams et al. 2010), with 1 being not at all anxious and 10 being extremely anxious. We used another 10-point VAS to assess anxiety about giving birth during the COVID-19 pandemic. We also used a modified version of the PRAS (Rini et al. 1999), asking women to think back before COVID-19 and then repeating the questions given the current climate (see Appendix Table 4). This created two PRAS scores: retrospective perceptions of anxiety prior to COVID-19 (referred to as “perceptions pre-COVID”) and perceptions of current pregnancy-related anxiety (referred to as “current PRAS”). The difference between these two scores was our outcome variable, as described below.

### Psychosocial risk factor measures

Five questions assessed psychosocial factors that may contribute to COVID-specific anxiety, including concerns about (1) food running out or being unavailable; (2) losing a job or decrease in family income; (3) loss of childcare/taking care of children at home; (4) tension/conflict between household members; and (5) self, baby, or family getting infected with COVID-19. Each was assessed via Likert scale, from strongly disagree (1) to strongly agree (5). A final question assessed whether the respondent or a family member works in healthcare with potential exposure to COVID-19 patients, whether the respondent or a family member works in essential services that require leaving home, whether the respondent lives in a state with ‘shelter in place’ orders, whether the respondent has been practicing social distancing, and whether she lives in a community or city with a high number of COVID-19 cases.

### Outcome variable

We utilized the net change in PRAS score (current PRAS – perceptions pre-COVID) as our outcome variable. Both the perceptions pre-COVID and current PRAS scores were calculated by reverse scoring the 4 positively worded items within

**Table 1** Demographics and pregnancy-related measures of 2740 pregnant women, regressed against change in pregnancy-related anxiety scale (PRAS) before and after COVID-19

Variable	Overall mean (95% CI)	$\beta$ (95% CI); <i>p</i> value
Maternal age (years) ( <i>N</i> = 2720)	32.7 (32.5, 32.8)	-0.10 (-0.13, -0.07); <0.001***
Number of previous pregnancies	1.7 (1.6, 1.7)	-0.03 (-0.11, 0.06); 0.554
Number of prenatal care visits this pregnancy	6.5 (6.3, 6.6)	0.03 (-0.001, 0.05); 0.065
	<i>N</i> (%)	
Region of residence ( <i>N</i> = 2695)		
Northeast	536 (19.9)	0.06 (-0.25, 0.37); 0.707
Midwest	1159 (43.0)	-0.15 (-0.40, 0.10); 0.240
South	619 (22.9)	0.21 (-0.08, 0.50); 0.159
West	381 (14.1)	-0.08 (-0.44, 0.27); 0.644
Area of residence ( <i>N</i> = 2736)		
Urban	725 (26.5)	0.12 (-0.15, 0.40); 0.385
Peri-urban	1559 (56.9)	-0.19 (-0.44, 0.05); 0.119
Rural	452 (16.5)	0.16 (-0.17, 0.49); 0.333
Education ( <i>N</i> = 2740)		
High school graduate or less	176 (6.4)	0.45 (-0.07, 0.97); 0.088
College graduate or less	1182 (43.1)	REF
Master's degree	701 (25.6)	-0.52 (-0.83, -0.22); 0.001***
Doctoral/professional degree	681 (24.9)	-0.48 (-0.78, -0.17); 0.002**
Caucasian race ( <i>N</i> = 2721)	2388 (87.7)	0.13 (-0.25, 0.50); 0.504
Married ( <i>N</i> = 2740)	2430 (88.7)	-0.82 (-1.20, -0.43); <0.001***
In 3rd trimester of pregnancy	1128 (41.2)	0.30 (0.05, 0.55); 0.018*
First pregnancy ( <i>N</i> = 2740)	429 (15.6)	0.19 (-0.15, 0.53); 0.268
Previous health conditions <sup>a</sup>	502 (18.4)	0.20 (-0.11, 0.52); 0.207
Previous depression/anxiety	982 (35.9)	0.39 (0.13, 0.64); 0.003**
Pregnancy health conditions <sup>b</sup>	526 (19.2)	0.29 (-0.02, 0.60); 0.071
Pregnancy-diagnosed depression/anxiety	154 (5.6)	1.26 (0.73, 1.80); <0.001***
Since COVID, stopped in-person PNC	706 (25.8)	0.54 (0.26, 0.82); <0.001***
Since COVID, used video for PNC	415 (15.2)	0.06 (-0.29, 0.40); 0.747
Since COVID, used phone for PNC	871 (31.8)	0.46 (0.20, 0.72); 0.001***
Before COVID, planned location of birth: ( <i>N</i> = 2739)		
Hospital	2641 (96.4)	0.97 (0.31, 1.63); 0.004**
Birth center outside a hospital	35 (1.3)	0.72 (-0.37, 1.81) 0.194
Home	39 (1.4)	-2.50 (-3.53, -1.47) <0.001***
Do not know	24 (0.9)	-0.85 (-2.16, 0.46); 0.203
Since COVID, planned location of birth: ( <i>N</i> = 2738)		
Hospital	2400 (87.7)	-0.99 (-1.36, -0.62); <0.001***
Birth center outside a hospital	41 (1.5)	0.40 (-0.60, 1.41); 0.431
Home	74 (2.7)	-1.24 (-1.99, -0.49); 0.001***
Do not know	223 (8.1)	1.74 (1.29, 2.18); <0.001***
Birth location moved away from hospital (including do not knows)	241 (8.8)	1.76 (1.32, 2.20); <0.001***

<sup>a</sup> Diagnosed prior to pregnancy with hypertension, heart disease, asthma, diabetes, cancer, autoimmune diseases, or HIV/AIDS

<sup>b</sup> During pregnancy, diagnosed with hypertension, preeclampsia, gestational diabetes, anemia, placenta previa

\**p* ≤ 0.05; \*\**p* ≤ 0.01; \*\*\**p* ≤ 0.001

the scale and then summing the 8 items, each with a range of 1–5 points. This yielded a possible range of 8–40 points, with

higher scores indicating a higher level of anxiety. The perceptions pre-COVID PRAS score was then subtracted from the

current PRAS score, creating a normally distributed range of values from  $-9$  to  $17$ .

## Predictor variables

Tables 1 and 2 illustrate the predictor variables. “Previous health conditions” reflected any of the following before pregnancy: high blood pressure, heart disease, asthma, diabetes, cancer, autoimmune diseases, or HIV/AIDS. “Previous depression/anxiety” was determined by the respondent indicating “yes” to the following question: “Before this pregnancy, had you been treated for depression or anxiety or other mental health issues?” The variable “pregnancy health conditions” was indicative of the respondent answering “yes” to any of the following: “Since becoming pregnant, have you been diagnosed with any of the following conditions? High blood pressure, preeclampsia, gestational diabetes, anemia, placenta previa, other diagnoses.” “Pregnancy-diagnosed depression/anxiety” was indicated if the respondent answered “yes” to the question, “Since becoming pregnant, have you been diagnosed with depression or anxiety?”

The variables “stopped in-person prenatal visits,” “used video visits for prenatal care,” and “used phone visits for prenatal care” were indicated by yes/no responses. The variables “food running out,” “losing a job,” “loss of childcare,” “tension/conflict in house,” and “getting infected” were determined from the percentage of respondents who either somewhat agreed or strongly agreed with statements about increased stress about each factor.

Risk factors for COVID were indicated by affirmative responses to self or family member being a healthcare worker with potential exposure to COVID+ patients, self or family member working in essential services that requires leaving home, living in a state with ‘shelter in place’ orders, practicing social distancing, and living in a community/city with a high number of COVID-19 cases.

The variables “anxiety about pregnancy” and “anxiety about delivery” during COVID were determined using the 10-point VAS described previously.

## Study size

There was no a priori sample size determined.

## Data analysis/statistical methods

All data were downloaded from Qualtrics and cleaned, removing records with more than 50% missing data. Basic descriptive statistics were calculated for all variables. As an internal validity check, the two anxiety questions assessed via visual analog scale were correlated with one another and with the difference in PRAS scores. Bivariate linear regression was conducted to compare how changes in PRAS scores were related to key variables of interest. Those variables found to be associated were used in multivariate linear regression to yield a final model. A  $p$  value of 0.05 was taken for statistical significance.

**Table 2** Anxiety measures and psychosocial risk factors related to COVID-19, regressed against change in self-reported pregnancy-related anxiety scale (PRAS) before and after COVID-19

Variable	Overall ( $N = 2740$ ) Mean (95% CI)	$\beta$ (95% CI); $p$ value
Anxiety about being pregnant during COVID <sup>a</sup>	6.5 (6.4, 6.6)	0.61 (0.56, 0.66); < 0.001***
Anxiety about giving birth during COVID <sup>a</sup>	7.6 (7.5, 7.6)	0.54 (0.49, 0.59); < 0.001***
Pre-COVID PRAS score	20.6 (20.5, 20.7)	–
Post-COVID PRAS score	23.9 (23.8, 24.0)	–
Since COVID, increased stress about...		
Food running out/availability	1622 (59.2)	1.24 (0.99, 1.49); < 0.001***
Losing a job/loss of income	1745 (63.7)	1.16 (0.91, 1.41); < 0.001***
Loss of childcare	1543 (56.3)	0.42 (0.18, 0.67); 0.001***
Tension/conflict in house	1028 (37.5)	0.78 (0.53, 1.03); < 0.001***
Getting infected	2556 (93.3)	1.82 (1.34, 2.31); < 0.001***
Risk factors for COVID		
Self/family healthcare worker	1133 (41.4)	– 0.07 (– 0.32, 0.18); 0.566
Self/family essential worker	1246 (45.5)	0.52 (0.27, 0.76); < 0.001***
Live with “shelter in place” orders	2117 (77.3)	– 0.34 (– 0.63, – 0.05); 0.021**
Practicing social distancing	2395 (87.4)	– 0.62 (– 0.99, – 0.25); 0.001***
Live in high COVID community	1149 (41.9)	0.41 (0.16, 0.65); 0.001***

<sup>a</sup> 1–10 visual analog scale with 1 being not at all and 10 being extremely anxious

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

## Ethical review and reporting criteria

All study materials and methods were reviewed and deemed exempt from ongoing review by the University of Michigan Institutional Review Board (HUM00179610). STROBE criteria were used in the planning, implementing, and reporting of this research (von Elm et al. 2008).

## Results

A total of 4274 women responded, 1114 who responded to less than half of the survey and 45 who indicated being less than 5 weeks pregnant and were excluded. Of the remaining 3115, 3070 answered the question regarding country of residence: 330 resided outside the USA and 2740 resided within the USA. For the purpose of the present paper, analyses are restricted to respondents from within the USA ( $n = 2740$ ).

Table 1 displays the *demographics and pregnancy-related characteristics* of respondents. Mean age was 32.7, 41.2% ( $N = 1128$ ) were in their third trimester, and 15.6% ( $N = 429$ ) were experiencing their first pregnancy. Respondents came from 47 states, most were white (87.7%,  $N = 2388$ ), and half were college graduates or less (49.5%,  $N = 1358$ ). More than a third had previously diagnosed depression, anxiety, or other mental health issue (35.9%,  $N = 982$ ). Approximately a quarter (25.8%,  $N = 706$ ) reported stopping in-person prenatal care visits since the COVID-19 pandemic began, 15.2% had used a video visit ( $N = 415$ ), and 31.8% ( $N = 817$ ) had used a phone visit for prenatal care. Those planning to give birth in a hospital dropped from 2641 (96.4%) prior to the COVID-19 pandemic to 2400 (87.7%) following the COVID-19 pandemic. This included women who said they no longer knew where they were going to give birth as well as women who said they would now give birth at home.

Table 1 also illustrates the beta coefficients for each variable when regressed against the difference in pre-COVID-19 and current PRAS scores. The factors significantly associated with greater changes in PRAS scores included being in the third trimester, having a history of or recent diagnosis of depression or anxiety, having stopped in-person prenatal care, or having used the phone for prenatal care. Women who originally planned to give birth at a hospital and those who moved away from planning to deliver at a hospital had significantly greater changes in PRAS scores. Factors associated with smaller changes in PRAS scores included higher maternal age, higher education, being married, and planning to give birth at home.

Anxiety scores shown in Table 2 indicate that women are anxious about being pregnant during the COVID-19 pandemic (mean 6.5 on a scale of 1–10, 95% CI 6.4, 6.6) but more anxious about giving birth during the COVID-19 pandemic (mean 7.6 on a scale of 1–10, 95% CI 7.5, 7.6). Mean PRAS scores for perceptions pre-COVID were 20.6 (95% CI 20.5,

20.7), and mean current PRAS scores were 23.9 (95% CI 23.8, 24.0). When comparing measures of anxiety against our outcome measure (difference in PRAS scores) as a consistency check, the relationships were as expected. Greater anxiety about being pregnant and giving birth were significantly associated with greater changes in PRAS scores ( $p < 0.001$ ).

In terms of *psychosocial risk factor indicators*, more than half of respondents reported increased stress about food running out or not being available (59.2%,  $N = 1622$ ), losing a job or loss of household income (63.7%,  $N = 1745$ ), or loss of childcare (56.3%,  $N = 1543$ ) (see Table 2). More than a third reported increasing stress about conflict between household members (37.5%,  $N = 1028$ ). Ninety three percent ( $N = 2556$ ) reported increased stress about getting infected with COVID-19. When asked about risk factors for COVID-19, slightly less than half of respondents (either themselves or their family members) were healthcare workers (41.4%,  $N = 1133$ ) or essential workers required to leave home (45.5%,  $N = 1246$ ). Forty two percent ( $N = 1149$ ) reported living a community or city with a high number of COVID-19 cases, 77.3% ( $N = 2117$ ) reported living in a state with “shelter in place” orders, and 87.4% ( $N = 2395$ ) reported practicing social distancing.

The variables significantly associated with greater changes in PRAS scores included increased stress about food availability, losing a job, loss of childcare, tension in the home, getting infected, self or family member being an essential worker, or living in a community with a high number of COVID-19 cases (see Table 2). The variables associated with smaller changes in PRAS scores included living in a state with shelter in place orders or practicing social distancing.

Table 3 illustrates that even after controlling for age, education, being in the third trimester, and previous mental health diagnoses, those reporting higher agreement with COVID-related stressors are significantly more likely to have a greater change in pregnancy-related anxiety. Women who report increased stress about food availability, tension/conflict within the home, and potentially getting infected with COVID-19 had significantly greater changes in PRAS scores, and the interaction term is significant for women who have less than a high school education, suggesting these women are particularly impacted by anxiety about job or income loss. In addition, women who themselves or family members are essential workers or who report living in a high COVID-19 area had greater changes in pregnancy-related anxiety. Notably, women who changed their birth plan away from delivering in a hospital had a significantly greater change in their

**Table 3** Multivariate linear regression reflecting factors associated with change in pre- to post-COVID pregnancy-related anxiety scale (PRAS) scores

Variable	$\beta$	95% CI; $p$ value
Demographic and pregnancy-related factors		
Maternal age (years)	-0.08	-0.10, -0.05; <0.001***
Education (ref: college graduate/less)		
High school graduate or less	-1.17	-2.25, -0.09; 0.034*
Master's degree	-0.22	-0.69, 0.30; 0.372
Doctoral/professional degree	0.12	-0.37, 0.61; 0.637
In 3rd trimester of pregnancy	0.50	0.26, 0.74; <0.001***
Pregnancy-diagnosed depression/anxiety	0.75	0.24, 1.26; 0.004**
Since COVID, stopped in-person PNC	0.42	0.15, 0.69; 0.002**
Since COVID, changed birth plan away from delivery in a hospital	1.26	0.84, 1.68; <0.001***
Anxiety and psychosocial risk factors		
Since COVID, increased stress about...		
Food running out/availability	0.77	0.51, 1.01; <0.001***
Losing a job/loss of income	0.47	-0.01, 0.94; 0.053
Tension/conflict in house	0.49	0.25, 0.73; <0.001***
Getting infected	1.23	0.76, 1.71; <0.001***
Risk Factors for COVID		
Self/family member essential worker	0.42	0.18, 0.66; 0.001**
Practicing social distancing	-0.86	-1.23, -0.49; <0.001***
Living in high-COVID community	0.42	0.17, 0.67; 0.001**
Interaction between anxious about loss of income or job and high school education or less	1.32	0.08, 2.57; 0.038*
Constant	3.47	2.36, 4.58; <0.001***

\* $p < 0.05$ , \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ Adjusted  $R^2 = 0.115$ 

pregnancy-related anxiety scale score. At the same time, controlling for all other factors, practicing social distancing was significantly associated with smaller changes in pre- to current PRAS scores.

## Discussion

This study found high levels of pregnancy-related anxiety among 2740 pregnant women from 47 states surveyed during the COVID-19 pandemic in the USA. The factors most strongly associated with greater changes in perceived pregnancy-related anxiety included COVID-19-related issues, such as stopping face-to-face prenatal visits and changing birth plan away from delivering in a hospital, as well as fear of food running out,

increased tension/conflict in the home, or fear of getting infected. In addition, self or family member being an essential worker or living in a location with a large number of COVID-19 cases were also significant drivers of greater changes in pregnancy-related anxiety scores. These factors were significant even after controlling for age, education, previous history of depression and anxiety, and other factors.

Similarly to Saccone et al. (2020)'s findings in Italy (Saccone et al. 2020), these findings indicate that the COVID-19 pandemic is having a profound impact on pregnancy-related anxiety. Prior research has established pregnancy-related anxiety as distinct from general anxiety or depression (Bayrampour et al. 2016) and is more detrimental to maternal and child outcomes (Blair et al. 2011; Kramer et al. 2009; Lobel et al. 2008).

Specifically, pregnancy-related anxiety has been linked to a higher rate of preterm birth as well as low-birthweight newborns (Dunkel Schetter 2011). Two important contributors to pregnancy-related anxiety have been demonstrated: *real or anticipated threat to pregnancy or its outcomes* and *low perceived control*. Both of these factors are amplified by the COVID-19 pandemic. For example, Harpel (2008) reported that women who perceived their pregnancies as high risk showed more anxiety yet felt reassured and less anxious if they had access to ultrasound exams. Our findings are consistent with this literature: Women who experienced their pregnancies as potentially threatened by the COVID-19 pandemic showed greater changes in pregnancy-related anxiety due to the COVID-19 outbreak. Similarly, women who experienced a COVID-related disruption in their anticipated pregnancy and labor experience (i.e., loss in control) showed greater changes in pregnancy-related anxiety. However, the direction of these latter relationships is not clear. It is possible that women with the greatest post-COVID-19 anxiety initiated the termination of face-to-face prenatal care, for example. Alternatively, it is also possible that the providers asked women to shift away from face-to-face visits and that this perceived “withdrawal of care” underlies women’s increased anxiety. Future research is needed to tease out the direction of effects.

Concerns about risk of infection were important drivers of anxiety, manifesting through changes in where women planned to give birth, as illustrated by the drop from 96.4% of women planning a hospital birth prior to the COVID-19 pandemic to 87.7% planning a hospital birth during the COVID-19 pandemic. Interestingly, women who reported having planned a home birth prior to the COVID-19 pandemic and those who planned a home birth during the COVID-19 pandemic showed some of the smallest changes in perceived pre-COVID PRAS scores to current PRAS scores. We hypothesize that this may be indicative of a greater locus of control among this group, as these women may have translated their concern about getting infected in a hospital setting to actionable control over the situation by planning labor in a perceived “safe” home environment. The group with the greatest increase in PRAS scores was those who said they did not know where they would give birth since the COVID-19 pandemic began. Less than 1% of respondents reported that, prior to COVID-19, they did not know where they would give birth ( $N=24$ ), compared with 8.1% who said that, since COVID-19, they did not know where they would give birth. Future research is warranted that explores the relationship between locus of control and decisions regarding where women choose to give birth.

For providers, it is important to recognize that pregnant women’s anxiety about the COVID-19 pandemic is likely to translate to more generalized pregnancy-related anxiety. Providers and the system as a whole need to be prepared to offer additional supportive services to pregnant women, especially as standard care is being reshaped due to social distancing (e.g., stopping face-to-face prenatal visits, limiting support during labor). Our findings indicated a relationship between greater changes in anxiety and a reduced preference for delivering in a hospital, a finding that is important for providers to recognize. Explicit discussions about birth plans, what providers and health systems can do to keep women and their babies safe, and the cost-benefit analysis of hospital-based versus home births will be extremely valuable in maximizing positive outcomes and minimizing maternal anxiety. Further research exploring flexible options for delivery care are also warranted (Renfrew et al. 2020).

In addition, women with increased anxiety during pregnancy are known to be at increased risk for postpartum depression or other mood disorders (Grigoriadis et al. 2019), suggesting ongoing monitoring for postpartum depression and other mood disturbances will be important (Grigoriadis et al. 2019; Muzik and Borovska 2010). It will also be important to expand telehealth options for screening, treating, and monitoring perinatal mental health.

Our findings contribute to a line of research documenting the effects of disaster, trauma, and life stressors during pregnancy on maternal mental health (Huizink et al. 2008; Laplante et al. 2008; Yehuda et al. 2005; Muzik et al. 2016; Seng et al. 2010), confirming the detrimental impact of the COVID-19 pandemic and its psychosocial ramifications, including heightened interfamilial tension and sociodemographic hardship, on increasing pregnancy-related anxiety. They also suggest, paralleling prior work, that living through a particularly stressful time may have additional impacts on women beyond the normative pregnancy worries and that women may need additional supports to recover and thrive, especially if they are living in communities with fewer resources. Future research is warranted exploring the long-term effects of the anxiety associated with COVID-19 on women who were pregnant during the pandemic.

This study is a nationwide sample of nearly 3000 pregnant women during the escalation of the COVID-19 pandemic in the USA, and it assesses not only their COVID-related anxieties but also their pregnancy-related anxiety. It is the first study to explore the relationship between these factors in a systematic way. One limitation of this study is the reliance on women’s retrospective assessment of pregnancy-related

anxiety prior to the COVID-19 pandemic, compared with how anxious they were at the time of the survey. While such retrospective assessment is not ideal and is subject to potential recall bias, it allows women to serve as their own controls, which we believe provides a better comparison than trying to use other studies as a basis of comparison. In addition, our online convenience sample introduces a bias toward better educated, more technology-savvy respondents. Minority populations are underrepresented in this sample and are also being impacted by COVID-19 more profoundly, and thus conclusions must be drawn with such a limitation in mind. Despite these limitations, this survey had representation from 47 states, including women of varying ages, education, parity, and risk status, and we believe this study captures important information about the impact of COVID-19 on maternal mental health.

## Conclusions

Pregnancy can be stressful for women during normal times, yet the COVID-19 pandemic has amplified pregnancy-related anxiety among many women. Healthcare providers will need to offer increased and ongoing support to their pregnant patients, even as in-person visits are curtailed and social distancing policies reduce opportunities for meaningful patient-provider interactions.

**Code availability** Not applicable.

**Authors' contributions** CAM conceptualization, methodology, software, formal analysis, writing – original draft, writing – review and editing

SDC conceptualization, methodology, formal analysis, writing – original draft, writing – review and editing

EK conceptualization, methodology, writing – original draft, writing – review and editing

MM conceptualization, methodology, writing – original draft, writing – review and editing

**Data availability** Data are available upon reasonable request.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethics approval** All study materials and methods were reviewed and deemed exempt from ongoing review by the University of Michigan Institutional Review Board (HUM00179610).

**Consent to participate** Participants were reminded of the elements of informed consent, but consent to participate was not documented due to the anonymous nature of the online survey.

**Consent for publication** Participants were assured that data would be anonymous, and thus no identifying information would be used in any publication.

## Appendix

**Table 4** Modified pregnancy-related anxiety scale (PRAS) (9) for assessment of anxiety before COVID-19 and during the pandemic

Pre-COVID PRAS	Post-COVID PRAS
1. Before COVID-19, I was confident of having a normal childbirth	1. I am confident of having a normal childbirth
2. Before COVID-19, I had a lot of fear regarding the health of my baby	2. I have a lot of fear regarding the health of my baby
3. Before COVID-19, I was worried that the baby could be abnormal	3. I am worried that my baby could be abnormal
4. Before COVID-19, I was afraid that I might be harmed during delivery	4. I am afraid that I might be harmed during delivery
5. Before COVID-19, I was worried about how the baby was growing and developing inside me	5. I am worried about how the baby is growing and developing inside me
6. Before COVID-19, I was worried about losing the baby	6. I am worried about losing the baby
7. Before COVID-19, I was worried about having a hard or difficult labor and delivery	7. I am worried about having a hard or difficult labor and delivery
8. Before COVID-19, I was worried about taking care of a new baby	8. I am worried about taking care of a new baby

\*All scored 1–5, from strongly disagree to strongly agree

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