


COVID-19 Vaccination and Intent Among Pregnant Women, United States, April 2021

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Abstract

Objectives: National data on COVID-19 vaccination coverage among pregnant women are limited. We assessed COVID-19 vaccination coverage and intent, factors associated with COVID-19 vaccination, reasons for nonvaccination, and knowledge, attitudes, and beliefs related to COVID-19 illness and vaccination among pregnant women in the United States.

Methods: Data from an opt-in internet panel survey of pregnant women conducted March 31–April 16, 2021, assessed receipt of ≥ 1 dose of any COVID-19 vaccine during pregnancy. The sample included 1516 women pregnant any time during December 1, 2020–April 16, 2021, who were not fully vaccinated before pregnancy. We used multivariable logistic regression to determine variables independently associated with receipt of COVID-19 vaccine.

Results: As of April 16, 2021, 21.7% of pregnant women had received ≥ 1 dose of COVID-19 vaccine during pregnancy, 24.0% intended to receive a vaccine, 17.2% were unsure, and 37.1% did not intend to receive a vaccine. Pregnant women with (vs without) a health care provider recommendation (adjusted prevalence ratio [aPR] = 4.86), those who lived (vs not) with someone with a condition that could increase risk for serious medical complications of COVID-19 (aPR = 2.11), and those who had received (vs not) an influenza vaccination (aPR = 2.35) were more likely to receive a COVID-19 vaccine. Common reasons for nonvaccination included concerns about safety risk to baby (37.2%) or self (34.6%) and about rapid vaccine development (29.7%) and approval (30.9%).

Conclusions: Our findings indicate a continued need to emphasize the benefits of COVID-19 vaccination during pregnancy and to widely disseminate the recommendations of the Centers for Disease Control and Prevention and other clinical professional societies for all pregnant women to be vaccinated.

Keywords

COVID-19, pregnancy, vaccination, intent, attitudes

Pregnant and postpartum women are at increased risk of severe illness from COVID-19, including intensive care unit admission, mechanical ventilation, or death, compared with nonpregnant women of reproductive age.¹ Approximately 8% to 11% of pregnant women with COVID-19 require hospitalization and 2% to 4% require admission to an intensive care unit.^{1–4} One study reported that pregnant women were significantly more likely than nonpregnant women to be admitted to an intensive care unit (10.5 vs 3.9 per 1000 cases).¹ Pregnant women with COVID-19 are at increased risk of adverse pregnancy complications, preterm birth, and other poor pregnancy outcomes.^{1,2,4–6} COVID-19 vaccines have been available in the United States via Emergency Use Authorization since December 2020, and they are currently recommended for all people aged ≥ 5 years, including

women who are pregnant, breastfeeding, or trying to get pregnant now, or might become pregnant.^{7,8} Pregnant women were included in the early phases of COVID-19 vaccination

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rollout, and most states classified pregnant women as a priority group for vaccination in early March 2020.^{9,10}

The COVID-19 vaccination program in the United States was implemented in phases beginning with health care personnel. Additional groups became eligible for vaccination soon after, including people with certain medical conditions, such as pregnancy, that increased risk of severe COVID-19 illness.^{9,11} National data on COVID-19 vaccination coverage and safety among pregnant women in the United States are limited. A study of the Vaccine Safety Datalink (VSD)¹² estimated that 16.3% of women who were pregnant any time from December 14, 2020, through May 8, 2021, received ≥ 1 dose of a COVID-19 vaccine during pregnancy, with the lowest vaccination coverage observed among non-Hispanic Black, Hispanic, and young (aged 18-24 years) women.¹³ Furthermore, information from VSD is limited and does not include information on vaccination intent, reasons for non-vaccination, or knowledge, attitudes, and beliefs related to COVID-19 illness and vaccination. In this study, we aimed to assess COVID-19 vaccination coverage and intent for vaccination during pregnancy, reasons for not receiving a vaccine, and knowledge, attitudes, and beliefs related to COVID-19 illness and vaccine among a representative sample of pregnant women in the United States.

Methods

To assess receipt of COVID-19 vaccine during pregnancy, the Centers for Disease Control and Prevention (CDC) added questions to its annual internet panel survey, which is conducted each April to provide estimates of end-of-season influenza vaccination coverage among pregnant women in the United States.¹⁴ CDC fielded the survey March 31–April 16, 2021 (before CDC's strengthening of COVID-19 vaccination recommendation for pregnant women⁹), recruiting pregnant women from a large, preexisting, opt-in internet panel of the general population operated by Dynata (www.dynata.com). Fourteen of 69 panelists recruited via email and 12 699 of 101 846 panelists recruited via the intercept method clicked on the survey link. A total of 12 571 (99.0%) panelists answered all screening questions, and 2522 (20.1%) respondents were determined to be eligible. A total of 2300 women aged 18-49 years who were pregnant any time since August 1, 2020, completed the survey (completion rate = 91.2%) (Supplementary Figure). Because of the timing of the first Emergency Use Authorization for a COVID-19 vaccine issued by the US Food and Drug Administration, in December 2020,¹⁵ we limited analyses to women who were pregnant on or after December 1, 2020 ($n = 1832$). We excluded women who provided incomplete information about COVID-19 vaccination status ($n = 10$) or reported any COVID-19 vaccination before or after pregnancy but not during pregnancy ($n = 306$). The final analytic sample included 1516 women. CDC reviewed this activity, which was conducted consistent with applicable federal law and

CDC policy (45 C.F.R. part 46; 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.).

We assessed COVID-19 vaccination status with the question, "Have you received a COVID-19 vaccine?" Respondents who answered yes were asked, "How many doses of COVID-19 vaccine have you received?" and "When during the course of your pregnancy did you receive the first (or only) dose of COVID-19 vaccine?" Respondents were not asked about vaccine type. Respondents who indicated receiving ≥ 1 dose of COVID-19 vaccine were also asked, "When during the course of your pregnancy did you receive the second dose of COVID-19 vaccine?" Respondents were considered vaccinated if they reported receiving ≥ 1 dose of vaccine "during my current/most recent pregnancy."

Respondents who reported not receiving a COVID-19 vaccine were asked, "How likely are you to get a COVID-19 vaccine if it is available to you while pregnant?" Response options included "Will definitely get a vaccine," "Will probably get a vaccine," "Am unsure about getting a vaccine," "Will probably not get a vaccine," and "Will definitely not get a vaccine." We grouped respondents by vaccination and intent status as follows: (1) women who received a COVID-19 vaccine during pregnancy, (2) women who were definitely/probably getting vaccinated, (3) women who were unsure about getting vaccinated, and (4) women who probably/definitely did not intend to get vaccinated. The survey also collected information on sociodemographic characteristics, receipt of health care provider recommendation for COVID-19 vaccination, trimester and place of vaccination, reasons for not getting a COVID-19 vaccine among those unvaccinated, and attitudes about COVID-19 illness and COVID-19 vaccination.

We used SAS-callable SUDAAN version 11.0.1 (RTI International) to calculate weighted proportions and corresponding 95% CIs. So that estimates could be generalizable to the US population of pregnant women, we constructed sample weights to match population control totals¹⁶⁻¹⁹ by age group, race and ethnicity, census region, and pregnancy status at the time of the survey. We developed a poststratification weight for each participant through a raking calibration procedure to minimize bias in the estimates due to disproportional representation of controlled subgroups.²⁰ We used t tests to assess differences between groups; we set the significance level at $P < .05$. We used multivariable logistic regression to determine variables independently associated with receipt of COVID-19 vaccine during pregnancy, and we tabulated adjusted prevalence ratios (aPRs) based on predicted marginals from the logistic regression model.²¹ Statistical measures were calculated with an assumption of random sampling and should be interpreted only as guides to assessing the associations from this nonprobability sample.²²

Results

Overall, 21.7% of pregnant women reported receiving a COVID-19 vaccine during pregnancy, 24.0% indicated that

they definitely/probably would get a vaccine, 17.2% were unsure about getting a vaccine, and 37.1% indicated that they probably/definitely would not get a vaccine. The largest percentage of vaccinated women received their first or only dose during the first trimester (42.4%) or second trimester (42.9%), and the most common places to be vaccinated were in a hospital (23.0%), at their gynecologist/obstetrician/midwife's office (22.4%), or at their family or other physician's office (20.4%). A health care provider recommendation for COVID-19 vaccine was reported by 50.6% of women (Table 1).

In bivariate analysis, race and ethnicity, essential worker status, health care provider recommendation for COVID-19 vaccine, having a condition other than pregnancy that could increase risk for serious medical complications of COVID-19, living with someone with a condition that could increase risk for serious medical complications of COVID-19, and having received an influenza vaccination during the 2020-2021 influenza season were associated with receipt of a COVID-19 vaccination during pregnancy. A higher percentage of Hispanic women than non-Hispanic White women reported being vaccinated (29.8% vs 18.9%). Women who did not self-identify as being an essential worker (16.7%) or were not currently working (12.5%) were less likely to be vaccinated than women who reported being an essential worker (30.5%). Women who had a health care provider recommendation for COVID-19 vaccination (vs women who did not), who had a condition other than pregnancy that could increase risk for serious medical complications of COVID-19 (vs women who did not), who lived with someone with a condition that could increase risk for serious medical complications of COVID-19 (vs women who did not), or who had received an influenza vaccination (vs women who had not) had higher vaccination coverage (38.3% vs 4.7%, 26.5% vs 17.0%, 40.0% vs 13.1%, and 34.3% vs 8.0%, respectively) (Table 1).

A greater percentage of women with a health care provider recommendation reported they definitely/probably would get a vaccine compared with those without a health care provider recommendation (29.9% vs 17.9%); a smaller percentage of women with a health care provider recommendation compared with those without a health care provider recommendation reported being unsure (11.2% vs 23.4%) or probably/definitely would not get a vaccine (20.6% vs 54.0%). Likewise, a higher percentage of women with a condition other than pregnancy that could increase risk for serious medical complications of COVID-19 reported they definitely/probably would get a vaccine than women without such a condition (27.7% vs 20.1%); women with such a condition were less likely than those without such a condition to report being unsure (13.6% vs 21.3%) or probably/definitely would not get vaccinated (32.2% vs 41.6%) (Table 1).

The results of the multivariable analysis to determine factors independently associated with receipt of a COVID-19 vaccination during pregnancy were generally consistent with

the results of the bivariate analysis. Women with a health care provider recommendation (aPR = 4.86), women who lived with someone with a condition that could increase risk for serious medical complications of COVID-19 (aPR = 2.11), and women who had received an influenza vaccination (aPR = 2.35) were more likely than their counterparts to receive a COVID-19 vaccination. Associations observed in bivariate analyses between receipt of ≥ 1 dose of a COVID-19 vaccine (identifying as Hispanic, having a condition that could increase risk for serious medical complications of COVID-19, and being an essential worker) were no longer significant in the multivariable model (Table 2).

The most common reason for nonvaccination for both women who definitely/probably would get vaccinated and women who were unsure was that they planned to wait and see if it is safe and might get it later (31.3% and 52.6%, respectively), and the top reason for women who probably/definitely would not get vaccinated was concern about possible safety risks to baby (42.2%) (Table 3). Women who definitely/probably would get vaccinated and those who were unsure also reported concerns about safety for baby (24.5% and 44.1%, respectively), and many of these women reported that they planned to wait and get vaccinated after pregnancy (25.4% and 29.9%, respectively). Both unsure women and those who probably/definitely would not get vaccinated reported concern about the COVID-19 vaccine being developed (29.3% and 40.1%, respectively) and approved (31.8% and 39.2%, respectively) too quickly.

In examining COVID-19-related knowledge, attitudes, and beliefs among all 1516 pregnant women, 25.7% indicated that COVID-19 vaccines are very effective and 26.4% indicated they are very safe. In addition, 52.6% strongly agreed/agreed that pregnant women should get the COVID-19 vaccine. Regarding COVID-19 illness, 30.6% were very worried about getting COVID-19, and 38.1% and 36.3%, respectively indicated it was very likely that getting COVID-19 while pregnant could harm her or her baby (Figure 1). Vaccination coverage was higher among women with positive attitudes about COVID-19 vaccine and more concern about getting COVID-19 than among women with negative attitudes about the vaccine and less concern about COVID-19. The highest vaccination coverage was among women who reported the vaccine was very effective (48.0%) and very safe (46.0%) and among women who strongly agreed pregnant women should get a COVID-19 vaccine (50.6%) (Figure 2).

Discussion

As of April 16, 2021, nearly 22% of women who were pregnant during December 2020 through April 2021 reported receiving ≥ 1 dose of COVID-19 vaccine during pregnancy. This estimate is similar to the only published estimate from VSD, which was 16.3% as of May 8, 2021.¹³ In addition, 24.0% of pregnant women intended to receive a vaccine, an additional 17.2% were unsure, and 37.1% did not intend to

Table 1. Receipt of ≥ 1 dose of a COVID-19 vaccine during pregnancy^a and intent^b to receive a COVID-19 vaccination among women pregnant any time during December 1, 2020–April 16, 2021, by selected characteristics, internet panel survey, United States, April 2021^c

Characteristic	Total, ^d no. (weighted %)	Weighted % (95% CI) ^e			
		Vaccinated (n = 388)	Definitely/probably will get a vaccine (n = 357)	Unsure (n = 255)	Probably/definitely will not get a vaccine (n = 516)
Overall ^f	1516 (100.0)	21.7 (18.8-24.8)	24.0 (20.5-27.7)	17.2 (14.6-20.1)	37.1 (33.3-41.0)
Age group, y					
18-24	537 (24.4)	18.2 (13.9-23.2)	21.5 (16.5-27.3) ^g	22.0 (16.4-28.3)	38.3 (32.8-44.1) ^g
25-34	636 (57.5)	23.0 (18.6-27.8)	21.3 (16.8-26.4) ^g	13.9 (11.0-17.2)	41.8 (36.1-47.8) ^g
35-49 [reference]	343 (18.0)	22.5 (17.6-28.0)	35.7 (26.1-46.3)	21.4 (14.4-29.9)	20.4 (15.0-26.7)
Race and ethnicity ^h					
Hispanic	503 (22.6)	29.8 (23.5-36.8) ^g	26.7 (20.4-33.8)	19.0 (13.3-26.0)	24.4 (19.6-29.8) ^g
Non-Hispanic Black	274 (19.8)	19.2 (11.0-30.0)	21.1 (12.0-32.9)	18.5 (11.8-26.8)	41.2 (30.1-53.0)
Non-Hispanic Other	129 (8.3)	22.4 (13.9-33.1)	24.7 (15.6-35.7)	17.5 (9.3-28.6)	35.5 (24.4-47.8)
Non-Hispanic White [reference]	609 (49.3)	18.9 (15.7-22.5)	23.8 (19.0-29.2)	15.9 (12.6-19.6)	41.5 (36.1-46.9)
Education					
\leq High school degree	380 (23.3)	19.3 (13.1-26.9)	18.3 (13.7-23.7) ^g	18.9 (13.7-25.1)	43.5 (36.9-50.3) ^g
Some college, no degree	232 (17.6)	— ⁱ	18.1 (12.4-25.2) ^g	18.4 (11.8-26.7)	49.0 (37.0-61.0) ^g
College degree	576 (38.5)	23.5 (19.5-27.8)	26.9 (20.6-34.1)	15.8 (11.9-20.4)	33.8 (27.8-40.1)
>College degree [reference]	327 (20.6)	27.4 (21.4-34.0)	29.8 (21.8-38.8)	16.9 (11.3-23.7)	26.0 (19.9-32.9)
Employment status ^j					
Essential worker [reference]	751 (48.5)	30.5 (25.3-36.0)	23.0 (18.0-28.6)	15.5 (12.0-19.7)	31.0 (25.7-36.6)
Nonessential worker	184 (11.8)	16.7 (11.0-23.8) ^g	33.4 (24.1-43.7)	13.2 (8.3-19.5)	36.7 (26.0-48.6)
Not currently working	580 (39.6)	12.5 (9.8-15.6) ^g	22.3 (17.0-28.4)	20.4 (15.9-25.6)	44.8 (38.7-51.0) ^g
Poverty status ^k					
At or above poverty threshold [reference]	1180 (77.5)	22.7 (19.9-25.7)	27.3 (23.2-31.7)	15.8 (13.1-18.7)	34.3 (29.8-38.9)
Below poverty threshold	319 (22.5)	17.5 (9.4-28.5)	12.9 (8.2-19.0) ^g	22.5 (15.5-30.8)	47.2 (38.8-55.6) ^g
Area of residence ^l					
Rural	180 (12.5)	16.1 (10.8-22.6)	14.1 (8.7-21.1) ^g	19.2 (12.3-27.8)	50.7 (42.0-59.3) ^g
Nonrural [reference]	1336 (87.5)	22.5 (19.3-26.0)	25.4 (21.5-29.6)	16.9 (14.1-20.0)	35.2 (31.0-39.5)
Region ^m					
Northeast [reference]	312 (15.1)	24.6 (19.0-30.9)	25.2 (18.2-33.2)	20.6 (14.6-27.8)	29.6 (22.8-37.2)
Midwest	288 (21.4)	22.0 (14.4-31.2)	24.0 (15.5-34.4)	14.7 (9.7-20.9)	39.3 (31.7-47.4)
South	627 (42.5)	18.6 (15.0-22.6)	22.6 (17.5-28.5)	17.8 (13.5-22.8)	41.1 (34.3-48.1) ^g
West	289 (21.0)	25.8 (18.7-34.0)	25.7 (18.1-34.6)	16.2 (11.0-22.7)	32.3 (25.3-39.8)
Health insurance coverage ⁿ					
Private/military insurance only [reference]	644 (43.9)	24.0 (19.6-28.9)	22.2 (18.4-26.5)	16.2 (12.7-20.4)	37.5 (31.2-44.2)
Any public insurance	775 (50.1)	21.1 (17.0-25.8)	25.2 (19.6-31.4)	18.2 (14.3-22.7)	35.5 (31.1-40.0)
None	96 (6.0)	— ⁱ	26.7 (13.8-43.3)	— ⁱ	— ⁱ
Health care provider recommendation ^o					
Yes	788 (50.6)	38.3 (32.8-44.0) ^g	29.9 (24.1-36.3) ^g	11.2 (8.3-14.6) ^g	20.6 (15.4-26.5) ^g
No [reference]	726 (49.4)	4.7 (3.3-6.6)	17.9 (14.5-21.7)	23.4 (19.2-28.0)	54.0 (48.8-59.0)
Has a condition other than pregnancy that could increase risk for serious medical complications of COVID-19 ^p					
Yes	716 (50.2)	26.5 (21.6-32.0) ^g	27.7 (21.8-34.3) ^g	13.6 (10.3-17.4) ^g	32.2 (26.3-38.5) ^g
No [reference]	774 (49.8)	17.0 (14.0-20.4)	20.1 (16.7-23.9)	21.3 (17.3-25.6)	41.6 (36.7-46.6)
Lives with someone who has a condition that could increase risk for serious medical complications of COVID-19 ^q					
Yes	528 (32.0)	40.0 (32.6-47.6) ^g	25.0 (18.2-32.8)	13.5 (9.8-18.1) ^g	21.5 (14.8-29.5) ^g
No [reference]	988 (68.0)	13.1 (10.9-15.7)	23.5 (19.5-27.9)	18.9 (15.6-22.6)	44.4 (39.9-49.1)
Influenza vaccination in 2020-2021 ^r					
Yes	851 (52.2)	34.3 (29.7-39.1) ^g	26.5 (22.1-31.3)	16.7 (13.4-20.4)	22.5 (18.9-26.4) ^g
No [reference]	663 (47.8)	8.0 (5.6-10.9)	21.2 (15.8-27.5)	17.7 (13.7-22.4)	53.1 (46.8-59.3)

(continued)

Table 1. (continued)

Characteristic	Total, ^d no. (weighted %)	Weighted % (95% CI ^e)			
		Vaccinated (n = 388)	Definitely/probably will get a vaccine (n = 357)	Unsure (n = 255)	Probably/definitely will not get a vaccine (n = 516)
Timing of receipt of first/only dose of COVID-19 vaccine		NA	NA	NA	NA
First trimester	121 (42.4)				
Second trimester	158 (42.9)				
Third trimester	51 (14.8)				
Place of first/only vaccination		NA	NA	NA	NA
Obstetrician/gynecologist/midwife's office	80 (22.4)				
Family or other physician's office	61 (20.4)				
Health department	48 (13.3)				
Hospital	76 (23.0)				
Store (supermarket, drug store)	30 (8.8)				
Other ^g	35 (12.2)				

Abbreviation: NA, not applicable.

^aRespondents pregnant since December 1, 2020, who had not been fully vaccinated against COVID-19 before their pregnancy were included in the analysis. Those who reported receiving ≥ 1 dose of COVID-19 vaccine during their pregnancy were considered vaccinated.

^bRespondents who reported not receiving a COVID-19 vaccination were asked how likely they are to get a COVID-19 vaccine (n = 1128); response options included definitely will, probably will, unsure, probably will not, and definitely will not get a COVID-19 vaccine.

^cData source: Kahn et al.¹⁴

^dThe total unweighted number and weighted proportion of respondents in the sample. The total for each of the characteristics may not add up to the overall because of missing responses.

^eKorn–Graubard 95% CI.

^fVaccination and intent categories add up to 100%.

^gSignificant difference detected using *t* test compared with reference group ($P < .05$).

^hRace and ethnicity were self-reported. Respondents identified as Hispanic might be of any race. The "Other" race category includes Asian, American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander, and women who selected "other" or >1 race.

ⁱEstimates do not meet the National Center for Health Statistics' standards of reliability.²³

^jRespondents were asked about their current employment status (working/not working), and those who indicated they were working were then asked about their current work or volunteer activities. Respondents were considered essential workers if they indicated being a health care worker working directly or not working directly with patients, frontline essential worker (not in health care), or essential worker (not in health care and not frontline). In addition, respondents could indicate that they were a nonessential worker or volunteer. Finally, respondents who indicated that they were not currently working or volunteering were grouped with respondents who indicated "not working" as their employment status.

^kPoverty status was defined based on the reported number of people living in the household and annual household income, according to US Census poverty thresholds.²⁴

^lRurality was defined by using zip codes where $>50\%$ of the population resides in a nonmetropolitan county, a rural census tract, or both, according to the Health Resources & Services Administration's definition of rural population.²⁵

^mNortheast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

ⁿRespondents who were pregnant on their survey date were asked what medical insurance or medical care coverage they had; respondents who had already delivered were asked what they had during their most recent pregnancy. Women considered to have public health insurance selected ≥ 1 of the following: Medicaid, Medicare, state-sponsored medical plan, or other government plan. Respondents considered to have private/military health insurance selected private medical insurance and/or military medical care and did not select any type of public health insurance.

^oRespondents were asked, "Since December 2020, has your doctor, nurse, or another medical professional recommended that you get a COVID-19 vaccination?"

^pFor this analysis, conditions (other than pregnancy) that could increase risk for serious medical complications of COVID-19 included asthma, chronic bronchitis or chronic obstructive pulmonary disease, cancer, diabetes, heart attack/disease/condition, chronic liver disease, kidney disease, Down syndrome, weakened immune system from solid organ transplant or from blood or bone marrow transplant/immune deficiencies/HIV/use of corticosteroids or other immune-weakening medicines, sickle cell disease, obesity, neurological/neuromuscular conditions, or being a current smoker. Respondents missing information were excluded from analysis (n = 27). Some conditions currently considered to be high risk for severe COVID-19 illness were not assessed by the survey.⁴

^qRespondents were asked if they lived with anyone who had chronic conditions like diabetes, heart disease, chronic lung disease, asthma, a neurologic or neuromuscular disease, immune system problems, kidney disease, sickle cell disease, or hemophilia, or if they lived with anyone else who was currently pregnant.

^rReceipt of influenza vaccination since July 1, 2020, before or during most recent pregnancy.

^s"Other" place of first or only COVID-19 vaccination includes other medically or nonmedically related place, such as a school, work, or a special site set up for COVID-19 vaccination.

receive a vaccine. The strongest factors associated with vaccination were receipt of a health care provider recommendation for vaccination, living with other individuals with a high-risk condition, and receipt of an influenza vaccination. Common reasons for nonvaccination included concerns about safety risk to baby (37.2%) and self (34.5%), and rapid vaccine development (29.6%) and approval (30.7%).

Although overall vaccination coverage estimates noted in our study and VSD are similar, coverage by race and ethnicity differs between the two studies. We found that Hispanic women had the highest vaccination coverage; however, they were among those with low vaccination coverage in VSD.¹³ In contrast to other maternal vaccinations, where disparities in coverage for Black women and women of "other" or multiple

Table 2. Results of multivariable analysis: factors associated with receipt of ≥ 1 dose of COVID-19 vaccine during pregnancy^a among women pregnant any time during December 1, 2020–April 16, 2021, internet panel survey, United States, April 2021^b

Characteristic	Adjusted prevalence ratio ^c (95% CI)
Age group, y	
18-24	1.03 (0.76-1.40)
25-34	1.22 (0.95-1.57)
35-49	1 [Reference]
Race and ethnicity ^d	
Hispanic	1.13 (0.91-1.41)
Non-Hispanic Black	0.99 (0.69-1.42)
Non-Hispanic Other	1.25 (0.91-1.70)
Non-Hispanic White	1 [Reference]
Education	
\leq High school degree	1.02 (0.74-1.41)
Some college, no degree	0.72 (0.44-1.16)
College degree	1.02 (0.83-1.38)
>College degree	1 [Reference]
Employment status ^e	
Essential worker	1 [Reference]
Nonessential worker	0.78 (0.57-1.07)
Not currently working	0.79 (0.62-1.01)
Poverty status ^f	
At or above poverty threshold	1 [Reference]
Below poverty threshold	0.98 (0.71-1.36)
Area of residence ^g	
Rural	0.98 (0.73-1.31)
Nonrural	1 [Reference]
Region ^h	
Northeast	1 [Reference]
Midwest	0.88 (0.64-1.22)
South	0.84 (0.64-1.11)
West	0.97 (0.73-1.29)
Health insurance coverage ⁱ	
Private/military insurance only	1 [Reference]
Any public insurance	0.83 (0.66-1.04)
None	0.63 (0.32-1.24)
Health care provider recommendation ^j	
Yes	4.86 (3.34-7.05) ^k
No	1 [Reference]
Has a condition other than pregnancy that could increase risk for serious medical complications of COVID-19 ^l	
Yes	1.04 (0.84-1.27)
No	1 [Reference]
Lives with someone with a condition that could increase risk for serious medical complications of COVID-19 ^m	
Yes	2.11 (1.67-2.67) ^k
No	1 [Reference]
Influenza vaccination in 2020-2021 ⁿ	
Yes	2.35 (1.67-3.32) ^k
No	1 [Reference]

^aRespondents pregnant since December 1, 2020, who had not been fully vaccinated against COVID-19 before their pregnancy were included in the analysis. Those who reported receiving ≥ 1 dose of COVID-19 vaccine during their pregnancy were considered vaccinated.

^bData source: Kahn et al.¹⁴

^cLogistic regression models included all variables listed in the table.

Table 2. (continued)

^dRace and ethnicity were self-reported. Respondents identified as Hispanic might be of any race. The “Other” race category included Asian, American Indian/Alaska Native, Native Hawaiian/Other Pacific Islander, and women who selected “other” or > 1 race.

^eRespondents were asked about their current employment status (working/not working), and those who indicated they were working were then asked about their current work or volunteer activities. Respondents were considered essential workers if they indicated being a health care worker working directly or not working directly with patients, frontline essential worker (not in health care), or essential worker (not in health care and not frontline). In addition, respondents could indicate that they were a nonessential worker or volunteer. Finally, respondents who indicated that they were not currently working or volunteering were grouped with respondents who indicated “not working” as their employment status.

^fPoverty status was defined based on the reported number of people living in the household and annual household income, according to US Census poverty thresholds.²⁴

^gRurality was defined using zip codes where $> 50\%$ of the population resides in a nonmetropolitan county, a rural census tract, or both, according to the Health Resources & Services Administration’s definition of rural population.²⁵

^hNortheast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

ⁱRespondents pregnant on their survey date were asked what medical insurance or medical care coverage they had; respondents who had already delivered were asked what they had during their most recent pregnancy. Women considered to have public health insurance selected at least 1 of the following: Medicaid, Medicare, state-sponsored medical plan, or other government plan. Respondents considered to have private/military health insurance selected private medical insurance and/or military medical care and did not select any type of public health insurance.

^jRespondents were asked, “Since December 2020, has your doctor, nurse, or another medical professional recommended that you get a COVID-19 vaccination?”

^kSignificant difference compared with the reference group ($P < .05$) determined by logistic regression.

^lFor this analysis, conditions (other than pregnancy) that could increase risk for serious medical complications of COVID-19 included asthma, chronic bronchitis or chronic obstructive pulmonary disease, cancer, diabetes, heart attack/disease/condition, chronic liver disease, kidney disease, Down syndrome, weakened immune system from solid organ transplant or from blood or bone marrow transplant/immune deficiencies/HIV/use of corticosteroids or other immune-weakening medicines, sickle cell disease, obesity, neurological/neuromuscular conditions, or being a current smoker. Respondents missing information were excluded from analysis ($n = 27$). Some conditions currently considered to be high risk for severe COVID-19 illness were not assessed by the survey.⁴

^mRespondents were asked if they lived with anyone who had chronic conditions like diabetes, heart disease, chronic lung disease, asthma, a neurologic or neuromuscular disease, immune system problems, kidney disease, sickle cell disease, or hemophilia, or if they lived with anyone else who was currently pregnant.

ⁿReceipt of influenza vaccination since July 1, 2020, before or during most recent pregnancy.

racers have persisted compared with White women, we found similar COVID-19 vaccination coverage among these racial groups.¹⁴ However, COVID-19 vaccination of pregnant women was low among all racial and ethnic groups in our study and continues to be low in VSD.²⁶ Finally, the differences observed could be due to the fact that all but 1 VSD site serve populations that have health insurance. Continuing to monitor vaccination and intent for vaccination by race and ethnicity and sociodemographic drivers is important to help ensure equitable access to COVID-19 vaccines for all pregnant women, especially because people who are Hispanic, Black, and of “other” races and ethnicities have experienced disproportionately higher rates than White people of hospitalization and death attributable to COVID-19.^{1,3,27}

(continued)

Table 3. Reasons^a for not receiving a COVID-19 vaccine among unvaccinated women pregnant any time during December 1, 2020–April 16, 2021, by vaccination intent, internet panel survey, United States, April 2021^b

Reason	Overall (N = 1128)		Definitely/probably will get a vaccine (n = 357)		Unsure (n = 255)		Probably/definitely will not get a vaccine (n = 516)	
	No.	Weighted % (95% CI) ^c	No.	Weighted % (95% CI) ^c	No.	Weighted % (95% CI) ^c	No.	Weighted % (95% CI) ^c
Concerns about possible safety risks to my baby	432	37.2 (32.9-41.6)	97	24.5 (17.1-33.3)	118	44.1 (35.9-52.7)	217	42.2 (35.5-49.1)
Plan to wait and see if it is safe and may get it	401	36.6 (32.3-41.1)	101	31.3 (22.3-41.5)	125	52.6 (43.9-61.1)	175	32.6 (27.0-38.6)
Concerned about possible safety risks to myself	376	34.6 (30.3-39.1)	71	24.0 (15.3-34.8)	98	38.7 (30.7-47.1)	207	39.6 (33.5-45.9)
Concerned that the COVID-19 vaccine was approved too fast	361	30.9 (27.2-34.7)	68	17.2 (12.1-23.3)	79	31.8 (24.2-40.1)	214	39.2 (33.2-45.5)
Concerned that the COVID-19 vaccine was developed too fast	353	29.7 (26.2-33.4)	63	14.0 (10.2-18.7)	79	29.3 (22.3-37.0)	211	40.1 (33.9-46.4)
Don't think the vaccine will prevent COVID-19	265	25.0 (20.8-29.5)	— ^d	— ^d	53	19.2 (13.5-26.1)	176	33.8 (27.7-40.2)
Plan to wait and get it after my pregnancy	256	21.6 (17.9-25.7)	86	25.4 (16.8-35.6)	79	29.9 (22.8-37.8)	91	15.4 (11.9-19.3)
Don't trust the government	239	21.6 (18.1-25.4)	29	7.6 (4.2-12.5)	35	14.9 (9.3-22.2)	175	33.7 (27.7-40.1)
Plan to use masks and other precautions instead	271	21.5 (18.6-24.6)	48	11.8 (7.4-17.6)	72	25.8 (19.6-32.9)	151	25.7 (21.1-30.8)
Don't think the vaccination is effective in preventing COVID-19	223	21.4 (17.7-25.5)	— ^d	— ^d	39	14.7 (9.7-20.9)	145	30.4 (24.5-36.8)
Not a member of any group that is at high risk	233	19.9 (16.4-23.8)	75	21.5 (14.2-30.4)	59	21.6 (15.5-28.7)	99	18.1 (13.6-23.4)
Concerned about having an allergic reaction to the vaccine	240	19.5 (16.5-22.9)	64	13.8 (9.8-18.5)	62	25.8 (18.7-33.9)	114	20.3 (15.6-25.7)
Not in one of the groups recommended to get the vaccine	221	18.3 (15.2-21.8)	94	24.5 (18.2-31.9)	60	20.2 (13.9-27.7)	67	13.4 (9.3-18.6)
My doctor has not recommended a COVID-19 vaccine to me	221	16.7 (13.8-20.0)	72	19.3 (12.4-27.8)	56	17.3 (12.4-23.2)	93	14.8 (11.5-18.6)
The vaccine could give me COVID-19	158	14.0 (10.6-18.1)	32	8.8 (5.3-13.6)	30	9.2 (5.8-13.7)	96	19.6 (13.3-27.3)
Don't like vaccines	137	13.8 (10.4-17.9)	— ^d	— ^d	25	10.2 (5.4-17.2)	91	17.9 (12.7-24.2)
Don't like needles	127	11.2 (8.1-15.0)	30	7.9 (4.8-12.0)	28	8.8 (5.5-13.4)	69	14.5 (8.8-22.0)
Afraid of being exposed to COVID-19 while getting the vaccine	158	10.8 (8.8-13.1)	42	8.4 (5.7-11.9)	39	12.0 (7.3-18.3)	77	11.7 (8.8-15.3)
Don't think vaccines are beneficial	114	10.0 (7.6-12.8)	17	4.1 (2.2-7.1)	15	4.7 (2.4-8.1)	82	16.2 (11.6-21.6)
The vaccine was/is not available	122	9.7 (7.5-12.2)	84	23.4 (17.1-30.7)	19	6.5 (3.5-10.9)	19	2.2 (1.1-3.9)
Concerned about the costs associated with the vaccine	124	9.6 (7.5-12.1)	44	10.9 (6.8-16.2)	36	14.5 (8.7-22.3)	44	6.5 (4.5-9.1)
Already had COVID-19 and should be immune	84	8.5 (6.0-11.6)	— ^d	— ^d	20	6.7 (3.8-10.8)	43	9.5 (5.8-14.6)
COVID-19 is not a serious illness	78	8.3 (5.7-11.7)	— ^d	— ^d	11	2.8 (1.1-5.6)	52	13.2 (8.2-19.7)
Don't know where to get it	68	6.9 (4.4-10.1)	37	13.5 (7.1-22.6)	19	7.7 (3.8-13.4)	12	2.3 (0.8-5.1)
Didn't know I needed a vaccine against COVID-19	78	6.6 (4.5-9.3)	22	4.3 (2.4-6.9)	24	10.3 (5.8-16.6)	— ^d	— ^d
My doctor/health care provider told me not to get the vaccine	81	6.4 (4.8-8.4)	31	8.0 (4.7-12.5)	— ^d	— ^d	33	5.3 (3.4-7.8)
Other	19	2.2 (1.2-3.6)	6	1.8 (0.5-4.5)	— ^d	— ^d	11	2.4 (1.1-4.5)

^aRespondents were asked, "There are many reasons why people may not get COVID-19 vaccinations. Which of the following are reasons you have not gotten a COVID-19 vaccination? Mark all the reasons that apply to you."

^bData source: Kahn et al.¹⁴

^cKorn-Graubard 95% CI.

^dThe estimate for vaccination coverage was suppressed because it did not meet National Center for Health Statistics' standards of reliability.²³

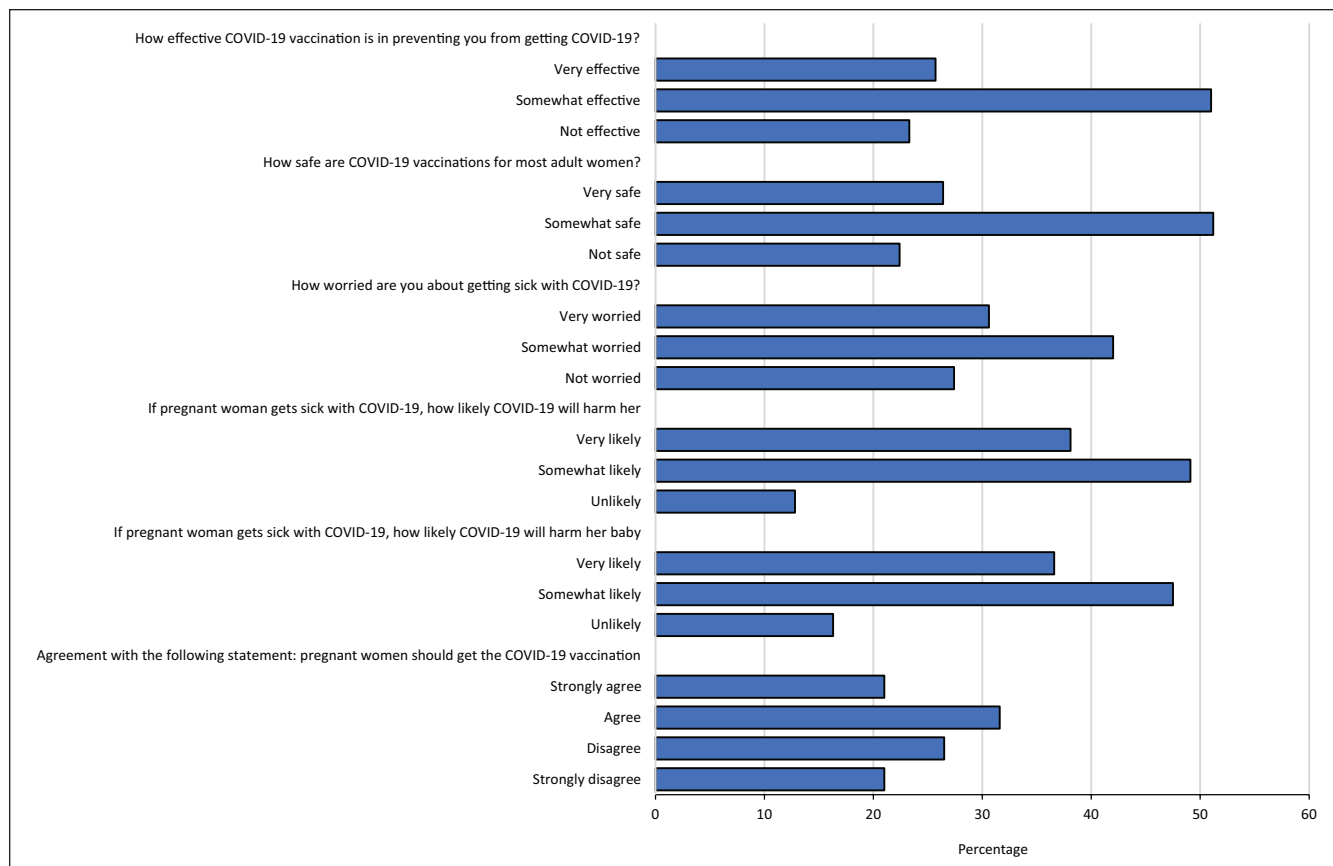


Figure 1. Attitudes about COVID-19 illness and vaccination among 1516 US women pregnant any time during December 1, 2020–April 16, 2021. Data source: Kahn et al.¹⁴

We observed lower intent for vaccination among pregnant women living in rural areas compared with women living in nonrural areas. CDC also noted lower vaccination coverage for adults aged ≥ 18 years based on an analysis of COVID-19 vaccine administration data, as well as for both influenza and tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccination among pregnant women from an earlier study, in 2020, where coverage was also lower in rural areas than in nonrural areas.^{14,28} Lower vaccination coverage and intent may be due to barriers such as access to vaccination and care, as well as higher levels of vaccine hesitancy in rural areas. Our analyses found higher levels of vaccine hesitancy among pregnant women living in rural areas compared with nonrural areas, with more than 50% reporting that they definitely/probably would not get a vaccine. Two other surveys also found that levels of vaccine hesitancy were highest in rural/nonmetropolitan communities; up to 40% of rural/nonmetropolitan residents reported that they would definitely not get a COVID-19 vaccine, compared with approximately 22% of metropolitan residents.^{29,30}

Health care providers are a trusted source of accurate vaccine information, and health care provider recommendation or offer of vaccination is a strong predictor of vaccination.^{14,30} Previous studies of influenza and Tdap (tetanus,

diphtheria, and acellular pertussis) vaccination showed that vaccination coverage is higher among pregnant women with a recommendation and/or offer for vaccination, and we observed similar findings for COVID-19 vaccination.¹⁴ In our study, 53% of pregnant women surveyed received a health care provider recommendation for COVID-19 vaccination; of those, almost one-third received a vaccine and more than one-quarter intended to get the vaccine during pregnancy. At the time the survey was implemented, pregnant women were eligible for and could receive any of the 3 COVID-19 vaccines that were available through the Emergency Use Authorization.⁹ However, since then, with increased real-world evidence about the safety and effectiveness of COVID-19 vaccination during pregnancy, CDC,^{7,8} the American College of Obstetricians and Gynecologists,³¹ and the Society for Maternal–Fetal Medicine³² have updated their guidance to strengthen the recommendation that pregnant women should receive COVID-19 vaccination. These recommendations have been widely disseminated and endorsed by many clinical professional organizations.³³ A set of strategies that includes engaging with hospital and health care systems, local and national professional associations, and medical societies; building confidence in COVID-19 vaccination; and providing tools and resources to help health

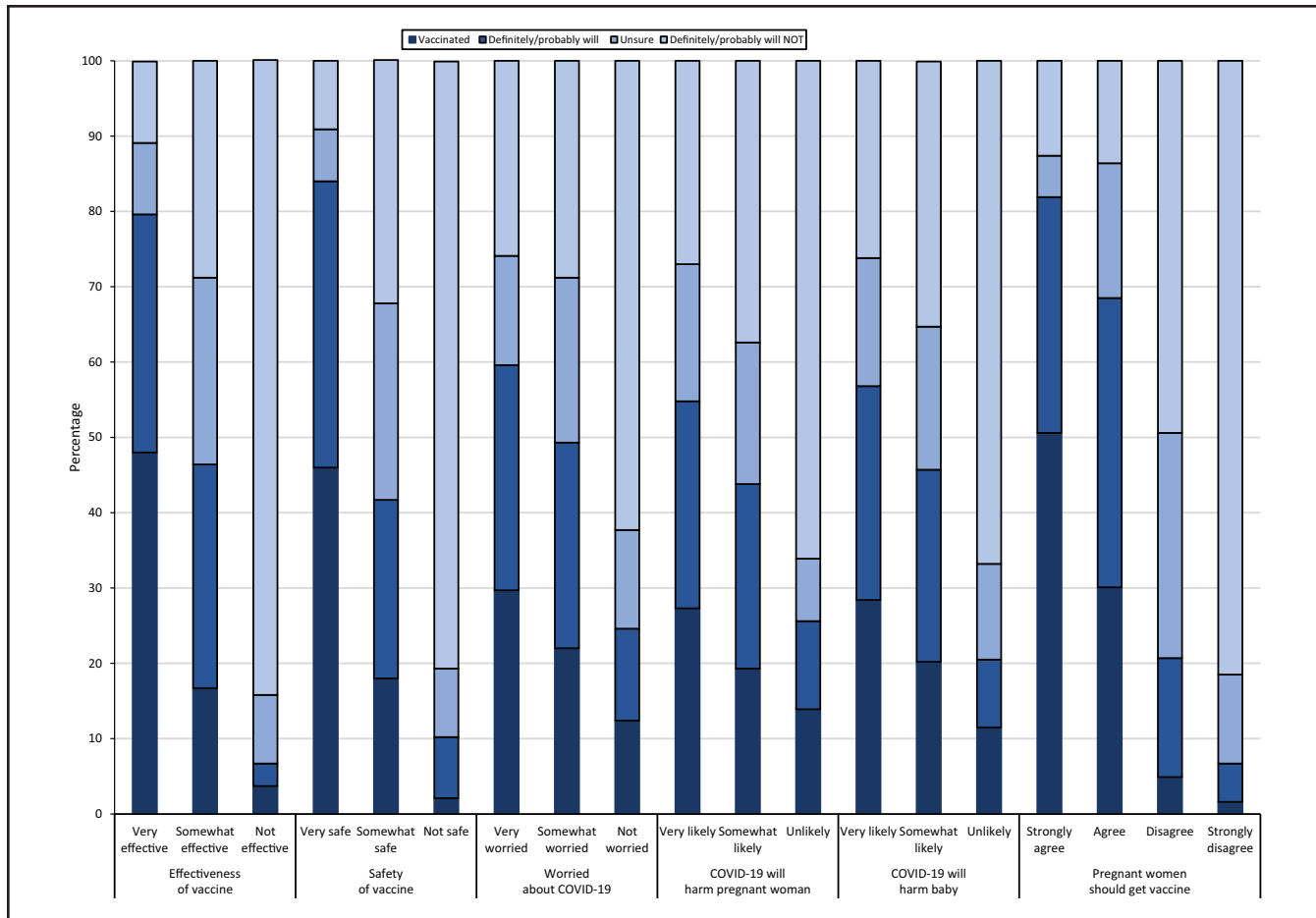


Figure 2. Receipt of ≥ 1 dose of COVID-19 vaccine during pregnancy and intent to receive a COVID-19 vaccination among 1516 women pregnant any time during December 1, 2020–April 16, 2021, by attitudes, internet panel survey, United States, April 2021. Respondents pregnant since December 1, 2020, who had not been fully vaccinated against COVID-19 before their pregnancy were included in the analysis. Those who reported receiving ≥ 1 dose of COVID-19 vaccine during their pregnancy were considered vaccinated. Respondents who reported not receiving a COVID-19 vaccination were asked how likely they are to get a COVID-19 vaccine ($n = 1128$); response options included definitely will, probably will, unsure, probably will not, and definitely will not get a COVID-19 vaccine. Data source: Kahn et al.¹⁴

care providers and medical support staff with vaccine conversations could help empower health care providers and promote confidence in their decision to recommend vaccination to their patients.³⁴

Finally, vaccine hesitancy, regardless of vaccine type, among pregnant women is well documented.³⁵ Vaccine hesitancy, combined with concerns about the safety of COVID-19 vaccine because of its fast development and approval process, likely contributes to lower coverage among pregnant women. Current analyses and earlier surveys on vaccination intent among pregnant women showed low acceptance of COVID-19 vaccination in this population; limited data on safety and the possibility of fetal harm were among the most frequently reported reasons for lack of intent to get vaccinated during pregnancy.³⁶⁻³⁸ Safety monitoring is ongoing, and additional data on the safety of COVID-19 vaccines for pregnant women and their infants will continue to be made

available.³⁹⁻⁴¹ Furthermore, recent reports showed that people who received COVID-19 mRNA vaccine during pregnancy passed antibodies to their fetuses, which could help protect them after birth; thus, additional studies are needed.⁴²

Limitations

This study had several limitations. First, while quota sampling and raking calibration procedures for poststratified weights result in point estimates that are likely demographically representative of the population of pregnant women in the United States, the calculation of SEs assumed a probability sample had been used. However, there was no probability of selection for each respondent because the internet panel survey was opt-in.²² Second, a potential for nonresponse and noncoverage bias may exist in the parameter estimates because of the self-selection process for entry into the panel

and participation in the survey. Previous literature suggests that the respondents of panel surveys may be more frequent internet users compared with the general population and may have attitudinal and behavioral differences that may result in different vaccination coverage.^{43,44} However, in sensitivity analyses, we did not find any significant trend or association between COVID-19 vaccination coverage and frequency of internet use among survey participants. In addition, although the point estimates may be biased, the measure of association is usually less affected by nonprobability sampling.^{45,46} Third, vaccination status was self-reported and not validated by medical record review and might be subject to recall or social desirability bias; however, previous vaccination coverage estimates from this survey have been similar to published estimates based on health care provider–reported data.⁴⁷ Fourth, some subgroups, such as non-Hispanic Asian women, had small sample sizes, and we were not able to assess vaccination coverage in those groups. Finally, we could not assess the effect of the pause in the Jansen (Johnson & Johnson) vaccine that occurred in April 2020 with this survey; however, we did not anticipate an effect on vaccination uptake given the increasing vaccination coverage in this population.²⁶

Despite these limitations, internet panel surveys are considered a useful assessment tool for timely evaluation of maternal vaccination coverage among pregnant women. In addition, this survey collected detailed information, not available from other sources, about timing of vaccination during pregnancy, commonly perceived barriers and reasons for vaccination in the context of pregnancy and COVID-19, and whether health care provider recommendation was received for COVID-19 vaccination during pregnancy.

Conclusions

Achieving high vaccination coverage is the most promising strategy to end the COVID-19 pandemic. Our findings provide insight into potential barriers to uptake of vaccination as well as knowledge, attitudes, and beliefs around both COVID-19 illness and vaccination among pregnant women. Although COVID-19 vaccination coverage is low among pregnant women in the United States, coverage may increase given the recent strengthening of recommendations and endorsement by many clinical professional organizations for COVID-19 vaccination for pregnant women^{7,8,31,32} and as access improves and more safety data become available. Addressing barriers to access and vaccine misinformation and hesitancy and generating additional scientific evidence on the safety and effectiveness of COVID-19 vaccines are critical for increasing vaccination uptake among pregnant women and women of childbearing age and ensuring equitable access to vaccines, especially as surges of new variants occur.⁴⁸ Finally, continued widespread dissemination of accurate and timely information through multiple channels of communication, including health care providers, pregnant

women, and women of childbearing age, could increase confidence and acceptance of COVID-19 vaccines in this population.

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Supplemental Material

Supplemental material for this article is available online.

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