

# COVID-19 vaccine uptake and attitudes among pregnant and postpartum parents



Kandice A. Kapinos, PhD; Maria DeYoreo, PhD; Rebecca Lawrence, BA; Molly Waymouth, MPH; Lori Uscher-Pines, PhD

**BACKGROUND:** Pregnancy poses increased risks from COVID-19, including hospitalization and premature delivery. Yet pregnant individuals are less likely to have received a COVID-19 vaccine.

**OBJECTIVE:** This study aimed to investigate COVID-19 vaccine uptake and reasons for delay or refusal among perinatal parents.

**STUDY DESIGN:** A total of 1542 eligible parents who delivered between 2019 and 2021 were surveyed through the Ovia parenting app, which has a nationally representative user base. Adjusted and nationally weighted means were calculated. Multivariate logistic regression and survival models were used to examine uptake.

**RESULTS:** At least 1 dose of the COVID-19 vaccine was received by 70% of the parents. Those with a bachelor's or graduate degree were significantly more likely to have received a vaccine relative to those with some college or less (adjusted odds ratio for bachelor's degree, 1.854; 95% confidence interval, 1.19–2.90; adjusted odds ratio for graduate

degree, 2.833; 95% confidence interval, 1.69–4.75). Parents living in rural areas were significantly less likely to have received a vaccine relative to those living in urban areas (adjusted odds ratio for small city, 0.62; 95% confidence interval, 0.45–0.86; adjusted odds ratio for rural area, 0.56; 95% confidence interval, 0.35–0.89); 56% (281/502) of unvaccinated parents considered that the vaccine “was too new.” Among those pregnant in 2021, 44% (258/576) received at least 1 dose, and 34% (195/576) reported that pregnancy had “no impact” on their vaccine decision.

**CONCLUSION:** There was significant heterogeneity in vaccine uptake and attitudes toward vaccines during pregnancy by sociodemographics and over time. Public health experts need to consider and test more tailored approaches to reduce vaccine hesitancy in this population.

**Keywords:** COVID-19 vaccines, pregnancy, vaccine hesitancy

## Introduction

COVID-19 vaccines are critical for pregnant people because pregnancy poses an increased risk of contracting COVID-19, being hospitalized, and giving birth prematurely.<sup>1–6</sup> Despite no evidence of safety risks for pregnant people and their offspring, and significant evidence of risks from SARS CoV-2 infection, COVID-19 vaccine acceptance and uptake in the perinatal population has lagged behind the general population.<sup>7</sup> The Centers for Disease Control and Prevention (CDC) currently estimates that approximately 67% of pregnant people were vaccinated as of January 2022, whereas nationally, approximately 77% of women aged 18 to 39 years were vaccinated.<sup>8</sup>

Although the first COVID-19 vaccines became available in the United States in 2020 for individuals aged  $\geq 16$  years, strong recommendations

## EDITOR'S CHOICE

regarding vaccination for pregnant and lactating parents came later, after analyses of vaccine surveillance data found no safety concerns.<sup>9</sup> Several subsequent studies have provided greater evidence supporting these recommendations.<sup>9–14</sup> In addition, new evidence has shown that infants benefit from maternal COVID-19 vaccination, with lower rates of hospitalization from COVID-19 infection during the first 6 months of life relative to infants with unvaccinated mothers<sup>15</sup> and greater antibody persistence relative to infants whose mothers had a natural SARS-CoV-2 infection.<sup>16</sup>

Undervaccination in this group may be occurring for several reasons. Previous research on vaccine uptake has emphasized the “5 Cs” as explanatory drivers for hesitancy: confidence, calculation of risks, constraints, complacency, and collective responsibility.<sup>17</sup> Confidence reflects individuals' beliefs about the safety and efficacy of the COVID-19 vaccine, which may have been diminished among this population because of concerns about insufficient testing in pregnant and postpartum individuals. In fact, early guidelines

were somewhat equivocal, with unclear guidance for pregnant people given their lack of representation in early clinical trials.<sup>18</sup> Related to this, calculations of risks were likely affected both by the confidence in the scientific evidence and by the significant misinformation about safety and effectiveness.<sup>19,20</sup> There were false claims that the COVID-19 vaccine affected fertility, increased miscarriage risks, and negatively affected male reproductive organs.<sup>21,22</sup> Constraints, including physical access or availability were less likely to be an issue in many communities in the United States, but complacency owing to perceptions that COVID-19 is “just a flu” and greater emphasis on individualism vs collectivism in the United States are ongoing challenges.<sup>23,24</sup>

Although previous work has documented that a significant proportion of people (including those who work in healthcare settings) are delaying or forgoing vaccination,<sup>20,25</sup> we know little about how decisions among birthing parents evolved over time as the pandemic progressed and the key factors in decisions to delay or refuse COVID-19 vaccines. This lack of information is preventing public health officials from

**Cite this article as:** Kapinos KA, DeYoreo M, Lawrence R, et al. COVID-19 vaccine uptake and attitudes among pregnant and postpartum parents. *Am J Obstet Gynecol MFM* 2022;4:100735.

2589-9333/\$36.00

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<http://dx.doi.org/10.1016/j.ajogmf.2022.100735>

## AJOG MFM at a Glance

**Why was this study conducted?**

More than 1500 new/expecting mothers who delivered between 2019 and 2021 were surveyed to investigate COVID-19 vaccine uptake and reasons for delay because there are significant benefits to vaccination for this population and their offspring.

**Key findings**

More than 70% had at least 1 dose of the COVID-19 vaccine, and 56% of unvaccinated parents considered that the vaccine “was too new.” Among those pregnant in 2021, 44% received at least 1 dose, and 34% reported that pregnancy had “no impact” on their vaccine decision.

**What does this add to what is known?**

There was significant heterogeneity in vaccine uptake and attitudes about vaccines during pregnancy by sociodemographics and over time.

more effectively tailoring communications to parents in the perinatal period and from designing interventions to combat misinformation about COVID-19 vaccines and other vaccines recommended during pregnancy. In this study, we examined the COVID-19 vaccine uptake and reasons for delay or refusal among perinatal parents who delivered infants from 2019 to 2021. We examined variation among individuals who were pregnant when the vaccine became available to the public and how pregnancy affected individuals' decision to receive vaccination.

**Materials and Methods****Study design and population**

In this cross-sectional study, we surveyed mothers from October to January 2022 across 3 “birth” cohorts based on the date of delivery: (1) July to December 2019 (infants aged 22–26 months at the time of survey), (2) March to May 2020 (infants aged 17–20 months at the time of survey), and (3) June to August 2021 (infants aged 2–5 months at the time of survey). Parents of multiples were instructed to answer the survey for the first-born child in a given cohort.

Active users of the Ovia parenting app (Ovuline, Inc. Boston, MA.) from Ovia's suite of parenting and pregnancy apps available in the United States for free download on iOS and Android devices were invited to complete our anonymous survey. Recruitment occurred until we obtained approximately 1500

respondents. Several previous studies have sampled Ovia users, who seem similar to the national population of birthing parents with respect to demographic characteristics.<sup>26–29</sup> Participants received a \$10 Amazon e-gift card for completing the survey. RAND's Institutional Review Board approved the study.

Users aged 18 to 45 years with infants born in 1 of the 3 birth cohorts delineated above were eligible. The survey instrument included 40 questions on vaccination status, including the month of receipt, several sociodemographic questions (mother's age, race/ethnicity, state of residence, urbanicity of residence, health insurance status, level of education, marital status, and income), and questions about breastfeeding. A draft version of the survey was assessed with 6 Ovia app users who gave birth in the spring of 2021. The survey was then revised to improve clarity and flow following cognitive testing.

**Measures**

Our primary outcome measure was receipt of COVID-19 vaccine according to the respondent's self-report of having received at least 1 dose as of January 2022. We examined receipt among our full sample and among those who were pregnant in the spring of 2021 when the COVID-19 vaccine first became available to the public. In addition, we calculated frequencies of the reasons reported for not receiving vaccination and the role of pregnancy in influencing decisions regarding vaccine receipt.

We examined outcomes in multivariate regression models adjusting for key sociodemographic and delivery measures: birthing parent's age category (18–24, 25–29, 30–34, ≥35), race/ethnicity (Black/African American, White, Hispanic, other), education (high school degree or less, some college, college degree, or graduate degree or higher), annual income category (<\$25,000, \$25,000–\$39,999, \$40,000–\$54,999, \$55,000–\$79,999, ≥\$80,000, not reported), marital status, health insurance (private/commercial, public, or self-pay), urbanicity of residence (large city, small city or town, suburb near a large city, or rural area), whether the infant had a neonatal intensive care unit stay at delivery, whether the infant was ever breastfed, and weeks of gestation at delivery.

**Statistical analysis**

We calculated sample descriptive statistics, including unadjusted means of our outcome variables that were weighted to be nationally representative for comparison with other estimates of vaccination rates among pregnant persons. Weights were calculated with CDC data on national births in 2019 using a raking procedure.<sup>30</sup> We used multivariate logistic regression and a Cox proportional-hazards model to examine correlates of vaccine receipt (yes/no) and timing (time to event), respectively. Hazard models are appropriate for modeling time to event analyses. In these models, we adjusted for maternal sociodemographics, infant characteristics at delivery, and delivery month and year. We calculated frequencies of reasons for not receiving vaccination stratified by birthing parent sociodemographics (age group, race/ethnicity, and educational attainment). Finally, we examined whether parents who were pregnant in the spring of 2021 reported that pregnancy affected their decision to receive vaccination. Statistical significance was determined using *P* values of <.05.

**Results**

A total of 6184 Ovia users clicked on the advertisement that explained the survey opportunity, and 1617 (26%) of those

were eligible (ie, delivered during the 3 periods of interest) to participate. After excluding observations with item nonresponse of our key measures, our analytical sample included 1542 parents (95%). In [Table 1](#), we report unweighted sample descriptive statistics for the full sample and stratified by vaccination status. The weighted proportion of parents in the full sample who reported receiving at least 1 dose of the COVID-19 vaccine was 70% (95% confidence interval [CI], 55–74) as of January 2022, with an average vaccination date of May 2021 for the first dose. We found statistically significant differences in maternal age, race/ethnicity, education, marital status, income, and urbanicity of residence by vaccination status.

In [Table 2](#), we report the adjusted odds ratios (aORs) and hazard ratios (aHRs) from the logistic and Cox proportional-hazards models, respectively. Across both models, there seemed to be an education gradient, with parents with a bachelor's degree or graduate degree being significantly more likely to have received  $\geq 1$  COVID-19 vaccines compared with those with some college or less (aOR for bachelor's degree, 1.854; 95% CI, 1.19–2.90; aOR for graduate degree, 2.833; 95% CI, 1.69–4.75; aHR for bachelor's degree, 1.574; 95% CI, 1.20–2.06; aHR for graduate degree, 2.078; 95% CI, 1.56–2.76). We also found consistent evidence that parents living in rural areas or small cities/towns were significantly less likely to have received COVID-19 vaccines compared with those in urban areas (aOR for small city, 0.62; 95% CI, 0.45–0.86; aOR for rural area, 0.56; 95% CI, 0.35–0.89; aHR for small city, 0.70; 95% CI, 0.59–0.84; aHR for rural area, 0.62; 95% CI, 0.47–0.82).

[Figure 1](#) shows the reasons parents reported not receiving  $\geq 1$  COVID-19 vaccines across the full sample of unvaccinated parents (shown in pink) and by racial/ethnic groups where we found significant differences (chi-square  $P < .05$ ). The most common reasons for lack of receipt were related to the newness (56%) and lack of trust in the vaccine (32%) and concerns related to harms to fertility (27%) and to the

infant (36%). The most frequently reported reason for not receiving the vaccine (vaccine was too new) was the same across all racial/ethnic groups; however, 67% (95% CI, 61–73) of unvaccinated White parents vs 55% of Black/African American (95% CI, 41–68) and 55% of Latinx parents (95% CI, 45–64) reported this reason. White parents were also more likely to report that they did not receive the vaccination because they were concerned that it would affect their fertility (40% [95% CI, 34–46]) compared with Black/African American (19% and 20% [95% CI, 8–30]) and Latinx parents (20% [95% CI, 12–27]), and also more likely to report that they were concerned it could harm their infant (49% [95% CI, 42–55] vs 34% of Black/African American [95% CI, 21–47] and 34% of Latinx parents [95% CI, 25–43]).

Next, we present results weighted nationally among parents who were pregnant in the spring of 2021 when COVID-19 vaccines first became available to the public ([Figure 2](#)). Overall, 44% (95% CI, 43–51) obtained at least 1 dose of the COVID-19 vaccine by January 2022, with 36% receiving the vaccine during pregnancy and 8% only after birth. There were stark differences in vaccine receipt and timing by educational attainment. Among those with a high school degree or less, only 29% received at least 1 dose during pregnancy, but an additional 19% received  $\geq 1$  doses after birth. However, among those with some college, we did not observe the same pattern, with only 18% having received a dose during pregnancy and an additional 1% reporting  $\geq 1$  doses after delivery. Among parents with a bachelor's degree or graduate degree, vaccination rates overall were greater than among the other groups, with the large majority of those who were vaccinated choosing to do so during pregnancy rather than delaying until after giving birth.

Among those pregnant in 2021, we asked about the impact that pregnancy had on their decision-making regarding the COVID-19 vaccine. More than one-third ( $n=195$ , 34%) reported that being pregnant had “no impact” on their

decision regarding vaccination, and 161 (28%) reported that being pregnant encouraged them to receive vaccination earlier than they would have otherwise ([Figure 3](#)). Only 40 (7%) reported that being pregnant made them less interested in receiving vaccination vs 133 (23%) who reported that being pregnant made them more interested in receiving vaccination; 90 (16%) reported that they delayed vaccination because of their pregnancy.

## Discussion

### Principal findings

Among parents using a popular pregnancy and parenting app targeted for sample inclusion, we found that approximately 70% had received at least 1 dose of the COVID-19 vaccine as of January 2022, but vaccination rates varied considerably by parental education and urbanicity. Reasons for not getting vaccinated were predominately related to concerns about the newness and safety of the vaccine, with White parents reporting these concerns at much higher rates than Black/African American or Latinx parents.

### Results in the context of what is known and clinical implications

The increased rate of these concerns among White people relative to minority parents is somewhat surprising given that previous research has shown higher rates of vaccine hesitancy among some minoritized racial/ethnic groups.<sup>31,32</sup> Our findings might be because of the fact that our sample included a disproportionate share of parents with college or graduate degrees, across all race/ethnic groups, and those individuals are less likely to be vaccine-hesitant.<sup>29,30,33,34</sup> Given that concerns related to the vaccine being new and questions about safety are consistently among the top reasons for not receiving vaccination overall and across subgroups, public health and clinical providers should focus on efforts to address those concerns.

Studies on effective strategies to reduce vaccine hesitancy among pregnant women have found some evidence that providing education and

**TABLE 1**  
**Sample descriptive statistics stratified by COVID-19 vaccination status**

Measures	Full sample (n=1542)		COVID-19 vaccine status as of January 2022				P value
			Had at least 1 dose (n=1105)		Had no doses (n=437)		
<b>Delivery date</b>							
Prepandemic (July 2019–Dec. 2019)	501	(32%)	337	(30%)	164	(38%)	.01
Early pandemic (March 2020–May 2020)	504	(33%)	362	(33%)	142	(32%)	
Late pandemic (June 2021–Aug. 2021)	537	(35%)	406	(37%)	131	(30%)	
Infant NICU stay	187	(12%)	133	(12%)	54	(12%)	.86
Ever breastfed	1446	(94%)	1039	(94%)	407	(93%)	.51
<b>Week of gestation at delivery</b>							
23–28	10	(1%)	7	(1%)	3	(1%)	.61
29–32	20	(1%)	15	(1%)	5	(1%)	
33–36	121	(8%)	81	(7%)	40	(9%)	
37–38	410	(27%)	285	(26%)	125	(29%)	
39–40	794	(51%)	583	(53%)	211	(48%)	
≥41	187	(12%)	134	(12%)	53	(12%)	
<b>Maternal age (y)</b>							
18–24	179	(12%)	102	(9%)	77	(18%)	.00
25–29	417	(27%)	246	(22%)	171	(39%)	
30–34	518	(34%)	395	(36%)	123	(28%)	
≥35	428	(28%)	362	(33%)	66	(15%)	
<b>Maternal race/ethnicity</b>							
White	881	(57%)	640	(58%)	241	(55%)	.01
Other	148	(10%)	111	(10%)	37	(8%)	
Black/African American	142	(9%)	89	(8%)	53	(12%)	
Hispanic/Latinx	371	(24%)	265	(24%)	106	(10%)	
<b>Maternal education</b>							
High school degree or less	227	(15%)	122	(11%)	105	(24%)	.00
Some college	425	(28%)	241	(22%)	184	(42%)	
Bachelor's degree	492	(32%)	392	(35%)	100	(23%)	

(continued)

TABLE 1

## Sample descriptive statistics stratified by COVID-19 vaccination status (continued)

Measures	Full sample (n=1542)		COVID-19 vaccine status as of January 2022				P value
			Had at least 1 dose		Had no doses		
Graduate degree	398	(26%)	350	(32%)	48	(11%)	
Married	1260	(82%)	935	(85%)	170	(74%)	.00
Private health insurance	1167	(76%)	906	(82%)	261	(60%)	
Public health insurance	344	(22%)	182	(16%)	162	(37%)	
Uninsured	31	(2%)	17	(2%)	14	(3%)	
Annual household income							
<\$25,000	155	(10%)	88	(8%)	67	(15%)	.00
\$25,000–\$39,999	237	(15%)	126	(11%)	111	(25%)	
\$40,000–\$54,999	191	(12%)	121	(11%)	70	(16%)	
\$55,000–\$79,999	208	(13%)	143	(13%)	65	(15%)	
≥\$80,000	645	(42%)	551	(50%)	94	(22%)	
No answer	106	(7%)	76	(7%)	30	(7%)	
Urbanicity							
A large city	409	(27%)	301	(27%)	108	(25%)	.00
Suburb near large city	589	(38%)	476	(43%)	113	(26%)	
Small city or town	417	(27%)	256	(23%)	161	(37%)	
Rural area	127	(8%)	72	(7%)	55	(13%)	

Data are presented as frequencies and column percentages (weighted to match national population estimates) in parentheses. The P value is based on the chi-square test for differences in measures/categories by vaccination status.

NICU, neonatal intensive care unit.

Kapinos. COVID-19 vaccine uptake among pregnant and postpartum parents. *Am J Obstet Gynecol MFM* 2022.

TABLE 2

## Adjusted odds ratios and hazard ratios for receipt of any COVID-19 vaccine and month of receipt

Measures	Logistic (DV=vaccinated)		Cox proportional-hazards model	
	OR	95% CI	HR	95% CI
<b>Delivery date</b>				
Prepandemic (July 2019–Dec 2019)	Reference			
Early pandemic (March 2020–May 2020)	1.36 <sup>a</sup>	(1.01–1.83)	1.20 <sup>a</sup>	(1.02–1.40)
Late pandemic (June 2021–Aug 2021)	1.30	(0.96–1.76)	1.05	(0.90–1.22)
Infant NICU stay (yes)	1.23	(0.81–1.86)	1.19	(0.96–1.48)
Ever breastfed (yes)	0.98	(0.59–1.60)	0.93	(0.72–1.20)
<b>Week of gestation at delivery</b>				
23–28	Reference			
29–32	1.63	(0.27–9.95)	1.18	(0.47–2.96)
33–36	0.81	(0.18–3.73)	0.94	(0.43–2.06)
37–38	0.89	(0.20–3.92)	0.97	(0.45–2.09)
39–40	0.80	(0.18–3.56)	1.02	(0.47–2.18)
≥41	0.83	(0.18–3.78)	0.95	(0.44–2.06)
<b>Maternal age (y)</b>				
18–24	Reference			
25–29	0.65 <sup>a</sup>	(0.43–0.97)	0.78	(0.60–1.01)
30–34	0.82	(0.52–1.29)	0.92	(0.70–1.20)
≥35	1.29	(0.78–2.12)	1.11	(0.84–1.47)
<b>Maternal race/ethnicity</b>				
White	Reference			
Other	1.26	(0.80–1.99)	0.90	(0.73–1.11)
Black/African American	0.66	(0.42–1.01)	0.73 <sup>b</sup>	(0.57–0.92)
Hispanic/Latinx	1.13	(0.83–1.53)	0.98	(0.84–1.13)
<b>Maternal education</b>				
High school degree or less	Reference			
Some college	0.86	(0.59–1.25)	0.94	(0.73–1.20)
Bachelor's degree	1.85 <sup>b</sup>	(1.19–2.90)	1.57 <sup>b</sup>	(1.20–2.06)
Graduate degree	2.83 <sup>c</sup>	(1.69–4.75)	2.08 <sup>c</sup>	(1.56–2.76)
Married	0.83	(0.59–1.17)	0.90	(0.74–1.09)
Private health insurance	1.64 <sup>a</sup>	(1.09–2.49)	1.24	(0.96–1.61)
Public health insurance	0.87	(0.56–1.35)	0.93	(0.71–1.21)
Uninsured	Reference			
<b>Annual household income</b>				
<\$25,000	Reference			
\$25,000–\$39,999	0.71	(0.45–1.11)	0.74 <sup>a</sup>	(0.55–0.98)
\$40,000–\$54,999	0.94	(0.57–1.54)	0.92	(0.68–1.24)
\$55,000–\$79,999	0.83	(0.48–1.41)	0.95	(0.69–1.30)
≥\$80,000	1.30	(0.77–2.20)	1.23	(0.91–1.66)

(continued)

**TABLE 2**  
**Adjusted odds ratios and hazard ratios for receipt of any COVID-19 vaccine and month of receipt** (continued)

Measures	Logistic (DV=vaccinated)		Cox proportional-hazards model	
	OR	95% CI	HR	95% CI
No answer	0.94	(0.51–1.71)	0.96	(0.68–1.36)
<b>Urbanicity</b>				
A large city	Reference			
Suburb near large city	1.23	(0.88–1.70)	1.02	(0.88–1.19)
Small city or town	0.62 <sup>b</sup>	(0.45–0.86)	0.70 <sup>c</sup>	(0.59–0.84)
Rural area	0.56 <sup>a</sup>	(0.35–0.89)	0.62 <sup>c</sup>	(0.47–0.82)

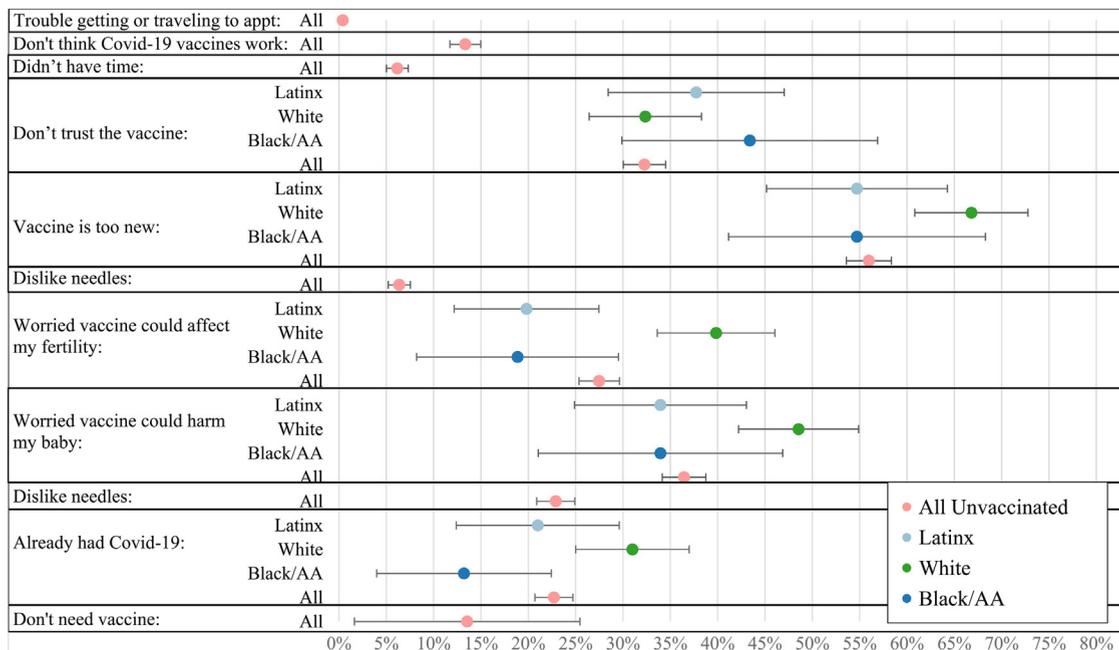
All covariates shown were included in the estimation models.

CI, confidence interval; DV, dependent variable; HR, hazard ratio; OR, odds ratio.

<sup>a</sup> P<.10; <sup>b</sup> P<.05; <sup>c</sup> P<.01.

Kapinos. COVID-19 vaccine uptake among pregnant and postpartum parents. Am J Obstet Gynecol MFM 2022.

**FIGURE 1**  
**Percentage of nonvaccinated parents reporting reasons for not receiving vaccine**



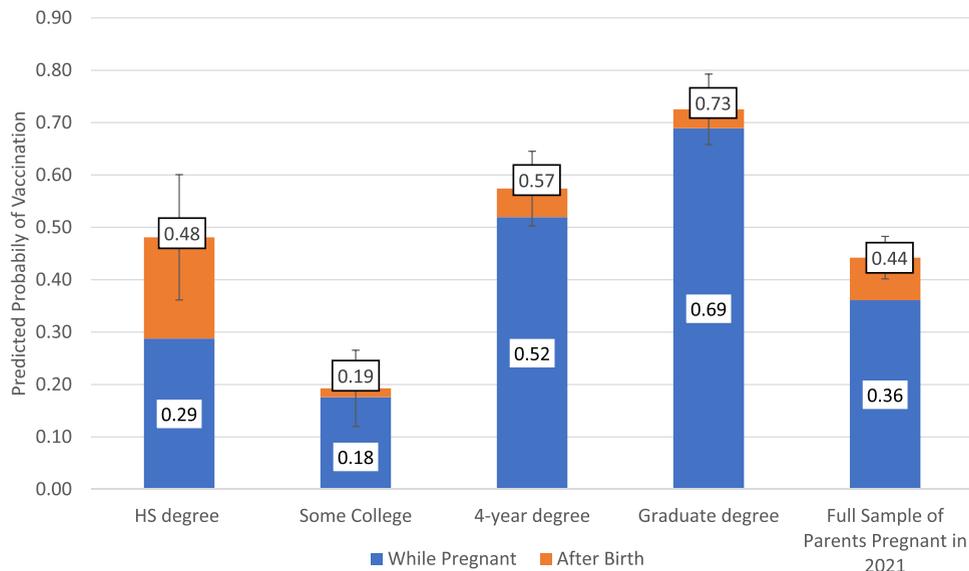
The frequencies of reasons given for not being vaccinated by unvaccinated parents as percentages of all unvaccinated parents and subgroups by race/ethnicity.

“All” n=437; Latinx n=106; Black/AA n=53. We did not report results separately for those in the “other” race/ethnicity because of small samples (n=37). Respondents indicating no COVID-19 vaccination receipt were asked: “There are different reasons why people do not get vaccinated for COVID-19. What are the main reasons why you have not received a COVID-19 vaccine? Check all that apply.” In cases where there were no statistically significant differences across racial/ethnic groups in the reasons reported for not obtaining a vaccine, only the percentage of all unvaccinated parents is reported; 95% confidence intervals shown.

AA, African American.

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**FIGURE 2**  
**Percentage of late pandemic parents with 1+ dose**



Vaccination uptake among parents pregnant during 2021 stratified by educational attainment. Uptake is reported for receipt during pregnancy and after birth.

Full sample of parents pregnant in 2021, n=576; HS degree n=68; some college n=114; 4-year degree n=186; graduate degree n=170. We did not report results separately for those with missing education because of small samples (n=38); 95% confidence intervals shown.

HS, high school.

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information to expectant parents, providing additional training to medical staff, and leveraging health system tools (eg, clinical decision supports) can improve vaccine uptake.<sup>35,36</sup> However, misinformation surrounding the COVID-19 vaccine has reached new levels as internet platforms and social media have made it easy for misinformation to spread.<sup>37–39</sup> One approach may be to frame the vaccine educational information preemptively to expectant parents, warning about misinformation that they may encounter as they try to decide about whether the vaccine is right for them (incidentally referred to as “inoculation” in the communications literature).<sup>40,41</sup> Of course, this requires additional time from already time-constrained providers and resources to remain informed about the latest conspiracy theories or falsehoods being shared.

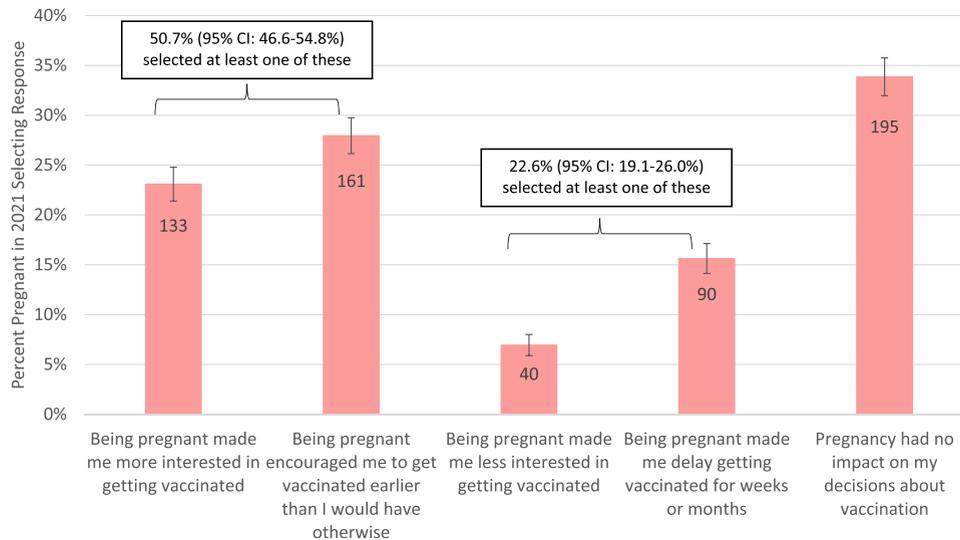
In addition, providers need to be honest with patients in cases where the

scientific evidence is unclear to not undermine credibility and trust, particularly among racial and ethnic groups among which medical mistrust persists because of historic mistreatment both directly within medicine, but also more systemically within US society.<sup>42</sup> For example, early in 2021, there were limited data on vaccine safety during pregnancy, with postadministration surveillance analyses only being published in April 2021 in the United States. The studies indicated that vaccination did not increase miscarriage risk.<sup>43</sup> Pregnant individuals who endeavored to “research” vaccine safety themselves would have found significant variation internationally in recommendations for COVID-19 vaccination during pregnancy.<sup>44</sup> Taken together, patient concerns about unknown safety and efficacy of the vaccine (at least early on) suggest that providers needed to acknowledge evidence uncertainty while at the same time presenting the risks

from COVID-19 infection during pregnancy. This can improve both patients’ confidence and risk calculations—2 key factors in vaccine hesitancy.

There was significant heterogeneity in the reported impact of pregnancy on vaccine decision-making. Overall, more than half of respondents reported that being pregnant increased their interest in vaccination, including 28% who reported wanting to get vaccinated earlier. However, approximately 23% were less interested or deliberately delayed getting vaccinated because of pregnancy. This suggests that improving uptake may require addressing different challenges among the “5 Cs” depending on parental attitudes. Those who have positive attitudes about receiving vaccination during pregnancy but have not yet received all doses may have practical constraints (eg, difficulty in taking time off from work), or may become complacent as case rates wane. Those who have negative attitudes may be exposed to

**FIGURE 3**  
**Reported impact of pregnancy on decision to receive vaccination**



Distribution of responses to the question “What impact did pregnancy have on your decisions about COVID-19 vaccination? Check all that apply.” n=576. Respondents who gave birth in 2021 were asked: “What impact did pregnancy have on your decisions about COVID-19 vaccination? Check all that apply.”

CI, confidence interval.

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more misinformation, which requires a different approach.

### Research implications

More research is needed to test these different strategies to determine the most effective approaches for improving uptake among these different populations.

### Strengths and limitations

Our study provides insight into the evolution of parental decisions to obtain the COVID-19 vaccine over time and the key reasons for vaccine refusal, which is critical to developing public health and provider approaches for increasing vaccine uptake. We note the following limitations. Although our sample was drawn from a nationally representative user base that has been used in several other studies, eligible parents (delivering in the windows of interest in 2019, 2020, and 2021) had to decide to participate in the study, which means our results may not be representative. The advantage, however, of our use of online surveys from a popular

platform used by new and expecting parents is that we were able to survey a relatively large and geographically dispersed population of parents. Because our study relied on self-reported survey data and did not include items on all measurable parental characteristics, the usual concerns of potential biases from survey research, including recall bias (particularly among those pregnant in 2019), social desirability bias, and omitted variables bias apply.<sup>45</sup>

### Conclusions

We found that in our sample of parents in the perinatal period, vaccination rates were lower than among all adults aged 18 to 45 years in the United States, largely because of reasons that are particularly salient for this population (fertility and infant safety).<sup>8</sup> We also found significant variation in the timing of vaccine receipt among those who were pregnant in 2021 and a nonlinear correlation of vaccination status with education. Taken together, public health experts need to consider and test more tailored approaches to reduce vaccine

hesitancy among pregnant and postpartum parents who are uniquely vulnerable to COVID-19. ■

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### Author and article information

From the RAND Corporation, Arlington, VA (Dr Kapinos, Ms Lawrence, Ms Waymouth, and Dr Uscher-Pines); Peter O'Donnell Jr. School of Public Health, The University of Texas Southwestern Medical Center, Dallas, TX (Dr Kapinos); RAND Corporation, Santa Monica, CA (Dr Deyoreo).

Received Aug. 10, 2022; accepted Aug. 22, 2022.

The authors report no conflict of interest.

This study was supported by grants from the National Institutes of Health (NIH) (1 R01 NR018837 and 1 R01 NR018837-02S1). The content is solely the responsibility of the authors and does not necessarily represent the views of the NIH.

Corresponding author: Kandice A. Kapinos, PhD. [kkapinos@rand.org](mailto:kkapinos@rand.org)