



ORIGINAL ARTICLE

COVID-19 vaccine hesitancy and acceptance among pregnant people contacting a teratogen information service

Kirstie Perrotta^{1,2}  | Angela Messer^{1,2} | Sonia Alvarado^{1,2} | Mara Gaudette^{1,2} |
Cindy Tran² | Gretchen Bandoli² 

¹MotherToBaby California, San Diego, California, USA

²Department of Pediatrics, University of California, San Diego, La Jolla, California, USA

Correspondence

Kirstie Perrotta, MotherToBaby California, 7910 Frost Street, Suite 370, San Diego, CA 92123, USA.

Email: kperrotta@health.ucsd.edu

Funding information

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Abstract

Pregnant people are at increased risk of severe illness from SARS-CoV-2 infection and are more likely to be admitted to an intensive care unit, be put on a mechanical ventilator, and die, if infected. Having COVID-19 during pregnancy also increases the risk of preterm delivery. Vaccination is a critical tool for controlling the COVID-19 pandemic; however, to date, just over 30% of pregnant people in the United States have been vaccinated. It is important to identify any barriers to acceptance of the COVID-19 vaccine among the pregnant population so that specific hesitancy concerns can be addressed. Our objective was to identify the proportion of pregnant people who are unsure or not planning to be vaccinated against COVID-19 and collect information about their reasons for hesitancy. A questionnaire examining views on COVID-19 vaccine interest was administered to 299 pregnant people who contacted MotherToBaby 3/1/21–7/23/21. Questions obtained information about the perception of COVID-19 risk in pregnancy, interest in receiving a COVID-19 vaccine while pregnant, and reasons for acceptance or hesitancy. Within the sample, 21% had already been vaccinated against COVID-19, 43% were planning to get vaccinated, 9% were not planning to receive the vaccine, and 27% were undecided. Women who were not planning to get vaccinated and those that were undecided both said their concern was ‘not enough safety information for pregnancy’. Individuals aged 18–25, those who made less than \$50,000/year, and those who lived in the Northeast were more likely to be hesitant. Based on these data, continued efforts to collect and communicate high-quality and understandable information to pregnant people about vaccine safety should be a key priority in efforts to increase vaccine acceptance among this group.

KEYWORDS

attitudes, communication, COVID-19, health behavior, pregnancy, vaccination

1 | INTRODUCTION

In 2019 the World Health Organization (WHO) listed vaccine hesitancy as one of the top ten threats to global health (WHO, 2019). Just one year later, reports of a new virus (SARS-CoV-2) emerged

out of China. Within weeks, this novel coronavirus (COVID-19) had swept across the globe, constituting the rare announcement from WHO of a global pandemic (WHO, 2020). With no known therapeutics or vaccine cases and deaths quickly escalated. Masks, social distancing, hand washing, and other preventative measures were

recommended by leading health organizations, but a vaccine was touted as the key to returning to some sense of normalcy.

On December 11, 2020, the Pfizer-BioNTech mRNA vaccine was approved by the U.S. Food and Drug Administration (FDA) under emergency use authorization (EUA) (FDA, 2021a). A little over a week later the Moderna vaccine, which also uses mRNA technology, was approved for EUA (FDA, 2021b). A third vaccine by Janssen, which uses viral vector technology, was approved for EUA in February 2021 (FDA, 2021c).

Initial guidance from the U.S. Centers for Disease Control and Prevention (CDC) stated that pregnant people could choose to get a COVID-19 vaccine if they were part of a group that was recommended to be vaccinated (such as healthcare providers). Over time, the CDC revised their messaging to say 'If you are pregnant, you can receive a COVID-19 vaccine'. Current recommendations now state that all pregnant people should be vaccinated against COVID-19 (CDC, 2021a).

Despite increasing support for the inclusion of people who are pregnant in clinical trials (ACOG, 2015), all preclinical trial phases excluded this population. This initial lack of data on the use of COVID-19 vaccines in pregnant people created a void, as the CDC had categorized pregnancy as a condition that put individuals at 'increased risk of severe illness from the virus that causes COVID-19' based on data indicating a higher risk for mechanical ventilation and intensive care unit (ICU) admission (Delahoy et al., 2020).

In June 2021, preliminary data from the V-Safe surveillance program for COVID-19 vaccines, the CDC's COVID-19 pregnancy registry, and the Vaccine Adverse Event Reporting (VAERS) system became available (Shimabukuro et al., 2021). This paper provided early information on pregnancy outcomes among 827 women vaccinated with one of the two mRNA vaccines, primarily in the third trimester. The findings of this analysis noted no increased risk for preterm birth, small for gestational age, or neonatal death. A second study, published in July 2021, reported on an additional 57 pregnant women who received the Pfizer mRNA vaccine after 26 weeks gestation (Bookstein Peretz et al., 2021). The researchers found no increased risk for preterm delivery and no cases of fetal or neonatal complications or fetal death. These studies provided pregnant people with some data on which to base their decision to get vaccinated, but sample sizes were small, and first trimester outcomes were still unavailable.

Vaccine skepticism during pregnancy is not a new issue specific to the COVID-19 vaccine, but rather, a problem that healthcare providers, public health professionals, and teratogen information services have been collectively combatting for many years. The CDC has recommended that pregnant women receive two vaccines during every pregnancy: the inactivated influenza vaccine and the Tdap vaccine (CDC, 2021b). Despite this recommendation, uptake of both vaccines in the United States (U.S.) is historically low (CDC, 2017; CDC, 2018). Hesitation with the COVID-19 vaccine, which was created in record time and uses a new type of technology, was expected within the pregnant population. In 2020, the Organization of Teratology Information (OTIS) and the Society for Birth Defects Research and Prevention (BDRP) released a joint statement that

What is known about this topic

Pregnant people are at increased risk for adverse maternal and fetal outcomes due to COVID-19 infection. Similar to other recommended vaccines in pregnancy, COVID-19 vaccine uptake in this population remains low.

What this paper adds to this topic

This paper discusses specific reasons for hesitancy among a subset of pregnant people who contacted a teratogen information service and highlights certain demographics that are predictive of COVID-19 vaccine hesitancy. This information can be utilized by healthcare professionals, including genetic counselors, in discussions with patients who have concerns about the vaccine, and can help craft public health messaging aimed at increasing vaccine acceptance.

highlights the need to better understand vaccine hesitancy and find ways to address this issue (Rasmussen et al., 2020).

To aid genetic counselors with counseling on this exposure, it is imperative that any possible barriers to receipt of a COVID-19 vaccine during pregnancy be identified. While still respecting client autonomy in their medical decision-making, counseling efforts can focus on areas of identified concerns for the pregnant client. We sought to evaluate this topic by surveying pregnant people in the United States who contacted a teratogen information service by chat about their views on vaccine hesitancy.

2 | METHODS

2.1 | Study population

MotherToBaby, a service of the non-profit Organization of Teratology Information Specialists (OTIS), is a trusted source of evidence-based information on the safety of medications and other exposures during pregnancy and while breastfeeding (MotherToBaby, 2022). This free service is available to people who are pregnant and/or breastfeeding, their family members, health professionals, and the general public via chat, text, phone, and email. Data for this project were obtained from a questionnaire that was offered to pregnant people who contacted the MotherToBaby live chat service with any exposure questions between March 1, 2021, and July 23, 2021. Chat inquiries are accepted from women throughout the United States. Those who were not pregnant (e.g. breastfeeding or healthcare provider), those under 18, and those with an 'out of realm' question (e.g. am I pregnant?) were excluded. Individuals were typically asked if they were interested in completing the survey at the beginning of the chat session. They could choose to complete or decline the questionnaire and still receive exposure counseling. Participants were incentivized to participate with a \$5.00 Amazon gift card.

2.2 | Questionnaire measures

Upon consent, four Teratogen Information Specialists administered the questionnaire on the live chat service, an innovative technology used by more than one-third of pregnant people who contact the MotherToBaby service. The ten questions were designed to obtain information about perception of COVID-19 risk in pregnancy, interest in receiving one of the COVID-19 vaccines while pregnant or breastfeeding, specific reasons for COVID-19 vaccine acceptance or hesitancy (more than one answer choice could be selected), and general stance on routine vaccination (Tdap and influenza) in pregnancy. Demographics including weeks of gestation, zip code, maternal race and ethnicity, education, income, health insurance, and marital status were also collected. Age was collected as a pre-chat requirement but was not specifically asked in the questionnaire.

2.3 | Statistics

Descriptive analyses (chi-squared) of COVID-19 vaccine attitudes were used to examine trends across demographic and maternal characteristics. Prevalence ratios and prevalence differences with 95% confidence intervals were estimated for demographic /maternal characteristics and vaccine interest during pregnancy (yes/already vaccinated vs. no/don't know). Statistical analysis was performed using R Studio Version 1.25033.

2.4 | Ethical compliance

This study was reviewed by the University of California San Diego (UCSD) Institutional Review Board (IRB) and was certified as exempt from IRB review under 45 CFR 46.104(d), category 2 on January 12, 2021.

3 | RESULTS

Of the 299 women who completed the survey, 62 (20.7%) indicated that they had already been vaccinated against COVID-19, 128 (42.8%) were interested in getting vaccinated, and 27 (9.0%) were not planning to receive the vaccine. An additional 82 women (27.4%) were undecided at the time the question was asked (Figure 1).

A lower proportion of 18–25 year olds (37.0%) received the vaccine compared to those that were 34+ (68.1%) (PR = 0.54, CI: 0.30, 0.84; PD = -31.10, CI: -51.24, -10.97). A lower proportion of those with an income of less than \$50,000/year (52.1%) received the vaccine compared with those with an income of more than \$50,000/year (68.7%) (PR: 0.76, CI: 0.61, 0.94; PD: -16.59, CI: -28.60, -4.58). A lower proportion of those with below a bachelor's degree (52.7%) received the vaccine compared with those with a bachelor's degree and above (65.5%), though the confidence intervals were wide and the association not statistically significant (PR = 0.80, CI: 0.32, 1.06;

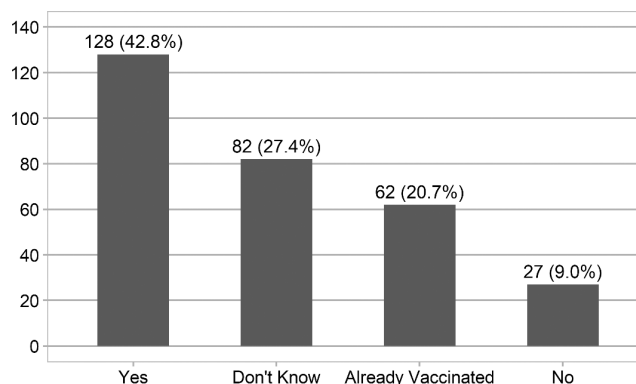


FIGURE 1 Answers to survey question 5: 'If you are offered the COVID-19 vaccine during pregnancy, would you be interested in getting the shot?' (n = 299)

PD: -12.80, CI: -27.33, 1.69). Compared to those in the West (71.8%), those in the Northeast (56.7%), Midwest (57.1%), and South (61.8%) were less likely to have received the vaccine. Estimates for the latter two comparisons were not statistically significant. (Table 1).

Previous COVID-19 infection, planned receipt of both influenza and Tdap vaccines during pregnancy, and being Hispanic/Latina were not significantly associated with vaccine hesitancy. Additionally, there was not a statistically significant difference in vaccine hesitancy between those who were White compared to those who were Asian. Comparisons between other racial groups were not performed due to the low sample size.

Among those that had not yet received the vaccine, 56.5% of those in their 1st trimester were willing to receive it, 50.5% in their 2nd trimester were willing, and 54.7% of those in their 3rd trimester were willing (Table 2).

Among those who were planning to get vaccinated against COVID-19, the main reason cited was 'to protect my baby from COVID-19 infection' (31.0%) followed closely by 'to protect myself from COVID-19 infection' (30.4%). Women who were not planning to get vaccinated overwhelmingly noted that their concern was 'not enough safety information for pregnancy' (53.9%). Respondents who were undecided about vaccination at the time of the survey were also largely concerned about the lack of safety data in pregnancy (74.5%) (Figures 2 and 3).

4 | DISCUSSION

This paper contributes to the growing body of literature on vaccine hesitancy in pregnancy. More than one-third of the women who completed our survey indicated that they were either not planning to receive a COVID-19 vaccine, or were unsure about getting vaccinated; citing lack of pregnancy safety data as their primary concern. Pregnant people who were younger and lower-income were more likely to be hesitant.

Vaccination in pregnancy is a historically contentious topic, and uptake of other routinely recommended vaccines is often low. As of

TABLE 1 Associations between sociodemographic characteristics, prior COVID-19 infection, and receipt of Flu/Tdap vaccine with vaccine intentions among pregnant people who completed the survey, March 1, 2021–July 23, 2021 (N = 299)

	Sample	Yes/already vaccinated		No/don't know		Measures of association	
	N (Col %)	N = 190	Row %	N = 109	Row %	PR (95% CI) ^b	PD (%), (95%CI)
Age							
18–25	27 (9.5)	10	37.0	17	63.0	0.54 (0.30, 0.84)	–31.10 (–51.24, –10.97)
26–33	143 (50.5)	94	65.7	49	34.3	0.96 (0.81, 1.15)	–2.40 (–14.00, 9.18)
34+	113 (39.9)	77	68.1	36	31.9	1.00 (Reference)	1.00 (Reference)
Previous COVID infection							
Yes	30 (10.1)	18	60.0	12	40.0	0.94 (0.69, 1.27)	–4.05 (–22.50, 14.41)
No	267 (89.9)	171	64.0	96	36.0	1.00 (Reference)	1.00 (Reference)
Flu/Tdap^a vaccine							
Both and either	256 (85.9)	161	62.9	95	37.1	0.91 (0.73, 1.14)	–6.16 (–21.34, 9.03)
Neither	42 (14.1)	29	69.0	13	31.0	1.00 (Reference)	1.00 (Reference)
Race							
Asian	48 (16.1)	33	68.8	15	31.3	1.00 (Reference)	1.00 (Reference)
White	216 (72.2)	134	62.0	82	38.0	0.90 (0.73, 1.12)	–6.70 (–21.34, 7.91)
Black	12 (4.0)	11	91.7	1	8.3	N/A ^b	N/A ^b
Indian/Native American	1 (0.3)	1	100.0	0	0	N/A ^b	N/A ^b
Pacific Islander	2 (0.7)	1	50.0	1	50.0	N/A ^b	N/A ^b
Other	20 (6.7)	10	50.0	10	50.0	N/A ^b	N/A ^b
Ethnicity							
Hispanic/Latina	47 (15.9)	29	61.7	18	38.3	0.97 (0.76, 1.24)	–1.79 (–16.88, 13.34)
Non-Hispanic/Non-Latina	249 (84.1)	158	63.5	91	36.5	1.00 (Reference)	1.00 (Reference)
Education							
Bachelor's degree and above	238 (81.2)	156	65.5	82	34.5	1.00 (Reference)	1.00 (Reference)
Below bachelor's degree	55 (18.8)	29	52.7	26	47.3	0.80 (0.32, 1.06)	–12.80 (–27.33, 1.69)
Income							
\$50,000 or more	195 (67.5)	134	68.7	61	31.3	1.00 (Reference)	1.00 (Reference)
Less than \$50,000	94 (32.8)	49	52.1	45	47.9	0.76 (0.61, 0.94)	–16.59 (–28.60, –4.58)
U.S. Region							
Northeast	67 (22.7)	38	56.7	29	43.3	0.79 (0.62, 1.00)	–15.10 (–29.64, 0.56)
Midwest	42 (14.2)	24	57.1	18	42.9	0.80 (0.60, 1.06)	–14.68 (–31.84, 2.49)
South	76 (25.8)	47	61.8	29	38.2	0.86 (0.70, 1.06)	–9.98 (–23.76, 3.81)
West	110 (37.3)	79	71.8	31	28.2	1.00 (Reference)	1.00 (Reference)

^aFlu/Tdap Vaccine = Planned receipt or receipt of seasonal influenza vaccine and/or tetanus, diphtheria, and pertussis vaccine.

^bPrevalence ratios weren't estimated due to limited sample size.

Abbreviations: CI, confidence interval; PD, prevalence difference; PR, prevalence ratio.

2017, the most recent year for which data are available, Tdap vaccination coverage during pregnancy was reported to be 50.4% among women with live births (CDC, 2017) while influenza vaccination coverage among pregnant women before and during pregnancy was just 35.6% (CDC, 2018). Higher health literacy status has been associated with higher chance of flu vaccination uptake in pregnancy, making this issue even more inequitable (Brixner et al., 2021). Flu and Tdap

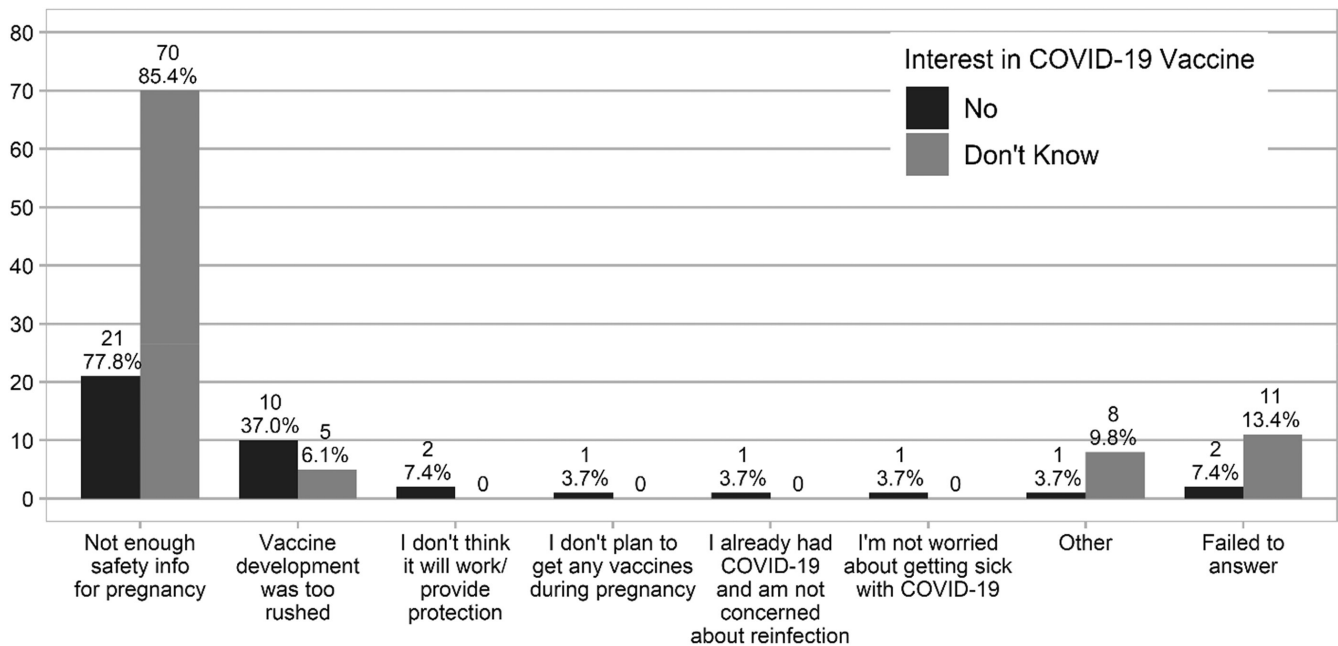
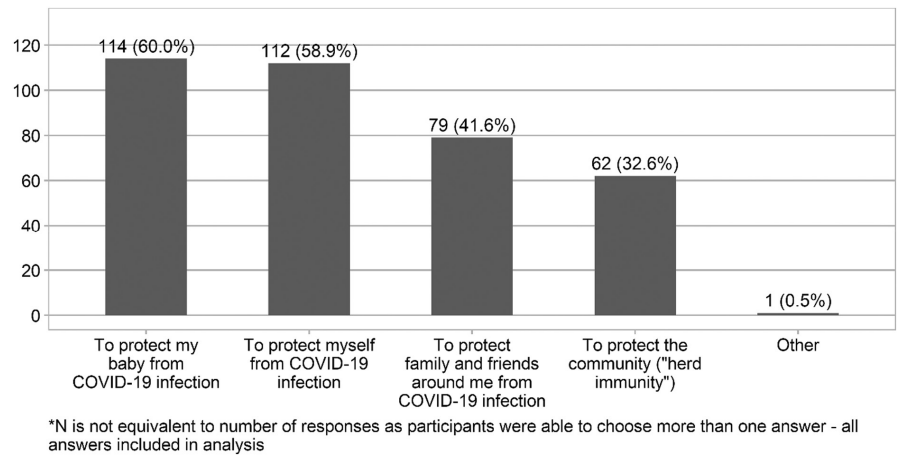
vaccines have long been recommended for use in pregnancy and there is a large body of evidence supporting their safety, yet many pregnant people still choose not to get them. COVID-19 vaccines, on the other hand, are newer and have more limited pregnancy data. Consequently, it was expected that there would be lower inoculation rates. However, given that pregnant people infected with SARS-CoV-2 are at increased risk for ICU admission and death, and have

TABLE 2 Vaccination intentions by Trimester of Questionnaire Completion

Trimester	Yes (n = 128)	No (n = 27)	Don't know (n = 82)
First	56.5% (52)	14.1% (13)	29.3% (27)
Second	50.5% (46)	8.8% (8)	7% (37)
Third	54.7% (29)	11.3% (6)	34.0% (18)
Missing	100.0% (1)	0.0% (0)	0.0% (0)

consistent with what the CDC reported nationally as of 7/24/21 (one day after the end of our survey collection period) where they indicate that 22.9% of all pregnant people have received at least one dose of a COVID-19 vaccine (CDC, 2021c). One hundred and twenty-eight women (42.8%) stated they were interested in getting vaccinated against COVID-19 during their pregnancy. The main reason cited for vaccination within this group was 'to protect my baby from COVID-19 infection' (31.0%). Pregnant people are often motivated by what they perceive to be best for their baby. The survey data demonstrated that this was a driving factor for many women choos-

FIGURE 2 Answers to survey question 6: 'Why do/did you want to get vaccinated during pregnancy?' (n = 190)



*N is not equivalent to number of responses as participants were able to choose more than one answer - all answers included in analysis

FIGURE 3 Answers to survey question 7: 'Why do you NOT want to get vaccinated during pregnancy?' among those that said 'No' (n = 27) and 'Don't Know' (n = 82) to vaccination

a higher risk for preterm birth (Karasek et al., 2021), this group has been identified as high priority for vaccination.

During the data collection period, a total of 62 women (20.7%) stated they had already received a COVID-19 vaccine. This is

ing to get vaccinated, even in the absence of extensive pregnancy safety data. This may in part help explain why Tdap vaccination rates are higher than influenza vaccination rates. Tdap is recommended later in pregnancy to allow for transfer of antibodies to the baby. In

contrast, flu vaccines are recommended in any trimester, primarily to provide protection for the pregnant person. Teratogen Information Services, healthcare providers (including genetic counselors), and other public health organizations should take this motivation into consideration; focusing on the benefits for the baby. Although much remains to be elucidated about the amount and duration of protection provided to the baby when the COVID-19 vaccine is administered during pregnancy, the fact that antibodies are known to cross the placenta is an important talking point.

Twenty-seven women (9.0%) stated that they were not planning to receive the COVID-19 vaccine. The main reason cited for refusal was 'not enough safety information for pregnancy' (53.9%). This is an understandable concern as the pregnancy data were limited at the time of survey administration. While some women from this group may decide to get vaccinated as the data on this topic grows, others may continue to be hesitant. For the latter group, a discussion of risk vs. benefit is important. Among those who said they were not planning to get vaccinated, almost half (48.1%) replied that they did not know if a COVID-19 infection would be better or worse in pregnancy, while 14.8% expected it to be the same as an infection in a non-pregnant person. Education on this topic is critical, with an urgent need to point out the very real risks for mom and baby if a woman is infected with COVID-19 during her pregnancy, and the lack of known risks associated with the vaccines. In providing this education to people who are pregnant, health literacy must be at the forefront of the conversation. Research shows that limited health literacy is associated with unhealthy behaviors during pregnancy, and a recent systemic review found that those with limited health literacy had more and longer hospital stays and lower utilization of preventive services compared with people who show an adequate level of health literacy (Nawabi et al., 2021). Patient-facing healthcare providers, such as genetic counselors, should ensure that people who are pregnant are provided with the latest, continually growing, body of evidence on this topic in a way that is easy to understand. The MotherToBaby COVID-19 vaccine fact sheet is written at an '8th-grade level' to reach as many individuals with varying levels of health literacy as possible and is a great resource for genetic counselors and their clients: <https://mothertobaby.org/fact-sheets/covid-19-vaccines/>. The CDC also continues to put out patient-friendly information on this topic and is another important resource in the effort to reach women of all literacy levels.

Eighty-two women (27.4%) were undecided about vaccination when the question was asked. These respondents were also largely concerned about the lack of safety data in pregnancy (74.5%). The above strategies can be applied to this group to encourage vaccination. A thorough overview of the mechanism of COVID-19 vaccines (the fact that they are not live vaccines and are unlikely to cross the placenta), is also an important talking point. Multiple studies have found that a healthcare provider's recommendation to vaccinate is strongly associated with uptake of vaccines in pregnancy (Brixner et al., 2021; Gorman et al., 2012; Moir et al., 2020). For those who are 'undecided' about getting vaccinated, this may be one of the best approaches to employ. In an era in which so much information can

be found online, it can be difficult to know who to believe. However, healthcare providers, including genetic counselors, continue to be a trusted voice for many in the community. By taking the time to sit down and hear a patient's concerns, they can have an enormous effect on their decision to vaccinate.

Attention should be paid to those groups that were more likely to be hesitant: those ages 18–25, individuals whose income was less than \$50,000/year, and those who resided in the Northeast region of the United States. Young people should be reminded that pregnancy is a risk factor for developing complications from COVID-19 regardless of age. Public health messaging should continue to promote the fact that COVID vaccines are free. Those in the Northeast should be reminded that COVID-19 infection rates can change over time, and when states in their region have substantial or high community spread, everyone who lives there is at risk (CDC, 2021d).

Our findings were consistent with multiple other studies that have come out on COVID-19 vaccine hesitancy in the pregnant population in recent months. Tao et al. (2021) found that 77.4% of pregnant women in mainland China were willing to be vaccinated when the COVID-19 vaccine became available. This is slightly higher than the 63.5% of our sample who had already been vaccinated or were planning to. Ceulemans et al. (2021) identified COVID-19 vaccine hesitancy among 40%–50% of pregnant and breastfeeding women at the end of the first wave of the pandemic in 2020, which is marginally higher than the 36.4% who responded 'no' or 'unsure' when asked about getting vaccinated for COVID-19 in our 2021 survey. Slight discordance in percentages may be attributable to differences in individual countries' case numbers and timing of data collection, but findings were generally consistent. Goncu Ayhan et al. (2021) reported similar hesitancy findings as we did, identifying lack of data about COVID-19 vaccine safety in pregnant populations and possibility of harm to the fetus as the leading reasons for not wanting to be vaccinated during pregnancy. Although Tao et al. (2021) reported 'refuse any vaccination during pregnancy' as the main reason for hesitancy among those who were unsure or not interested in getting vaccinated, vaccine safety was the second most common concern noted. Since the end of our survey period, more data has become available on the use of COVID-19 vaccines in pregnancy. We are hopeful that publication of these pregnancy outcomes will address any lingering concerns about vaccine safety in pregnancy that was identified by ourselves and others as a top reason for hesitancy.

4.1 | Strengths and limitations

In late March 2021, MotherToBaby re-established a partnership with the CDC and was listed as a resource on their web page about COVID-19 vaccines in pregnancy (CDC, 2021a). This increased traffic to the live chat service exponentially, allowing us to attempt to collect a geographically diverse sample in a short period of time. The ability to structure the questionnaire in a qualitative manner, with opportunities to submit free text responses, was another strength

that allowed us to capture information on specific reasons for vaccine hesitancy and acceptance.

Limitations include the use of a volunteer sample that may not represent the general population. Although efforts were made to reach underserved populations both locally and nationally, the majority of our sample reported being non-Hispanic ethnicity (83.1%) and White race (72.2%). There also may have been selection bias in our sample related to sources of information gathering, as the women who completed the survey were likely seeking reputable information on COVID-19 vaccines from our website. Their vaccine intentions may not be generalizable to all pregnant individuals.

4.2 | Practice implications

Genetic counselors play an important role in prenatal education, helping guide conversations for clients facing difficult choices. Their ability to convey accurate data about use of COVID-19 vaccines in pregnancy is of pivotal importance to promote informed decision-making among this population. Knowing the reasons why some individuals may be more likely to be hesitant can help genetic counselors frame conversations in a way that is most beneficial to their patients, promoting client-centered, non-coercive, and value-based decision-making (ACGC, 2019).

5 | CONCLUSION

More than one-third of the sample indicated that they were either not planning to receive a COVID-19 vaccine, or were unsure about getting vaccinated, citing lack of pregnancy safety data as their primary concern. Pregnant people who are younger and lower-income were more likely to be hesitant. As trusted healthcare professionals, genetic counselors will continue to serve an important role in the dissemination of pregnancy research on COVID-19 vaccines, ensuring that those who are hesitant to vaccinate receive the most up-to-date information available.

AUTHOR CONTRIBUTIONS

Authors Perrotta and Messer confirm that they had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All of the authors gave final approval of this version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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COMPLIANCE WITH ETHICAL STANDARDS

CONFLICT OF INTEREST

Authors Perrotta, Messer, Alvarado, Gaudette, Tran, and Bandoli declare that they have no conflicts of interest.

HUMAN STUDIES AND INFORMED CONSENT

This study was reviewed by the University of California San Diego (UCSD) Institutional Review Board (IRB) and was certified as exempt from IRB review. Research activities were conducted in compliance with applicable UCSD and Rady Children's Hospital – San Diego policies and ethical standards as well as local, state, and federal regulations. Informed consent was obtained for all participants who voluntarily completed the survey via live chat.

ANIMAL STUDIES

No non-human animal studies were carried out by the authors for this article.

DATA SHARING AND DATA ACCESSIBILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Kirstie Perrotta  <https://orcid.org/0000-0001-5446-0238>

Gretchen Bandoli  <https://orcid.org/0000-0003-2167-8921>

REFERENCES

- Accreditation Council for Genetic Counseling. (2019). *Practice based competencies*. <https://www.gceducation.org/practice-based-competencies/>
- ACOG Committee Opinion No. 646. (2015). Ethical considerations for including women as research participants. *Obstetrics and Gynecology*, 126(5), e100-7. <https://doi.org/10.1097/AOG.0000000000001150>
- Bookstein Peretz, S., Regev, N., Novick, L., Nachshol, M., Goffer, E., Ben-David, A., Asraf, K., Doolman, R., Levin, E. G., Regev Yochay, G., & Yinon, Y. (2021). Short-term outcome of pregnant women vaccinated by BNT162b2 mRNA COVID-19 vaccine. *Ultrasound in Obstetrics & Gynecology*, 58, 450–456. <https://doi.org/10.1002/uog.23729>
- Brixner, A., Brandstetter, S., Böhmer, M. M., Seelbach-Göbel, B., Melter, M., Kabesch, M., Apfelbacher, C., & KUNO-Kids Study Group. (2021). Prevalence of and factors associated with receipt of provider recommendation for influenza vaccination and uptake of influenza vaccination during pregnancy: cross-sectional study. *BMC Pregnancy and Childbirth*, 21(1), 723. <https://doi.org/10.1186/s12884-021-04182-w>
- Centers for Disease Control and Prevention. (2017). *AdultVaxView. Pregnant women and Tdap vaccination, internet panel survey, United States*. <https://www.cdc.gov/vaccines/imz-managers/coverage/adultvaxview/pubs-resources/tdap-report-2017.html>
- Centers for Disease Control and Prevention. (2018). *Influenza. Estimates of influenza vaccination coverage among adults—United States, 2017–18 Flu Season*. <https://www.cdc.gov/flu/fluview/coverage-1718-estimates.htm>
- Centers for Disease Control and Prevention. (2021a). *COVID-19 vaccines while pregnant or breastfeeding*. <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/pregnancy.html>

- Centers for Disease Control and Prevention. (2021b). *Vaccines during pregnancy FAQs*. <https://www.cdc.gov/vaccinesafety/concerns/vaccines-during-pregnancy.html#Which>
- Centers for Disease Control and Prevention. (2021c). *COVID data tracker. COVID-19 vaccination among pregnant people aged 18–49 years overall, by race/ethnicity, and date reported to CDC – vaccine safety data-link,* United States. Figure 3*. <https://covid.cdc.gov/covid-data-tracker/#vaccinations-pregnant-women>
- Centers for Disease Control and Prevention. (2021d). *COVID data tracker*. <https://covid.cdc.gov/covid-data-tracker/>
- Ceulemans, M., Foulon, V., Panchaud, A., Winterfeld, U., Pomar, L., Lambelet, V., Cleary, B., O'Shaughnessy, F., Passier, A., Richardson, J. L., Allegaert, K., & Nordeng, H. (2021). Vaccine willingness and impact of the COVID-19 pandemic on women's perinatal experiences and practices – a multinational, cross-sectional study covering the first wave of the pandemic. *International Journal of Environmental Research and Public Health*, 18(7), 3367. <https://doi.org/10.3390/ijerph18073367>
- Delahoy, M. J., Whitaker, M., O'Halloran, A., Chai, S. J., Kirley, P. D., Alden, N., Kawasaki, B., Meek, J., Yousey-Hindes, K., Anderson, E. J., Openo, K. P., Monroe, M. L., Ryan, P. A., Fox, K., Kim, S., Lynfield, R., Siebman, S., Davis, S. S., Sosin, D. M., ... Meador, S. (2020). Characteristics and maternal and birth outcomes of hospitalized pregnant women with laboratory-confirmed COVID-19 – COVID-NET, 13 States, March 1–August 22, 2020. *MMWR. Morbidity and Mortality Weekly Report*, 69, 1347–1354. <https://doi.org/10.15585/mmwr.mm6938e1>
- Goncu Ayhan, S., Oluklu, D., Atalay, A., Menekse Beser, D., Tanacan, A., Moraloglu Tekin, O., & Sahin, D. (2021). COVID-19 vaccine acceptance in pregnant women. *International Journal of Gynaecology and Obstetrics*, 154(2), 291–296. <https://doi.org/10.1002/ijgo.13713>
- Gorman, J. R., Brewer, N. T., Wang, J. B., & Chambers, C. D. (2012). Theory-based predictors of influenza vaccination among pregnant women. *Vaccine*, 31(1), 213–218. <https://doi.org/10.1016/j.vaccine.2012.10.064>
- Karasek, D., Baer, R. J., McLemore, M. R., Bell, A. J., Blebu, B. E., Casey, J. A., Coleman-Phox, K., Costello, J. M., Felder, J. N., Flowers, E., Fuchs, J. D., Gomez, A. M., Karvonen, K., Kuppermann, M., Liang, L., McKenzie-Sampson, S., McCulloch, C., Oltman, S. P., Pantell, M. S., ... Jelliffe-Pawlowski, L. L. (2021). The association of COVID-19 infection in pregnancy with preterm birth: A retrospective cohort study in California. *The Lancet Regional Health – The Americas*, 2, 100027. <https://doi.org/10.1016/j.lana.2021.100027>
- Moir, D., Gunter, K., Lynch, L. A., Vogrin, S., & Said, J. (2020). Antenatal vaccine uptake: A cross-sectional study investigating factors influencing women's choices in pregnancy. *The Australian & New Zealand Journal of Obstetrics & Gynaecology*, 60(5), 729–737. <https://doi.org/10.1111/ajo.13146>
- MotherToBaby. (2022). *Our Work*. <https://mothertobaby.org/our-work/>
- Nawabi, F., Krebs, F., Vennedey, V., Shukri, A., Lorenz, L., & Stock, S. (2021). Health literacy in pregnant women: a systematic review. *International Journal of Environmental Research and Public Health*, 18(7), 3847. <https://doi.org/10.3390/ijerph18073847>
- Rasmussen, S. A., Kancherla, V., & Conover, E. (2020). Joint position statement on vaccines from the Society for Birth Defects Research and Prevention and the Organization of Teratology Information Specialists. *Birth Defects Research*, 112(7), 527–534. <https://doi.org/10.1002/bdr2.1674>
- Shimabukuro, T. T., Kim, S. Y., Myers, T. R., Moro, P. L., Oduyebo, T., Panagiotakopoulos, L., Marquez, P. L., Olson, C. K., Liu, R., Chang, K. T., Ellington, S. R., Burkel, V. K., Smoots, A. N., Green, C. J., Licata, C., Zhang, B. C., Alimchandani, M., Mba-Jonas, A., Martin, S. W., ... CDC v-safe COVID-19 Pregnancy Registry Team. (2021). Preliminary findings of mRNA Covid-19 vaccine safety in pregnant persons. *The New England Journal of Medicine*, 384(24), 2273–2282. <https://doi.org/10.1056/NEJMoa2104983>
- Tao, L., Wang, R., Han, N., Liu, J., Yuan, C., Deng, L., Han, C., Sun, F., Liu, M., & Liu, J. (2021). Acceptance of a COVID-19 vaccine and associated factors among pregnant women in China: a multi-center cross-sectional study based on health belief model. *Human Vaccines & Immunotherapeutics*, 17(8), 2378–2388. <https://doi.org/10.1080/21645515.2021.1892432>
- U.S. Food & Drug Administration. (2021a). *Comirnaty and Pfizer BioNTech COVID-19 vaccine*.
- U.S. Food & Drug Administration. (2021b). *US FDA. Moderna COVID-19 vaccine*. <https://www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/moderna-covid-19-vaccine>
- U.S. Food & Drug Administration. (2021c). *Janssen COVID-19 vaccine*. <https://www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/janssen-covid-19-vaccine>
- World Health Organization. (2019). *Ten threats to global health in 2019*. <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>
- World Health Organization. (2020). *Timeline: WHO's COVID-19 response*. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline>

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