

AJPM FOCUS

INCLUSIVITY IN PEOPLE, METHODS, AND OUTCOMES

RESEARCH ARTICLE

COVID-19 Vaccine Hesitancy in the Perinatal Period: A Survey Among Residents of Hawaii



Mary S. Tschann, PhD, MPH,¹ Taylor N. Ronquillo, MPH,¹ Lauren M. Sternberg, BS,²
Zarina J. Wong, BA,¹ Reni Soon, MD, MPH,¹ Bliss E.K. Kaneshiro, MD, MPH¹

Introduction: This study describes the vaccination status among people in Hawaii who are attempting pregnancy, currently pregnant, recently delivered (<6 months), and/or breastfeeding and documents common concerns and information sources associated with vaccine decision making.

Methods: We conducted a cross-sectional online survey between April and September 2022 throughout Hawaii. The anonymous surveys were disseminated through flyers and online links posted by physician offices and community partners throughout Hawaii.

Results: Final analyses included 165 responses. Almost half of the respondents ($n=75$, 45%) were unvaccinated, 38% ($n=62$) were fully vaccinated, and 17% ($n=28$) were partially vaccinated. The most influential sources for vaccine decision making for vaccinated respondents were their health-care providers ($n=28$, 45%) and official healthcare organizations ($n=22$, 36%), whereas unvaccinated respondents reported friends/family ($n=28$, 37%) and their healthcare providers ($n=26$, 35%) as their most influential sources. Top COVID-19 vaccine concerns for unvaccinated individuals were reactions to vaccine ($n=78$, 76%) and concerns for safety of the vaccine ($n=75$, 73%).

Conclusions: Efforts should be made to increase and expand vaccine education about the benefits and safety of vaccines during pregnancy beyond the pregnant person to create more supportive social norms for COVID-19 vaccination in the perinatal period. Consistent and unequivocal support across medical specialties, including obstetrics, pediatrics, and family medicine, is also crucial for encouraging the uptake of the vaccine during pregnancy or when breastfeeding.

AJPM Focus 2024;3(2):100179. © 2023 The Authors. Published by Elsevier Inc. on behalf of The American Journal of Preventive Medicine Board of Governors. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

INTRODUCTION

Pfizer-BioNTech and Moderna mRNA coronavirus disease 2019 (COVID-19) vaccines were both released in December 2020,^{1,2} and vaccination for pregnant and lactating women has been consistently endorsed by the Centers for Disease Control and Prevention (CDC), the American College of Obstetricians and Gynecologists, and the Society for Maternal-Fetal Medicine.^{3–5} Pregnant individuals who contract severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) are at an

From the ¹Division of Family Planning, Department of Obstetrics, Gynecology, and Women's Health, John A. Burns School of Medicine, University of Hawaii, Honolulu, Hawaii; and ²John A. Burns School of Medicine, University of Hawaii, Honolulu, Hawaii

Address correspondence to: Taylor N. Ronquillo, MPH, John A. Burns School of Medicine, University of Hawaii, 1380 Lusitana Avenue, Suite 1004, Honolulu HI 96813. E-mail: tronq@hawaii.edu.

2773-0654/\$36.00

<https://doi.org/10.1016/j.focus.2023.100179>

increased risk of intensive care unit admission; preterm birth and medically indicated preterm birth; neonatal complications; pre-eclampsia/eclampsia; severe COVID-19 infection, including acute respiratory distress syndrome; and maternal mortality.^{6–8} The vaccine has been shown to be safe and effective in preventing severe disease and death in pregnant people.^{9–12}

COVID-19 vaccination among pregnant women has lagged behind the nonpregnant population nationally, even in states where general vaccine uptake is high.^{13,14} Shortly after vaccine approval (between December 2020 and May 2021), a study of 135,968 pregnant women in the U.S. found that only 16.3% of pregnant individuals in the study had received 1 or more doses of the COVID-19 vaccine and that 5.5% of pregnant individuals had initiated vaccination during pregnancy.¹³ After the vaccine became more widely available to adults, a subsequent study in October 2022 found that pregnant women still lagged behind their peers, with 71.4% of pregnant people in the U.S. aged 18–49 years having completed their primary series compared with 78.3% of people in the general population aged >18 years in the U.S.¹⁵

Similar trends exist in Europe. In Scotland, researchers surveyed 144,548 pregnant women and found that 15% had received at least 1 dose of a COVID-19 vaccine from December 1, 2020 to October 31, 2021.¹⁴ In addition, this study found that by October 2021, 85% of the nonpregnant female population in Scotland had received 1 or more vaccines, but only 43% of women who gave birth that month had received 1 or more vaccines.

Prior research demonstrates that concerns about vaccine safety in pregnancy are not novel; concerns about influenza and tetanus toxoid, diphtheria toxoid, and acellular pertussis vaccine safety both for the pregnant person and the fetus influence maternal vaccination decision making.¹⁶ Similar hesitation has been identified in both a 2020 and 2021 survey of pregnant women, which also documented persistent concerns about a perceived lack of data about the safety of the COVID-19 vaccine and concerns about harm to the pregnant person and/or the fetus.^{17,18} In addition, other studies found that long-term health concerns from the COVID-19 vaccine and belief in conspiracy theories were frequently cited reasons for pregnant women declining the vaccine.^{19,20} The exclusion of pregnant individuals from vaccine trials and subsequent inconsistency in the prioritization of pregnant people in early vaccination efforts may have compounded these concerns and reinforced the decision to delay or refuse vaccination for some individuals.^{21,22}

This lower uptake of vaccines during the perinatal period was reflected in data collected by the hospital and

health systems in Hawaii, which found vaccination rates among pregnant patients to be around 48%, compared with 78% in the general population (Hawaii Department of Health Solicitation, March 2022). This prompted public health leadership in the state to call for new and tailored strategies to reach unvaccinated people in the perinatal period.²³ The currently recognized strategies for increasing vaccine acceptance include direct outreach to undervaccinated communities, increasing the number and locations of vaccine sites, and encouraging physicians to have thoughtful communication with patients.²⁴ Research conducted in Hawaii and elsewhere has emphasized that vaccine status is closely tied to which sources of information an individual favors.^{25,26} Vaccination rates are higher among those who trust official sources, such as medical professionals or government agencies such as CDC, than among those who use unofficial sources, such as social media.^{25,26} Vaccine information sources have been shown to be the strongest predictor of vaccine uptake.^{25,26}

The aim of this study was to (1) describe the vaccination status among people in Hawaii who are attempting pregnancy, currently pregnant, recently delivered (<6 months), and/or breastfeeding and (2) document common concerns and information sources associated with vaccine decision making. Ultimately, the results of this study can contribute to the development of a better-tailored approach to encourage vaccine uptake among individuals in the perinatal period.

METHODS

Study Sample

We conducted this cross-sectional online survey between April and September 2022. Eligible respondents were aged at least 18 years, were currently residing in Hawaii, and met at least 1 of the following criteria: considering pregnancy or attempting pregnancy, currently pregnant, recently delivered (within 6 months of the date of survey completion), or currently breastfeeding. We recruited respondents through physical flyers and online links posted by physician offices and community partners (including perinatal service providers, such as the Special Supplemental Nutrition Program for Women, Infants, and Children and postpartum support groups). Surveys were anonymous. Respondents could elect to complete a separate form to request a \$10 electronic gift card after completing the survey. The study was approved by the University of Hawaii IRB. Our target sample size was 500 unique responses, which would provide adequate power for comparative analysis of population subgroups.

Measures

Respondents were asked to report demographic information, vaccine history and decision making, and the most influential sources they used to make decisions about vaccination. Partially and unvaccinated individuals were also asked to indicate whether they agreed with a list of concerns regarding the COVID-19 vaccine, which was derived from previously published vaccine hesitancy research.²⁷

Statistical Analysis

Of note, immediately after launching our survey in April 2022, the survey was flooded with bot and scam responses (more than 2,000 responses in 24 hours), despite using bot detection software in our survey platform. We paused data collection for 1 month to create a new screening process derived from published best practices to combat bot survey responses and receive IRB approval for this new process.²⁸ This new screening approach required participants to disclose a local address and used open-text responses rather than multiple choice to verify eligibility. This new screening process significantly reduced the total number of surveys received and slowed our intake process because we had to individually review each submission but ultimately increased the valid and verifiable responses in our data set. Data collection with this new screening procedure resumed in May 2022 and was utilized through the end of the study in September 2022. Data were collected using Qualtrics survey software and analyzed using SPSS 28.0.

RESULTS

We received 2,213 responses, of which 170 were deemed to be valid. Of these, 165 had complete information about vaccination status and were included in the final analysis.

Almost half of the respondents ($n=75$, 45%) were unvaccinated, and 38% ($n=62$) were fully vaccinated (with or without booster shots). Partially vaccinated respondents (1 dose of a 2-dose primary series) made up 17% ($n=28$) of the sample. [Table 1](#) shows the characteristics of the respondents by vaccination status. Unvaccinated respondents were more likely to be currently pregnant, recently pregnant, and/or breastfeeding, whereas those considering or trying pregnancy were more likely to be fully vaccinated. Unvaccinated respondents were from less populous/more rural islands and more commonly worked in jobs that had no direct contact with the public. Of the 165 respondents, 18 (11%) reported testing positive for COVID-19 before or at the time of survey completion.

Of the 75 respondents who had not been vaccinated, 86% ($n=65$) confirmed that they intended to get the vaccine later. The vast majority of respondents in this group stated that they would get the vaccine when they were done breastfeeding ($n=60$, 92%). We also asked all respondents about their experiences with other standard vaccinations in pregnancy, including influenza vaccine and tetanus, diphtheria, and pertussis vaccination. Among those who had not received COVID-19 vaccination, 63% ($n=47$) had also not received influenza or tetanus, diphtheria, and pertussis in their current or prior pregnancies.

Respondents were asked to name the most influential information source for their vaccine decision making ([Figures 1 and 2](#)). Vaccinated individuals indicated by a large margin that their doctor/healthcare provider and official healthcare/government resources were the most influential information sources in their vaccine decision making. Unvaccinated individuals cited both friends and family and healthcare providers as nearly equivalent influences. Sources such as social media and news were less frequently selected as the most influential resource among respondents across vaccine categories.

Unvaccinated and partially vaccinated individuals were asked to confirm whether they agreed with various concerns about the COVID-19 vaccine. [Table 2](#) shows the frequency of these responses. The top 2 most commonly cited concerns, cited by 76% ($n=78$) and 73% ($n=75$), respectively, were concerns about having a bad reaction to the vaccine and concern with the safety of the vaccine. The next most frequently endorsed statements (both at $n=53$, 52%) were “my partner doesn’t want me to get the COVID-19 vaccine” and “there’s not enough information about the vaccine.”

DISCUSSION

Our survey identified differences by vaccination status across demographic characteristics and preferred information sources. The influence of family, friends, and partners was high in our study and aligns with other research in similar populations.²⁹

Increasing vaccine acceptance and support among partners, family members, and friends of pregnant people should be a priority in this next phase of the pandemic response. It is also important to note that among the unvaccinated, the influence of individuals’ healthcare providers was twice as high as that of official healthcare organizations such as CDC or the Food and Drug Administration. This may indicate that some respondents’ healthcare providers reinforced or failed to challenge the individual’s decision not to receive the vaccine in the perinatal period. It also could suggest that these

Table 1. Characteristics of Respondents by Vaccination Status (N=165)

Characteristics	Vaccinated, n=62	Partially vaccinated, n=28	Not vaccinated, n=75
Age, years, mean (SD)	32.3 (6.5)	27.8 (3.8)	28.9 (4.6)
Pregnancy status			
Trying to get pregnant/considering pregnancy	21 (72.4%)	1 (3.4%)	7 (24.1%)
Currently pregnant	26 (31.3%)	19 (22.9%)	38 (45.8%)
Delivered within the prior 6 months	9 (34.6%)	4 (15.4%)	13 (50.0%)
Currently breastfeeding	12 (35.3%)	4 (11.8%)	18 (52.9%)
Employment type			
Direct medical care	6 (46.2%)	2 (15.4%)	5 (38.5%)
Healthcare setting (not direct medical care)	6 (18.8%)	9 (28.1%)	17 (53.1%)
Regular contact with the public	14 (40.0%)	8 (22.9%)	13 (37.1%)
No regular contact with the public	6 (37.5%)	0	10 (62.5%)
Other	29 (42.6%)	10 (14.7%)	29 (42.6%)
Race			
Native Hawaiian or other Pacific Islander	15 (20.0%)	13 (17.3%)	47 (62.7%)
White	30 (50.0%)	8 (13.3%)	22 (36.7%)
Asian	18 (72.0%)	2 (8.0%)	5 (20.0%)
Black or African American	5 (35.7%)	4 (28.6%)	5 (35.7%)
Prefer not to answer	3 (100%)	0	0
Middle Eastern	1 (50.0%)	1 (50.0%)	0
Household income			
\$15,001–\$30,000	2 (66.7%)	1 (33.3%)	0
\$30,001–\$60,000	11 (28.2%)	12 (30.8%)	16 (41.0%)
\$60,001–\$90,000	25 (32.1%)	10 (12.8%)	43 (55.1%)
\$90,001–\$120,000	7 (46.7%)	0	8 (53.3%)
>\$120,001	15 (55.5%)	5 (20.5%)	7 (25.9%)
Household size			
1	1 (50.0%)	0	1 (50.0%)
2	5 (15.2%)	4 (12.1%)	24 (72.7%)
3	14 (34.1%)	11 (26.8%)	16 (39.0%)
4	18 (42.9%)	9 (21.4%)	15 (35.7%)
5	17 (54.8%)	4 (12.9%)	10 (32.3%)
6	5 (38.5%)	0	8 (61.5%)
>6	1 (100%)	0	0
Education			
Less than high school	2 (66.7%)	0	1 (33.3%)
High school or GED	8 (38.1%)	2 (9.5%)	11 (52.4%)
Some college/college degree	37 (30.5%)	24 (19.8%)	60 (49.5%)
Started or completed graduate/doctoral program	14 (77.7%)	2 (11.1%)	2 (11.1%)

same individuals would be receptive to vaccine-supportive guidance from their providers, even if they have not yet chosen to receive the vaccine.

Personalized guidance within the context of an established patient–provider relationship has been shown to be an effective way to motivate health-protective behaviors.³⁰ This also highlights the need for consistent, supportive messaging across medical specialties, including family and internal medicine, obstetrics and gynecology, and pediatrics, with regard to the safety of and protection garnered from vaccination during the perinatal

period. As has recently been pointed out in the press, peer-reviewed publications must also be mindful of the framing of results and even the titles of their manuscripts so as not to infer or suggest risks that are not supported by the data.³¹

Conspiracy-based theories were infrequently endorsed and should not be central to campaigns addressing vaccine hesitancy. Our survey responses echoed findings from other research that encourages the focus of education about vaccines to be on the safety of the vaccines in the perinatal period along with encouraging trust in our

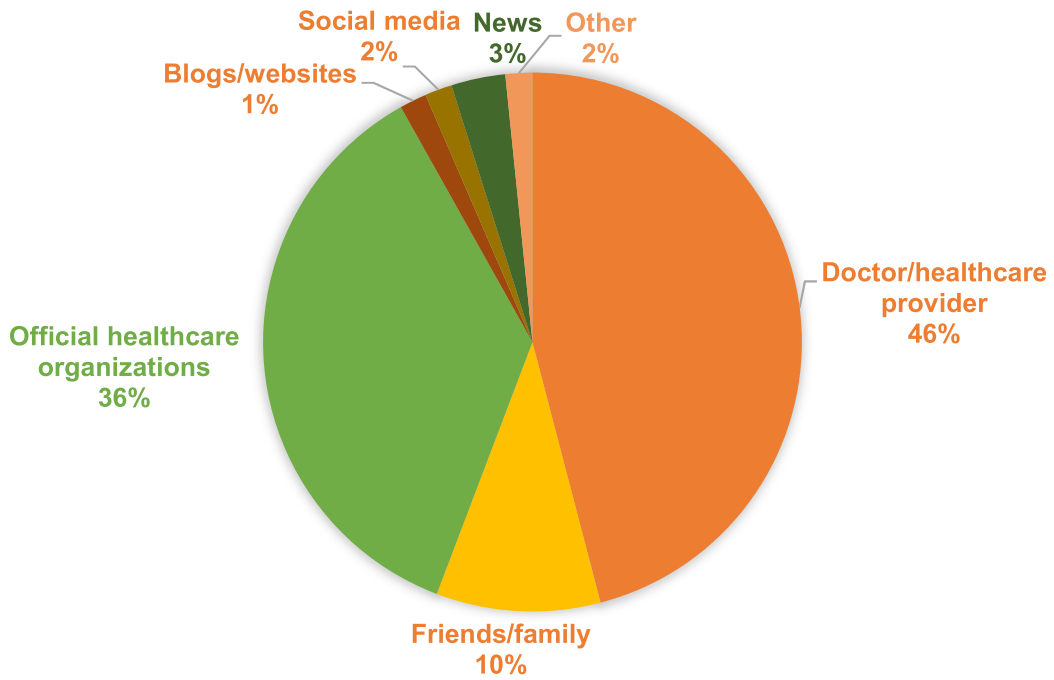


Figure 1. Most influential resources for vaccination decision making among vaccinated respondents.

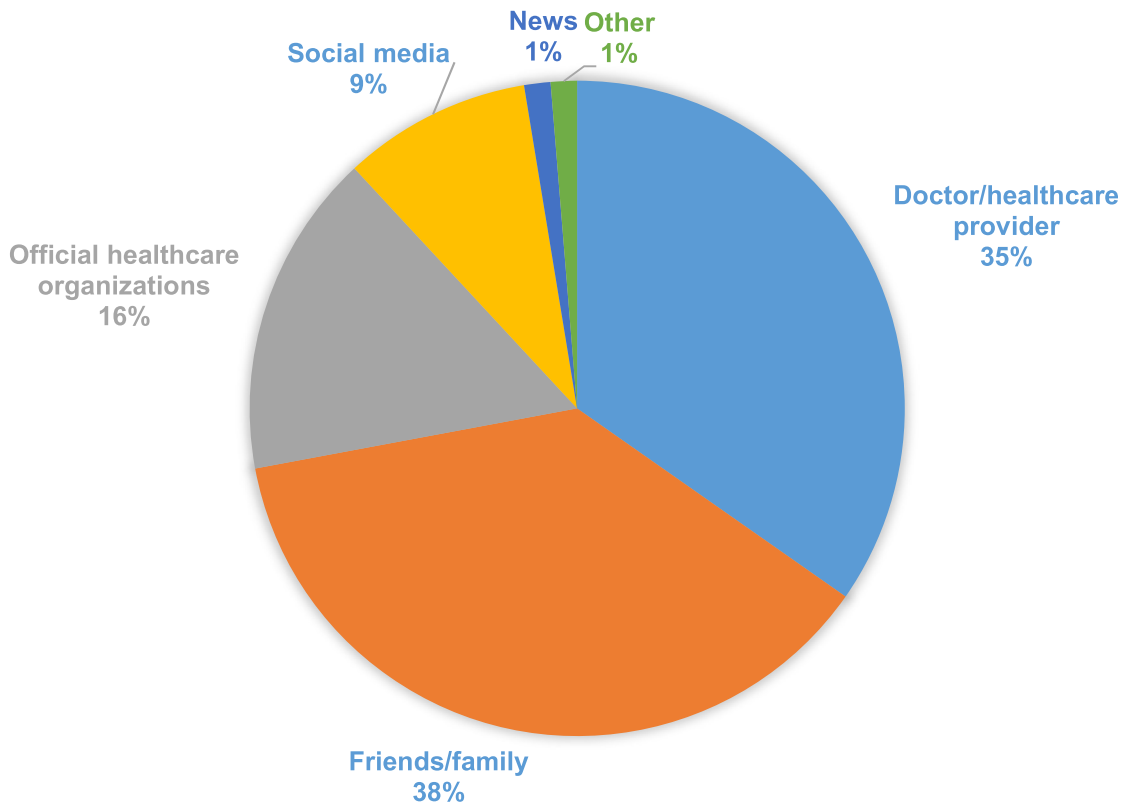


Figure 2. Most influential resources for vaccination decision making among unvaccinated respondents.

Table 2. Frequency of Agreement With Vaccine Hesitancy Reasons Among Unvaccinated and Partially Vaccinated Respondents

Do any of the following reflect your feelings about or experiences with the COVID-19 vaccine? (select all that apply), n=103	Yes, n (%)
I am worried I will have a bad reaction to the vaccine	78 (75.7%)
I am worried about the safety of the vaccine	75 (72.8%)
There's not enough information about the vaccine	53 (51.5%)
My partner doesn't want me to get the COVID-19 vaccine	53 (51.5%)
I'm waiting to see what happens to other people who get the vaccine	50 (48.5%)
Vaccines can cause health problems like autism or infertility	48 (46.6%)
I don't trust companies that create vaccines or drugs (Big Pharma)	46 (44.7%)
My family doesn't want me to get the COVID-19 vaccine	41 (39.8%)
I'm waiting for a recommendation from my doctor or other health care provider	39 (37.9%)
The vaccine is too new. I don't take new vaccines	39 (37.9%)
I don't trust what the government tells me (CDC, Department of Health, State of Hawaii)	39 (37.9%)
I don't know if I can get it with my health conditions or allergies	37 (35.9%)
I don't know if the vaccine will protect me against COVID-19	31 (30.1%)
I don't think employers or schools should be able to mandate getting the COVID-19 Vaccine	30 (29.1%)
I don't think the vaccine was properly tested	26 (25.2%)
I'm afraid of needles and injections	15 (14.6%)
The COVID vaccine might give me COVID-19	12 (11.7%)
I'm not at risk for COVID-19 so I don't need the vaccine	12 (11.7%)
I think the approval process was rushed	12 (11.7%)
I am healthy so COVID-19 will not harm me	11 (10.7%)
I believe the virus was created by a government or person so that I would take the vaccine	10 (9.7%)
I don't think that the vaccine can prevent me from getting very sick from COVID-19	8 (7.8%)
I do not believe that COVID-19 is a serious threat to my health	7 (6.8%)
I don't believe COVID is real	7 (6.8%)
God (or another higher power) will protect me from COVID-19	6 (5.8%)
I think there's a microchip in the vaccine	6 (5.8%)
My religion prohibits getting vaccines	6 (5.8%)
I prefer to develop immunity by getting COVID-19	5 (4.9%)
I am already immune from a past COVID-19 infection so I don't need the COVID-19 vaccine	4 (3.9%)
The vaccine is too expensive	3 (2.9%)
The vaccine is not available to me	3 (2.9%)
I don't take any vaccines	2 (1.9%)

CDC, Centers for Disease Control and Prevention.

healthcare infrastructure.^{32–34} Among the frequently endorsed statements was the belief that “there’s not enough information about the vaccine,” which underlies the importance of increasing public perception of the reliability and trustworthiness of both biomedical research and our regulatory systems with regard to novel vaccines.

A critical finding in our survey was that a very large proportion of unvaccinated respondents were willing to be vaccinated at a later time. A vast majority of these respondents cited the end of breastfeeding as the time that they would be most comfortable getting vaccinated. Because the influence of partners and family members is considerable with regard to vaccine decision making,

educational efforts aimed at the broader population’s understanding of the safety of the vaccine and its protective nature for a fetus and a newborn with a naïve immune system are critical.

Our findings are also influenced by the timeline of vaccine availability. Respondents who are currently trying or considering conception may have been vaccinated before pregnancy was a primary concern or consideration, whereas those who are currently or recently pregnant may have been in the middle of their attempts of conception or midgestation when vaccines became widely available. The willingness to become vaccinated after breastfeeding mentioned earlier aligns with this trend.

Limitations

Our study is limited because it is an internet-based survey with significant interference from illegitimate respondents. Consequentially, we had a smaller total number of legitimate responses, which limits the complexity of analysis and the generalizability of results. However, we included respondents across a large perinatal time period from preconception, during gestation, postpartum, and lactation, providing us with an increased perspective into the understanding of vaccine hesitancy across this pregnant population.

CONCLUSIONS

Our research suggests actionable and varied approaches for potentially increasing vaccine acceptance among pregnant people. We take inspiration from previously published work that addresses vaccination through the 4 Cs: confidence, complacency, convenience, and compassion.³⁵ We believe that applying the specific insights of our population within these 4 Cs can help inform future vaccine campaigns to increase vaccine uptake in the perinatal period and has the potential to generate more tailored outreach techniques for our state.

These findings suggest an opportunity to better reach individuals in the perinatal period through consistent and unequivocal messaging about vaccine safety and benefits in the perinatal period across obstetrics, family medicine, and pediatric providers while also suggesting that broader campaigns to increase positive social norms related to COVID-19 vaccination during the perinatal period could be effective. Leading with empathy and a shared concern for the well-being of the pregnant person and their infant is critical because our data suggest that vaccine delay is rooted in wanting to avoid exposing their fetus or infant to something that is considered unsafe or risky. Patients in the perinatal period seem to consider the risk of the vaccine as greater than the risk of the virus, and future outreach should focus on reversing that narrative to make clear the true benefits of vaccination and the risks of COVID-19 exposure during the uniquely high-risk perinatal period.

ACKNOWLEDGMENTS

The study was approved by the Human Studies Program at the University of Hawaii (Protocol 2022-00258).

Support for this research came from the Early Childhood Action Strategy.

Declaration of interest: none.

CREDIT AUTHOR STATEMENT

Mary S. Tschann: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. Taylor N. Ronquillo: Investigation, Project administration, Visualization, Writing – original draft, Writing – review & editing. Lauren M. Sternberg: Investigation, Writing – original draft, Writing – review & editing. Zarina J. Wong: Investigation, Writing – original draft, Writing – review & editing. Reni Soon: Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing. Bliss E.K. Kanehiro: Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing.

REFERENCES

1. FDA takes key action in fight against COVID-19 by issuing emergency use authorization for first COVID-19 vaccine. Food and Drug Administration. <https://www.fda.gov/news-events/press-announcements/fda-takes-key-action-fight-against-covid-19-issuing-emergency-use-authorization-first-covid-19>. Updated December 11, 2020. Accessed November 9, 2022.
2. FDA takes additional action in fight against COVID-19 by issuing emergency use authorization for second COVID-19 vaccine. Food and Drug Administration. <https://www.fda.gov/news-events/press-announcements/fda-takes-additional-action-fight-against-covid-19-issuing-emergency-use-authorization-second-covid>. Updated December 18, 2020. Accessed November 9, 2022.
3. Centers for Disease Control and Prevention. COVID-19 Vaccination for Pregnant People to Prevent Serious Illness, Deaths, and Adverse Pregnancy Outcomes from COVID-19. Atlanta, GA: Centers for Disease Control and Prevention; 2021. <https://emergency.cdc.gov/han/2021/han00453.asp>.
4. COVID-19 vaccination considerations for obstetric–gynecologic care. American College of Obstetricians and Gynecologists. <https://www.acog.org/clinical/clinical-guidance/practice-advisory/articles/2020/12/covid-19-vaccination-considerations-for-obstetric-gynecologic-care>. Updated June 3, 2022. Accessed November 9, 2022.
5. Statement: SARS-CoV-2 vaccination in pregnancy. Society for Maternal-Fetal Medicine (SMFM). https://s3.amazonaws.com/cdn.smfm.org/media/4181/SMFM_COVID_Vaccine_2023.pdf. Updated September 14, 2023. Accessed November 9, 2022.
6. Mullins E, Hudak ML, Banerjee J, et al. Pregnancy and neonatal outcomes of COVID-19: coreporting of common outcomes from PAN-COVID and AAP-SONPM registries. *Ultrasound Obstet Gynecol*. 2021;57(4):573–581. <https://doi.org/10.1002/uog.23619>.
7. Villar J, Ariff S, Gunier RB, et al. Maternal and neonatal morbidity and mortality among pregnant women with and without COVID-19 infection: the INTERCOVID multinational cohort study. *JAMA Pediatr*. 2021;175(8):817–826. <https://doi.org/10.1001/jamapediatrics.2021.1050>.
8. Wei SQ, Bilodeau-Bertrand M, Liu S, Auger N. The impact of COVID-19 on pregnancy outcomes: a systematic review and meta-analysis. *CMAJ*. 2021;193(16):E540–E548. <https://doi.org/10.1503/cmaj.202604>.
9. Dagan N, Barda N, Biron-Shental T, et al. Effectiveness of the BNT162b2 mRNA COVID-19 vaccine in pregnancy. *Nat Med*. 2021;27(10):1693–1695. <https://doi.org/10.1038/s41591-021-01490-8>.
10. Goldshtein I, Nevo D, Steinberg DM, et al. Association between BNT162b2 vaccination and incidence of SARS-CoV-2 infection in pregnant women. *JAMA*. 2021;326(8):728–735. <https://doi.org/10.1001/jama.2021.11035>.

11. Shimabukuro TT, Kim SY, Myers TR, et al. Preliminary findings of mRNA Covid-19 vaccine safety in pregnant persons. *N Engl J Med.* 2021;384(24):2273–2282. <https://doi.org/10.1056/NEJMoa2104983>.
12. Zauche LH, Wallace B, Smoots AN, et al. Receipt of mRNA Covid-19 vaccines and risk of spontaneous abortion. *N Engl J Med.* 2021;385(16):1533–1535. <https://doi.org/10.1056/NEJMc2113891>.
13. Razzaghi H, Meghani M, Pingali C, et al. COVID-19 vaccination coverage among pregnant women during pregnancy - eight integrated health care organizations, United States, December 14, 2020–May 8, 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70(24):895–899. <https://doi.org/10.15585/mmwr.mm7024e2>.
14. Stock SJ, Carruthers J, Calvert C, et al. SARS-CoV-2 infection and COVID-19 vaccination rates in pregnant women in Scotland. *Nat Med.* 2022;28(3):504–512. <https://doi.org/10.1038/s41591-021-01666-2>.
15. COVID data tracker. Centers for Disease Control and Prevention. <https://covid.cdc.gov/covid-data-tracker>. Updated November 27, 2023. Accessed November 29, 2023.
16. Lutz CS, Carr W, Cohn A, Rodriguez L. Understanding barriers and predictors of maternal immunization: identifying gaps through an exploratory literature review. *Vaccine.* 2018;36(49):7445–7455. <https://doi.org/10.1016/j.vaccine.2018.10.046>.
17. Goncu Ayhan S, Oluklu D, Atalay A, et al. COVID-19 vaccine acceptance in pregnant women. *Int J Gynaecol Obstet.* 2021;154(2):291–296. <https://doi.org/10.1002/ijgo.13713>.
18. Battarbee AN, Stockwell MS, Varner M, et al. Attitudes toward COVID-19 illness and COVID-19 vaccination among pregnant women: a cross-sectional multicenter study during August–December 2020. *Am J Perinatol.* 2022;39(1):75–83. <https://doi.org/10.1055/s-0041-1735878>.
19. Erchick DJ, Agarwal S, Kaysin A, Gibson DG, Labrique AB. Changes in prenatal care and vaccine willingness among pregnant women during the COVID-19 pandemic. *BMC Pregnancy Childbirth.* 2022;22(1):558. <https://doi.org/10.1186/s12884-022-04882-x>.
20. Ennab F, Babar MS, Khan AR, et al. Implications of social media misinformation on COVID-19 vaccine confidence among pregnant women in Africa. *Clin Epidemiol Glob Health.* 2022;14:100981. <https://doi.org/10.1016/j.cegh.2022.100981>.
21. Smith DD, Pippen JL, Adesomo AA, Rood KM, Landon MB, Costantine MM. Exclusion of pregnant women from clinical trials during the coronavirus disease 2019 pandemic: a review of international registries. *Am J Perinatol.* 2020;37(8):792–799. <https://doi.org/10.1055/s-0040-1712103>.
22. Grünebaum A, McCullough LB, Litvak A, Chervenak FA. Inclusion of pregnant individuals among priority populations for coronavirus disease 2019 vaccination for all 50 states in the United States. *Am J Obstet Gynecol.* 2021;224(5):536–539. <https://doi.org/10.1016/j.ajog.2021.01.026>.
23. COVID-19 vaccination clinical & professional resources. Centers for Disease Control and Prevention. <https://www.cdc.gov/vaccines/covid-19/index.html>. Updated May 13, 2022. Accessed November 9, 2022.
24. Penaia CS, Morey BN, Thomas KB, et al. Disparities in native Hawaiian and pacific islander COVID-19 mortality: a community-driven data response. *Am J Public Health.* 2021;111(S2):S49–S52. <https://doi.org/10.2105/AJPH.2021.306370>.
25. Juarez R, Kang Z, Okihiro M, Garcia BK, Phankitnirudorn K, Maunakea AK. Dynamics of trust and consumption of COVID-19 information implicate a mechanism for COVID-19 vaccine and booster uptake. *Vaccines (Basel).* 2022;10(9):1435. <https://doi.org/10.3390/vaccines10091435>.
26. Loomba S, de Figueiredo A, Piatek SJ, de Graaf K, Larson HJ. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nat Hum Behav.* 2021;5(3):337–348. <https://doi.org/10.1038/s41562-021-01056-1>.
27. Fisher KA, Bloomstone SJ, Walder J, Crawford S, Fouayzi H, Mazor KM. Attitudes toward a potential SARS-CoV-2 vaccine : a survey of U.S. adults. *Ann Intern Med.* 2020;173(12):964–973. <https://doi.org/10.7326/M20-3569>.
28. Zhang Z, Shuofei Zhu, Mink J, Xiong A, Song L, Wang G. Beyond bot detection: combating fraudulent online survey Takers*. In: Proceedings of the ACM Web Conference 2022 (WWW '22). New York, NY. Association for Computing Machinery, 2022:699–709. <https://doi.org/10.1145/3485447.3512230>.
29. Kiefer MK, Mehl R, Costantine MM, et al. Characteristics and perceptions associated with COVID-19 vaccination hesitancy among pregnant and postpartum individuals: a cross-sectional study. *BJOG.* 2022;129(8):1342–1351. <https://doi.org/10.1111/1471-0528.17110>.
30. Schaal NK, Zöllkau J, Hepp P, Fehm T, Hagenbeck C. Pregnant and breastfeeding women's attitudes and fears regarding the COVID-19 vaccination. *Arch Gynecol Obstet.* 2022;306(2):365–372. <https://doi.org/10.1007/s00404-021-06297-z>.
31. Mandavilli A. The covid pandemic's hidden casualties: pregnant women. *The New York Times.* December 8, 2022. <https://www.nytimes.com/2022/12/08/health/pregnant-women-covid-flu-vaccine.html>. Accessed December 23, 2022.
32. Jayagobi PA, Ong C, Thai YK, et al. Perceptions and acceptance of COVID-19 vaccine among pregnant and lactating women in Singapore: a cross-sectional study. *medRxiv.* Posted online July 4, 2021. <https://doi.org/10.1101/2021.06.29.21259741>.
33. Hosokawa Y, Okawa S, Hori A, et al. The prevalence of COVID-19 vaccination and vaccine hesitancy in pregnant women: an Internet-based cross-sectional study in Japan. *J Epidemiol.* 2022;32(4):188–194. <https://doi.org/10.2188/jea.JE20210458>.
34. Bianchi FP, Stefanizzi P, Di Gioia MC, Brescia N, Lattanzio S, Tafuri S. COVID-19 vaccination hesitancy in pregnant and breastfeeding women and strategies to increase vaccination compliance: a systematic review and meta-analysis. *Expert Rev Vaccines.* 2022;21(10):1443–1454. <https://doi.org/10.1080/14760584.2022.2100766>.
35. Shook LL, Kishkovich TP, Edlow AG. Countering COVID-19 vaccine hesitancy in pregnancy: the “4 Cs”. *Am J Perinatol.* 2022;39(10):1048–1054. <https://doi.org/10.1055/a-1673-5546>.