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Research Article

COVID-19 Vaccination Hesitancy in Women Who Desire Future Fertility/Pregnancy

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Abstract

Objective: To evaluate the attitudes toward SARS-CoV-2 (COVID-19) vaccination by unvaccinated women who desire future fertility.

Methods: An electronic survey was sent out to 68,720 women (ages 18-44) who were seen at Penn State Milton S. Hershey Medical Center between 2016 and 2021. Categorical survey responses were summarized as frequencies and percentages. Logistic regression was utilized to determine whether the timing of pregnancy affected the likelihood of worrying about whether the vaccine would impact either the baby's health or the participant's fertility. Results are quantified via odds ratios (OR) and corresponding 95% confidence intervals (CI).

Results: 600 consented and eligible unvaccinated women participated in the survey of which 210 (35.0%) were currently attempting or planning pregnancy within a year and 318 (53.0%) in the next 1-5 years. 448 (74.7%) worried the vaccine would harm the baby and 423 (70.5%) worried the vaccine would decrease the chances of becoming pregnant. Of these respondents, 244 (48.0%) stated to reconsider the choice not to vaccinate if given information from a trusted source; the most common source being a healthcare provider. Women did not report being influenced by a family member/friend's decision to not vaccinate (495 (82.5%).

Conclusion: A majority of unvaccinated women were hesitant to receive the vaccine at least partially due to fear of harm to the baby or fertility. Considering that a large subset of these participants responded to reconsider vaccination if given more information by a healthcare provider, future interventions aimed toward provider-driven vaccine promotion could potentially lower vaccine hesitancy rates.

Keywords: COVID-19; Vaccine hesitancy; SARS-CoV-2; Fertility; Pregnancy; Clinical practice; Peri-conception.

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Introduction

Coronavirus disease 19 (COVID-19) vaccination rates had exponentially risen until approximately late June 2021. Despite the ongoing efforts to encourage further vaccination, the percentage of fully vaccinated people in the United States has reached a plateau at about 69% [1] and vaccine hesitancy continues [2].

Women have been particularly hesitant to receive COVID-19 vaccinations, especially during pregnancy or during the reproductive years, noting concern for the safety of the fetus and infertility [3-9].

Interestingly, the American College of Obstetricians and Gynecologists (ACOG), the Society for Maternal-Fetal Medicine (SMFM), and the American Society for Reproductive Medicine (ASRM) have all highlighted the safety of the vaccine for pregnant, lactating, and fertility patients [10-14].

Moreover, the medical literature demonstrates that the risks of infection with COVID-19, including pre-term delivery, pre-eclampsia, stillbirth, maternal ICU admissions, or the need for ventilators [15-20], largely outweigh any supposed risks of obtaining the vaccine.

Despite overwhelming evidence supporting vaccination, unvalidated claims continue to pervade social media outlets. Assertions that the COVID-19 vaccine would lead to female infertility have resulted in increased internet searches related to the subject [21-23].

In addition to these issues, concerns regarding the vaccine and additional women's

health issues have also expanded throughout the pandemic. Media outlets and even some vaccine studies have shown menstrual cycle changes around the time of vaccination including heavier bleeding, painful cramps, irregular cycles, or even post-menopausal bleeding [24-31]. The media has also covered topics such as abnormalities in mammogram results, which have been linked to expected lymph node enlargement from the vaccines [32-34]. Mixed messages about the true clinical significance/implications of these findings are hypothesized to contribute to vaccine hesitancy [35].

Rationale reported for vaccine hesitancy includes the need for more information, antivaccine attitudes, lack of trust, concern for side effects, desire for a longer term of immunity, and other vaccine-specific questions [2,36-46].

In addition to general vaccine hesitancy, it is becoming increasingly apparent that perinatal vaccine hesitancy is also becoming a global issue [8,47-50]. Despite this, there is sparse literature that explores attitudes toward COVID-19 vaccination in patients who desire fertility in the United States [3,9,51].

Therefore, the primary purpose of our study is to survey vaccine hesitancy among female patients who are expecting to conceive either currently or in the future, and to evaluate the characteristics of this population, partner's influence, the source of concern, and reason for the decision including ways by which participants would reconsider vaccination. Given the impact of COVID-19 on pregnancy outcomes and the public interest regarding female infertility, the study aims to fill a gap

in the literature regarding opinions on vaccine hesitancy and to inform the way in which decisions are influenced in unvaccinated females of childbearing age so that this information could be applied to forging solutions promoting vaccination in this population.

Materials and methods

An electronic REDCap survey was created in 2021 in order to measure the attitudes of women toward the COVID-19 vaccination. The English-speaking partially or fully unvaccinated females between the ages of 18 to 44 who desire future fertility, have a uterus, and have been seen in any capacity (i.e. inpatient or outpatient) were surveyed at Penn State Milton S. Hershey Medical Center in Hershey, PA between 6/01/2016 and 07/01/2021.

Those who opted to not receive the second dose of a two-dose COVID-19 vaccine qualified as partially unvaccinated. Males, pregnant women, women without a uterus, fully vaccinated women, and partially vaccinated women who were unable to receive the second dose due to a medical reason or allergic reaction were excluded from participation. Individuals who were previously pregnant were not excluded.

As an incentive, participants who were eligible and completed the survey could optionally enroll in a drawing for a chance to win one of six \$100 Amazon gift cards. This funding was obtained through the institution's Obstetrics & Gynecology Departmental Research Committee and the

survey was approved by the Institutional Review Board (IRB) at the institution.

An Enterprise Information Management (EIM) processing tool was used to identify 68,720 emails corresponding to potentially eligible female patients aged 18-44 seen at the institution. The survey was sent out initially using REDCap's survey distribution tool on August 16th, 2021. Two reminder emails were subsequently sent on August 23rd, and August 30th of 2021 to the same list of 68,720 emails. The survey was kept open for a total of 4 weeks. An IRB-approved email script was used and the Summary Explanation of the Research containing an explanation of the study was included on the first page of the survey.

Participants first answered a set of qualifier questions. These qualifier questions determined vaccination status, pregnancy status, and whether the participant desired future fertility. If the patient met the eligibility requirements for the study based on responses to these questions, participants continued the survey.

Demographic data on the participant and the partner, if applicable, was obtained. The survey aimed to identify reasons for vaccine hesitancy, with a focus on participant attitudes regarding how the vaccine might affect the future fertility/pregnancy and what information, if any, would lead participants to reconsider vaccination.

The questions composed were based on recent literature regarding vaccine hesitancy [3,9,51] and discovery questions based on clinical experience in order to further explore

the socio-scientific issue of COVID-19 vaccine hesitancy, so that the current knowledge base on this topic may be expanded.

Age, race, and ethnicity were defined by the investigator, and were collected based on categories approved by the NIH, CDC, and, the United States Census Bureau.

On the survey, the classifications used for race were White, Black or African American, Asian or Asian Indian, American Indian or Alaska Native, Middle Eastern or North African, Native Hawaiian or Other Pacific Islander, and Other.

The classifications used for ethnicity, per the guidelines, were Hispanic or Latina and Non-Hispanic. A “Prefer Not to Answer” option for both race and ethnicity questions was also included. The data was collected in the hopes of generalizing the demographic data to that of the state and county within which the institution resides.

The survey was conducted electronically to ensure anonymity and to limit conformity bias and response bias as much as possible. Categorical survey responses were summarized as frequencies and percentages. Logistic regression was utilized to determine whether the timing of pregnancy affected the likelihood of worrying about whether the vaccine would impact either the baby’s health or the participant’s fertility. Results are quantified via odds ratios (OR) and corresponding 95% confidence intervals (CI).

Results

Overall, 3981 participants consented, meaning to read the terms of the study, and

proceeded to the qualifier section. Of these participants, 3185 (80.0%) were deemed ineligible after completing the qualifier section (i.e. met exclusion criteria), 113 (2.8%) did not complete the qualifier section, and 683 (17.2%) were eligible to continue with the survey. Of the participants who were deemed ineligible, 2279 (71.6%) were fully vaccinated, 139 (4.4%) were partially vaccinated with the second dose pending or unable to receive due to health or socioeconomic factors, 155 (4.9%) were currently pregnant, and 612 (19.2%) did not desire pregnancy at any point.

Out of the 683 eligible and consented participants, 605 answered survey questions after qualifying, with a majority (575 (95.2%)) completing the survey in its entirety. The final sample size for analysis included 600 fully unvaccinated participants (5 survey completers who received one dose of a two-dose vaccine were excluded) (Figure 1). The majority (575 (95.2%)) completed the survey in its entirety. The final sample size for analysis included 600 fully unvaccinated participants (5 survey completers who received one dose of a two-dose vaccine were excluded) (Figure 1).

Demographic characteristics of the analytic cohort are presented in Table 1. A majority of respondents (53%) were 25-34 years of age, non-Hispanics (85%), and White (76.3%). Over three-quarters of participants (79.7%) reported having one partner. In Table 2, the demographic characteristics of the partners are shown. Of note, 375 (78.5%) reported that the partner was not vaccinated. Only 73 (15.3%) reported that the partner affected the decision to not to get vaccinated.

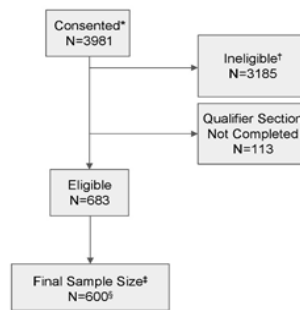


Figure 1: Flowchart demonstrating the pathway to reach the final sample size. * = Respondents who opened the survey link and continued to the qualifier questions after reading and accepting the terms of informed consent prior to the start of the survey. † = Respondents who were either pregnant, fully vaccinated, or not hoping to become pregnant in the future. ‡ = Respondents who either partially or fully completed the survey. § = Excludes 5 eligible survey participants who were partially vaccinated.

Characteristics	n (%)
Age	
18-24	128 (21.3%)
25-34	318 (53.0%)
35-44	112 (18.7%)
Prefer not to answer	12 (2.0%)
No response*	30 (5.0%)
Ethnicity	
Non-Hispanic	510 (85.0%)
Hispanic or Latina	33 (5.5%)
Prefer not to answer	27 (4.5%)
No response*	30 (5.0%)
Race	
White	458 (76.3%)
Black or African-American	33 (5.5%)
Asian/Asian Indian	4 (0.7%)
American Indian/Alaska Native	3 (0.5%)
Middle Eastern/North African	2 (0.3%)
Native Hawaiian or Other Pacific Islander	0 (0.0%)
Other Race	10 (1.7%)
Multi-racial†	21 (3.5%)

Prefer not to answer	39 (6.5%)
No response*	30 (5.0%)
Highest Level of Education	
High School	86 (14.3%)
Some College	141 (23.5%)
College Degree	240 (40.0%)
Graduate School Degree or Above	91 (15.2%)
Prefer not to answer	12 (2.0%)
No response*	30 (5.0%)
Annual Household Income	
<\$50,000	184 (30.7%)
\$50,000-\$100,000	185 (30.8%)
>\$100,000	125 (20.8%)
Prefer not to answer	76 (12.7%)
No response*	30 (5.0%)
Partner Status	
No partner	99 (16.5%)
1 partner	478 (79.7%)
2 or more partners	4 (0.7%)
No response*	19 (3.2%)
When would you see yourself attempting to become pregnant?	
Currently attempting	84 (14.0%)
Within 1 year	126 (21.0%)
1-5 years	318 (53.0%)
More than 5 years	72 (12.0%)
18-24	128 (21.3%)
25-34	318 (53.0%)
35-44	112 (18.7%)
Prefer not to answer	12 (2.0%)
No response*	30 (5.0%)

Table 1. Demographics of participants, including political affiliation, partner status, and timeline of when respondents plan to become pregnant. †Includes participants who made the following multiple selections: 1 subject selected both Black and Other, 1 subject selected both White and Other, 5 subjects selected both White and American Indian/Alaska Native, 3 subjects selected both White and Asian, 9 subjects selected both White and Black/African American, and 2 subjects selected White, Black/African American, and American Indian/Alaska Native.

Characteristic	n (%)
Partner Age	
18-24	58 (12.1%)
25-34	271 (56.7%)
35-44	119 (24.9%)
45 or older	17 (3.6%)
Prefer not to answer	13 (2.7%)
Partner Gender	
Male	458 (95.8%)
Female	8 (1.7%)
Prefer not to answer	12 (2.5%)
Partner Vaccination Status	
Fully vaccinated	70 (14.6%)
Partially vaccinated	10 (2.1%)
Not vaccinated	375 (78.5%)
Prefer not to answer	23 (4.8%)

Table 2. Characteristics of respondents' partners.

When asked to identify reasons for vaccine hesitancy, 448 (74.7%) participants indicated worry that the vaccine will harm the baby if participants become pregnant, and similarly, 423 (70.5%) indicated worry that the vaccine will decrease the chances of becoming pregnant.

The percentage of participants with pregnancy/fertility concerns was highest in women who were currently attempting or planning pregnancy within a year (Table 3).

Notably, each of these 2 subgroups (currently attempting pregnancy and planning pregnancy within a year) were approximately 5 times more likely to report concern the vaccine will harm the baby compared to participants not planning pregnancy for at least 5 years (OR [95% CI]: 4.9 [2.3,10.4] and 5.0 [2.6,9.9], respectively, both $p < .0001$)

(Figure 2A). With respect to fertility concerns, those currently attempting pregnancy were more likely to worry the vaccine will decrease pregnancy chances compared to those not planning for at least 5 years (OR=2.0, 95% CI [1.0,4.0], $p = 0.04$) (Figure 2B).

Social media was most frequently indicated as a source of pregnancy/fertility concerns (Table 3). Of the 203 respondents who indicated social media platforms made participants worry that the vaccine would harm the baby, 84.7% selected Facebook, followed by Instagram (41.9%), and Twitter (24.6%). Interestingly, of the free text responses for those who chose the "Other" social media platform, 10 participants (4.9%) noted the newer outlet TikTok. Similar selections were made regarding which social media platforms influenced the opinion that

vaccination would decrease the chances of becoming pregnant. Notably, 117 (26.1%) and 105 (24.8%) respondents had selected

healthcare providers as a source of pregnancy and fertility concerns, respectively.

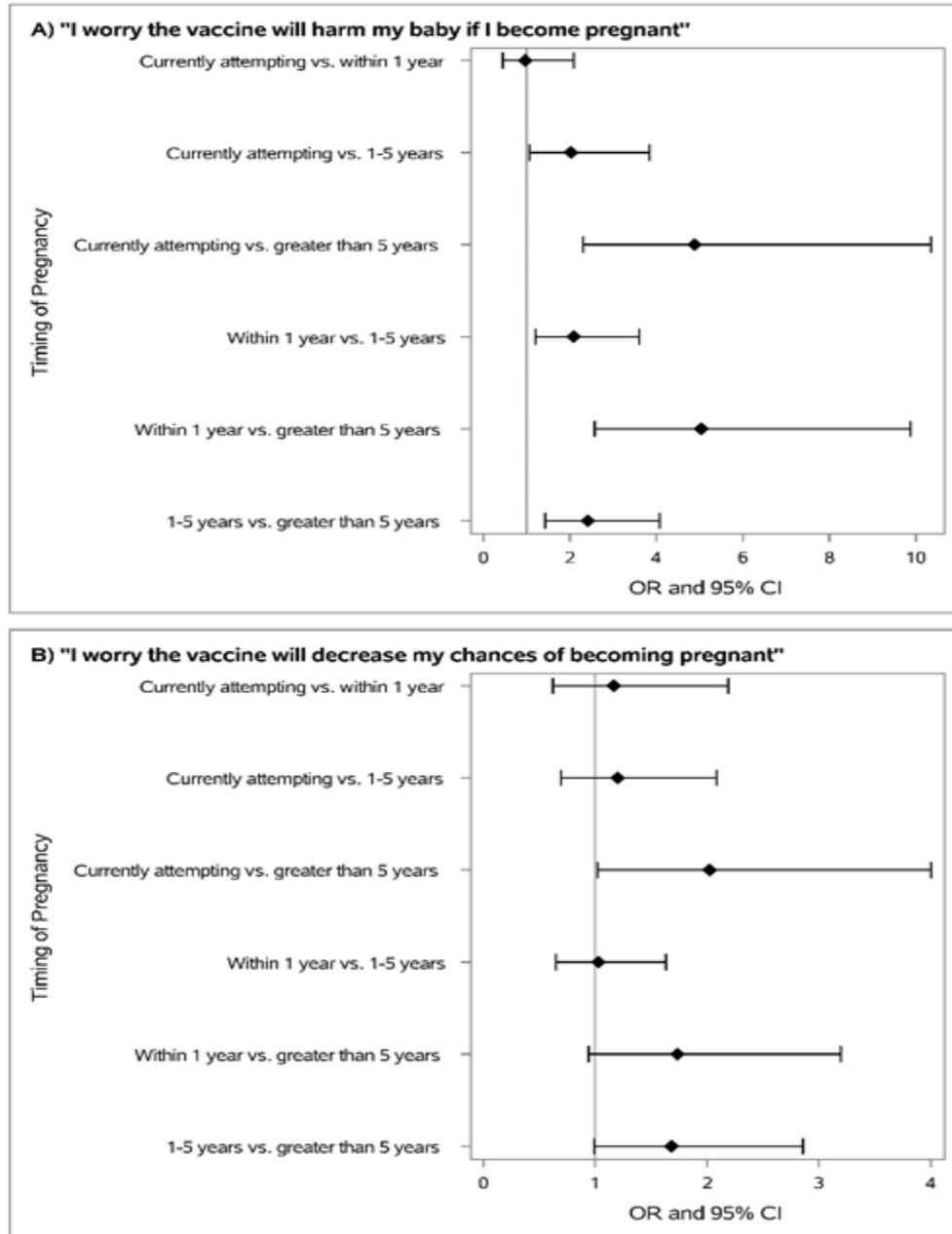


Figure 2. Odds ratios (OR) and 95% confidence intervals (CI) correspond to (A) “I worry that the vaccine will harm my baby if I become pregnant” and (B) “I worry that the vaccine will decrease my chances of becoming pregnant.”

Category		I worry that the vaccine will harm my baby if I become pregnant	I worry that the vaccine will decrease my chances of becoming pregnant	
All subjects (n=600)		448 (74.7%)	423 (70.5%)	
Sources*	TV News	135 (30.1%)	111 (26.2%)	
	Social Media	203 (45.3%)	191 (45.2%)	
	Partner/Spouse	91 (20.3%)	70 (16.6%)	
	A family member other than the spouse	161 (35.9%)	134 (31.7%)	
	Friend	152 (33.9%)	140 (33.1%)	
	Healthcare Provider	117 (26.1%)	105 (24.8%)	
Timing of Pregnancy Subgroups	Currently attempting pregnancy	(n=84)	71 (84.5%)	63 (75.0%)
	Within 1 year	(n=126)	107 (84.9%)	90 (71.4%)
	1-5 years	(n=318)	232 (73.0%)	227 (71.4%)
	Greater than 5 years	(n=72)	38 (52.8%)	43 (59.7%)

Table 3. Assessment of pregnancy and fertility concerns. *Participants could select multiple sources.

Of the 448 patients who reported the worry that the vaccine will harm the baby if participants become pregnant, only 91 participants (20.3%) noted that a partner had influenced this worry.

Of the 423 participants who worried that the vaccine would decrease the chances of becoming pregnant, 70 (16.6%) participants noted that a partner had influenced this worry.

When asked what other sources led to pregnancy/fertility worries, participants mentioned common themes including opinions/research/personal beliefs, the lack of data and further research on the vaccine,

and even the opinions of doctors who spoke to participants regarding the topic (Table S1).

In addition to pregnancy/fertility concerns, 505 (84.2%) were concerned about other side effects of the vaccine, 551 (91.8%) felt the vaccine has not been out long enough to believe it is safe, 371 (61.8%) reported about not trusting manufacturers of the vaccines, and 113 (18.8%) were concerned about a particular ingredient used in the vaccine. Of the respondents who were concerned about other side effects of the vaccine, the three most frequently indicated were feeling sick in general (fever, fatigue, and headaches) (78.0%), blood clotting (73.1%), and heart

issues (66.5%). Other notable side effect concerns influencing decisions to not vaccinate were menstrual cycle length changes (39.6%) and irregular bleeding between periods (35.1%) (Table 4).

Of those who responded with “other” side effect concerns (17.0%), common themes reported were paralysis, neurological issues, seizures, and death (Table S1).

When asked why the manufacturers were not trusted, respondents included themes such as how fast the vaccine was created with the need for more data/research, not believing in the virus or vaccinations, and lack of Food and Drug Administration (FDA) approval at the time the survey was sent out.

Those who were concerned about a specific vaccine ingredient listed ingredients such as aborted fetuses/fetal cell lines, mRNA, propylene glycol, and stem cells (Table S1). A majority of participants (495 (82.6%))

reported not being influenced by a family member/friend’s decision to not vaccinate.

Almost half of the respondents who reported pregnancy and/or fertility concerns would reconsider vaccination if given more information on this topic (244, 48.0%). A majority of these respondents (75.4%) indicated a willingness to receive this information from a healthcare provider while other options were online resources (43.0%), paper resources (34.4%), and other resources (9.8%). Those who indicated “other” listed resources including research articles, years of studies/data on the vaccination, and reliable sources such as moms who received the vaccine and were still able to conceive (Table S1). Similarly, half of the respondents who were concerned with the vaccine’s ingredients and side effects would reconsider the choice if given more information, with the majority preferring this information from a healthcare provider.

Other Vaccine Concerns	n (%)
Side effects	505 (84.2%)
Sick in general (fever, fatigue, headaches) *	394 (78.0%)
Blood clotting*	369 (73.1%)
Heart issues*	336 (66.5%)
Menstrual cycle length changes*	200 (39.6%)
Irregular bleeding between periods*	177 (35.1%)
Painful cramping*	114 (22.6%)
Breast changes*	73 (14.5%)
Post-menopausal bleeding*	67 (13.3%)
Other side effects*	86 (17.0%)
The vaccine has not been out long enough to believe it is safe	551 (91.8%)
Do not trust the vaccine manufacturers	371 (61.8%)
Concerned about a specific vaccine ingredient	113 (18.8%)

Table 4. Other vaccine side effects were a concern to participants. * Denominator is n=505 who reported side effect concerns.

What or who made you worry that the vaccine will harm your baby if you become pregnant?	
There is no extensive research on vaccination and pregnancy because it is unethical to do studies on pregnant women. History of women and vaccines/medications that cause all types of birth defects.	My own opinion. Maybe after 5 years of the vaccine being around so there can be more research, I may change my opinion but as of right now there hasn't been enough time for someone to truly know
There is not enough research to prove this vaccine won't hurt a baby.	CDC, Medical journals, and research that I have done
Doctors in my family	Doctors that are not my provider
I've completed my own research and come to these decisions on my own accord.	If I don't trust it for my own body because I am not sure what it will do to me then I would worry about what it would do to a baby growing in me.
It's not FDA-approved for children	It hasn't been studied and is a very new type of vaccine
Lack of data on vaccine safety in pregnant women	Lack of research
There have been instances in the past where pregnant women or women who may become pregnant were given medications etc. without anyone knowing the full repercussions for the children down the road and then the offspring were sterile or at a high risk of cancer because of the medication/treatment. I don't think this has been sufficiently researched in regard to outcomes for women of reproductive age and the offspring. I'd feel awful if I inadvertently caused harm of that kind to my child.	Previous mRNA vaccine attempts didn't work. This current vaccine is experimental and should not be tested on anyone with a growing baby inside them. It is my personal belief based on common sense and backed by actual science.
Not being FDA approved	There is no long-term research that has been done. And I have friends who have seen breast growth at the age of 20 after getting the Pfizer vaccine. This seems unusual and concerns me that it affects women's reproductive health.
What or who made you worry that the vaccine will decrease your chances of becoming pregnant?	
There is not enough research on long-term side effects	Various websites
medical journals	Website articles. Instagram stories of real-life women.

There have been zero studies done on vaccines during pregnancy and the effect on reproduction	Research from healthcare professionals
Reading research articles on the vaccine's impact on the fertility of the animals used.	Personal belief
Vaccines affecting lymph nodes including ovaries	Too many unknowns on the effects of the vaccine on the body
Reports of adverse effects	Don't have data on this yet
Waves of women have fertility issues after introducing the HPV vaccine; lack of data	Religious
What side effects have you heard about that influenced your decision not to vaccinate?	
Bell's palsy and miscarriage	Blood clots
Death	Decrease in lactation
Early preterm labor and unwell placenta after birth	GBS, stroke, neurologic defects, death
Hearing loss	Infertility
Menstrual cycle changes, in any way	Neurologic disease
Paralysis, heart attack, and death	Seizures, paralysis, myocarditis
Loss of baby/pregnancy, harm to the baby	History of autoimmune in family, personal hormone imbalances, Not fully approved by FDA, do not want to continually be getting boosters, not effective for delta or lambda possibly
What vaccine ingredient(s) did you hear about that concern(s) you?	
Several ingredients in the mRNA vaccines have been linked to higher rates of allergic reactions in sensitive patients. Also, for religious reasons aborted fetal cells used in the development of the vaccines are a negative factor.	Stem cells from aborted babies, and most of the ingredients.
(2-hexyldecanoate), 2 [(polyethylene glycol)-2000]-N, N-ditetradecylacetamide	Chemicals that I don't know about or understand as well as aborted fetuses. That is not okay.
MRNA, aborted fetal cell line	Polyethylene glycol
tromethamine, PEG2000, SM102, along with most of the other ingredients in the vaccine.	HEK 293
How would you like to receive more information regarding COVID-19 vaccination and its effects on fertility/pregnancy?	
Directly from a medical professional, face to face.	If I were to be told by my doctor who knows all the health issues that it was safe for me personally then I would be more likely.

Once long-term side effects studies are done.	People who have received it have successfully gotten pregnant and had the child with no issues and the child shows no signs of issues years afterward.
Research articles in peer-reviewed journals.	Women's health podcasts, research papers
Years from now once the vaccine has been FDA-approved.	None of the above makes any difference. It's not the venue, it's the format that is important. Repeating the same old 'trust us, we're the authority' isn't going to move anyone. What needs to happen is a two-sided panel discussion, live, in public view. BOTH SIDES need to be represented; not simply 'We're the CDC and we say so.' And not 'FDA approved blah blah'--that's all one-sided. We have to see the discussion unfold by honest brokers who don't have a personal stake in the outcome. Government

Table S1. Examples of free text survey responses (random order, each box separate response).

Most respondents noted that the decision toward vaccination was not influenced by a family member's or friend's decision. This finding complements the study done by Turocy et al., which found that there was no relationship between vaccine acceptance and the loss of a close friend or a relative [3]. A majority of the participants had a partner at the time of responding and only a small fraction reported that the partner had influenced the decision to not get vaccinated. Interestingly, most mentioned that the partner was not vaccinated as well. This may be because there are certain subconscious influences such as availability heuristics and social upbringing versus receiving direct verbal persuasion to distrust the vaccine.

One major limitation in many of the observational studies regarding vaccine hesitancy performed thus far is the timing of when the survey was sent to participants. These studies focus on either the prospects of the vaccine or the responses during the early

months after which the vaccine had just begun being administered [36-39,61,62]. In contrast, an electronic survey was conducted to evaluate the attitudes of non-vaccinated female patients within the health system who are looking to become fertile or pregnant after two-thirds of the U.S. population has been vaccinated. The survey was sent out around the beginning of the vaccination plateau period after the vaccines had been present for half of the year and about when a majority of the population had been vaccinated. This gives us a sample size with participants who continue to remain hesitant towards the vaccine despite other external pressures to receive the vaccine including healthcare workers, friends, family, and employers. Additionally, the FDA approved the Pfizer-BioNTech vaccination on August 23rd, which is when the second reminder had been sent out [63]. Responses occurred both before and after a major event which could have had an impact on participant attitudes, considering

some participants had listed lack of FDA approval as a reason to not be fully vaccinated. The timing of the survey allows us to capture anti-vaccination beliefs at a time point that exists prior to any government mandates or new strains of the virus [64, 65].

There are certain limitations to the survey study. Firstly, there is the possibility of dishonest answers due to social desirability bias and respondents attempting to protect privacy. Survey fatigue can also be present; 30 participants (5%) did not complete the survey in its entirety but were still included in the analysis. Secondly, the study may suffer from non-response bias because it is unknown which women who were sent the survey but did not respond would have been eligible.

Thirdly, it is important to recognize that the demographics at the institution represent mainly White, non-Hispanic participants, and therefore, the results may not be generalizable to diverse populations.

Further, the study design would not include those without internet access, who speak languages other than English, or who are without adequate literacy to be able to respond. At the time of performing the study in the early Fall of 2021, there was not yet a release of any SARS-CoV-2 booster doses. Therefore, this study does not fully encapsulate the evolving vaccination status of participants who had initially taken the survey. However, many reasons for vaccine hesitancy still remain, and the present study has aimed to examine these reasons for refusal.

The study reveals that the strongest factors that influence negative attitudes towards the vaccine and fertility/pregnancy at the

institution are extrinsic and online. Although almost a quarter of respondents had noted that healthcare providers were a source of fertility/pregnancy concerns, many of the respondents who would reconsider vaccination preferred to receive more information regarding the vaccine and fertility/pregnancy from the healthcare provider. The idea of healthcare providers being a source of information is important to consider and is supported by other literature regarding vaccine hesitancy [2,51,66,67].

However, there is also evidence of distrust of the medical system in women considering/undergoing fertility treatment [51] and despite the findings, only half of the participants felt the attitudes could be changed with more information about the vaccine. This implies that there needs to be further research on what could influence the other half.

A future study could explore the development/benefits of various interventions that assist in reducing the number of patients who are hesitant to obtain the COVID-19 vaccine because of concerns for harm to the fertility or baby. Ultimately, continued efforts in addressing vaccine hesitancy will set precedent for vaccine counseling in women's health for future novel emerging infectious diseases.

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