

## ORIGINAL ARTICLE

# Gender, socioeconomic status, and COVID-19 vaccine hesitancy in the US: An intersectionality approach

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**Abstract**

Previous research on coronavirus disease 2019 (COVID-19) vaccine hesitancy lacks a gender perspective, and it is unclear whether gender intersects with socioeconomic status to co-produce inequalities in people's intent to take vaccines. The current study draws on intersectionality theory and uses data from the 2021 US Household Pulse Survey ( $n = 50,359$ ). Both bivariate and multivariate statistical analyses were conducted. The results suggest that American women had a higher vaccine hesitancy rate than men. Gender interacts with socioeconomic status to shape people's vaccine hesitancy in a complex way. Specifically, women living in poverty or currently working were more vaccine-hesitant, while poverty and employment status did not affect men's vaccine hesitancy. However, not having a college education contributed to both women's and men's COVID-19 vaccine hesitancy. Moreover, women were more worried about the safety of the vaccine, but men's hesitancy tended to be driven by lower perceptions of COVID-19 dangers and belief in conspiratorial claims.

**KEYWORDS**

COVID-19, gender, socioeconomic status, vaccine hesitancy

## INTRODUCTION

The long-term control of the coronavirus disease 2019 (COVID-19) pandemic hinges on the development and uptake of preventive vaccines. In March 2021, the Biden administration started a large-scale vaccine confidence campaign to encourage Americans to get vaccinated against the coronavirus (Diamond, 2021). According to the Centres for Disease Control and Prevention, by the end of May 2021, nearly 50.5% of Americans had received at least one dose of the COVID-19 vaccine, and more than 40.7% were fully vaccinated (CDC, 2021). However, a sizeable proportion of the population is still hesitant about COVID-19 vaccines. An NPR poll conducted in April 2021 suggests that one in four Americans said they would refuse a coronavirus vaccine, and another 5% were “undecided” (Brumfiel, 2021). Defined as: “delay in acceptance or refusal of vaccination despite the availability of vaccination services” (MacDonald, 2015), vaccine hesitancy is a complex cognitive and behavioural construct depending on types of vaccines, places, and times (World Health Organization, 2014). Vaccine hesitancy is particularly concerning for the global efforts to control the COVID-19 pandemic as it prevents nations from reaching herd immunity.

In the literature of vaccine hesitancy, findings on gender have been inconsistent. For example, some researchers found that men were more likely than women to accept influenza vaccination (Nagata et al., 2013), while others argued that gender was not a consistent predictor of influenza vaccine hesitancy (Yeung et al., 2016). A linkage between gender and COVID-19 vaccine hesitancy has been identified by recent studies. Based on an online survey ( $n = 672$ ) conducted in May 2020 in the US, Malik et al. (2020) reported that women were less willing to take COVID-19 vaccines than men. This finding was confirmed by many other studies conducted in the US or other countries (e.g., Callaghan et al., 2021; Fisher et al., 2020; Latkin, Dayton, Yi, Colon, & Kong, 2021; Lazarus et al., 2021; Malik et al., 2020; Sallam, 2021; Troiano & Nardi, 2021). However, a small group of researchers suggested different results. Khubchandani et al. (2021) surveyed a community-based sample of the American adult population ( $n = 1878$ ) in June 2020. Their analyses did not indicate gender differences in COVID-19 vaccine hesitancy. Latkin, Dayton, Yi, Konstantopoulos, et al. (2021) conducted an online survey ( $n = 592$ ) in July 2020 and found that women had greater intentions to obtain a COVID-19 vaccine than men. Different sampling strategies, analytical approaches, and sample characteristics may have caused the mixed findings, but more importantly, neither of those studies have a particular focus on gender. In other words, the ongoing dialogue about COVID-19 vaccine hesitancy lacks a gender perspective.

On the other hand, some evidence suggests that people's vaccine hesitancy is also related to their socioeconomic backgrounds. For instance, people with lower income and less education are less willing to pursue COVID-19 vaccination (Callaghan et al., 2021; Fisher et al., 2020; Malik et al., 2020). Some researchers found that people who lost a job or were not working were more likely to accept a COVID-19 vaccine than those who continued to work during the pandemic (Dror et al., 2020). Others argued that employed individuals were more inclined to take COVID-19 vaccines than people who were unemployed (Malik et al., 2020). However, the intersection of gender and socioeconomic status remains unanswered in the context of COVID-19 vaccine hesitancy. The intersectionality approach was first introduced by feminist scholars to study gender and race. They argued that gender and race should be examined as intersecting dimensions of oppression but not separate mechanisms of power (Collins, 1990; Crenshaw, 1989, 1991). Later, other axes of significance, such as social class, sexuality, and age, have been added to the framework (Kosnick, 2011; Zarkov, 2011). To the best of our knowledge, the intersectionality approach has never been applied to research to COVID-19 vaccine hesitancy.

Moreover, there are other sociodemographic factors influencing people's willingness to accept vaccination. Due to interpersonal and systemic racism, less interaction with healthcare professionals, and historical biomedical-related mistrust, racial/ethnic minorities, especially African Americans, have lower confidence in COVID-19 vaccines (Callaghan et al., 2021; Hamel et al., 2021; Malik et al., 2020). Age is also an important predictor, as younger adults are less enthusiastic about taking COVID-19 vaccines (Sallam, 2021). Interestingly, Khubchandani et al. (2021) noticed that in the US, COVID-19 vaccine hesitancy was greater for people who had children at home. Dror et al. (2020) also observed that having children at home was a negative predictor for accepting COVID-19 vaccines in Israel. In addition, recent publications suggest that hesitancy or opposition to COVID-19 vaccination might be caused by the novelty of the disease, the rapid speed of vaccine development, mistrust in science, and the politicization of the vaccine (Funk & Tyson, 2020; Hamel et al., 2020).

In summary, to fill the gaps in the literature and advance the understanding of COVID-19 vaccine hesitancy in the US, the current study draws on intersectionality theory and offers a novel gender perspective. We applied sophisticated statistical modeling to clarify the intersectional effects of gender and socioeconomic status on vaccine hesitancy while controlling for other sociodemographic factors. We address three key research questions: RQ1) *Are there gender differences in COVID-19 vaccine hesitancy in the US?* RQ2) *How does gender intersect with socioeconomic status to shape people's hesitancy towards COVID-19 vaccination?* RQ3) *Do women and men have different concerns about COVID-19 vaccines?* To answer those questions, we utilize a nationally representative sample from the 2021 Household Pulse Survey (HPS), administered by the US Census Bureau.

## METHODS

### Data

The US HPS is designed to quickly and efficiently collect data to measure American household experiences during the coronavirus pandemic. In collaboration with other federal agencies, the US Census Bureau developed the HPS questionnaire and selected a large national representative sample by utilising its Master Address File (MAF), which is considered the gold standard frame for US statistics (Fields et al., 2020). Email addresses and mobile telephone numbers were added from the Census Bureau Contact Frame to the MAF (Fields et al., 2020). The HPS questionnaire includes questions on how education, employment, food security, health, housing, household spending, intention to receive a COVID-19 vaccination, and transportation have been affected by the ongoing crisis.

Data used in this paper were from the Phase three collection of the HPS. Specifically, we used a sample collected between 17 February 2021 and 1 March 2021. The Census Bureau used Qualtrics as the data collection platform. Sampled households were contacted by both email and text messages, and reminders were sent to nonrespondents. In total, 1,039,370 housing units were selected from the sampling frame, and 77,788 people answered the online questionnaire. Our analyses included 50,359 respondents who reported that they had not received a COVID-19 vaccine. We applied the recommended sampling weight to our analyses, so that the results of this study can be generalized to the national level. The publicly available microdata file was downloaded from the HPS public use file webpage (<https://www.census.gov/programs-surveys/household-pulse-survey/datasets.html>).

## Outcome measures

In Phase three of the HPS, a series of questions about people's attitudes and behaviours related to COVID-19 vaccines were added to the questionnaire. In particular, the HPS asks: "Once a vaccine to prevent COVID-19 is available to you, would you..." Responses include "definitely get a vaccine," "probably get a vaccine," "probably NOT get a vaccine," and "definitely NOT get a vaccine." Our primary outcome variable takes on a value of one if the respondent intended to refuse ("definitely NOT get a vaccine" or "probably NOT get a vaccine") COVID-19 vaccination and 0 if the respondent intended to be vaccinated ("definitely get a vaccine" or "probably get a vaccine"). We created a binary variable as the outcome measure because we were interested in what factors were associated with people being vaccine-hesitant. Among the 50,359 respondents who had not received a COVID-19 vaccine, 9% reported they would "definitely NOT get a vaccine," 12% "probably NOT get a vaccine," 19% "probably get a vaccine," and 60% "definitely get a vaccine."

Respondents who answered that they were hesitant to be vaccinated were presented with a follow-up multi-answer question asking about their specific concerns regarding COVID-19 vaccines. Using responses to this question, we constructed four dichotomous indicators for four typical vaccine-related concerns (see Table 1).

## Explanatory measures

Based on insights from previous research, we used four groups of explanatory measures: demographics, socioeconomic status, household structure, and health-related variables. For demographics, age was calculated based on the respondent's reported date of birth; we used the respondent sex variable from the HPS (1 = female; 0 = male [reference]); race/ethnicity was recoded into five binary variables (White, non-Hispanic [reference]; Black, non-Hispanic; Asian, non-Hispanic; Hispanic; Other racial/ethnic groups, non-Hispanic). For our sample, the average age was 51 years old; 59% of respondents were female, 72% White, 8% Black, 5% Asian, 11% Hispanic, and 4% were from other racial/ethnic groups.

Socioeconomic status was measured through three dimensions. First, based on respondents' reported highest degree completed, two categories were created to measure their education level (1 = below Bachelor's degree; 0 = Bachelor's or graduate degree [reference]). Second, household income before taxes was provided by the HPS. Based on the federal poverty threshold, household income, household size, and numbers of children, we categorised respondents into two groups: living in households above the federal poverty threshold [reference] and living in households below the federal poverty threshold. Third, we included employment status: during the last 7 days, the respondent was employed [reference], unemployed, or retired. In total, 40% of respondents in our sample were from households below the poverty threshold, 50% did not have a Bachelor's degree, and 25% were unemployed when taking the survey.

In terms of household structure, we included whether the respondent was living with children (1 = yes; 0 = no [reference]), the total number of people (adults and children) living with the respondent in the same household, and the respondent's current marital status (1 = married; 0 = unmarried [reference]). We also controlled for the type of building where the respondent was living, such as a house [reference], an apartment, a mobile home, or an RV/van/boat. The average household size was 3 people, about 37% of respondents were living with children, and 57% were married. Moreover, 63% of respondents were living in a house, 15% were living in an apartment, 3% were living in a mobile house, and 0.4% were living in a recreational vehicle (RV), van, or boat.

TABLE 1 Descriptive statistics ( $n = 50,359$ )

	Min.	Max.	Mean	Std. Dev.	Yes	No	% Missing
Outcome measures:							
The intention on getting COVID-19 vaccine							
Definitely NOT get a vaccine	0	1	-	-	4491	45,750	0.2
Probably NOT get a vaccine	0	1	-	-	5765	44,476	0.2
Probably get a vaccine	0	1	-	-	9567	40,674	0.2
Definitely get a vaccine	0	1	-	-	30,418	19,823	0.2
Concerns related to COVID-19 vaccines							
"I am concerned about possible side effects of a COVID-19 vaccine."	0	1	-	-	10,016	40,343	0.0
"I don't believe I need a COVID-19 vaccine."	0	1	-	-	2967	47,392	0.0
"I don't trust the government."	0	1	-	-	3742	46,617	0.0
"I am concerned about the cost of a COVID-19 vaccine."	0	1	-	-	1094	49,265	0.0
Explanatory measures:							
<i>Demographics</i>							
Age	18	88	50.7	14.8	-	-	-
Sex							
Male [ref]	0	1	-	-	20,479	29,880	0.0
Female	0	1	-	-	29,880	20,479	0.0
Race/ethnicity							
White [ref]	0	1	-	-	36,452	13,907	0.0
Black	0	1	-	-	4186	46,173	0.0
Asian	0	1	-	-	2486	47,873	0.0
Hispanic	0	1	-	-	5397	44,962	0.0
Other racial/ethnic groups	0	1	-	-	1838	48,521	0.0
<i>Socioeconomic status variables</i>							
Household income							
Above the poverty threshold [ref]	0	1	-	-	30,455	19,904	0.0
Below the poverty threshold	0	1	-	-	19,904	30,455	0.0
Education level							
Bachelor's or graduate degree [ref]	0	1	-	-	25,118	25,241	0.0
Below Bachelor's degree	0	1	-	-	25,241	25,118	0.0
Employment status							
Employed	0	1	-	-	29,977	20,231	0.3
Unemployed [ref]	0	1	-	-	12,523	37,685	0.3
Retired	0	1	-	-	7708	42,500	0.3

(Continues)

TABLE 1 (Continued)

	Min.	Max.	Mean	Std. Dev.	Yes	No	% Missing
<i>Household structure</i>							
Living with children							
No [ref]	0	1	-	-	31,530	18,829	0.0
Yes	0	1	-	-	18,829	31,530	0.0
Marital status							
Unmarried [ref]	0	1	-	-	21,476	28,600	0.6
Married	0	1	-	-	28,600	21,476	0.6
Household size	1	10	2.9	1.5	-	-	-
Building type							
House [ref]	0	1	-	-	31,572	9202	19.0
Apartment	0	1	-	-	7582	33,192	19.0
Mobile home	0	1	-	-	1412	39,362	19.0
RV/van/boat	0	1	-	-	208	40,566	19.0
<i>Health-related variables</i>							
Had COVID-19							
No [ref]	0	1	-	-	43,505	6724	0.3
Yes	0	1	-	-	6724	43,505	0.3
Covered by a health insurance							
Yes [ref]	0	0	-	-	47,900	2459	0.0
No	0	0	-	-	2459	47,900	0.0

Finally, for health-related variables, the HPS asked whether a doctor or other health care provider ever told the respondent that she/he was infected with the coronavirus (1 = yes; 0 = no [reference]). We constructed a variable to measure if the respondent was currently covered by a health insurance or health coverage plan (1 = yes; 0 = no [reference]). In March 2021%, 13% of respondents in our sample had COVID-19 before, and 5% did not have any health insurance. Descriptive statistics of all analysis variables are included in Table 1.

## Research design and statistical analysis

Figure 1 demonstrates the overall research design of the study. In total, three sets of analyses were conducted to answer the three research questions. For *Analysis I*, we conducted the Chi-square test to compare women versus men's intentions to be vaccinated against COVID-19. *Analysis II* involves using generalized estimating equations (GEEs) to predict COVID-19 vaccine hesitancy. Specifically, to examine the intersectionality between gender and socioeconomic status, two GEE models were estimated among women (Model 1) versus men (Model 2). In both models, vaccine hesitancy was used as the dependent variable, socioeconomic status variables were focal independent variables, and demographics, household structure variables, and health-related variables were used as control variables. *Analysis III* was conducted among respondents who indicated that

	Population	Explanatory Measures		Outcome Measures	Statistical Analysis	Research Questions
		Focal Independent Variables	Control Variables			
1	People who had not taken COVID-19 vaccines (n=50,359)	Gender	-	Vaccine Hesitancy	Bivariate Analysis	<b>RQ1:</b> <i>Are there gender differences in COVID-19 vaccine hesitancy in the US?</i>
2	People who had not taken COVID-19 vaccines (n=50,359)	Gender & Socioeconomic Status	Demographics; Household Structure; Health	Vaccine Hesitancy	Multivariate Analysis	<b>RQ2:</b> <i>How does gender intersect with socioeconomic status to shape people's hesitancy towards COVID-19 vaccination?</i>
3	People who had not taken COVID-19 vaccines and were vaccine-hesitant (n=19,823)	Gender	Socioeconomic Status; Demographics; Household Structure; Health	Concerns Related to COVID-19 Vaccines	Multivariate Analysis	<b>RQ3:</b> <i>Do women and men have different concerns about COVID-19 vaccines?</i>

FIGURE 1 Research design

they were hesitant to take a COVID-19 vaccine. Four GEE models (Models 3–6) were estimated to predict the four vaccine-related concerns, in which gender was used as the focal independent variable, while other variables (i.e., socioeconomic status, demographics, household structure, health) were control variables.

Generalized estimating equations are appropriate for this study because: first, like generalized linear models, GEEs relax the assumptions of traditional regression models (e.g., normality of variable distribution; Diggle et al., 2002; Liang & Zeger, 1986; Zeger & Liang, 1986; Zorn, 2001); second, GEEs are more suitable than generalized linear models to analyse clustered data (Zorn, 2001). The HPS data has a three-level clustered structure: the 50,359 respondents were clustered within four census regions (i.e., Northeast, South, Midwest, West) and 50 states and Washington DC. Thus, we used census regions and states to define clusters for the two models. There were 51 clusters in total, and the number of respondents in each cluster ranged between 161 and 1811 people. Since our dependent variables were binary, we selected the binomial distribution with a logit link function under the exchangeable correlation matrix for the six models (Garson, 2012). We also used Variance Inflation Factor (VIF) and tolerance to detect whether the model results were affected by multicollinearity. The statistical software, SPSS 22, International Business Machines Corporation (IBM), was used for the three sets of analyses.

## RESULTS

### Are there gender differences in COVID-19 vaccine hesitancy in the US?

We conducted the chi-square test on gender and the four categories of the vaccine hesitancy variable. As shown in Figure 2, 10% of women (vs. 8% men) reported that they would definitely not get a COVID-19 vaccine; 13% of women (vs. 10% men) said that they probably would not get a COVID-19 vaccine; 20% of women (vs. 18% men) reported that they probably would get a

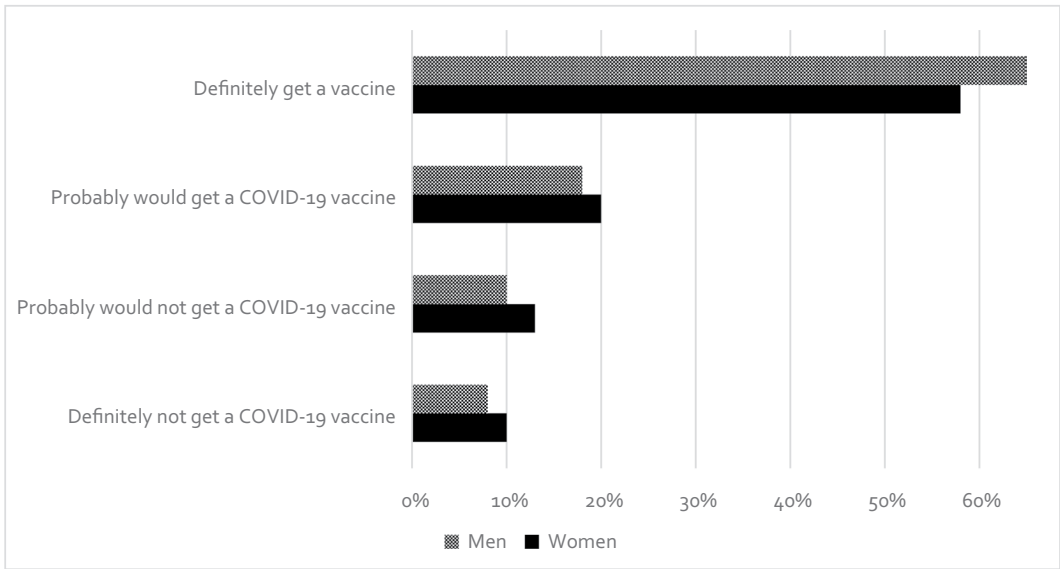


FIGURE 2 Coronavirus disease 2019 (COVID-19) vaccine acceptance and hesitancy by gender

COVID-19 vaccine; while 57% women (vs. 64% men) said that they would definitely get a vaccine. Based on the Chi-square test result, gender differences across the four categories were statistically significant ( $p < 0.0001$ ).

### How does gender intersect with socioeconomic status to shape people's hesitancy towards COVID-19 vaccination?

Table 2 reports the results from the two GEE models predicting COVID-19 vaccine hesitancy among women (Model 1) versus men (Model 2). In terms of the three dimensions of socioeconomic status, if the respondent did not have a college degree, women were 98% ( $p < 0.0001$ ), and men were 173% ( $p < 0.0001$ ) more likely to be vaccine-hesitant than their counterparts who had a college degree. Compared to women living in households above the poverty threshold, women from households below the poverty threshold were 30% more likely to be hesitant to pursue a COVID-19 vaccine ( $p < 0.0001$ ); yet, there was no statistically significant association between household income and men's vaccine hesitancy ( $p = 0.707$ ). As compared to women who were unemployed, women who were retired were 24% less hesitant about COVID-19 vaccines ( $p = 0.001$ ), but women who were working were 19% more hesitant ( $p = 0.003$ ). Employment status was not significantly associated with men's vaccine hesitancy ( $p > 0.05$ ).

With regard to demographics, for both women and men, age was negatively related to their vaccine hesitancy for COVID-19 ( $p < 0.0001$ ;  $p = 0.007$ ). As compared to White women, African American women were 46% more likely to be vaccine-hesitant ( $p < 0.0001$ ), while Asian women (78%,  $p < 0.0001$ ) and men (78%,  $p < 0.0001$ ) and Hispanic women (39%,  $p < 0.0001$ ) and men (47%,  $p < 0.0001$ ) were less likely to be vaccine-hesitant. Men from other racial/ethnic groups were more likely to be hesitant about COVID-19 vaccination than White men (73%,  $p < 0.0001$ ).

For household structure, household size and marital status were not significant predictors of vaccine hesitancy for either women or men ( $p > 0.05$ ). However, having children in the



**TABLE 2** Results of the generalized estimating equation models predicting coronavirus disease 2019 (COVID-19) vaccine hesitancy

	Model 1 (women) (n = 29,880)			Model 2 (men) (n = 20,479)		
	B	Exp(B)	p	B	Exp(B)	p
Intercept	-1.311***	0.270***	<0.0001	-2.086***	0.124***	<0.0001
Socioeconomic status variables:						
Household income						
Above the poverty threshold	Ref	Ref	Ref	Ref	Ref	Ref
Below the poverty threshold	0.261***	1.299***	<0.0001	0.040	1.040	0.707
Education level						
Bachelor's or graduate degree	Ref	Ref	Ref	Ref	Ref	Ref
Below Bachelor's degree	0.682***	1.977***	<0.0001	1.004***	2.728***	<0.0001
Employment status						
Unemployed	Ref	Ref	Ref	Ref	Ref	Ref
Employed	0.177**	1.193**	0.003	0.355	1.427	0.234
Retired	-0.279**	0.757**	0.001	-0.273	0.761	0.110
Demographics:						
Age	-0.015***	0.985***	<0.0001	-0.008**	0.992**	0.007
Race/ethnicity						
White	Ref	Ref	Ref	Ref	Ref	Ref
Black	0.381***	1.464***	<0.0001	0.185	1.203	0.222
Asian	-1.535***	0.215***	<0.0001	-1.518***	0.219***	<0.0001
Hispanic	-0.488***	0.614***	<0.0001	-0.644***	0.525***	<0.0001
Other racial/ethnic groups	0.023	1.023	0.897	0.548***	1.730***	<0.0001
Household structure:						
Household size	0.017	1.017	0.414	0.054	1.055	0.088
Living with children						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.418***	1.518***	<0.0001	0.132	1.141	0.301
Marital status						
Unmarried	Ref	Ref	Ref	Ref	Ref	Ref
Married	0.034	1.035	0.414	0.100	1.105	0.349
Building type						
House	Ref	Ref	Ref	Ref	Ref	Ref
Apartment	-0.070	0.932	0.445	-0.353**	0.703**	0.009
Mobile home	0.503***	1.653***	<0.0001	0.359*	1.432*	0.029
RV/van/boat	1.066*	2.905*	0.010	1.397***	4.042***	<0.0001
Health-related variables:						
Had COVID-19						
No	Ref	Ref	Ref	Ref	Ref	Ref

(Continues)

TABLE 2 (Continued)

	Model 1 (women) (n = 29,880)			Model 2 (men) (n = 20,479)		
	B	Exp(B)	p	B	Exp(B)	p
Yes	0.091	1.095	0.279	-0.089	0.915	0.312
Covered by a health insurance						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.129	1.138	0.212	0.511***	1.666***	<0.0001

Note: Results presented in Table 2 were weighted based on the HPS recommended sampling weights. Binomial distributions with a logit link function.

Abbreviation: GEE, generalized estimating equation.

\*\*\* $p < 0.0001$ , \*\* $p < 0.01$ , \* $p < 0.05$ .

household made women 52% ( $p < 0.0001$ ) more likely to be vaccine-hesitant. Further, the type of building where people were living was also related to vaccine hesitancy. For women, living in a mobile home was associated with 65% more vaccine-hesitancy ( $p < 0.0001$ ), while living in an RV, van, or boat was associated with 190% more vaccine-hesitancy ( $p = 0.010$ ), as compared to living in a house. Similarly, for men, living in a mobile home (43%,  $p = 0.029$ ) or an RV/van/boat (304%,  $p < 0.0001$ ) was associated with higher odds of being vaccine-hesitant. Interestingly, men living in an apartment were 30% less likely to be vaccine-hesitant than those living in a house ( $p = 0.009$ ), but this was not a significant predictor of women's vaccine hesitancy ( $p = 0.445$ ). For health-related variables, when not covered by health insurance, men were 67% more likely to be vaccine-hesitant ( $p < 0.0001$ ).

## Do women and men have different concerns about COVID-19 vaccines?

Tables 3-a and 3-b report the results from the four GEE models predicting four vaccine-related concerns (Models 3–6). Among the 19,823 vaccine-hesitant respondents, women were 29% more likely than men to report that they were concerned about possible side effects of a COVID-19 vaccine ( $p < 0.0001$ ), while men were more likely than women to report that they did not need a vaccine (41%,  $p < 0.0001$ ) or they did not trust the government (39%,  $p < 0.0001$ ). There was no significant difference between women and men in terms of their concerns on the cost of vaccines ( $p = 0.096$ ). Finally, based on VIF and tolerance, the inferences of all GEE models were not affected by multicollinearity.

## DISCUSSION

Vaccine hesitancy represents a serious threat to global health. Recent estimates suggest that a range of 60%–75% of the population must have COVID-19 immunity in order to reach herd immunity (Anderson et al., 2020; Britton et al., 2020). Encouraging trust in COVID-19 vaccination is critical to achieving such a goal (Harrison & Wu, 2020). Using the HPS data collected by the Census Bureau in early March 2021, we found that among American adults who had not received COVID-19 vaccines, two in five were hesitant about getting vaccinated against coronavirus. This study contributes to understanding vaccine hesitancy for COVID-19 in the US by offering a gender perspective. Our results confirmed a higher vaccine hesitancy rate among women

**TABLE 3 A** Results of the generalized estimating equation models predicting coronavirus disease 2019 (COVID-19) vaccine-related concerns

	<b>Model 3 “I am concerned about possible side effects of a COVID-19 vaccine.” (n = 19,823)</b>			<b>Model 4 “I don’t believe I need a COVID-19 vaccine.” (n = 19,823)</b>		
	<i>B</i>	<i>Exp(B)</i>	<i>p</i>	<i>B</i>	<i>Exp(B)</i>	<i>p</i>
Intercept	0.500***	1.649***	<0.0001	0.016	1.016	0.960
Female	0.251***	1.286***	<0.0001	−0.531***	0.588***	<0.0001
Socioeconomic status variables:						
Household income						
Above the poverty threshold	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Below the poverty threshold	−0.082	0.921	0.300	−0.338**	0.713**	0.001
Education level						
Bachelor’s or graduate degree	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Below Bachelor’s degree	−0.186***	0.830***	<0.0001	−0.041	0.960	0.509
Employment status						
Unemployed	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Employed	0.094	1.098	0.305	0.130	1.139	0.174
Retired	0.142	1.153	0.313	0.249	1.282	0.117
Demographics:						
Age	−0.011***	0.989***	<0.0001	−0.028***	0.972***	<0.0001
Race/ethnicity						
White	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Black	0.073	1.075	0.538	−0.898***	0.407***	<0.0001
Asian	0.316	1.372	0.098	−0.511	0.600	0.161
Hispanic	−0.026	0.974	0.678	−0.612**	0.542**	0.001
Other racial/ethnic groups	−0.051	0.950	0.754	0.224	1.250	0.328
Household structure:						
Household size	0.024	1.024	0.314	0.045	1.046	0.173
Living with children						
No	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Yes	−0.015	0.986	0.809	−0.086	0.918	0.380
Marital status						
Unmarried	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Married	−0.036	0.965	0.562	0.023	1.024	0.824
Building type						
House	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>	<i>Ref</i>
Apartment	0.048	1.050	0.680	−0.307*	0.735*	0.048
Mobile home	0.303*	1.354*	0.043	−0.253	0.777	0.162
RV/van/boat	−0.634*	0.530*	0.020	0.001	1.001	0.998

(Continues)

TABLE 3A (Continued)

	Model 3 "I am concerned about possible side effects of a COVID-19 vaccine." (n = 19,823)			Model 4 "I don't believe I need a COVID-19 vaccine." (n = 19,823)		
	B	Exp(B)	p	B	Exp(B)	p
Health-related variables:						
Had COVID-19						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.272**	0.762**	0.002	-0.006	0.994	0.953
Covered by a health insurance						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.050	0.952	0.768	-0.077	0.926	0.640

Note: Results presented in Table 3a were weighted based on the HPS recommended sampling weights. Binomial distributions with a logit link function.

Abbreviation: GEE, generalized estimating equation.

\*\*\*p < 0.0001, \*\*p < 0.01, \*p < 0.05

than men, which is consistent with previous studies (Callaghan et al., 2021; Fisher et al., 2020; Latkin, Dayton, Yi, Colon, & Kong, 2021; Lazarus et al., 2021; Malik et al., 2020; Sallam, 2021; Troiano & Nardi, 2021).

By employing the theory of intersectionality, we demonstrate that gender, as an axis of significant, interacts with people's social backgrounds to shape their vaccine hesitancy in a complex way, depending on the dimensions of socioeconomic status. For example, income and employment affected women but not men. Women living in poverty or currently working were more vaccine-hesitant than women from households above the poverty threshold or unemployed. However, the effect of education appears to extend to both genders, as the lack of a college degree contributes to both women and men's COVID-19 vaccine hesitancy. Those findings first illuminate the importance of applying an intersectionality approach in the study of vaccine hesitancy. If we did not examine women and men separately in our analyses, like most other studies, we might conclude that people with lower socioeconomic status were, in general, more hesitant to accept COVID-19 vaccines (e.g., Callaghan et al., 2021; Ferdinand et al., 2020; Khubchandani et al., 2021). The intersectional lens helped us detect that poverty and being employed were only associated with women's vaccine hesitancy, while not having a college education was a risk factor for both women and men.

Previous research suggests that the high level of COVID-19 vaccine hesitancy in lower-income communities could be explained by preexisting vaccine hesitancy, lower health literacy, lower trust with healthcare professionals, and cost-based concerns (Callaghan et al., 2021; Ferdinand et al., 2020; Fisher et al., 2020; Malik et al., 2020; Quinn et al., 2020; Shen et al., 2020; Webb et al., 2019). Our findings appear to indicate that those drivers for vaccine hesitancy associated with low income or poverty might affect women more than men. For employment, Khubchandani et al. (2021) offered an explanation that those who were not working but would like to return to employment might be more motivated to take the COVID-19 vaccine as it can facilitate return to work. Following this line of thinking, our results might suggest that returning to the workforce motivates women (but not men) to be vaccinated.

On the other hand, working women might also be more hesitant to take COVID-19 vaccines for fear that vaccine side effects could disrupt their multiple responsibilities from work and

**TABLE 3 B** Results of the generalized estimating equation models predicting coronavirus disease 2019 (COVID-19) vaccine-related concerns

	<b>Model 5 “I don’t trust the government.” (n = 19,823)</b>			<b>Model 6 “I am concerned about the cost of a COVID-19 vaccine.” (n = 19,823)</b>		
	<b>B</b>	<b>Exp(B)</b>	<b>p</b>	<b>B</b>	<b>Exp(B)</b>	<b>p</b>
Intercept	-1.072***	0.342***	<0.0001	-1.992***	0.136***	<0.0001
Female	-0.499***	0.607***	<0.0001	-0.229	0.796	0.096
Socioeconomic status variables:						
Household income						
Above the poverty threshold	Ref	Ref	Ref	Ref	Ref	Ref
Below the poverty threshold	-0.008	0.992	0.934	0.192	1.212	0.225
Education level						
Bachelor's or graduate degree	Ref	Ref	Ref	Ref	Ref	Ref
Below Bachelor's degree	0.135*	1.145*	0.023	0.352***	1.422***	<0.0001
Employment status						
Unemployed	Ref	Ref	Ref	Ref	Ref	Ref
Employed	0.085	1.089	0.356	-0.124	0.883	0.548
Retired	0.224	1.251	0.149	-0.267	0.766	0.235
Demographics:						
Age	-0.006*	0.994*	0.028	-0.025***	0.976***	<0.0001
Race/ethnicity						
White	Ref	Ref	Ref	Ref	Ref	Ref
Black	-0.140	0.869	0.376	-0.595**	0.551**	0.008
Asian	-1.213***	0.297***	<0.0001	-0.412	0.662	0.278
Hispanic	-0.473**	0.623**	0.009	0.194	1.214	0.455
Other racial/ethnic groups	-0.083	0.920	0.692	-0.010	0.990	0.966
Household structure:						
Household size	0.069*	1.072*	0.021	0.138*	1.148*	0.028
Living with children						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes		0.998	0.988	-0.227	0.797	0.149
Marital status						
Unmarried	Ref	Ref	Ref	Ref	Ref	Ref
Married	-0.093	0.911	0.279	-0.373	0.689	0.093
Building type						
House	Ref	Ref	Ref	Ref	Ref	Ref
Apartment	-0.120	0.887	0.067	0.313	1.368	0.092
Mobile home	0.157	1.171	0.374	0.208	1.231	0.453
RV/van/boat	0.402	1.495	0.358	-0.529	0.589	0.341

(Continues)

TABLE 3 B (Continued)

	Model 5 "I don't trust the government." (n = 19,823)			Model 6 "I am concerned about the cost of a COVID-19 vaccine." (n = 19,823)		
	B	Exp(B)	p	B	Exp(B)	p
Health-related variables:						
Had COVID-19						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	-0.196*	0.822*	0.027	-0.568**	0.566**	0.002
Covered by a health insurance						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	0.063	1.065	0.705	0.838***	2.312***	<0.0001

Note: Results presented in Table 3b were weighted based on the HPS recommended sampling weights. Binomial distributions with a logit link function.

Abbreviation: GEE, generalized estimating equation.

\*\*\*p < 0.0001, \*\*p < 0.01, \*p < 0.05.

family. Indeed, our results show that women were more concerned about the vaccine side effects than men. At the same time, women have been facing an increase in familial care and domestic chores during the pandemic (Craig, 2021; Craig & Churchill, 2021; Dunatchik et al., 2021; Hennekam & Shymko, 2020; Power, 2020; Zamorro & Prados, 2021) and have suffered disproportionate job loss and increased unpaid work hours, in comparison to men (Aker, 2021; Collins et al., 2021; Holder et al., 2021; Landivar et al., 2020). We also found that women who had children were more likely to be vaccine-hesitant, while the same pattern was not found among men. Previous studies documented American parents' opposition to childhood vaccination before the pandemic (e.g., Siddiqui et al., 2013) and their reluctance to be vaccinated during COVID-19 (e.g., Dror et al., 2020; Khubchandani et al., 2021). Our results suggest that women's vaccine hesitancy might be related to their childcare responsibilities.

We also examined other sociodemographic factors that contribute to COVID-19 vaccine hesitancy. For demographics, we found that African American women were more likely to be vaccine-hesitant than Whites women. Low COVID-19 vaccine confidence among African American communities has been documented (Callaghan et al., 2021) and shown to be linked to racism, negative healthcare experiences, and historical trauma due to biomedical science abuses (Hamel et al., 2020; Holder et al., 2021; Webb et al., 2019). More research is needed to understand the gender difference in vaccine hesitancy within African Americans. Less vaccine hesitancy research has focussed on Asians and Hispanics. Jones et al. (2020) found that Asian respondents had adequate knowledge concerning the facts of the COVID-19 pandemic. Another study on human papillomavirus (HPV) vaccination suggests that acculturation, knowledge of HPV, knowledge of the HPV vaccine's efficacy attributed to acceptance of the vaccine among Hispanics (Galbraith et al., 2016). It is possible that acculturation and knowledge of COVID-19 vaccines were related to the high vaccine acceptance among Asians and Hispanics. Consistent with previous research (Sallam, 2021), we found that younger people were less willing to accept COVID-19 vaccination than older adults.

People living in mobile homes or RVs had a higher COVID-19 vaccine hesitancy. It might be that mobile home/RV residents feel safe about their living conditions and are less concerned about being infected by the coronavirus. Interestingly, early exploratory research on the RV

lifestyle indicates that as compared to other elderly people, RV residents are relatively young and are often in good health (Null & Bailey, 1994). They might feel they did not need a vaccine. In fact, few studies have investigated the relationship between housing type and people's health behaviour (Hotle et al., 2020), and to the best of our knowledge, no prior studies have linked the type of building where people live to their COVID-19 vaccine hesitancy. For health-related factors, we found that having health insurance was related to men but not women's vaccine hesitancy, as uninsured men were more vaccine-hesitant. Callaghan et al. (2021) also found that in the US, men are more likely to oppose COVID-19 vaccination due to the lack of health insurance than women. However, only a small proportion of people (5%) in our study were not covered by any health insurance. The effect of health insurance on vaccine hesitancy needs to be examined in future research.

Finally, concerns about COVID-19 vaccines were also gendered. Possible side effects were the major distress for women, which might be related to the fact that women are in general more likely to practice risk-avoiding behaviours (Yaqub et al., 2014). However, this finding may also be indicative of gendered power relations within medicine. Indeed, the patriarchal foundations of medicine have been shown to generate women's distrust in medicine or hesitancy towards seeking healthcare (Grodzicka, 2021). Conversely, men were more likely than women to believe that they did not need a COVID-19 vaccine or they did not trust the government. Based on those results, we conclude that women's COVID-19 vaccine hesitancy seems to be more related to concerns about the safety of the vaccine, while men's hesitancy tends to be driven by lower perceptions of COVID-19 dangers, higher levels of self-rated health, and belief in conspiratorial claims surrounding the disease.

## LIMITATIONS

Despite the contributions to the literature, the results of the present study might be affected by several limitations. First, we acknowledge that people's reported vaccine hesitance or acceptance might not translate into actual behaviour, mainly because COVID-19 is a fast-moving crisis, and there is a time lag between the measurement of vaccine intention and the observation of behaviour. Second, socioeconomic and cultural characteristics in different states might influence whether people reported vaccine hesitancy. In this study, we used GEE models to control state-level effects statistically; however, GEEs were limited in detecting the individual effect of each state-level factor. Future research could investigate variations in vaccine hesitancy across states and utilise a mixed-effects approach to examine how state-level factors directly influence people's vaccine hesitancy. Third, the HPS did not collect information on whether participants were pregnant, which has been shown to be a contributor to vaccine hesitancy in women (Goncu Ayhan et al., 2021; Skjefte et al., 2021). Fourth, our analyses were based on data collected in early March 2021, when COVID-19 vaccines were not available to all age groups. People's attitudes might change as more Americans are vaccinated safely. However, gender dynamics in vaccine hesitancy is itself critical, and necessitates further research, in particular qualitative research. Nevertheless, future researchers should continue examining people's intent to accept COVID-19 vaccination and pay special attention to how it varies between women and men, and how it changes over time.

## CONCLUSIONS

The current study reveals a nuanced picture of social inequality surrounding COVID-19 vaccine hesitancy from a gender perspective. Our analyses contribute to the scholarship on vaccine hesitancy by uncovering the complex intersection of gender and socioeconomic status. The results also provide insights into future directions for improving COVID-19 vaccine confidence and uptake. Particularly, gender-based approaches are needed. Concurrent research has documented the disproportionate burden women have endured during the pandemic. Yet, women also had greater vaccine hesitancy and were more concerned about the vaccine side effects. Thus, tailored outreach strategies that directly address the concerns of women, and women living with children, should be developed to encourage trust in vaccination and empower women to vaccinate themselves and their families. At the same time, more resources should be provided to women living in low-income households and working women.

Culturally competent strategies should also be developed for African American communities, especially African American women (Quinn et al., 2020; Webb et al., 2019). Given the historic medicinal trauma the black community faced in the US (Washington, 2006), local and federal governments ought to assert an aggressive education campaign that emphasises the necessity for the COVID-19 vaccine, while reconciling this historical trauma. Vaccine developers need to be more transparent with information regarding vaccine trials and emphasize racial/ethnic inclusivity during testing (Painter et al., 2021). In addition, scientific organisations and public health experts should target vaccine efficacy education campaigns to address hesitancy among young adults, especially those who do not have a college education. Finally, as this study demonstrates, we must begin taking an intersectional approach to research and policymaking in order to address systemic issues that have led to institutional mistrust, which puts women and minorities who have been disproportionately affected by the pandemic at greater risk even when a solution is available.

## AUTHOR CONTRIBUTION

**Danielle Xiaodan Morales:** Conceptualization; Lead, Formal analysis; Lead, Methodology; Lead, Writing – original draft; Lead, Writing – review & editing; Lead. **Tyler Beltran:** Formal analysis; Supporting, Methodology; Supporting, Writing – review & editing; Supporting. **Stephanie Morales:** Formal analysis; Supporting, Methodology; Supporting, Writing – review & editing; Supporting.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available at <https://www.census.gov/programs-surveys/household-pulse-survey/datasets.html>.

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