COVID-19 Vaccine Intentions and Hesitancy among Healthcare Workers of a Multisite Academic Healthcare System: A Cross-sectional Study.*

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PH 560 MPH Culminating Experience

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Abstract

Background

Vaccinations against SARS-CoV-2 infections have proved essential to both the reduction of morbidity and mortality from COVID-19 and the end of the pandemic. However, while the pandemic's toll is vast, hesitancy to receive these safe and effective vaccines is a concerning trend that warrants further study in order to identify failures in the public health messaging framework. Surveillance of vaccine hesitancy was conducted early in the vaccine rollouts, among healthcare workers. The goal was to identify if healthcare workers (HCWs) who had higher risks for exposure and infection also had higher rates of vaccine hesitancy.

Methods

Details of the study and recruitment techniques have been reported previously (Wilkins et al. 2021). HCWs were given a survey of vaccine intentions with possible responses of "Yes", "No", and "Unsure". Surveys were completed from November 2020 to January 2021 and a sensitivity analysis was performed for the Emergency Use Authorization (EUA). Demographic, exposure, and serologic characteristics are presented, as well as multinomial logistic regression and adjusted/unadjusted odds ratios.

Results

4,180 HCWs reported 77.1% intention to be vaccinated, with 17.4% unsure and 5.5% reporting they would not be vaccinated. The number of unsure HCWs dropped following the EUA. Lowest odds for intentions were found among nurses, women, non-Hispanic Black, and 30-39-year-old HCWs. Significantly higher odds for intentions were found among physicians, men, Asians, and older HCWs.

Conclusions

Disparities in vaccine intentions among these distinct groups is a concerning trend—especially among those participating in patient care—that could be better remediated through the use of earlier, robust public health messaging that targets hesitant individuals.

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has had a profound global impact, causing 130,422,190 confirmed cases of coronavirus disease 2019 (COVID-19) and 2,842,135 deaths as of April 5, 2021, doubling totals from December 1, 2020 (WHO). To combat this unprecedented public health crisis, the availability of vaccines is crucial to the reduction of morbidity and mortality from SARS-CoV-2 infection. Early reports of vaccine hesitancy suggest that only 54-58% of Americans intend to get one of the currently available SARS-CoV-2 vaccines, which marks a decrease from earlier estimates of 67-71% (Daly 2020; Szilagyi et. al 2021; Reinhart 2020; Malik et. al 2020; Reiter et. al 2020). If a downward trend truly exists in vaccine intentions, it is particularly alarming considering expert recommendation suggests that as low as 40% but as high as 90% of the population must get vaccinated to see reductions in incidence, hospitalizations, and deaths (Moghadas et. al 2020; Anderson et al., 2020). Healthcare workers (HCWs) were given priority status to be one of the first groups vaccinated. This meant vaccine access to a large portion of the U.S. population (approximately 18,000,000 of America's 330,063,047 people are HCWs, as of February 1) (CDC, US Census Bureau). Because of HCWs' synergistic occupational and community risks for SARS-CoV-2 infection (Wilkins et. al 2021), their public influence as exemplars of best practice and their proximity to infected or vulnerable populations, HCW vaccine hesitancy would be particularly worrisome for current public health practice and future pandemics. Thus, the goal of this analysis was to assess HCW vaccine intentions at the beginning of the U.S. vaccine rollout and assess associations between vaccine hesitancy and level of exposure risk.

Methods

Study Design and Setting

This was a cross-sectional analysis of survey data from an ongoing prospective cohort study of HCWs conducted in a large, tertiary academic health care system (Wilkins et al. 2021). Participating HCWs were from 10 hospitals (the largest in downtown Chicago, with others in the west, northwest, and north suburbs of Chicago), 18 immediate care centers, and 325 outpatient practices in the Chicago area and surrounding Illinois suburbs.

Study Population and Measures

Details of the study and recruitment techniques have been reported previously (Wilkins et al. 2021). In short, HCWs were recruited in May and June 2020 to participate in a prospective cohort assessing the prevalence and incidence of SARS-CoV-2 IgG antibody seropositivity and COVID-19. Serology testing (via the semi-quantitative Abbott Immunoassay System to measure anti-nucleocapsid IgG) was conducted between May 26th and July 10th, 2020, and then follow-up testing was conducted between November 9th, 2020, and January 8th, 2021. Participants were administered a baseline survey in the first month of participation that assessed: COVID-19 diagnosis and symptoms, demographic characteristics, occupational group, participation in specific occupational tasks (such as caring for COVID-19 patients or being involved in procedures such as hemodialysis, nebulizer therapy colonoscopies, and more), and community exposure to COVID-19 (Wilkins et al. 2021). Participants were sent monthly surveys via email to ascertain new exposures, diagnoses, symptoms, or testing for COVID-19. The survey question on vaccine intention was, “Are you willing to get a vaccine in the next six

months?" This question was asked during the 6th monthly survey, occurring between November 25th, 2020, and January 9th, 2021. These parameters of survey administration began 3 weeks before and ended 4 weeks after the first COVID-19 mRNA vaccine Emergency Use authorization (EUA; Pfizer: December 11, Moderna: December 18). Participant outcomes in the electronic medical record were ascertained retrospectively and prospectively to identify incident COVID-19 cases (based on PCR testing and physician diagnosis) from March 1st, 2020, to January 8th, 2021.

Statistical Analysis

Demographics, exposure characteristics, and serostatus for SARS-CoV-2 IgG (including incident COVID-19) were assessed by the participants' COVID-19 vaccine intentions (Yes, No, Unsure). Occupations were categorized into four groups (physician, registered nurse, administrative, and other) based on a priori risk for COVID-19 and for consistent stability of model estimates (Wilkins et al. 2021). Race and ethnicity were included due to their known associations with COVID-19, with smaller groups categorized together due to their limited sample size. Respondents to the vaccine intention survey and non-respondents were also compared to determine if there were any significant differences in demographics and exposures. Chi-square analyses were used to describe unadjusted associations. Sensitivity analyses were conducted to determine intentions before and after the EUA, as the survey was administered over the span of the determination of the EUAs for both Pfizer and Moderna vaccines. Multinomial logistic regression was used to identify independent associations between demographic and exposure characteristics and intention to get or not get the vaccine. For simplicity, Unsure and Yes groups were combined, and multivariable logistic

regression results are reported. Unadjusted and adjusted Odds ratios (ORs) and 95% confidence intervals (CIs) are presented. Statistical significance was considered based on the 95% CI's (not significant if CI included 1) or p-value <0.05.

Results

The 6th monthly survey with the vaccine intention question was completed by 4,180 (64.2%) HCWs of the 6,510 initially enrolled in the study. Respondents did significantly differ from non-respondents in terms of their occupation, race/ethnicity, age, and baseline antibody seropositivity for SARS-CoV-2. A higher proportion of respondents held administrative roles and a lower proportion of respondents were nurses, non-Hispanic White, and in older age groups. Respondents also had a lower point prevalence of baseline antibody seropositivity than non-respondents.

Of those who responded (n=4,180), 77.1% indicated they intended to get the vaccine or had already received the vaccine (23.2%),17.4% were not sure if they would get the vaccine, and 5.5% reported that they would not get the vaccine. There were significant differences in intention to get vaccinated by occupation, gender, race/ethnicity, age, both hospital and community exposures, and participant serology results (Table 1). Physicians had the highest vaccine intentions (92.1%) whereas nurses (71.2%) and 'other' occupation groups (72.6%) had the lowest vaccine intentions (p<0.001). Women reported lower vaccine intentions than men (73.7% vs 90.9%, p<0.001) (**Table 1**). Among racially distinct groups, Asian HCWs had the highest vaccine intentions (82.9%) whereas non-Hispanic African Americans had the lowest (57.3%) (p<0.001). Respondents ages 30–39 years old had the highest vaccine hesitancy, with higher proportions of this age bracket reporting 'unsure' or 'no' to

intending to get the vaccine (p<0.008). Participants reporting involvement in patient care procedures reported higher intention to get vaccinated than those who were not involved in patient care procedures, as well (80.0% vs 74.2%, p<0.001).

Vaccine intention was higher in HCW participants who completed the survey after the Pfizer and Moderna EUA's than before (85.8% vs 70.4%). Before the EUAs, 23.4% of HCWs were unsure about getting the vaccine and 6.2% reported they would not get the vaccine; after the EUAs, only 9.6% were unsure and 4.6% reported they would not get the vaccine (**Figure 1**).

The unadjusted findings were consistent in multinomial regression models (not shown), confirming that the same demographics and exposures were associated with intentions to get or not get the vaccine. Multivariable logistic regression results for 'Yes' versus 'Unsure' and 'No' groups are shown in **Figure 2**. Compared to physicians, being a nurse or Other occupational group was associated with lower odds of intending to get the vaccine (aOR=0.59 95% CI 0.45-0.76, aOR=0.66, 95% CI 0.52-0.84, respectively); while physicians had the highest odds of vaccine intention (OR=2.47, 95% CI 1.73-3.57). Non-Hispanic Blacks (versus referent group Asians, OR=0.35, 95% CI 0.21-0.59) and women (versus referent group men, OR=0.38, 95% CI 0.29-0.50) had lower odds of intending to get the vaccine. Participants aged 30-39 years (versus <30 years) also had lower odds of getting vaccinated (OR=0.67, 95% CI 0.53-0.85). Being exposed to procedures or having a negative serology test for COVID-19 at follow-up increased the odds of vaccination intention (versus no follow-up test) (OR=1.38, 95% CI 1.16-1.65, OR=1.47, 95% CI 1.24-1.73, respectively). The participants who completed the survey

before the EUAs for vaccines had higher odds of vaccine hesitancy (OR=0.34, 95% CI 0.29-0.41).

Discussion

Among HCWs in the cohort, we found that early in the process to make vaccines available, vaccine intentions were higher among HCWs (77.1%) than estimates from the general U.S. population, which reached 49% by February 2021 per CDC (MMWR Vol. 70, 2021). However, there were considerable differences in intentions between HCW's occupational and demographic groups. Ironically, higher vaccine hesitancy rates were observed in groups at higher risks for COVID-19. Most notably, nurses had the lowest intentions to get the vaccine even after controlling for the differences in demographic and exposure characteristics. These findings are consistent with previous research showing that nurses have lower influenza vaccination rates than physicians (Martinello et al. 2003; Clark et al. 2009; Toronto et al. 2010), as well as recent research showing similarly diminished COVID-19 vaccine acceptance (Dror et al. 2020). This finding is particularly troublesome as nurses have the highest rates of SARS-CoV-2 infection among HCW groups (Wilkins et al. 2021; Hamel et al. 2020; Kwok et al. 2021). Not only could low vaccine uptake put front line nurses at risk for severe COVID-19 infection or post-infectious sequelae, but prolonged occupational contact with patients and other HCWs also increases the possibility of spread within healthcare settings. Further research into the perceptions and beliefs that determine vaccine decision-making in nurses is urgently needed, including beliefs of protection from future infections conferred by prior infection. In addition, specific concerns of women and those age 30-

39, that may be hesitant for age or gender specific reasons such as reproductive concerns need to be studied.

In our cohort, Black participants reported 65% lower odds of intention to get vaccinated than Asian participants, consistent with other studies examining COVID-19 vaccine intentions and perceptions in Black non-HCW populations just prior to the vaccine roll-out (Malik et al. 2020; Szilagyi et al. 2020; Guidry et al. 2020). Higher reporting of being unsure or not being willing to be vaccinated by Black participants, even after controlling for other factors, is concerning due to the disproportionate burden of COVID infection and severe COVID complications observed in Black people. This study did not assess the reasons for participants' vaccine hesitancy or deliberation; such hesitancy may be due to mistrust of the broader healthcare system but also lack of confidence building in the COVID-19 vaccine (CDC). It is reasonable to speculate that the fundamental issue of mistrust between the African American community and medicine at large likely undermines vaccine uptake even among HCW.

Women's intentions to get vaccinated were lower than men. Other studies have found a similar trend (Reinhart 2020; Szilagyi et al. 2020; Malik et al. 2020; Fisher et al. 2020; Guidry et al. 2020). Because our cohort's nurse population was predominantly female, this poses the need for future studies to investigate more health beliefs that contribute to vaccine hesitancy, in both women and the nursing occupation in general. Older age was associated with higher intentions to become vaccinated, in concordance with other studies as well (Reinhart 2020; Szilagyi et al. 2020; Malik et al. 2020; Fisher et al. 2020; Guidry et al. 2020). People 65 and older are at significant risk for COVID-19

hospitalization and death, and an increased interest in vaccination may reflect recognition by HCWs in this age group of their elevated risk.

Individuals who had negative serology results also had higher likelihood of intending to get vaccinated, while those who had previously had COVID-19 were more likely to report no or unsure about getting vaccinated. These differences may be explained by perceptions of immunity following natural infection with SARS-CoV-2. Although some degree of resistance to future infection likely exists for a short time period, our group and others have observed seroconversion and reinfection events in seropositive individuals (Wilkins et al. 2021; Lumley et al. 2021). Average duration of IgG seropositive status among these studies has been about three months, suggesting that immunity may wane over time. This recognition of transient and labile post-infection immunity is reflected in current CDC guidelines that recommend vaccination in those who have been previously infected.

Completing the survey after the EUA for both the Pfizer and Moderna vaccines was associated with higher intentions to get vaccinated. Previous studies have shown that people were concerned with EUAs due to the concept of the experimental nature of the vaccines being approved and that vaccinations intentions decreased with an EUA release of the vaccine (Guidry et al. 2020; Kreps et al. 2020). Several factors may explain the contrary findings of this study that, following the EUA, vaccine intentions increased. In many places, COVID-19 rates were increasing during this time period due to a post-Thanksgiving surge in cases. In addition, the high vaccine efficacy associated with the Pfizer and Moderna vaccines introduced a level of excitement reflective of the published clinical trial results. The growing recognition that this measure was more

effective than non-biological prevention measures (i.e., mask and social distancing) and the potential for reducing risk at work and home to end the pandemic was likely very appealing among our cohort.

These findings were disseminated via email to cohort members, and background information regarding seroprevalence was also delivered publicly via twitter and published in Open Forum Infectious Diseases (Wilkins et al. 2021). A stakeholder panel was utilized during the cohort development to guide equitable application of results. This survey is currently being repeated at six months, to identify incident vaccine hesitancy; then, changes will be communicated to participants.

In conclusion, we found that among HCWs, groups such as women, 30-39-year-olds, and non-Hispanic Black participants had lower intentions of getting vaccinated early in the vaccine rollout. Understanding how public health messaging, content material, and other factors including historical medical abuse, lack of transparency, and experimentation influenced vaccine perception of these groups will be the key to targeting future messages to improve vaccine uptake. Ultimately, consistent, valid, accurate, and unified public health messaging schemes are essential to the reversal hesitancy in these vulnerable populations, to address mistrust and misinformation earlier in the vaccine development process. The use of the Health Belief Model in the formation of future interventions may prove to be more effective in changing perceived susceptibility and perceived severity of COVID-19. Many strategies have been identified for promoting COVID-19 vaccination to patients to date, as opinion leaders and stakeholders speak out on public platforms to increase uptake. Participatory research is still needed with HCWs to translate this experience into an analysis of how more

effective and equitable messaging can be developed while addressing underlying mistrust of health care systems and recognizing historical injustices underscore groups who have received inequitable and detrimental healthcare.

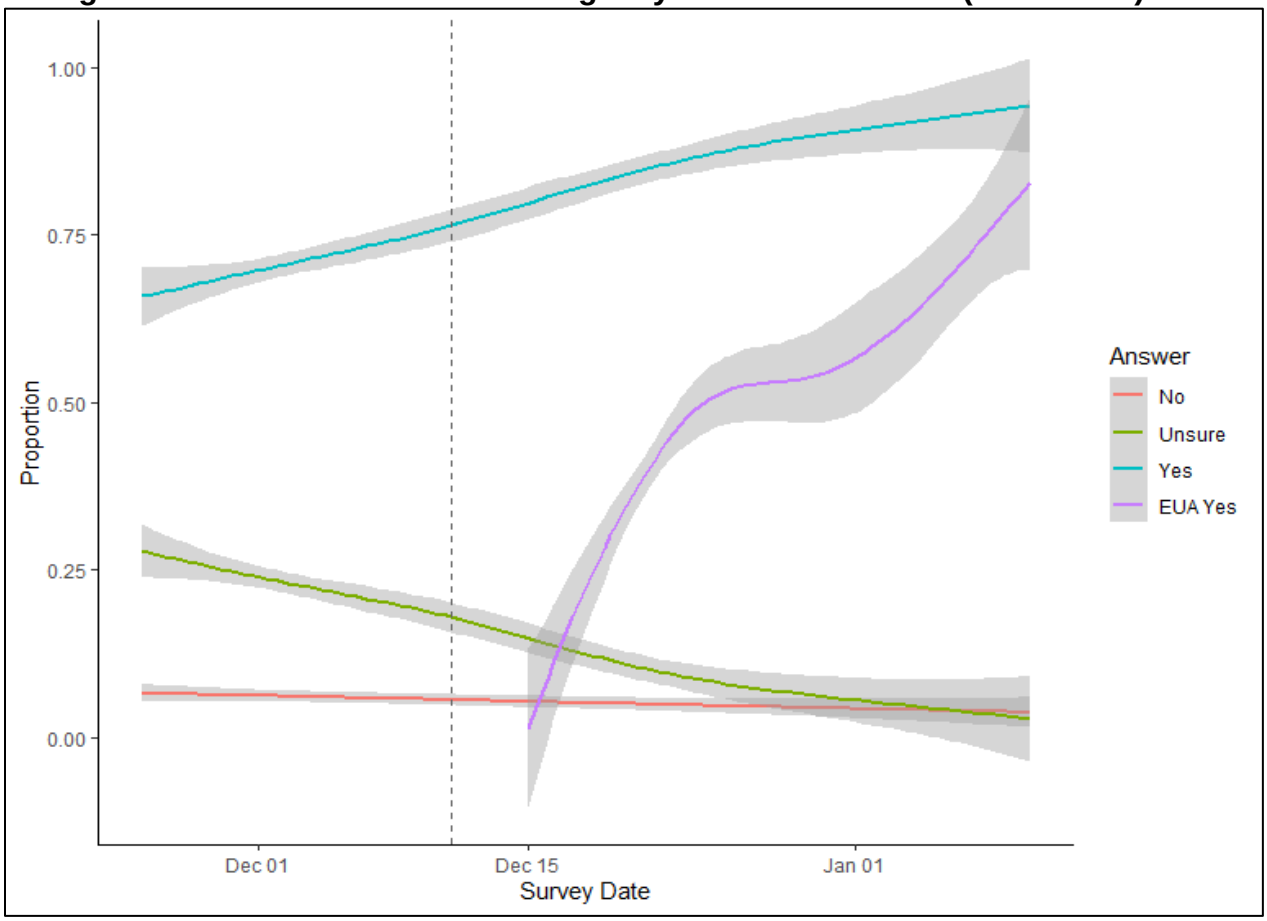
Table 1. Healthcare worker demographic and characteristics by intention to get the COVID-19 vaccine

Characteristics	Yes N=3222	Unsure N=728	No N=230	Total N=4180	p-value
Occupation					< 0.001
- Physician	739 (92.1%)	53 (6.6%)	10 (1.2%)	802 (100.0%)	
- Registered Nurses	776 (71.2%)	231 (21.2%)	83 (7.6%)	1090 (100.0%)	
- Administrative	526 (79.6%)	107 (16.2%)	28 (4.2%)	661 (100.0%)	
- Other occupations	1181 (72.6%)	337 (20.7%)	109 (6.7%)	1627 (100.0%)	
Gender					< 0.001
- Female	2466 (73.7%)	668 (20.0%)	214 (6.4%)	3348 (100.0%)	
- Male	756 (90.9%)	60 (7.2%)	16 (1.9%)	832 (100.0%)	
Race/Ethnicity					< 0.001
- Asian	316 (82.9%)	51 (13.4%)	14 (3.7%)	381 (100.0%)	
- Hispanic/Latino	175 (68.4%)	58 (22.7%)	23 (9.0%)	256 (100.0%)	
- Multiracial	57 (71.2%)	21 (26.2%)	2 (2.5%)	80 (100.0%)	
- Non-Hispanic Black	55 (57.3%)	26 (27.1%)	15 (15.6%)	96 (100.0%)	
- Non-Hispanic White	2551 (77.8%)	559 (17.0%)	170 (5.2%)	3280 (100.0%)	
- AI/AN/NH/PI/Other/NA[1]	68 (78.2%)	13 (14.9%)	6 (6.9%)	87 (100.0%)	
Age Category					0.008
- 18-29	512 (77.8%)	108 (16.4%)	38 (5.8%)	658 (100.0%)	
- 30-39	1013 (73.7%)	271 (19.7%)	91 (6.6%)	1375 (100.0%)	
- 40-49	747 (78.4%)	154 (16.2%)	52 (5.5%)	953 (100.0%)	
- 50-59	599 (78.2%)	129 (16.8%)	38 (5.0%)	766 (100.0%)	
- 60+	351 (82.0%)	66 (15.4%)	11 (2.6%)	428 (100.0%)	
COVID-19 Patient Exposure in the past month					0.389
- No	1556 (77.6%)	351 (17.5%)	98 (4.9%)	2005 (100.0%)	
- Unsure	411 (74.9%)	104 (18.9%)	34 (6.2%)	549 (100.0%)	
- Yes, I think so	237 (76.2%)	59 (19.0%)	15 (4.8%)	311 (100.0%)	
- Yes, definitely	1018 (77.4%)	214 (16.3%)	83 (6.3%)	1315 (100.0%)	
Procedure Exposure in the past month					< 0.001
- No	1557 (74.2%)	409 (19.5%)	132 (6.3%)	2098 (100.0%)	
- Yes	1665 (80.0%)	319 (15.3%)	98 (4.7%)	2082 (100.0%)	
COVID-19 Exposure Out of Hospital in the past month					0.145
- No	2034 (77.7%)	441 (16.9%)	142 (5.4%)	2617 (100.0%)	
- Unsure	658 (75.5%)	174 (20.0%)	40 (4.6%)	872 (100.0%)	
- Yes, I think so	177 (77.3%)	34 (14.8%)	18 (7.9%)	229 (100.0%)	
- Yes, definitely	353 (76.4%)	79 (17.1%)	30 (6.5%)	462 (100.0%)	
Household COVID-19 Exposure					0.371
- No	3085 (77.3%)	689 (17.3%)	218 (5.5%)	3992 (100.0%)	
- Yes	137 (72.9%)	39 (20.7%)	12 (6.4%)	188 (100.0%)	
History of COVID-19					0.040
- No	2932 (77.6%)	647 (17.1%)	200 (5.3%)	3779 (100.0%)	
- Yes	290 (72.3%)	81 (20.2%)	30 (7.5%)	401 (100.0%)	
Baseline Serology Result					0.460
- Negative	3087 (77.2%)	691 (17.3%)	222 (5.5%)	4000 (100.0%)	

- Positive	135 (75.0%)	37 (20.6%)	8 (4.4%)	180 (100.0%)	
6-month Follow-up Serology Result					< 0.001
- Did not return	836 (71.0%)	259 (22.0%)	82 (7.0%)	1177 (100.0%)	
- Negative	2239 (80.3%)	418 (15.0%)	130 (4.7%)	2787 (100.0%)	
- Positive	147 (68.1%)	51 (23.6%)	18 (8.3%)	216 (100.0%)	

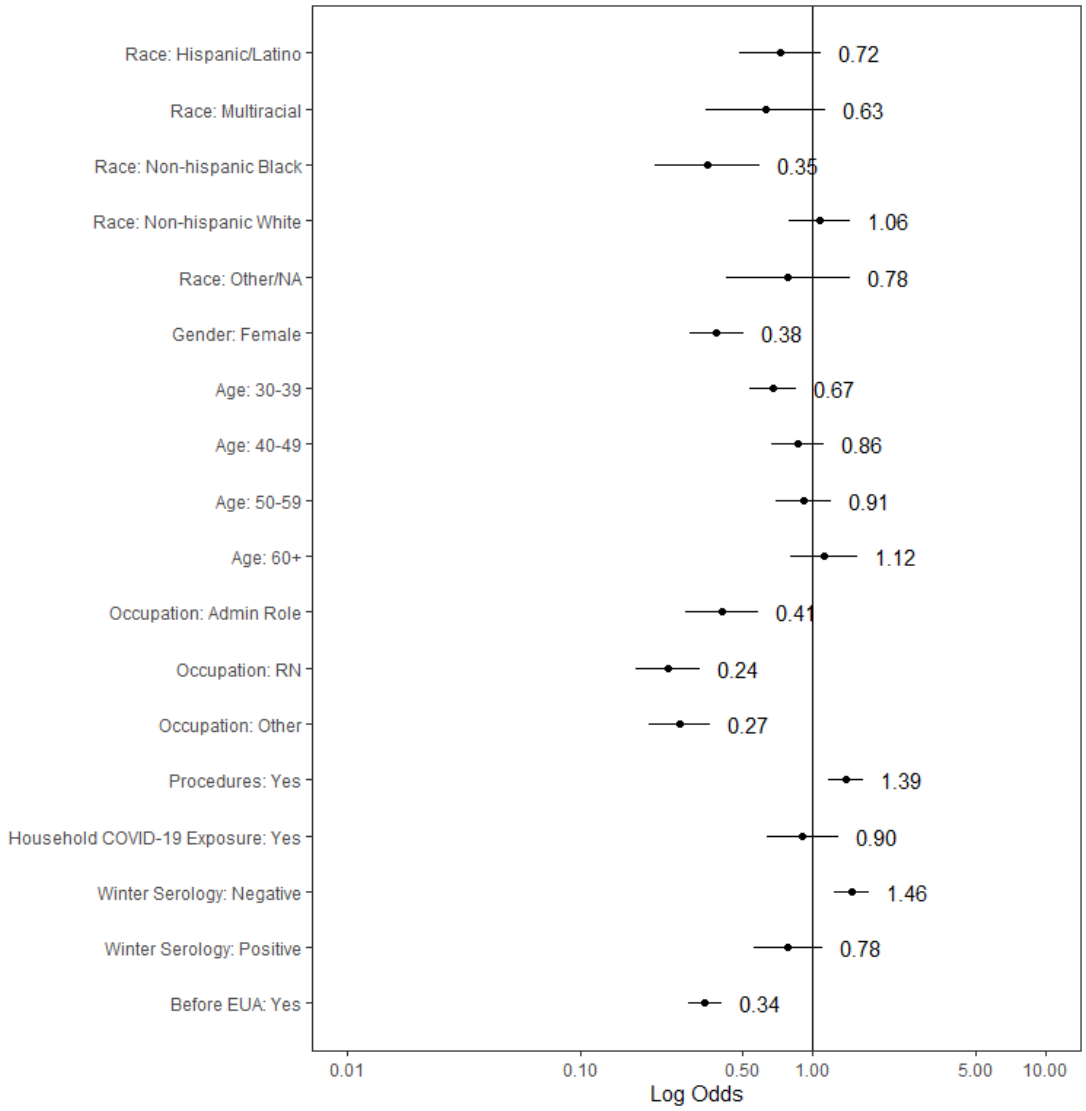
[1] **AI/AN/NH/PI/Other/NA – Represents American Indian/Alaska Native/Native Hawaiian/Other Pacific Islander/Other/Did not answer.**

Figure 1. Participants response to willingness to get vaccinated over time and by timing of first COVID-19 vaccine Emergency Use Authorization (dotted line)[1]



[1]Note that "Yes" is a sum between willingness to get the vaccine in the future and yes based on EUA. EUA is shown in purple to illustrate the percentage that were saying yes.

Figure 2. Multivariable model of the association between willingness to get a COVID-19 vaccine and characteristics.



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Appendix

Supplemental Table 1. 'Other' occupations by intention to get the COVID-19 vaccine

Occupation category	Yes N=1181	Unsure N=337	No N=109	Total N=1627
Clinical/Education coordinator	27 (65.9%)	13 (31.7%)	1 (2.4%)	41 (100.0%)
High Risk Resp. Providers	22 (71.0%)	7 (22.6%)	2 (6.5%)	31 (100.0%)
Laboratory Personnel	80 (73.4%)	20 (18.3%)	9 (8.3%)	109 (100.0%)
Medical Assistant	51 (63.0%)	15 (18.5%)	15 (18.5%)	81 (100.0%)
Mental Health/Counseling	67 (78.8%)	16 (18.8%)	2 (2.4%)	85 (100.0%)
Nurse Practitioner	143 (80.8%)	29 (16.4%)	5 (2.8%)	177 (100.0%)
Other Miscellaneous	150 (77.7%)	35 (18.1%)	8 (4.1%)	193 (100.0%)
Patient Access/Registration	78 (62.9%)	36 (29.0%)	10 (8.1%)	124 (100.0%)
Patient Care Tech or equivalent	74 (67.3%)	27 (24.5%)	9 (8.2%)	110 (100.0%)
Pharmacy	76 (78.4%)	18 (18.6%)	3 (3.1%)	97 (100.0%)
Phlebotomist	18 (64.3%)	4 (14.3%)	6 (21.4%)	28 (100.0%)
Physician Assistant	84 (84.8%)	12 (12.1%)	3 (3.0%)	99 (100.0%)
Physical or Occupational Therapy/Speech Pathologist	138 (72.3%)	41 (21.5%)	12 (6.3%)	191 (100.0%)
Radiology/X-ray Technician	74 (63.2%)	31 (26.5%)	12 (10.3%)	117 (100.0%)
Security/Floor Admin	23 (60.5%)	11 (28.9%)	4 (10.5%)	38 (100.0%)
Sonographer	28 (59.6%)	13 (27.7%)	6 (12.8%)	47 (100.0%)
Support Services	21 (67.7%)	9 (29.0%)	1 (3.2%)	31 (100.0%)