Racial/Ethnic Differences in COVID-19 Vaccine Hesitancy Among Health Care Workers in 2 Large Academic Hospitals

Florence M. Momplaisir, MD, MSHP; Barbara J. Kuter, PhD, MPH; Fatemeh Ghadimi, MD, MPH; Safa Browne, MPH; Hervette Nkwihoreze, MPH; Kristen A. Feemster, MD, MPH, MSHPR; Ian Frank, MD; Walter Faig, PhD; Angela K. Shen, ScD, MPH; Paul A. Offit, MD; Judith Green-McKenzie, MD, MPH

Abstract

IMPORTANCE Significant differences in hesitancy to receive COVID-19 vaccination by race/ethnicity have been observed in several settings. Racial/ethnic differences in COVID-19 vaccine hesitancy among health care workers (HCWs), who face occupational and community exposure to COVID-19, have not been well described.

OBJECTIVE To assess hesitancy to COVID-19 vaccination among HCWs across different racial/ethnic groups and assess factors associated with vaccine hesitancy.

DESIGN, SETTING, AND PARTICIPANTS This survey study was conducted among HCWs from 2 large academic hospitals (ie, a children’s hospital and an adult hospital) over a 3-week period in November and December 2020. Eligible participants were HCWs with and without direct patient contact. A 3-step hierarchical multivariable logistic regression was used to evaluate associations between race/ethnicity and vaccine hesitancy controlling for demographic characteristics, employment characteristics, COVID-19 exposure risk, and being up to date with routine vaccinations. Data were analyzed from February through March 2021.

MAIN OUTCOMES AND MEASURES Vaccine hesitancy, defined as not planning on, being unsure about, or planning to delay vaccination, served as the outcome.

RESULTS Among 34,865 HCWs eligible for this study, 12,034 individuals (34.5%) completed the survey and 10,871 individuals (32.2%) completed the survey and reported their race/ethnicity. Among 10,866 of these HCWs with data on sex, 8,362 individuals (76.9%) were women, and among 10,833 HCWs with age data, 5,923 individuals (54.5%) were younger than age 40 years. (Percentages for demographic and clinical characteristics are among the number of respondents for each type of question.) There were 8,388 White individuals (77.2%), 882 Black individuals (8.1%), 845 Asian individuals (7.8%), and 449 individuals with other or mixed race/ethnicity (4.1%), and there were 307 Hispanic or Latino individuals (2.8%). Vaccine hesitancy was highest among Black HCWs (732 individuals [83.0%]) and Hispanic or Latino HCWs (195 individuals [63.5%]) \( P < .001 \). Among 5,440 HCWs with vaccine hesitancy, reasons given for hesitancy included concerns about side effects (4,737 individuals [87.1%]), newness of the vaccine (4,306 individuals [79.2%]), and lack of vaccine knowledge (4,091 individuals [75.2%]). The adjusted odds ratio (aOR) for vaccine hesitancy was 4.98 (95% CI, 4.11-6.03) among Black HCWs, 2.10 (95% CI, 1.63-2.70) among Hispanic or Latino HCWs, 1.48 (95% CI, 1.21-1.82) among HCWs with other or mixed race/ethnicity, and 1.47 (95% CI, 1.26-1.71) among Asian HCWs compared with White HCWs \( P < .001 \). The aOR was decreased among Black HCWs when adjusting for employment characteristics and COVID-19 exposure risk (aOR, 4.87; 95% CI, 3.96-6.00; \( P < .001 \)) and being up to date with prior vaccines (aOR, 4.48; 95% CI, 3.62-5.53; \( P < .001 \)) but not among HCWs with other racial/ethnic backgrounds.

(continued)
CONCLUSIONS AND RELEVANCE  This study found that vaccine hesitancy before the authorization of the COVID-19 vaccine was increased among Black, Hispanic or Latino, and Asian HCWs compared with White HCWs. These findings suggest that interventions focused on addressing vaccine hesitancy among HCWs are needed.

Introduction

It has been more than a year since the first case of COVID-19 was reported in the US, and as of June 2021, more than 30 million diagnoses of COVID-19 and 590,000 deaths have been attributed to this outbreak.\(^1,2\) Although the pandemic has impacted everyone, COVID-19 disease burden disproportionately falls on members of racial/ethnic minority groups. Black and Hispanic or Latino individuals are nearly 3-fold more likely to be hospitalized owing to COVID-19 and approximately 2-fold more likely to die from the disease compared with White non-Hispanic individuals.\(^3\) With 3 authorized SARS-CoV-2 vaccines available for emergency use in the U.S.,\(^4-6\) it is important to increase access to COVID-19 vaccines and address COVID-19 vaccine hesitancy in communities where it is still high.\(^7,8\)

The vaccine allocation process in the US prioritized health care workers (HCWs) and residents of long-term care facilities, who were the first to be offered COVID-19 vaccines. As COVID-19 vaccination expands, it is important to continue to assess uptake of vaccination among HCWs across different racial/ethnic groups and ensure equitable allocation of vaccines. HCWs face occupational and community exposure to COVID-19, and they are essential to the public health response to this pandemic. Although the risk of occupational infection is low with proper use of personal protective equipment, studies have found that Black and Hispanic or Latino HCWs have a higher burden of infection, associated with increased community exposure to SARS-CoV-2.\(^9,10\) In a large study of 10,275 HCWs,\(^9\) community exposure and living in areas with increased COVID-19 prevalence were associated with most infections among HCWs. The odds of being infected with COVID-19 were increased 2-fold among Black HCWs and HCWs with multiracial backgrounds compared with White HCWs. The differential risk for community acquisition of SARS-CoV-2 among HCWs from racial/ethnic minority groups likely stems from historical and systemic practices that have disadvantaged communities of color and led to residential segregation, which is associated with increased exposure to SARS-CoV-2.\(^11\) Thus, uptake of COVID-19 vaccines is particularly crucial for HCWs living in communities with increased disease burden.

As an extension of our previous work,\(^12\) we analyzed data from a large survey of HCWs at 2 hospitals in Philadelphia in the weeks prior to the launch of the COVID-19 vaccine for HCWs. The purpose of this study was to describe COVID-19 vaccine hesitancy, defined as intent to decline vaccination, being unsure about vaccination, or intent to delay vaccination, across different racial/ethnic groups of HCWs and assess factors associated with vaccine hesitancy.

Methods

Institutional review boards at each hospital in this survey study reviewed the protocol and determined that the study was exempt from further review and informed consent because the identity of participants could not readily be ascertained directly or through identifiers linked to participants. This study is reported following the American Association for Public Opinion Research (AAPOR) reporting guideline.
Study Design and Participants
This was a cross-sectional survey study among HCWs. Eligible HCWs were asked to complete a confidential survey to assess their intention to receive a COVID-19 vaccine. HCWs with and without direct patient contact were eligible for this study if they were employees of hospital A (a children’s hospital) or hospital B (an adult hospital) or contracted by a third party to work at either hospital. Employees received an invitation to complete the survey using their work email. Reminders were sent via email once a week over a 3-week period in November and December 2020. HCWs who participated in COVID-19 vaccine clinical trials and those who did not report their race/ethnicity were excluded from our total sample in this analysis by race/ethnicity.

Survey
The survey focused on intention to receive a COVID-19 vaccine among HCWs and their family, when they planned to be vaccinated after being offered the vaccine (ie, immediately or 3 month, 6 months, or 12 months later), concerns about vaccine safety, level of vaccine efficacy desired, vaccination history and children’s vaccination history, and demographic characteristics. When assessing intention to receive the COVID-19 vaccine, the following assumptions about the vaccine were presented: that it would be at least 50% effective and available at no cost and that vaccination would be voluntary. Employment characteristics included hospital of employment, role in the hospital, and years of employment. We also assessed HCWs’ exposure risk for COVID-19 in the hospital and in the community (ie, household and family exposure), as well as their history of COVID-19 infection. The surveys were developed and distributed using the Research Electronic Data Capture (REDCap) software version 10.9.4 (Vanderbilt University), and the data were stored in a secure server.

Outcome Variable
Vaccine hesitancy was the outcome. HCWs were classified as being hesitant if they reported that they did not plan to receive a vaccine or were unsure about receiving a COVID-19 vaccine or if they planned on delaying receipt of the vaccine for 3 months, 6 months, or 12 months. HCWs who reported that they were planning to receive the COVID-19 vaccine as soon as it was available to them were classified as not hesitant.

Covariates
Demographic Characteristics
Demographic characteristics of HCWs included age, race/ethnicity, sex, education level, and residential area categorized as urban, suburban, or rural. Race/ethnicity was categorized as White, Black or African American, Asian, Hispanic or Latino, and other or mixed race/ethnicity. The other or mixed race/ethnicity category included American Indian or Alaska Native, Pacific Islander or Hawaiian, or mixed race/ethnicity categories.

Employment Characteristics
Employment characteristics included hospital of employment (ie, hospital A or B) and whether the role was clinical with direct patient contact (eg, roles as physicians, nurses, or physical therapists), nonclinical with direct patient contact (eg, roles in transport or food and cleaning services), or nonclinical with no patient contact (eg, roles as administrative and research staff). We also collected years of employment (ie, <1 year, 2-4 years, or ≥5 years).

Risk of COVID-19 Exposure
We assessed occupational risk of COVID-19 exposure by the area of work in the hospital. COVID-19 units, emergency departments (EDs), and intensive care units (ICUs) represented high-risk areas for COVID-19 exposure compared with other floors and service units, where the risk of exposure was considered moderate. Low-risk areas included administrative offices, the home (ie, working remotely), and research labs. We assessed community exposure by asking if individuals had family or
household members with past COVID-19 infection. We also asked HCWs if they had a prior COVID-19 diagnosis.

**Being Up to Date With Routine Vaccinations**

We asked if HCWs or their children were up to date on routine vaccinations. We additionally asked HCWs if they had refused vaccination for themselves or their children in the past.

**Statistical Analysis**

We completed descriptive summary statistics (ie, frequencies and percentages) of COVID-19 vaccine hesitancy and HCW demographic and employment characteristics stratified by race/ethnicity. Differences in other variables across different racial/ethnic groups were evaluated by χ² tests with a significance level of \( P = .05 \). All tests were 2-sided. We reported the reasons for vaccine hesitancy among HCWs who were hesitant and reasons for vaccine acceptance among HCWs who were not hesitant. We then conducted a 3-step hierarchical multivariable logistic regression using the following approach: the first model included demographic characteristics; the second model included variables in model 1, HCW employment characteristics, and risk for COVID-19 exposure; and the third model included variables in model 2 and being up to date on routine vaccinations. This approach was used to evaluate whether HCW employment characteristics and COVID-19 exposure risk (in model 2) and being up to date on other routine vaccinations (in model 3) were associated with race/ethnicity and vaccine hesitancy, after controlling for co-variates in the models.

Data analysis was conducted using SAS statistical software version 9.4. (SAS Institute). Data were analyzed from February through March 2021.

**Results**

Among 34865 eligible HCWs, 12034 individuals (34.5%) completed the survey. After excluding 9 individuals (<0.1%) who received the COVID-19 vaccine in clinical trials and 1163 individuals (9.7%) who did not provide their race/ethnicity, our sample included 10 871 HCWs. Among 10 866 of these HCWs with data on sex, 8362 (76.9%) were women, and among 10 833 HCWs with age data, 5923 individuals (54.5%) were younger than age 40 years. (Percentages for demographic and clinical characteristics are among the number of respondents for each type of question.) There were 8388 White individuals (77.2%), 882 Black individuals (8.1%), 845 Asian individuals (7.8%), and 449 individuals with other or mixed race/ethnicity (4.1%), and there were 307 Hispanic or Latino individuals (2.8%).

**COVID-19 Vaccine Hesitancy by Race/Ethnicity**

Overall, 5440 individuals (50.0%) had vaccine hesitancy. Vaccine hesitancy was highest among Black HCWs (732 individuals [83.0%; 95% CI, 80.4%-85.4%]) and Hispanic or Latino HCWs (195 individuals [63.5%; 95% CI, 57.9%-68.9%]), followed by HCWs with other or mixed race/ethnicity (244 individuals [54.3%; 95% CI, 49.6%-59.0%]), Asian HCWs (398 individuals [47.1%; 95% CI, 43.7%-50.5%]), and White HCWs (3871 individuals [46.2%; 95% CI, 45.1%-47.2%]) (\( P < .001 \)) (Table 1). Most HCWs with vaccine hesitancy (3719 individuals [68.4%]) were those who were not planning to receive or were unsure about receiving the vaccine; 1721 individuals (31.6%) planned to delay the vaccine. The number and percentage who reported not planning to receive or being unsure about receiving the vaccine by race/ethnicity were as follows: 620 Black individuals (70.3%), 140 Hispanic or Latino individuals (45.6%), 185 individuals with other or mixed race/ethnicity (41.2%), 2555 White individuals (30.5%), and 219 Asian individuals (25.9%).

**HCWs Demographic and Employment Characteristics by Race/Ethnicity**

Demographic and employment characteristics for HCWs by race/ethnicity are presented in Table 1. Across all racial/ethnic groups, HCWs were mostly younger than age 40 years of age, and most held a
Table 1. Demographic and Clinical Characteristics of HCWs by Race/Ethnicity

| Characteristic | HCWs, No./total No. (%) | P value |
|---------------|-------------------------|---------|
| **HCW characteristic** | | |
| Vaccine hesitancyb | | |
| Yes | 3871/8388 (46.1) | 732/882 (83.0) | 398/845 (47.1) | 244/449 (54.3) | 195/307 (63.5) | 5440/10871 (50.0) | <.001 |
| No | 4517/8388 (53.9) | 150/882 (17.0) | 447/845 (52.9) | 205/449 (45.7) | 112/307 (36.5) | 5431/10871 (49.9) | |
| Demographic characteristic | | |
| Age, y | | |
| <40 | 4549/8363 (54.4) | 391/878 (44.5) | 511/843 (60.6) | 298/444 (67.1) | 174/305 (57.1) | 5923/10833 (54.7) | <.001 |
| 40-64 | 3428/8363 (41.0) | 470/878 (53.5) | 325/843 (38.6) | 135/444 (30.4) | 128/305 (42.0) | 4486/10833 (41.4) | |
| ≥65 | 386/8363 (4.6) | 17/878 (1.9) | 7/843 (0.8) | 11/444 (2.5) | 3/305 (1.0) | 424/10833 (3.9) | |
| Sex | | |
| Men | 1836/8384 (21.9) | 142/882 (16.1) | 270/845 (32.0) | 116/449 (25.8) | 69/307 (22.6) | 2433/10866 (22.4) | <.001 |
| Women | 6509/8384 (77.6) | 737/882 (83.6) | 572/845 (67.7) | 311/449 (69.3) | 233/307 (76.1) | 8362/10866 (77.0) | |
| Otherc | 39/8384 (0.5) | 3/882 (0.3) | 3/845 (0.4) | 22/449 (4.9) | 4/307 (1.3) | 71/10866 (0.7) | |
| Education | | |
| <Bachelor’s degree | 805/8387 (9.6) | 395/882 (44.8) | 30/845 (3.6) | 70/444 (15.6) | 76/307 (24.8) | 1376/10870 (12.7) | <.001 |
| Bachelor’s or master’s degree | 5342/8387 (63.7) | 397/882 (45.0) | 381/845 (45.1) | 245/444 (54.6) | 146/307 (47.6) | 6511/10870 (59.9) | |
| Postgraduate degree | 2240/8387 (26.7) | 90/882 (10.2) | 434/845 (51.4) | 134/444 (29.8) | 85/307 (27.7) | 2983/10870 (27.4) | |
| Residential area | | |
| Urban | 3138/8387 (37.4) | 493/881 (56.0) | 418/845 (49.5) | 252/444 (56.3) | 164/307 (53.4) | 4465/10868 (41.1) | <.001 |
| Suburban | 5049/8387 (60.2) | 372/881 (42.2) | 417/845 (49.4) | 186/444 (41.5) | 134/307 (43.7) | 6158/10868 (56.7) | |
| Rural | 200/8387 (2.4) | 16/881 (1.8) | 10/845 (1.2) | 22/444 (4.9) | 4/307 (1.3) | 71/10866 (0.7) | |
| HCW employment characteristic | | |
| Hospital of Employment | | |
| Hospital A | 5173/8388 (61.7) | 607/882 (68.8) | 439/845 (52.0) | 281/449 (62.6) | 209/307 (68.1) | 6709/10871 (61.7) | <.001 |
| Hospital B | 3215/8388 (38.3) | 275/882 (31.2) | 406/845 (48.1) | 168/449 (37.4) | 98/307 (31.9) | 4162/10871 (38.3) | |
| Role in the hospital | | |
| Clinical, with patient contact | 5057/7818 (64.7) | 287/806 (35.6) | 509/805 (63.2) | 235/407 (57.7) | 138/276 (50.0) | 6226/10112 (61.6) | <.001 |
| Nonclinical, with patient contact | 696/7818 (8.9) | 203/806 (25.2) | 32/805 (4.0) | 45/407 (11.1) | 31/276 (11.2) | 1007/10112 (10.0) | |
| Nonclinical, with no patient contact | 2065/7818 (26.4) | 316/806 (39.2) | 264/805 (32.8) | 127/407 (31.2) | 107/276 (38.8) | 2879/10112 (28.5) | |
| Years of employment at hospital, y | | |
| <1 | 650/8386 (7.8) | 75/882 (8.5) | 106/845 (12.5) | 71/449 (15.9) | 48/306 (15.7) | 950/10866 (8.7) | <.001 |
| 2-4 | 2583/8386 (30.8) | 306/882 (34.7) | 324/845 (38.3) | 185/449 (41.4) | 133/306 (43.5) | 3531/10866 (32.5) | |
| >5 | 5153/8386 (61.5) | 501/882 (56.8) | 415/845 (49.1) | 191/449 (42.7) | 125/306 (40.9) | 6385/10866 (58.8) | <.001 |
| Risk for COVID-19 exposure | | |
| Area with increased COVID-19 riskd | | |
| High | 2315/7791 (29.7) | 165/772 (21.4) | 235/794 (29.6) | 132/420 (31.4) | 86/276 (31.2) | 2933/10053 (29.2) | <.001 |
| Moderate | 3685/7791 (47.3) | 308/772 (39.9) | 364/794 (45.8) | 183/420 (43.6) | 107/276 (38.8) | 4647/10053 (46.2) | |
| Low | 1791/7791 (23.0) | 299/772 (38.7) | 195/794 (24.6) | 105/420 (25.0) | 83/276 (30.1) | 2473/10053 (24.6) | |
| Family or household member with COVID-19 | 1279/8388 (15.2) | 188/882 (21.3) | 58/845 (6.9) | 68/449 (15.1) | 68/307 (22.2) | 1661/10871 (15.3) | <.001 |
| Diagnosed with COVID-19 | 284/8388 (3.4) | 44/882 (5.0) | 14/845 (1.7) | 15/449 (3.3) | 16/307 (5.2) | 373/10871 (3.4) | .008 |

(continued)
bachelor’s or master’s degree. Most White HCWs (5049 of 8387 individuals [60.2%]) lived in the suburbs. Similar proportions among all 845 Asian HCWs lived in urban and suburban neighborhoods (418 individuals [49.5%] and 417 individuals [49.4%], respectively), while most Black HCWs, Hispanic or Latino HCWs, and HCWs with other or mixed race/ethnicity lived in an urban area (P < .001). Most HCWs held clinical jobs with direct patient contact, except for Black HCWs, among whom the largest percentage held nonclinical jobs with no patient contact (316 of 806 individuals [39.2%]) followed by clinical jobs with patient contact (287 of 806 individuals [35.6%]) (P < .001). Most HCWs had been employed for 2 or more years.

### HCWs’ Risk for COVID-19 Exposure by Race/Ethnicity

Across all racial/ethnic groups, the highest proportion of HCWs worked in areas of moderate risk for COVID-19 exposure, ranging from 107 of 276 Hispanic or Latino individuals (38.8%) to 3685 of 7791 White individuals (47.3%) (P < .001) (Table 1). Black and Hispanic or Latino HCWs were more likely to have had a COVID-19 diagnosis, with 44 Black HCWs (5.0%) and 16 Hispanic or Latino HCWs (5.2%) who had COVID-19 compared with 284 White HCWs (3.4%), 15 HCWs with other or mixed race/ethnicity (3.3%), and 14 Asian HCWs (1.7%) (P = .008). Similarly, Black HCWs (188 individuals [21.3%]) and Hispanic or Latino HCWs (68 individuals [22.2%]) were more likely to have family or household members with a history of COVID-19 compared with White HCWs (1279 individuals [15.2%]), HCWs with other or mixed race/ethnicity (68 individuals [15.1%]) and Asian HCWs (58 individuals [6.9%]) (P < .001).

### Being Up to Date on Routine Vaccinations by Race/Ethnicity

We also asked HCWs if they were up to date with all or most routine vaccinations (Table 1), and responses ranged from 824 Black HCWs (93.4%) to 8222 White HCWs (98.0%) (P < .001). The proportion of HCWs who reported that they had ever refused a vaccine for themselves varied from 28 Asian HCWs (3.3%) to 148 Black HCWs (16.8%) (P < .001), and the proportion of HCWs who ever refused a vaccine for their children varied from 11 of 446 Asian HCWs (2.5%) to 100 of 595 Black HCWs (17.2%) (P < .001).
Reasons for COVID-19 Vaccine Hesitancy Among HCWs Who Were Hesitant

In Table 2, we report the frequency of reasons for vaccine hesitancy (from most to least common) by race/ethnicity and among 5440 individuals who indicated they were hesitant to receive the vaccine. Concerns among the entire surveyed population expressing hesitancy included side effects (4737 individuals [87.1%]), the newness of the vaccine (4306 individuals [79.2%]), not knowing enough about the vaccine (4091 individuals [75.2%]), the chance that it may not work (1535 individuals [28.2%]), and concerns that they may become infected with COVID-19 by receiving the vaccine (1170 individuals [21.5%]). Other reasons associated with outcomes from the disease, such as not being concerned about getting seriously ill from COVID-19 (455 individuals [8.4%]) or belief that COVID-19 is not as serious as people say it is (96 individuals [1.8%]), were of less significant concern.

Reasons for COVID-19 Vaccine Acceptance Among HCWs Who Were Not Hesitant

Reasons for vaccination among 5431 HCWs who were not hesitant are listed in Table 3 from most to least common reason for vaccine acceptance across different racial/ethnic groups. These reasons include the desire to protect their family (5225 individuals [96.2%]), themselves (5123 individuals [94.3%]), or their community (4574 individuals [84.2%]); to return to normal life (3998 individuals [73.6%]); to avoid becoming ill (3957 individuals [72.9%]); and to feel safe around people (3671 individuals [66.6%]).

Adjusted Associations Between Race/Ethnicity and COVID-19 Hesitancy

Model 1 shows the association between race/ethnicity and vaccine hesitancy adjusting for demographic characteristics, such as age, sex, education, and area of residence (Table 4). Black HCWs had almost 5-fold higher odds of being hesitant to get a COVID-19 vaccine compared with White HCWs; the adjusted odds ratio (aOR) compared with White HCWs was 4.98 (95% CI, 4.11-6.03) for Black HCWs, 2.10 (95% CI, 1.63-2.70) for Hispanic or Latino HCWs, 1.48 (95% CI, 1.21-1.82) for HCWs with other or mixed race/ethnicity, and 1.47 (95% CI, 1.26-1.71) for Asian HCWs (P < .001).

When adjusting for employment characteristics and COVID-19 exposure risk in model 2 and being up to date with prior vaccines in model 3, the aORs for hesitancy were decreased among Black HCWs and remained stable for other HCWs. The aORs for Black HCWs were 4.87 (95% CI, 3.96-6.00);

### Table 2. Reasons for Vaccine Hesitancy by Race/Ethnicity Among 5440 HCWs Who Were Hesitant

| Reason for not getting vaccinateda | HCWs, No. (%) |  |
|-----------------------------------|---------------|---|
|                                  | White (n = 3871) | Black (n = 732) | Asian (n = 398) | Other race/ethnicity (n = 244)b | Hispanic or Latino (n = 195) | Total |
| Concern about side effects        | 3344 (86.4) | 650 (88.8) | 356 (89.5) | 218 (89.3) | 169 (86.7) | 4737 (87.1) |
| Vaccine is too new                 | 3015 (77.9) | 627 (85.7) | 309 (77.6) | 197 (80.7) | 158 (81.0) | 4306 (79.2) |
| Don’t know enough about the vaccine | 2898 (74.9) | 575 (78.6) | 292 (73.4) | 181 (74.2) | 145 (74.4) | 4091 (75.2) |
| It may not work                    | 960 (24.8) | 316 (43.2) | 116 (29.2) | 83 (34.0) | 60 (30.8) | 1535 (28.2) |
| Concern about getting infected with COVID-19 from the vaccine | 649 (16.8) | 292 (39.9) | 101 (25.4) | 73 (29.9) | 55 (28.2) | 1170 (21.5) |
| Not concerned about getting seriously ill from COVID-19 | 304 (7.9) | 83 (11.3) | 24 (6.0) | 26 (10.7) | 18 (9.2) | 455 (8.4) |
| Other                             | 312 (8.1) | 51 (7.0) | 29 (7.3) | 29 (11.9) | 11 (5.6) | 432 (7.9) |
| I don’t like vaccines             | 68 (1.8) | 63 (8.6) | 5 (1.3) | 13 (5.3) | 7 (3.6) | 156 (2.9) |
| COVID-19 outbreak is not as serious as some people say it is | 70 (1.8) | 13 (1.8) | 4 (1.0) | 6 (2.5) | 3 (1.5) | 96 (1.8) |
| I don’t like needles              | 43 (1.1) | 19 (2.6) | 4 (1.0) | 7 (2.9) | 4 (2.1) | 77 (1.4) |
| I won’t have time to get vaccinated | 7 (0.2) | 4 (0.6) | 2 (0.5) | 3 (1.2) | 1 (0.5) | 17 (0.3) |
| None of the above                 | 30 (0.8) | 9 (1.2) | 3 (0.8) | 2 (0.8) | 3 (1.5) | 47 (0.9) |

Abbreviation: HCWs, health care workers.

a HCWs could select more than 1 response. Those who were hesitant are those who would not take the vaccine immediately. Reasons are listed only for HCWs with vaccine hesitancy.

b Other and mixed race/ethnicity included American Indian or Alaska Native, Pacific Islander or Hawaiian, and mixed race/ethnicity.
Discussion

According to the World Health Organization (WHO), vaccine hesitancy is defined as “the reluctance or refusal to vaccinate despite the availability of vaccines.” Vaccine hesitancy continues to be a considerable threat to global health and is among the top health priorities to tackle for WHO and the US. This survey study found that vaccine hesitancy was high among HCWs and there were substantial differences in COVID-19 vaccine hesitancy by race/ethnicity among HCWs, a population with potentially more access to accurate information about vaccine science and limited barriers to vaccine access. We found that, compared with White HCWs, hesitancy was highest among Black and Hispanic or Latino HCWs, followed by HCWs of other or mixed race/ethnicity and Asian HCWs. In the logistic regression models, Black HCWs had the greatest increase in odds of vaccine hesitancy compared with White HCWs, followed by Hispanic or Latino HCWs. This increase in odds remained high across regression models after adjusting for demographic variables, employment characteristics, and COVID-19 exposure risk, and it decreased among Black HCWs when adjusting for status regarding being up to date with routine vaccinations. In addition to reasons for vaccine hesitancy reported here, it is possible that mistrust of the health care system owing to historical mistreatment in research and medical care, particularly in the Black community, may contribute to hesitancy.14

Our results are consistent with prior studies finding that hesitancy toward a COVID-19 vaccine is particularly high among Black and Hispanic or Latino HCWs. In one survey of 3479 HCWs across 5 hospitals conducted shortly before our survey, 81% of Black HCWs and 70% of Hispanic or Latino HCWs were not willing to take the COVID-19 vaccine, mostly because they wanted to wait for safety data before deciding on vaccination.15 Another survey of 5287 HCWs conducted at approximately the same time as our survey found that 69.2% of Black and 60.7% of American Indian or Alaska Native HCWs disagreed with or were unsure about getting a COVID-19 vaccine.16 Data on vaccine hesitancy for Asian HCWs have been mixed15,17,18; however, reasons for vaccine hesitancy are similar to what has been reported for HCWs of other racial/ethnic groups and center on safety concerns.17 Interestingly, adjusting for employment characteristics and exposure to COVID-19 was not associated with much change in the aORs in our study, potentially suggesting that being in a health care

Table 3. Reasons for Vaccine Acceptability Among 5431 HCWs Who Planned to Receive the Vaccine

| Reason for vaccine acceptability | HCWs, No. (%) | White (n = 4517) | Asian (n = 447) | Other race/ethnicity (n = 205) | Black (n = 150) | Hispanic or Latino (n = 112) | Total |
|----------------------------------|--------------|----------------|---------------|-----------------------------|----------------|-------------------------|-------|
| Want to protect my family       | 4361 (96.6)  | 423 (94.6)     | 194 (94.6)    | 138 (92.0)                 | 109 (97.3)    | 5225 (96.2)             |
| Want to protect myself          | 4288 (94.9)  | 409 (91.5)     | 185 (90.2)    | 139 (92.7)                 | 102 (91.1)    | 5123 (94.3)             |
| Want to protect my community    | 3809 (84.3)  | 380 (85.0)     | 172 (83.9)    | 118 (78.7)                 | 95 (84.8)     | 4574 (84.2)             |
| Life won’t get back to normal until most people are vaccinated | 3342 (74.0) | 329 (73.6) | 150 (73.2) | 96 (64.0) | 81 (72.3) | 3998 (73.6) |
| Want to prevent getting seriously ill from COVID-19 | 3292 (72.9) | 334 (74.7) | 137 (66.8) | 113 (75.3) | 81 (72.3) | 3957 (72.9) |
| Allow me to feel safe around other people | 299 (66.4) | 307 (68.7) | 129 (62.9) | 110 (73.3) | 72 (64.3) | 3617 (66.6) |
| I want to travel again          | 2051 (45.4)  | 226 (50.6)     | 101 (49.3)    | 66 (44.0)                  | 56 (50.0)     | 2500 (46.0)             |
| My employer recommends the vaccine | 811 (18.0) | 54 (12.1) | 28 (13.7) | 29 (19.3) | 17 (15.2) | 939 (17.3) |
| I have a chronic condition, so it is important I am vaccinated | 654 (14.5) | 53 (11.9) | 20 (9.8) | 44 (29.3) | 16 (14.3) | 787 (14.5) |
| Doctor recommends the vaccine   | 633 (14.0)   | 41 (9.2)       | 22 (10.7)     | 27 (18.0)                  | 11 (9.8)      | 734 (13.5)              |

Abbreviation: HCWs, health care workers.

a Reasons for vaccine acceptability were assessed among HCWs who reported that they were planning on receiving the vaccine as soon as it was available.

b Other and mixed race/ethnicity included American Indian or Alaska Native, Pacific Islander or Hawaiian, and mixed race/ethnicity.
Table 4. Odds of COVID-19 Vaccine Hesitancy by Health Care Worker Characteristic

| Characteristic                          | Model 1<sup>a</sup> | P value | Model 2<sup>b</sup> | P value | Model 3<sup>c</sup> | P value |
|----------------------------------------|---------------------|---------|---------------------|---------|---------------------|---------|
|                                       | OR (95% CI)         |         | OR (95% CI)         |         | OR (95% CI)         |         |
| Race/ethnicity                         |                     |         |                     |         |                     |         |
| White (Reference)                      | 1                   |         | 1                   |         | 1                   |         |
| Black                                  | 4.98 (4.11-6.03)    | <.001   | 4.87 (3.96-6.00)    | <.001   | 4.48 (3.62-5.53)    | <.001   |
| Hispanic or Latino                     | 2.10 (1.63-2.70)    | <.001   | 2.08 (1.58-2.74)    | <.001   | 2.03 (1.53-2.68)    | <.001   |
| Asian                                  | 1.47 (1.26-1.71)    |         | 1.53 (1.30-1.80)    |         | 1.56 (1.32-1.83)    |         |
| Mixed or other                         | 1.48 (1.21-1.82)    |         | 1.54 (1.23-1.92)    |         | 1.44 (1.15-1.80)    |         |
| Sex                                    |                     |         |                     |         |                     |         |
| Men (Reference)                        | 1                   |         | 1                   |         | 1                   |         |
| Women                                  | 2.39 (2.15-2.65)    | <.001   | 2.38 (2.12-2.67)    | <.001   | 2.27 (2.02-2.55)    | <.001   |
| Other or prefer not to answer          | 2.59 (1.53-4.40)    |         | 2.50 (1.41-4.42)    |         | 2.34 (1.31-4.19)    |         |
| Age, y                                 |                     |         |                     |         |                     |         |
| <40                                    | 1.00 (Reference)    |         | 1.00 (Reference)    |         | 1.00 (Reference)    |         |
| 40-64                                  | 0.74 (0.68-0.81)    | <.001   | 0.73 (0.66-0.81)    | <.001   | 0.69 (0.62-0.78)    | <.001   |
| ≥65                                    | 0.42 (0.33-0.53)    |         | 0.43 (0.33-0.57)    |         | 0.42 (0.32-0.56)    |         |
| Education level                        |                     |         |                     |         |                     |         |
| <Bachelor’s degree (Reference)         | 1                   |         | 1                   |         | 1                   |         |
| Bachelor’s or master’s degree          | 0.62 (0.54-0.71)    | <.001   | 0.62 (0.53-0.73)    | <.001   | 0.63 (0.53-0.74)    | <.001   |
| Postgraduate degree                    | 0.28 (0.24-0.32)    |         | 0.27 (0.22-0.32)    |         | 0.28 (0.23-0.34)    |         |
| Area of residence                      |                     |         |                     |         |                     |         |
| Urban (Reference)                      | 1                   |         | 1                   |         | 1                   |         |
| Suburban                               | 1.45 (1.32-1.58)    | <.001   | 1.38 (1.25-1.52)    | <.001   | 1.35 (1.22-1.50)    | <.001   |
| Rural                                  | 2.08 (1.56-2.76)    |         | 2.27 (1.65-3.13)    |         | 2.14 (1.54-2.96)    |         |
| Employment length, y                   |                     |         |                     |         |                     |         |
| <1                                     | NA                  | NA      | 1 [Reference]       | .01     | 1.31 (1.11-1.56)    | .001    |
| 1-4                                    | NA                  | NA      | 1.27 (1.07-1.50)    | .03     | 1.38 (1.16-1.65)    |         |
| ≥5                                     | NA                  | NA      | 1.29 (1.09-1.53)    | .03     | 1.38 (1.16-1.65)    |         |
| Level of patient care                  |                     |         |                     |         |                     |         |
| Clinical with direct patient contact   | NA                  | NA      | 1 [Reference]       | .39     | 1.01 (0.91-1.12)    | .74     |
| Some patient interaction               | NA                  | NA      | 0.84 (0.71-1.00)    | .03     | 0.83 (0.70-0.99)    | .03     |
| Nonclinical with no patient contact    | NA                  | NA      | 0.85 (0.74-0.98)    | .86     | 0.86 (0.75-0.99)    |         |
| Occupation COVID-19 exposure risk      |                     |         |                     |         |                     |         |
| High                                   | NA                  | NA      | 1 [Reference]       | .90     | 1.09 (0.89-1.04)    |         |
| Moderate                               | NA                  | NA      | 1.01 (0.91-1.12)    | .90     | 1.09 (0.89-1.04)    |         |
| Low                                    | NA                  | NA      | 1.11 (0.95-1.31)    | .03     | 0.98 (0.89-1.08)    | .71     |
| Employment site                        |                     |         |                     |         |                     |         |
| Hospital A                             | NA                  | NA      | 1 [Reference]       | .05     | 1.00 (0.91-1.12)    | .41     |
| Hospital B                             | NA                  | NA      | 0.99 (0.90-1.09)    | .90     | 0.98 (0.89-1.08)    |         |
| COVID-19 diagnosis                     |                     |         |                     |         |                     |         |
| Yes                                    | NA                  | NA      | 1 [Reference]       | .10     | 1.00 (0.91-1.12)    | .41     |
| No or unsure                           | NA                  | NA      | 0.80 (0.61-1.04)    | .05     | 0.77 (0.59-1.00)    |         |
| Family COVID-19 diagnosis              |                     |         |                     |         |                     |         |
| Yes                                    | NA                  | NA      | 1 [Reference]       | .27     | 1.01 (0.83-1.08)    | .41     |
| No or unsure                           | NA                  | NA      | 0.93 (0.81-1.06)    | .27     | 0.95 (0.70-1.08)    | <.001   |
| Refused prior vaccination              |                     |         |                     |         |                     |         |
| Yes                                    | NA                  | NA      | NA                  | <.001   | 1.01 (0.89-1.04)    | <.001   |
| No or unsure                           | NA                  | NA      | NA                  | .37     | 0.29 (0.23-0.37)    |         |
| No children                            | NA                  | NA      | NA                  | .44     | 0.32 (0.23-0.44)    |         |

(continued)
environment and having first-hand knowledge of the disease were not significant factors associated with overcoming hesitancy.

Uptake of COVID-19 vaccines, even among HCWs, seems to lag among racial/ethnic groups in which vaccine hesitancy is high. A multisite cohort surveillance study conducted in January 2021, including HCWs from 20 EDs, found that 65.4% of Black HCWs received the COVID-19 vaccine compared with 88.5% of White HCWs. A March 2021 national survey from the Kaiser Family Foundation showed that of 1300 HCWs, 48% had not received the COVID-19 vaccine. The breakdown by race/ethnicity for individuals who received the vaccine was 39% for Black HCWs, 44% for Hispanic HCWs, and 57% for White HCWs. Access to COVID-19 vaccines was not an issue, given that 93% of hospital HCWs reported receiving the COVID-19 vaccine from their employers (vs at other vaccination sites) and 91% reported that it was very easy or somewhat easy to get vaccinated.

Strategies to increase COVID-19 vaccination among HCWs are needed. Although the Centers for Disease Control and Prevention and Food and Drug Administration have generally advised against COVID-19 vaccine mandates for vaccines authorized under the Emergency Use Authorization, some health care systems have mandated COVID-19 vaccination for their HCWs, using the influenza vaccine as a precedent. This approach may help accelerate vaccination for individuals who planned to delay or were contemplating vaccination; however, it will be important to monitor unintended outcomes associated with these mandates given that this approach may be associated with increased health and economic disparities if HCWs lose employment for refusing the vaccine. Other strategies, such as positive and culturally responsive messaging on COVID-19 vaccines and using vaccinated HCWs as vaccine ambassadors, should also be tested.

**Strengths and Limitations**

Our study has several strengths. We conducted a large survey of HCWs before vaccine implementation in the US, and our findings highlight existing differences in COVID-19 vaccine hesitancy by race/ethnicity. Our sample represented HCWs from a broad range of backgrounds and roles. The 3-step hierarchical model we used allowed us to understand the relative associations of demographic characteristics, employment variables, COVID-19 risk exposure, and prior receipt of vaccines with COVID-19 vaccine hesitancy.

Our findings should be interpreted in the context of several important limitations. With a response rate of approximately 35%, there is a risk of selection bias and limited generalizability of the results. Although our sample was large, we surveyed respondents in 2 hospitals at 1 university-affiliated academic institution. Furthermore, because we used a convenience sample, we were not able to compare demographic characteristics of respondents and nonrespondents. It is possible that survey respondents were more likely to be hesitant and wanted their voices known. Our study measured intention to vaccinate prior to vaccine availability. As more people have gotten vaccinated and the acceptability of COVID-19 vaccines has increased in the general public, HCWs’ attitudes toward vaccination may have changed. Additionally, our survey did not include specific questions on attitudes, beliefs, or mistrust concerning the vaccine.

| Characteristic                           | Model 1* OR (95% CI) | P value | Model 2* OR (95% CI) | P value | Model 3c OR (95% CI) | P value |
|-----------------------------------------|----------------------|---------|----------------------|---------|----------------------|---------|
| Uptodate on most or all vaccinations    |                      |         |                      |         | 1 [Reference]        | .045    |
| Yes                                    | NA                   | NA      | NA                   | NA      | 1.39 (1.01-1.91)     | .045    |
| No or unsure                           | NA                   | NA      |                      |         |                      |         |

Abbreviations: NA, not applicable; OR, odds ratio.

* Model 1 adjusted for demographic characteristics, including age, sex, education, and area of residence.

* Model 2 included Model 1 and adjusted for employment and COVID-19 risk characteristics, including years of employment, role in the hospital, area of employment in the hospital, prior COVID-19 diagnosis, and family or household member with COVID-19.

* Model 3 included Model 2 and adjusted for being up to date with routine vaccinations, ever refusing a vaccine, and ever refusing a vaccine for their children.
Conclusions

This study found that approximately half of all HCWs were hesitant about COVID-19 vaccines, with the highest rates among Black and Hispanic or Latino HCWs. These results suggest that more work is needed to ensure confidence in COVID-19 vaccination, particularly among Black and Hispanic or Latino individuals, who are disproportionately impacted by the pandemic. Developing messaging emphasizing the individual, family, and community benefits of getting the vaccine and providing continued transparency on the safety profile of COVID-19 vaccines are simple approaches that may be rapidly disseminated across health care systems to improve vaccine acceptance among HCWs.
3. Centers for Disease Control and Prevention. Risk for COVID-19 infection, hospitalization, and death by race/ethnicity. Updated June 17, 2021. Accessed January 22, 2021. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html

4. Oliver SE, Gargano JW, Marin M, et al. The Advisory Committee on Immunization Practices’ interim recommendation for use of Pfizer-BioNTech COVID-19 vaccine—United States, December 2020. MMWR Morb Mortal Wkly Rep. 2020;69(50):1922-1924. doi:10.15585/mmwr.mm6950e2

5. Oliver SE, Gargano JW, Marin M, et al. The Advisory Committee on Immunization Practices’ interim recommendation for use of Moderna COVID-19 vaccine—United States, December 2020. MMWR. Morb Mortal Wkly Rep. 2020;69(51):1653-1656. doi:10.15585/mmwr.mm695152e1

6. Oliver SE, Gargano JW, Scobie H, et al. The Advisory Committee on Immunization Practices’ interim recommendation for use of Janssen COVID-19 Vaccine—United States, February 2021. MMWR Morb Mortal Wkly Rep. 2021;70(9):329-332. doi:10.15585/mmwr.mm7009e4

7. Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? Vaccine. 2020;38(42):6500-6507. doi:10.1016/j.vaccine.2020.08.043

8. Callaghan T, Moghtaderi A, Lueck JA, et al. Correlates and disparities of COVID-19 vaccine hesitancy. SSRN. 2020. doi:10.2139/ssrn.3667971

9. Baker JM, Nelson KN, Overton E, Lopman BA, Lash TL, Photakis M, et al. Quantification of occupational and community risk factors for SARS-CoV-2 seropositivity among healthcare workers in a large US healthcare system. medRxiv. Preprint posted online November 3, 2020.

10. Wilkins JT, Gray EL, Wallia A, et al. Seroprevalence and correlates of SARS-CoV-2 antibodies in health care workers in Chicago. Open Forum Infect Dis. 2020;8(1):a582. doi:10.1093/ofid/ofaa582

11. Webb Hooper M, Nápoles AM, Pérez-Stable EJ. COVID-19 and racial/ethnic disparities. JAMA. 2020;323(24):2466-2467. doi:10.1001/jama.2020.8598

12. Kuter BJ, Browne S, Momplaisir FM, et al. Perspectives on the receipt of a COVID-19 vaccine: a survey of employees in two large hospitals in Philadelphia. Vaccine. 2021;39(12):1693-1700. doi:10.1016/j.vaccine.2021.02.029

13. Akbar R. Ten threats to global health in 2019. World Health Organization. Accessed March 1, 2021. https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019

14. Egede LE, Walker RJ. Structural racism, social risk factors, and Covid-19—a dangerous convergence for Black Americans. N Engl J Med. 2020;383(12):e77. doi:10.1056/NEJMp2023616

15. Shelkar R, Sheikh AB, Upadhyay S, et al. COVID-19 vaccine acceptance among health care workers in the United States. Vaccines (Basel). 2021;9(2):119. doi:10.3390/vaccines9020119

16. Shaw J, Stewart T, Anderson KB, et al. Assessment of U.S. health care personnel (HCP) attitudes towards COVID-19 vaccination in a large university health care system. Clin Infect Dis. 2021;ciab054. doi:10.1093/cid/ciab054

17. Gadoto A, Halbrook M, Martin-Blais R, et al. Cross-sectional assessment of COVID-19 vaccine acceptance among health care workers in Los Angeles. Ann Intern Med. 2021;174(6):882-885. doi:10.7326/M20-7580

18. Schrading WA, Trent SA, Paxton JH, et al; Project COVERED Emergency Department Network. Vaccination rates and acceptance of SARS-CoV-2 vaccination among U.S. emergency department health care personnel. Acad Emerg Med. 2021;28(4):455-458. doi:10.1111/acem.14236

19. Painter EM, Usery EN, Patel A, et al. Demographic characteristics of persons vaccinated during the first month of the COVID-19 vaccination program—United States, December 14, 2020-January 14, 2021. MMWR Morb Mortal Wkly Rep. 2021;70(5):174-177. doi:10.15585/mmwr.mm7005e1

20. Kirzinger A, Kearney A, Hambel L, Brodie M. KFF/The Washington Post frontline health care workers survey. Accessed June 3, 2021. https://www.kff.org/report-section/kff-washington-post-frontline-health-care-workers-survey-vaccine-intentions/

21. Rothstein MA, Parnett WE, Reiss DR. Employer-mandated vaccination for COVID-19. Am J Public Health. 2021;111(6):1061-1064. doi:10.2105/AJPH.2020.306166

22. Penn Medicine. Penn Medicine to require all health system employees to receive COVID-19 vaccine. Accessed June 4, 2021. https://www.pennmedicine.org/news/news-releases/2021/may/penn-medicine-to-require-all-health-system-employees-to-receive-covid19-vaccine

23. Momplaisir F, Haynes N, Nikwihoreze H, Nelson M, Werner RM, Jemmott J. Understanding drivers of COVID-19 vaccine hesitancy among Blacks. Clin Infect Dis. 2021;ciab102. doi:10.1093/cid/ciab102

24. Szilagyi PG, Thomas K, Shah MD, et al. National trends in the US public’s likelihood of getting a COVID-19 vaccine—April 1 to December 8, 2020. JAMA. 2020;325(4):396-398. doi:10.1001/jama.2020.26419