ARTICLE

COVID-19 vaccine hesitancy: Race/ethnicity, trust, and fear

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Abstract

Understanding and minimizing coronavirus disease 2019 (COVID-19) vaccine hesitancy is critical to population health and minimizing health inequities, which continue to be brought into stark relief by the pandemic. We investigate questions regarding vaccine hesitancy in a sample ($n = 1205$) of Arkansas adults surveyed online in July/August of 2020. We examine relationships among sociodemographics, COVID-19 health literacy, fear of COVID-19 infection, general trust in vaccines, and COVID-19 vaccine hesitancy using bivariate analysis and a full information maximum likelihood (FIML) logistic regression model. One in five people (21,21.86%) reported hesitancy to take a COVID-19 vaccine. Prevalence of COVID-19 vaccine hesitancy was highest among Black/African Americans (50.00%), respondents with household income less than \$25K (30.68%), some college (32.17%), little to no fear of infection from COVID-19 (62.50%), and low trust in vaccines in general (55.84%). Odds of COVID-19 vaccine hesitancy were 2.42 greater for Black/African American respondents compared to White respondents ($p < 0.001$), 1.67 greater for respondents with some college/technical degree compared to respondents with a 4-year degree ($p < 0.05$), 5.48 greater for respondents with no fear of COVID-19 infection compared to those who fear infection to a great extent ($p < 0.001$), and 11.32 greater for respondents with low trust in vaccines ($p < 0.001$). Sociodemographic differences in COVID-19 vaccine hesitancy raise concerns about the potential of vaccine implementation to widen existing health disparities in COVID-19 related infections, particularly among Black/African Americans. Fear of infection and general mistrust in vaccines are significantly associated with vaccine hesitancy.

Study Highlights

WHAT IS THE CURRENT KNOWLEDGE ON THE TOPIC?
Prior research has documented that coronavirus disease 2019 (COVID-19) vaccine hesitancy varies greatly by race and ethnicity. However, many questions remain regarding patterns of vaccine hesitancy across sociodemographics and attitudes.

WHAT QUESTION DID THIS STUDY ADDRESS?

What proportion of Arkansans are hesitant to get the COVID-19 vaccine? How does COVID-19 vaccine hesitancy differ across sociodemographic groups in Arkansas? How does knowledge of how to protect one's self against the virus, fear of the virus, and general trust for vaccines relate to COVID-19 vaccine hesitancy?

WHAT DOES THIS STUDY ADD TO OUR KNOWLEDGE?

This study is the first to look at sociodemographic differences in COVID-19 vaccine hesitancy in a highly vulnerable rural state that ranks third for prevalence of individuals at high risk for serious illness from COVID-19. The COVID-19 vaccine hesitancy was highest among respondents with lower household income, some college, and little to no fear of infection from COVID-19.

HOW MIGHT THIS CHANGE CLINICAL PHARMACOLOGY OR TRANSLATIONAL SCIENCE?

This study can inform public health interventions aiming to reduce the unequal burden of COVID-19 morbidity and mortality through equitable vaccine distribution and health communication.

INTRODUCTION

In January 2020, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)—the etiological agent of coronavirus disease 2019 (COVID-19)—was detected for the first time in a patient in the United States (US). By December 2020, COVID-19 was the leading cause of death in the US,[1] with a disproportionate loss of life occurring among communities of color.[2] In December 2020, distribution of 2 COVID-19 vaccines began across the US.[3] The next major goal is to achieve population immunity.

Population immunity is achieved when a large enough percentage of a population becomes immune—either through prior infection or vaccination—such that even the nonimmune are indirectly protected. To achieve population immunity for vaccine preventable diseases, high uptake rates are necessary. With COVID-19's estimated reproduction rate of 5.8, population immunity thresholds to stop COVID-19 transmission range between 73% and 84%.[3] The potential for population immunity against COVID-19 is threatened by hesitancy toward the COVID-19 vaccine. Vaccine hesitancy refers to a spectrum of behaviors that include refusal as well as delayed acceptance of a vaccine.[4] Polls tracking COVID-19 vaccine hesitancy in May of 2020 estimated that 28% of the US population would probably or definitely *not* get the COVID-19 vaccine.[5] Hesitancy rose to between 49% and 50% in September 2020, and slightly declined to 40% and 42% in November 2020, the month before a vaccine would become available for the first time.[5,6]

Prior research has demonstrated that sociodemographic factors, such as age, sex, race/ethnicity, income, and education are correlates of vaccine hesitancy.[7,8] Sociodemographic factors are understood to be dimensions of social positioning shaping life chances and experiences, subsequently influencing trust and assessment of risk. Vaccine hesitancy varies by

race and ethnicity, with Black/African Americans reporting some of the highest level of general vaccine hesitancy and lowest levels of vaccine confidence.[9,10] The high level of vaccine hesitancy would be concerning on its own but combined with the growing evidence that COVID-19 is exacting a disproportionate toll on racial minorities, it is especially worrisome.[2,11]

Vaccine refusal and under-vaccination at the community level is associated with resurgence of vaccine-preventable diseases, including measles and pertussis.[12] Clusters of outbreaks occur in communities where vaccine uptake is not sufficient,[13] and geographic variation in COVID-19 vaccine hesitancy suggests state-level analysis may be equally as important as national-level studies.[14] This paper examines vaccine hesitancy among adults living, working, or receiving care in Arkansas. Arkansas is in the top 10 states for rural populations (43.84%), which often lack adequate health care resources and primary care providers,[15] and is ranked third among US states with the highest percentages (46.50%) of populations at high risk for serious illness due to COVID-19.[16] The following research questions were examined: (1) What proportion of Arkansans are hesitant to receive a vaccine for COVID-19?; (2) How does COVID-19 vaccine hesitancy differ across socio-demographic groups in Arkansas?; and (3) How does knowledge of how to protect one's self against the virus (COVID-19 health literacy), fear of the virus, and general trust for vaccines relate to COVID-19 vaccine hesitancy? We propose the following series of hypotheses.

Hypothesis 1 *COVID-19 vaccine hesitancy will be significantly associated with sociodemographic factors (H1.1: age; H1.2: sex; H1.3: race/ethnicity; H1.4: income; and H1.5: education).*

Hypothesis 2 *COVID-19 vaccine hesitancy will be negatively associated with COVID-19 health literacy.*

Hypothesis 3 *COVID-19 vaccine hesitancy will be negatively associated with fear of COVID-19 infection.*

Hypothesis 4 *COVID-19 vaccine hesitancy will be negatively associated with general vaccine confidence.*

MATERIALS AND METHODS

Study design and respondents

Data were collected via online survey from volunteer research participants enrolled in the ARresearch registry.[17] The survey was conducted in July and August 2020. Recruitment emails were distributed to 4077 valid email addresses. The emails described the study and invited individuals to complete the survey. Research Electronic Data Capture (REDCap) was used to administer the consent and survey.[18] Inclusion criteria included being an adult (age ≥18) and living, working, and/or receiving health care in the state of Arkansas. A total of 1288 responses to the survey were collected (response rate = 31.59%). Of those, 1221 met the inclusion criteria, and 1205 answered at least a portion of the survey. A $20 gift card was provided as an incentive. The study was approved by the Institutional Review Board at the University of Arkansas for Medical Sciences (UAMS; IRB #261226).

Measurement

COVID-19 vaccine hesitancy was captured through the question "If a vaccine for COVID-19 were available today, what is the likelihood that you would get vaccinated?" Possible responses included extremely likely, likely, unlikely, and very unlikely. Those responses were dichotomized to indicate vaccine hesitancy, with both "unlikely" responses coded as 1 and both "likely" responses coded as 0.

Sociodemographic measures included age, sex, race and ethnicity, income, and education. Age was measured as a continuous variable. Sex was measured as a nominal variable (i.e., men and women), as were race and ethnicity (i.e., Black/African American, White, Other racial groups, and Hispanic/Latinx people of all races). Income was measured in 4 ranked categories beginning with less than $25,000, $25,000 to less than $50,000, $50,000 to less than $75,000, and $75,000 or more. Education was a categorical variable and included high school diploma or less, some college or technical degree, and a 4-year college degree or more. Nominal and ordinal measures were recoded as dummy variables when they were included in the full information maximum likelihood logistic regressions.

COVID-19 health literacy was captured by the statement: "I know how to protect myself from COVID-19."

Respondents could answer with "not sure at all," "maybe/not sure," and "yes, completely sure." Less than 2% answered with "not sure at all," so this response was combined with the "maybe/not sure" response and coded as 0 to indicate less health literacy. Those who answered "yes, completely sure" were coded as 1 to indicate higher health literacy regarding how to protect one's self against COVID-19.

Fear of COVID-19 infection was measured by asking respondents to "rate the extent of your concern" about being infected by COVID-19. Possible responses included "to a great extent," "somewhat," "very little," and "not at all." These were coded from 1 to 4, respectively, with the higher numbers indicating greater complacency toward COVID-19 infection. Responses of "don't know" or "prefer not to answer" were coded as missing ($n = 6$).

General vaccine trust was assessed by asking, "Overall how much do you trust vaccines?" Respondents could answer with "not at all," "very little," "somewhat," "to a great extent," and "completely." Those who answered "to a great extent" or "completely" were coded as 1 to indicate a high level of trust. The other responses were coded as 0 to indicate lower levels of trust.

Statistical analysis

We used bivariate analyses and multivariable logistic regressions to test associations among sociodemographic characteristics, COVID-19 health literacy, fear of COVID-19 infection, trust in vaccines, and COVID-19 vaccine hesitancy. Bivariate relationships were tested using both t-tests and χ^2 analyses. Analyses were conducted using Stata/SE 15.1. We explored multivariable relationships among hesitancy about the COVID-19 vaccine and sociodemographic characteristics, COVID-19 health literacy, fear of COVID-19 infection, and trust in vaccines. To minimize the limitations of missing data, we tested these associations in full information maximum likelihood (FIML) logistic regression analyses using Mplus version 7.8.[19] FIML logistic regression makes use of all nonmissing values in estimating model parameters and yields results comparable to modern missing data methods, such as multiple imputation.[19]

RESULTS

Table 1 presents the descriptive statistics for the sample. Respondents' mean age was 48 years, and 75.23% were women. The sample closely resembled the racial composition of Arkansas and was distributed evenly across income categories, with each category making up between 21% and 27% of the sample. The sample was over-representative of respondents age 25 years or older with a college degree (61.75%) compared

to the state of Arkansas (23%) and the general US population (32%).[20] The majority (65.53%) of respondents felt completely sure they knew how to protect themselves against COVID-19, and 72.03% reported high trust in vaccines in general. More than three-quarters os the respondents (78.14%) reported that

they were likely or extremely likely to get the COVID-19 vaccine if it were available to them; however, 21.86% reported that they were unlikely or very unlikely to get it.

Bivariate analyses

Table 2 presents the bivariate analyses among all independent variables and COVID-19 vaccine hesitancy. There was

TABLE 1 Descriptive statistics for sample of Arkansas adults

	Frequency	% or $\bar{x}$	SD	Range
Sociodemographic controls				
Age	1205	48.13	15.56	18.3–92.4
Sex	1203	0.75	0.43	0–1
Women	905	75.23		
Men	298	24.77		
Race/ethnicity	1202	2.03	0.65	1–4
Black/African American	161	13.39		
White	918	76.37		
Other racial groups	43	3.58		
Hispanic/Latinx	80	6.66		
Income	974	1.56	1.10	0–3
<$25K	205	21.05		
$25K <$50K	284	29.16		
$50K <$75K	221	22.69		
>$75K	264	27.10		
Education	1202	1.48	0.70	0–2
High school or less	145	12.06		
Some college	331	27.54		
Four-year degree	726	60.40		
COVID-19 attitudes/feelings				
COVID-19 health literacy	1082	0.345	0.47	0–1
Maybe/not sure	373	34.47		
Completely sure	709	65.53		
Fear of COVID-19 infection	1069	2.05	0.80	1–4
Great extent	268	25.07		
Somewhat	532	49.77		
Very little	216	20.21		
Not at all	53	4.96		
Vaccine confidence				
General vaccine trust	1144	0.720	0.44	0–1
Low trust	320	27.97		
High trust	824	72.03		
Vaccine hesitancy				
COVID-19 vaccine hesitancy	1066	0.218	0.41	0–1
Hesitant	233	21.86		
Not hesitant	833	78.14		

Abbreviation: COVID-19, coronavirus disease 2019; SD, standard deviation.

TABLE 2 Prevalence of COVID-19 vaccine hesitancy among Arkansans adults

	COVID-19 vaccine hesitancy	
	Hesitant % (n) or $\bar{x}$	t-test or χ^2 p value
Sociodemographic controls		
Age	45.36	0.002
Sex		
Women	23.10 (182)	
Men	18.41 (51)	
Race/ethnicity		p < 0.001
Black/African American	50.00 (64)	
White	18.37 (151)	
Other racial groups[a]	9.76 (4)	
Hispanic/Latinx	19.18 (14)	
Income		p < 0.001
<$25K	30.68 (54)	
$25K <$50K	23.28 (61)	
$50K <$75K	19.70 (40)	
>$75K	13.10 (33)	
Education		p < 0.001
High school or less	27.20 (34)	
Some college	32.17 (92)	
Four-year degree	16.23 (106)	
COVID-19 attitudes/feelings		
COVID-19 health literacy		0.574
Maybe/not sure	20.30 (68)	
Completely sure	21.85 (142)	
Fear of COVID-19 infection		p < .001
Great extent	15.90 (38)	
Somewhat	18.81 (92)	
Very little	25.00 (49)	
Not at all	62.50 (30)	
Vaccine confidence		
General vaccine trust		p < 0.001
Low trust	55.84 (153)	
High trust	9.51 (74)	

Abbreviation: COVID-19, coronavirus disease 2019.

[a]Interpret findings for Other racial groups category cautiously.

statistically significant variation in COVID-19 vaccine hesitancy based on age ($t = 3.17$; $p < 0.01$), race/ethnicity ($\chi^2 = 68.93$, $p < 0.001$), income ($\chi^2 = 20.42$, $p < 0.001$), education ($\chi^2 = 32.04$, $p < 0.001$), fear of infection ($\chi^2 = 55.76$, $p < 0.001$), and general vaccine confidence ($\chi^2 = 257.01$, $p < 0.001$). The average age for respondents reporting they were likely to get the COVID-19 vaccine (49.02) was 3.66 years higher than the average for those who reported hesitancy (45.36). COVID-19 vaccine hesitancy was highest among Black/African American respondents (50.00%), followed by Hispanic/Latinx respondents (19.18%), and White respondents (18.37%). COVID-19 vaccine hesitancy was highest for those in the lowest income category (30.68%) and steadily declined as income category increased, with the highest income group reporting the lowest hesitancy (13.10%). Respondents with some college or a technical degree reported the highest prevalence of COVID-19 vaccine hesitancy (32.17%) across education categories, followed by those with a high school degree or less (27.20%) and those with a 4-year degree (16.23%) who reported the lowest prevalence of hesitancy. Respondents who did not fear infection of COVID-19 at all had the highest prevalence of COVID-19 vaccine hesitancy of any group (62.50%). Respondents who feared COVID-19 infection to a great extent had a much lower prevalence of COVID-19 vaccine hesitancy (15.90%). The greatest difference in COVID-19 vaccine hesitancy was between respondents who have high trust (9.51%) and those who have low trust (55.84%) in vaccines in general. There was no significant difference in vaccine hesitancy by sex or COVID-19 health literacy.

Multivariable analyses

Table 3 presents the FIML logistic regression results for vaccine hesitancy specific to the COVID-19 vaccine. Odds of reporting COVID-19 vaccine hesitancy were significantly associated with age, race/ethnicity, education, fear of infection, and general vaccine trust. Odds of COVID-19 vaccine hesitancy decreased as age increased ($p < 0.05$). Black/African American respondents had 2.42 times greater odds of vaccine hesitancy compared to White respondents ($p < 0.001$). Those with some college or a technical degree had 1.67 times the odds of vaccine hesitancy compared to those with a 4-year degree ($p < 0.05$). Those who felt very little fear of COVID-19 infection had 2.05 greater odds of COVID-19 vaccine hesitancy compared to those who feared COVID-19 infection to a great extent ($p < 0.05$). Those who reported they did not fear a COVID-19 infection at all had 5.48 greater odds of vaccine hesitancy compared to those who feared infection to a great extent ($p < 0.001$). Those who had low trust in vaccines in general had 11.32 greater odds of vaccine hesitancy compared to those who reported low levels of trust ($p < 0.001$).

TABLE 3 FIML logistic regression of COVID-19 vaccine hesitancy

	Est.	OR	SE	p value	Sig.
Sociodemographics					
Age	−0.01	0.98	0.01	0.026	*
Sex					
Female	0.32	1.38	0.21	0.137	
Race/ethnicity[a]					
White	–	–	–	–	
Black/African American	0.88	2.42	0.25	$p < 0.001$	***
Other racial groups	-1.26	0.28	0.64	0.049	*
Hispanic/Latinx	−0.34	0.70	0.42	0.416	
Income					
<$25K	0.42	1.53	0.33	0.206	
$25K <$50K	0.21	1.24	0.30	0.476	
$50K <$75K	0.35	1.42	0.31	0.254	
>$75K	–	–	–	–	
Education					
High school or less	−0.17	0.84	0.28	0.553	
Some college	0.51	1.67	0.23	0.028	*
Four-year degree	–	–	–	–	
COVID-19 attitudes/feelings					
COVID-19 health literacy					
Maybe/not sure	−0.42	0.65	0.21	0.050	
Completely sure	–	–	–	–	
Fear of COVID-19 infection					
Great extent	–	–	–	–	
Somewhat	0.44	1.56	0.25	0.083	
Very little	0.72	2.05	0.29	0.014	*
Not at all	1.70	5.48	0.34	$p < 0.001$	***
Vaccine confidence					
General vaccine trust					
Low trust	2.47	11.32	0.19	$p < 0.001$	***
High trust	–	–	–	–	

Abbreviations: COVID-19, coronavirus disease 2019; Est., Estimate; FIML, full information maximum likelihood; OR, odds ratio; SE, standard error; Sig., significance.

[a]Interpret findings for Other racial groups category cautiously.

*** $p < 0.001$, *$p < 0.05$.

DISCUSSION

Overall, we find the majority of respondents (79%) are not hesitant to take a COVID-19 vaccine. However, 1 in 5 (21.86%) did report vaccine hesitancy, selecting they would be unlikely or very unlikely to take a COVID-19 vaccine. This is a large enough portion of the sample to potentially

affect the capacity of the COVID-19 vaccine to achieve population immunity (Ke et al., 2020). This is slightly lower than earlier estimates for COVID-19 vaccine hesitancy in the US general population in May 2020 ranging from 27–33%,[5,14] but much lower than subsequent US estimates reported in September (49%) and November (39–44%) 2020.[5,6,21] The lower reported hesitancy may be due to changes in respondents' views of the vaccine over time, differences in state versus national-level hesitancy, the high percentage of those with 4-year college degrees in this sample, or the increasing probability respondents or someone they know have been severely affected by COVID-19.

COVID-19 vaccine hesitancy differed significantly across age (H1.1), race/ethnicity (H1.3), income (H1.4), and education (H1.5). Respondents who were younger, Black/African American, lower income, and had some college or a technical degree had a higher prevalence and odds of vaccine hesitancy than those who were older, White, in higher income brackets, or 4-year college degree holders. These findings are consistent with prior literature[14,22,23] but add new insight as the first article to have a large and diverse sample from a rural state with a large high-risk population.

Half of all Black/African American respondents reported hesitancy to get the COVID-19 vaccine, and their odds of vaccine hesitancy were more than double White respondents'. This finding is consistent with prior literature that documented Black/African American hesitancy towards the COVID-19 vaccine.[14,21–23] This finding is of great concern because Black/African Americans bear a greater burden of COVID-19 hospitalizations and deaths,[2,22] and hesitancy to get the COVID-19 vaccine could perpetuate long-term racial health disparities.

Racial differences in COVID-19 vaccine attitudes highlight the need for "trustworthiness before trust."[24] Distrust of the medical establishment by Black/African Americans is often traced back to the Tuskegee syphilis study, but the distrust is deeply rooted beyond a single incident and is predicated on centuries of racist exploitation by medical researchers and doctors.[25] Racism within the medical establishment is ongoing, and Black/African Americans do not need an extensive knowledge of the history of medical racism to inform their view of vaccines when many only need to consider recent experiences.[26,27] Ongoing and uncritical usage of terms such as "herd immunity" during this pandemic exemplifies the durability of language that intersected with eugenics and became popularized at a time when eugenic racism was growing in the (US) and United Kingdom.[28]

As hypothesized, education was significantly associated with COVID-19 vaccine hesitancy, which is partially consistent with prior studies.[14,22,23] However, we were surprised to find those with some college or a technical degree reported the highest prevalence of COVID-19 vaccine hesitancy (32.17%) across the education categories, followed by those with a high school degree or less (27.20%) and those with a 4-year degree (16.23%), who reported the lowest prevalence of vaccine hesitancy. Although some polls have demonstrated differences in hesitancy across educational attainment, results showed those with some college to be similar to those with high school education.[5] This study documents a more complex relationship between education and COVID-19 vaccine hesitancy that should be examined further.

Vaccine hesitancy was positively associated with less fear of infection by COVID-19 (H3). Specifically, those who feared COVID-19 infection very little or not at all had odds of vaccine hesitancy two to five times greater than those who feared infection to a great extent. Black/African American respondents in this study had the highest prevalence of fearing infection to a great extent across all racial/ethnic groups, meaning that high COVID-19 vaccine hesitancy for Black/African Americans is unlikely to be explained by insufficient fear of COVID-19 infection. Our finding that a lack of or limited fear is significantly associated with vaccine hesitancy is consistent with prior studies on vaccines in general.[29] However, this is the first study to our knowledge to document a significant association between low levels of fear of infection and hesitancy to get the COVID-19 vaccine.

As hypothesized, COVID-19 vaccine hesitancy was negatively associated with general vaccine confidence (H4). Respondents who reported high levels of trust in vaccines in general had significantly lower odds of COVID-19 vaccine hesitancy compared to those with low trust in vaccines in general. This finding is consistent with numerous findings on the relationship between trust and vaccine hesitancy, particularly those that examine racial/ethnic differences.[10,29] However, this study is among a limited body of work to examine general vaccine trust and hesitancy specific to COVID-19 vaccines. We do not find support for differences in COVID-19 vaccine hesitancy by sex (H1.2) or COVID-19 health literacy (H2).

Strengths and limitations

This study does have limitations. The data are cross-sectional and do not allow us to determine causality or assess trends in COVID-19 vaccine hesitancy across time. The sample was over-representative of women and college educated respondents, and the study recruited respondents who had previously enrolled in a registry to be contacted for research purposes. The high number of respondents with a college degree limits the generalizability of these results to the state population. Finally, our measure of health literacy is limited to the respondents' own self-assessment of how well they know how to protect themselves against COVID-19, and we do not know if that assessment is accurate.

These limitations are offset to a degree by the large and diverse sample, which closely mirrored the racial/ethnic composition of

a highly rural state. Another strength of this study is that it includes a large percentage of non-metro residents (33.28%) as determined by rural-urban commuting area (RUCA). Although examining racial/ethnic differences in vaccine hesitancy was a focus of this study, the limited number of responses from racial groups such as Native Hawaiians and Pacific Islanders, Asians, American Indian, and Alaskan Natives did not allow us to assess differences between some communities of color. Future studies of COVID-19 vaccine hesitancy should consider oversampling for these groups to ensure specific information about their levels of vaccine hesitancy are known.

These results have already helped shape our vaccination efforts. The results of this study have been used to develop an equitable distribution plan within the state's only academic medical center with specific targets to ensure racial/ethnic geographic and equality. Specifically, the authors and their institution have set up a mobile vaccine distribution system that goes into rural and remote areas and is partnering with community-based and faith-based organizations on a nontraditional educational campaign to build trust.

CONCLUSION

Understanding determinants of COVID-19 vaccine hesitancy is important in ensuring broad uptake of the COVID-19 vaccine and in reducing health disparities. Trust in vaccines in general, race/ethnicity, and fear of COVID-19 infection are important factors shaping COVID-19 vaccine hesitancy, with Black/African Americans reporting significantly more vaccine hesitancy. As Warren and colleagues[24] point out, trustworthiness must precede trust, and the historical and ongoing racism within medical institutions precludes trust. Building trust in institutions takes a concerted effort and time. Although the urgency of the pandemic is spurring efforts toward trust and transparency, without a sustained effort of community engagement, any gains in trust may be lost.

Vaccine hesitancy is high enough to undermine population immunity in a highly vulnerable and rural state in the US. Moreover, it is highest among the sociodemographic groups who have faced disproportionate COVID-19 morbidity and mortality. Racial/ethnic disparities highlight historical and contemporary distrust in the medical establishment and ongoing experiences of racism/discrimination by communities of color. Finally, public health messaging for the COVID-19 vaccine must consider the role of people's fears of infection, general trust in vaccines, and the historical and ongoing mistreatment of many racial/ethnic minorities.

Further investigation is needed to determine ways in which fear and trust may or may not explain vaccine hesitancy across racial groups. The mechanisms explaining vaccine hesitancy are likely to differ across racial groups. For example, even though low levels of fear are associated with increased odds of vaccine hesitancy, Black/African Americans have both the highest levels of COVID-19 vaccine hesitancy *and* the highest prevalence of fearing infection to a great extent. Moreover, given the consistent findings of racial disparities in vaccine hesitancy, researchers must begin to more explicitly examine experiences of discrimination and systemic racism in predicting vaccine hesitancy.

AUTHOR CONTRIBUTIONS
D.E.W., J.A.A., K.B., J.P.S., C.R.L., H.C.F., G.M.C., and P.A.M. wrote the manuscript. D.E.W., J.A.A., J.P.S., and P.A.M. designed the research. D.E.W., J.A.A., J.P.S., and P.A.M. performed the research. D.E.W., J.A.A., and J.P.S. analyzed the data.

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REFERENCES
1. Woolf SH, Chapman DA, Lee JH. COVID-19 as the leading cause of death in the United States. *JAMA*. 2021;325:123–124.
2. Yancy CW. COVID-19 and African Americans. *JAMA*. 2020;323:1891–1892.
3. Healy J, Harmon A, Romero S, et al. *'The weapon that will end the war': Vaccinations begin across virus-ravaged America*. The New York Times; 2020.
4. MacDonald NE, SAGE Working Group on Vaccine. Hesitancy. Vaccine hesitancy: Definition, scope and determinants. *Vaccine*. 2015;33:4161–4164.
5. Funk C, Tyson A. *Intent to Get a COVID-19 Vaccine Rises to 60% as Confidence in Research and Development Process Increases*; 2020.
6. Reinhart R. *More Americans now willing to get COVID-19 vaccine*; 2020. https://www.news.gallup.com/poll/325208/americans-willing-covid-vaccine.aspx
7. Quinn SC, Jamison A, An JI, et al. Breaking down the monolith: Understanding flu vaccine uptake among African Americans. *SSM Popul Health*. 2018;4:25–36.
8. Shapiro GK, Tatar O, Dube E, et al. The vaccine hesitancy scale: Psychometric properties and validation. *Vaccine*. 2018;36:660–667.
9. Groom HC, Zhang F, Fisher AK, Wortley PM. Differences in adult influenza vaccine-seeking behavior: the roles of race and attitudes. *J Public Health Manag Pract*. 2014;20:246–250.

10. Quinn SC, Jamison AM, An J, Hancock GR, Freimuth VS. Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: Results of a national survey of White and African American adults. *Vaccine*. 2019;37:1168–1173.

11. Krieger N, Waterman PD, Chen JT. COVID-19 and overall mortality inequities in the surge in death rates by zip code characteristics: Massachusetts, January 1 to May 19, 2020. *Am J Public Health*. 2020;110:1850–1852.

12. Phadke VK, Bednarczyk RA, Salmon DA, Omer SB. Association between vaccine refusal and vaccine-preventable diseases in the United States: a review of measles and pertussis. *JAMA*. 2016;315:1149–1158.

13. World Health Organization (WHO). *Report of the Sage Working Group on Vaccine Hesitancy*; 2014.

14. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. *EClinicalMedicine*. 2020;26:100495.

15. Ku BS, Druss BG. Associations between primary care provider shortage areas and county-level COVID-19 infection and mortality rates in the USA. *J Gen Intern Med*. 2020;35:3404–3405.

16. Koma W, Neuman T, Claston Rae M, Kates J, Michaud J. How many adults are at risk of serious illness if infected with Coronavirus? Updated Data. 2020. https://www.kff.org/coronavirus-covid-19/issue-brief/how-many-adults-are-at-risk-of-serious-illness-if-infected-with-coronavirus/

17. McSweeney JC, Boateng B, James L, et al. Developing and launching a research participant registry. *Health Commun*. 2018;34(10):1159-1165.

18. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42:377–381.

19. Enders CK. *Applied missing data analysis*. Guilford Press; 2010.

20. American Community Survey. *U.S. Census Bureau QuickFacts: United States*; 2019.

21. 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*. 2021;325:396–398.

22. Fisher KA, Bloomstone SJ, Walder J, Crawford Sybil, Fouayzi H, Mazor KM. Attitudes toward a potential SARS-CoV-2 vaccine : a survey of U.S. adults. *Ann Intern Med*. 2020;173:964–973.

23. Kreps S, Prasad S, Brownstein JS, et al. Factors associated with US adults' likelihood of accepting COVID-19 vaccination. *JAMA Network Open*. 2020;3:e2025594.

24. Warren RC, Forrow L, Hodge DA, Truog RD. Trustworthiness before trust — Covid-19 vaccine trials and the Black community. *N Engl J Med*. 2020;383:e121.

25. Washington H. *Medical Apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present*. New York: Doubleday; 2006.

26. Smedley B, Stith A, Nelson A. *Unequal treatment: confronting racial and ethnic disparities in health care*. Washington (DC): National Academies Press (US); 2003.

27. McMillan Cottom T. I was pregnant and in crisis. All the doctors and nurses saw was an incompetent Black woman. In *Thick: And Other Essays*. The New Press; 2019.

28. Jones D, Helmreich S. A history of herd immunity. *The Lancet*. 2020;396:810–811.

29. Larson HJ. Vaccine trust and the limits of information. *Science*. 2016;353:1207.