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Factors associated with the intention to obtain a COVID-19 vaccine among a racially/ethnically diverse sample of women in the USA

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Abstract

Widespread uptake of the COVID-19 vaccine is critical to halt the pandemic. At present, little is known about factors that will affect vaccine uptake, especially among diverse racial/ethnic communities that have experienced the highest burden of COVID. We administered an online survey to a Qualtrics respondent panel of women ages 27–45 years ($N = 396$) to assess vaccine intentions and attitudes, and trusted vaccine information sources. 56.8% intended to be vaccinated and 25.5% were unsure. In bivariate analyses, a greater percentage of non-Latina White (NLW) and Chinese women reported that they would be vaccinated, compared with Latina and non-Latina Black (NLB) women ($p < 0.001$). Those who were uninsured, unemployed and those with lower incomes were less likely to say that they would be vaccinated. In analyses stratified by race/ethnicity, NLB women remained significantly less likely to report that they would be vaccinated compared with NLW women (adjusted odds ratio: 0.47; 95% confidence interval: 0.23, 0.94), controlling for age, marital status, income, education, employment, and insurance status. When analyses were additionally controlled for beliefs in vaccine safety and efficacy, racial/ethnic differences were no longer significant (adjusted odds ratio: 0.64; 95% confidence interval: 0.31, 1.34). Given that NLB women were less likely to report the intention to be vaccinated, targeted efforts will be needed to promote vaccine uptake. It will be critical to emphasize that the vaccine is safe and effective; this message may be best delivered by trusted community members.

Keywords

Vaccine, Coronavirus, Health disparities, Race/ethnicity, Women's health

Implications

Practice: Given that non-Latino Black women were less likely to report that they would get a COVID-19 vaccine, it will be essential to develop targeted strategies to communicate the safety and efficacy of the vaccine to this population.

Policy: Consistent messaging from public health authorities that emphasizes the rigorous and ethical development and testing of the vaccine and addresses the cognitive/affective and logistical barriers to vaccination is needed to achieve maximum vaccine uptake.

Research: Further research is necessary to test the effectiveness of intervention strategies and messaging that address perceived barriers to uptake of the COVID-19 vaccine.

INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has put a spotlight on long-standing racial/ethnic health inequities that have existed in the USA for centuries. Black and Latino populations have among the highest age-adjusted rates of COVID-19 infection and hospitalizations. Moreover, non-Latino Black and Latino people are 1.5–2.5 times as likely to die from the illness compared with White and Asian people [1]. Experts attribute the excess disease burden to the increased likelihood of exposure to COVID-19 (e.g., overrepresentation in public-facing jobs, residence in urban areas with high housing density), increased vulnerability to severe health consequences of the infection due to long-standing structural forces contributing to disparities in comorbidities, and limited access to healthcare. Regardless, many experts concur that the "return to normal life" will not be possible until a prophylactic vaccine for COVID-19 is widely available [2, 3]. High rates of vaccine uptake will be necessary to ensure that a large proportion of the population becomes immune (i.e., herd immunity), thereby limiting community transmission of the virus from person to person [4]. Estimates vary but it is believed that between 70% and 80% of the population would have to be vaccinated to achieve herd immunity [5, 6].

Given the critical role that a vaccine would play in controlling the pandemic, it is essential to understand potential uptake of the vaccine and factors associated with acceptance or resistance to vaccination, particularly among populations that have been disproportionately impacted by the pandemic. This is particularly important given the current context of declining vaccine confidence [7], mistrust of science [8, 9], and extreme political polarization, which has shaped COVID-19 behaviors and beliefs in the USA. As the nation launches a massive

vaccine distribution effort, effective vaccine campaign messages, and public health strategies need to be developed. The purpose of this study was to assess intention to obtain a COVID-19 among a diverse sample of American women and to examine differences in vaccine intentions across racial/ethnic groups. We assess vaccine intentions among women, as they often serve as gatekeepers for medical care in families.

METHODS

Data for this analysis are from a larger study of human papillomavirus (HPV) vaccine knowledge, attitudes, and intentions among a convenience sample women ages 27–45 administered between April 13, 2020 and June 8, 2020. In that study, we conducted an online survey with a Qualtrics panel of respondents (N = 396). Quotas were instituted to overrepresent women of diverse racial/ethnic groups to produce a sample that was 25% non-Latina Black (NLB), 25% Chinese, and 25% Latina. We elected to oversample Chinese women, as opposed to other Asian subgroups, because of rampant anti-Chinese sentiment in the USA which may impact vaccine intentions.

The survey included an item to assess COVID-19 vaccine intentions, our primary outcome. Respondents were asked: "If there were a vaccine to prevent coronavirus, would you get it?" with response options of "Yes," "No," or "Don't Know/Unsure." For those who responded that they would not get the vaccine or were unsure, we asked, "Why not?" and respondents were able to enter free text responses. Questions assessing prior testing for and diagnosis of COVID-19 were items developed by the National Institutes of Health [10]. For perceptions of vaccine safety and efficacy, we asked respondents their level of agreement with the following statements: "Most vaccines are safe" and "Most vaccines are effective" with 5-point Likert type response options (strongly agree to strongly disagree). To assess trusted sources of vaccine information, we asked respondents to indicate their level of trust in a variety of sources (health professionals, public health and government agencies, internet, social media, news, and family/friends) with response options on a Likert scale (ranging from "a great deal," "somewhat," "not very much," "not at all," or "don't know").

The primary predictor of interest, race/ethnicity, was categorized as non-Latina White (NLW), NLB, Latina, Chinese, and multiple races. Additional sociodemographic characteristics, including age (21–29, 30–39, 40–49), income (<$34,000, $35–74,000, >$75,000, not sure), education (high school or less, college or some college, graduate degree), employment (employed, unemployed), and insurance status (insured, uninsured), were assessed using items from the Behavioral Risk Factor Surveillance System [11].

Analysis

Descriptive statistics were produced for all women in the sample and stratified by race/ethnicity. Chi-squared tests were used to assess crude associations between women who did, did not, and were unsure about their intention to be vaccinated by sociodemographic and COVID-19-specific variables. Statistical significance was considered at the $p < .05$ level. An unadjusted logistic regression model was run with COVID-19 vaccine intention as the outcome and self-identified race/ethnicity as the main predictor. Sequential adjusted logistic regression models were run to assess the relationship between self-identified race/ethnicity and COVID-19 vaccine intention adjusted for age (Model 2), marital status, income, education, employment, and insurance (Model 3), belief in safety and efficacy of vaccines (Model 4), and trust in healthcare professionals (Model 5). Model 6 additionally adjusted Model 5 for belief in safety and efficacy of vaccines. We used this sequential process to develop models to ensure adjustment for grouped variables associated with socioeconomic status, health behaviors, and healthcare experiences. The data analysis for this paper was generated using SAS software, Version 9.4 of the SAS System for Windows (SAS Institute Inc., Cary, NC).

RESULTS

Characteristics of study sample

A total of 396 individuals participated in the study. Approximately one-quarter were NLW (29.5%), and one-quarter NLB (25.7%), with slightly fewer Latina women (17.9%) and few women of multiple races (3.5%). Most (82.6%) had at least some college education, were employed (58.7%), and had health insurance (82.8%). In total, 56.8% reported that they would get a COVID-19 vaccine and 25.5% were unsure or did not know if they would get it. Results from the "free text" response to the question of why the respondent did not want to be vaccinated or were unsure showed that many had concerns about potential side effects (18.9%), believed that there was insufficient time for vaccine testing (13.4%), had concerns about lack of vaccine efficacy (7.5%), or were distrustful of vaccines more generally (11.9%; Table 1).

Bivariate results

There were significant differences in vaccine intentions by race/ethnicity. Chinese women were the most likely to report that they would be vaccinated (70.7%), followed by women who were NLW (62.4%), multiple races (64.3%) Latina (53.5%), and NLB (39.2%) women reporting an intention to be vaccinated ($p < .001$). More Latina women reported that they were *not* going to get the vaccine than any other group (32.4% vs. 15.4% in NLW, 27.5% in NLB,

Table 1 | Characteristics of sample by race/ethnicity, *N* = 396

	Total sample (*N* = 396)	Non-Latina White (*N* = 117)	Non-Latina Black (*N* = 102)	Latina (*N* = 71)	Chinese (*N* = 92)	Multiracial (*N* = 14)	*p* value
Age							<.01
21–29	78 (19.7)	36 (30.8)	16 (15.7)	13 (18.3)	8 (8.7)	5 (35.7)	
30–39	211 (53.3)	61 (52.1)	54 (52.9)	38 (53.5)	53 (57.6)	5 (35.7)	
40–49	107 (27.0)	20 (17.1)	32 (31.4)	20 (28.2)	31 (33.7)	4 (28.6)	
Marital status							
Married	214 (54.0)	59 (50.4)	76 (74.5)	30 (42.3)	43 (46.7)	6 (42.9)	<.01
Not married	182 (46.0)	58 (49.6)	26 (25.5)	41 (57.8)	49 (53.3)	8 (57.1)	
Education							<.01
≤High school	69 (17.4)	18 (15.4)	31 (30.4)	15 (21.1)	3 (3.3)	2 (14.3)	
College/some college	242 (61.1)	79 (67.5)	58 (56.9)	47 (66.2)	51 (55.4)	7 (50.0)	
Graduate degree	85 (21.5)	20 (17.1)	13 (12.8)	9 (12.7)	38 (41.3)	5 (35.7)	
Employment							<.05
Employed	232 (58.7)	59 (50.9)	46 (45.1)	50 (70.4)	67 (72.8)	10 (71.4)	
Unemployed	163 (41.3)	57 (49.1)	56 (54.9)	21 (29.6)	25 (27.2)	4 (28.6)	
Income							<.01
<$34,000	120 (30.3)	40 (34.2)	46 (45.1)	15 (21.1)	16 (17.4)	3 (21.4)	
$35,000–74,000	144 (36.4)	46 (39.3)	37 (36.3)	30 (42.3)	26 (28.3)	5 (35.7)	
>$75,000	117 (29.6)	27 (23.1)	16 (15.7)	24 (33.8)	46 (50.0)	4 (28.6)	
Not sure	15 (3.8)	4 (3.4)	3 (2.9)	2 (2.8)	4 (4.4)	2 (14.3)	
Insurance							<.05
Insured	328 (82.8)	91 (77.8)	80 (78.4)	60 (84.5)	83 (90.2)	14 (100.0)	
Uninsured	68 (17.2)	26 (22.2)	22 (21.6)	11 (15.5)	9 (9.8)	0 (0.0)	
Self-reported health							.66
Excellent/very good/good	202 (51.0)	61 (52.1)	51 (50.0)	41 (57.8)	43 (46.7)	6 (42.9)	
Fair/poor	194 (49.0)	56 (47.9)	51 (50.0)	30 (42.3)	49 (53.3)	8 (57.1)	
Belief in vaccine testing							<.01
Well tested	253 (63.9)	81 (69.2)	41 (40.2)	44 (62.0)	75 (81.5)	12 (85.7)	
Unsure/not well tested	143 (36.1)	36 (30.8)	61 (59.8)	27 (38.0)	17 (18.5)	2 (14.3)	
Tested for COVID							.08
Yes	64 (16.2)	22 (18.8)	19 (18.6)	14 (19.7)	6 (6.5)	3 (21.4)	
No	332 (83.8)	95 (81.2)	83 (81.4)	57 (80.3)	86 (93.5)	11 (78.6)	
Diagnosed or suspected COVID infection							.09
Yes	18 (4.6)	6 (5.1)	6 (5.9)	6 (8.5)	0 (0.0)	0 (0.0)	
No	378 (95.5)	111 (94.9)	96 (94.1)	65 (91.6)	92 (100.0)	14 (100.0)	
Intention of taking COVID vaccine							<.01
Yes	225 (56.8)	73 (62.4)	40 (39.2)	38 (53.5)	65 (70.7)	9 (64.3)	
No	70 (17.7)	18 (15.4)	28 (27.5)	23 (32.4)	0 (0.0)	1 (7.1)	
Do not know/unsure	101 (25.5)	26 (22.2)	34 (33.3)	10 (14.1)	27 (29.4)	4 (28.6)	
Trust information from							
Doctors/nurses	363 (91.7)	110 (94)	93 (91.2)	64 (90.1)	84 (91.3)	12 (85.7)	.8
News outlets	158 (40.0)	37 (31.6)	43 (42.6)	29 (39.4)	44 (47.8)	6 (42.9)	.20
Social media	100 (25.3)	25 (21.6)	29 (27.5)	27 (38.0)	20 (21.7)	0 (0.0)	.01
Internet	241 (61.0)	66 (56.9)	65 (63.7)	42 (59.2)	61 (66.3)	7 (50.0)	.6
Public health/government agencies	337 (85.3)	105 (90.5)	81 (79.4)	62 (87.3)	77 (83.7)	12 (85.7)	.3
Family and friends	230 (58.4)	65 (56.0)	63 (61.8)	46 (65.7)	51 (55.4)	5 (35.7)	.20

0% in Chinese, $p < .01$). Among those who reported that they would be vaccinated, a greater percentage were insured (88.9% vs. 11.1%, $p < .001$), had higher levels of education (86% with at least some college vs. 13.8% with high school degree, $p < .001$), and expressed the belief that vaccines were safe and effective (83.6% vs. 16.4%, $p < .001$). More women with high income (>$75,000/year) reported that they would get the vaccine than women with low incomes (<$34,000/year; 35.1% vs. 25.3%, $p = .03$). Among those who highly trusted information from healthcare professionals, the majority were willing to be vaccinated (95.6%). Similar patterns were observed for those who trusted information from public health and government agencies (92.4%). More individuals who were *not* intending to get the vaccine relied on information from social media, although this was of marginal significance (34.8% vs. 24.9%, $p = .09$; Table 1).

Multivariate results

In the logistic regression model adjusted for sociodemographic characteristics (Model 3), NLB women had lower odds of reporting the intention to be vaccinated than women who identified as NLW (adjusted odds ratio [AOR]: 0.47, 95% confidence interval [CI]: 0.23, 0.94). Latina women were more likely to report that they would *not* be vaccinated (vs. being unsure) when compared with NLW women (AOR: 3.25, 95% CI: 1.20, 8.79). In Model 4 (which includes all Model 3 variables plus belief in vaccine testing for safety), the AOR for NLB versus NLW women was no longer statistically significant. However, in Model 5, which included all of the variables in Model 3 plus trust in vaccine information healthcare professionals, the AOR for NLB versus NLW women was again significant (Model 4: AOR: 0.64, 95% CI: 0.31, 1.34 vs. Model 5: AOR: 0.47, 95% CI: 0.23, 0.95). In Model 6, which includes all of the control variables plus belief in safety/efficacy *and* trust in healthcare providers), differences between NHW women and NHB women are no longer statistically significant (AOR: 0.64; 95% CI: 0.31, 1.34) and estimates are virtually unchanged from Model 4 (Table 2).

DISCUSSION

We found that nearly 57% of women in the study said they would get vaccinated if a COVID-19 vaccine were available. More than a quarter of the sample remained unsure about their intention to get a vaccine. Those with lower levels of income, education, and those who were uninsured were less likely to report the intention to be vaccinated. NLB women were significantly less likely to report that they would be vaccinated than NLW women, after adjusting for sociodemographic, COVID-19-specific covariates, and trust in information about vaccination from healthcare professionals. However, after

Table 2 | Adjusted odds ratios (AORs) and 95% confidence intervals (CIs): intention to be vaccinated, $N = 396$

AOR (95% CI)	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intend to be vaccinated versus unsure/do not know if would be vaccinated (ref NLW)						
Non-Latina Black	0.42 (0.22, 0.80)	0.44 (0.23, 0.85)	0.47 (0.23, 0.94)	0.64 (0.31, 1.34)	0.47 (0.23, 0.95)	0.64 (0.31, 1.34)
Latina	1.35 (0.59, 3.10)	1.42 (0.62, 3.26)	1.29 (0.54, 3.08)	1.34 (0.55, 3.28)	1.34 (0.56, 3.20)	1.35 (0.55, 3.31)
Chinese	0.86 (0.46, 1.62)	0.94 (0.49, 1.80)	0.68 (0.33, 1.39)	0.64 (0.30, 1.34)	0.72 (0.35, 1.47)	0.65 (0.31, 1.37)
Multiple races	0.80 (0.23, 2.83)	0.80 (0.22, 2.82)	0.55 (0.14, 2.07)	0.45 (0.11, 1.83)	0.59 (0.15, 2.30)	0.47 (0.12, 1.91)
Do not intend to be vaccinated versus unsure/do not know if would be vaccinated (ref NLW)						
Non-Latina Black	1.19 (0.54, 2.60)	1.20 (0.54, 2.64)	1.20 (0.52, 2.75)	0.97 (0.41, 2.30)	1.20 (0.52, 2.77)	0.97 (0.41, 2.32)
Latina	3.32 (1.28, 8.64)	3.34 (1.27, 8.75)	3.25 (1.20, 8.79)	2.98 (1.07, 8.26)	3.20 (1.18, 8.71)	2.95 (1.06, 8.21)
Chinese	Not powered	Not powered	Not powered	Not powered	Not powered	Not powered
Multiple races	0.36 (0.04, 3.50)	0.39 (0.04, 3.85)	0.29 (0.03, 3.03)	0.32 (0.03, 3.36)	0.25 (0.02, 2.72)	0.30 (0.028, 3.26)

Model 1: race/ethnicity. Model 2: race/ethnicity and age. Model 3: race/ethnicity, age, marital status, income, education, employment, and insurance. Model 4: race/ethnicity, age, marital status, income, education, employment, insurance, and belief in safety/efficacy. Model 5: race/ethnicity, age, marital status, income, education, employment, insurance, and trust in healthcare professionals. Model 6: race/ethnicity, age, marital status, income, education, employment, insurance, trust in healthcare professionals, and belief in safety/efficacy. NLW, non-Latina White.

adjusting for belief in vaccine safety and efficacy, racial/ethnic differences were no longer statistically significant. Notably, none of the Chinese women in our sample said they would decline vaccination; most said they would accept the vaccine (71%) with the remainder being undecided or unsure about vaccination.

Our findings regarding intention to be vaccinated are consistent with a national poll conducted by Tufts University/IPSOS [12] in May/June that found that 57% of NLW respondents reported they would get a COVID-19 vaccine compared with 48% of NLB respondents. Similarly, a May 2020 study from the Yale Institute for Global Health found that 68% of NLW respondents would be willing to get a COVID-19 vaccine compared with 40% of NLB respondents [13]. That same study found that NLB Americans reported lower COVID-19 vaccine acceptance (40%) and influenza vaccine uptake (42%) than nearly all other racial groups [14]. More recent national polls have found that about 60%–71% of the U.S. population intends to be vaccinated [15, 16], but that those with lower levels of income and education, and NLB populations are less likely to report that they would be vaccinated [15–18]. Several published studies have also found that beliefs about vaccine safety and efficacy are associated with vaccine intentions [13, 19, 20].

Concern about vaccines and "vaccine hesitancy" (defined by WHO as delay in acceptance or refusal of available vaccines) is not a new problem. In 2019, the WHO declared vaccine hesitancy as a top threat to global health [7]. Growing anti-vaccination sentiment has been stoked over the past decades by misinformation about potential vaccine side effects and long-term health consequences, perceived nefarious motives of pharmaceutical companies, and conspiracy theories about the source of various infectious agents [8, 9]. These types of messages have been found to spread more rapidly and effectively than legitimate public health messaging delivered through common social media platforms [14]. The COVID-19 pandemic has created a perfect storm to fuel these concerns: it is a novel virus, mistrust of government is high, and there is intense political polarization in this country [21–23]. Furthermore, the rapid vaccine development and testing process has led to perceptions that shortcuts may be taken [24].

Before discussing implications of our findings for practice and research, we acknowledge study limitations. First, we conducted a convenience sample among a Qualtrics panel, so care is needed when generalizing findings [25]. While electronically recruited panels are understood not to be completely representative of the U.S. population, they are equivalently representative as traditional recruitment approaches [25]. In our sample, 82.6% had a high school education or higher, compared with 87.7% for the U.S. population, and 48.9% of our sample had income under $50,000, compared with 42.1% for the U.S. population [15]. These comparisons suggest that the impact of misrepresentation arising from the panel is likely minimal. However, those willing to complete research studies are likely to be more receptive to health interventions than the general public [26] and data for this analysis were drawn from a larger study about HPV vaccination. We purposely oversampled diverse racial/ethnic groups and sexual and gender minorities but did not apply population weights to assess the needs of these underrepresented and undersurveyed groups. Our sample was limited to individuals who identified as women ages 27–45 years, therefore information about men and those in other age groups is needed, since we cannot assume that our findings apply to other groups. We included only one question on vaccine intentions and did not assess intentions over a specific timeframe, as is often done in "stages of change" models. A more nuanced understanding of vaccine intentions could be generated by assessing additional sociocultural and political influences on perceptions of the COVID-19 vaccine, and qualitative methods could be especially helpful in this process. However, study strengths include timeliness of findings (in preparation for vaccination availability) and having the ability to compare across different racial/ethnic groups for whom there has been inadequate representation in prior research.

Our findings point to the importance of mounting a national COVID-19 vaccine communication plan that includes a community-based participatory action research approach to ensure a trusted and culturally informed messaging strategy specifically tailored to Black and Latino populations, as appropriate. Interventions should address multiple levels of the socioecological model, including individual, interpersonal, community, and structural levels of influence [27]. A health communications campaign targeting *individual behavior* should emphasize that vaccine safety and efficacy are not being sacrificed by the expedited timeframe for development, and that the vaccine has been rigorously tested among diverse population groups. At the *interpersonal and community levels*, our findings suggest that trusted information sources (e.g., providers, public health authorities) should take the lead in disseminating vaccine information. While our data cannot speak to the impact of normative beliefs and altruistic motivations for vaccination, these types of messages (e.g., "We all do it to protect ourselves and others") may be particularly relevant in the context of the pandemic. Additionally, research has found that individuals and groups can help in combatting misinformation disseminated through social media by checking the accuracy of a message (e.g., CDC, FactCheck.org) before sharing it. Recent data show that subtle messaging encouraging people to consider the accuracy of

information before sharing it (i.e., "accuracy-nudge") decreases the likelihood of sharing misinformation [28]. Additionally, social corrections to incorrect information (i.e., users commenting on the post that the content is incorrect) has been found to be equivalently effective [29]. Several social media platforms have explored blocking or flagging of inaccurate or untrue claims, although some are concerned that this constitutes censorship [30].

A strong physician recommendation has been associated with uptake of other vaccines [31] and women in our study who trusted providers as purveyors of accurate information had higher intention to vaccinate. As such, we need to ensure that providers are skilled in communicating about this particular vaccine. Efforts to increase vaccine uptake have found that strong, "presumptive" messaging, which assumes that a patient will be vaccinated, is more effective than conversational language [32]. System interventions, such as reminders to providers in electronic medical records, have been found effective for other vaccines and should be instituted for COVID-19 [33]. To reduce barriers associated with access to care and cost/lack of insurance, the COVID-19 vaccine should be free and/or covered by insurance without preauthorization. Vaccination should also be widely available with flexible hours in convenient settings, such as provider offices, urgent care facilities, federally funded health centers, school health programs, and pharmacies. At the policy level, federal or state mandates for vaccination for employment or school enrollment has been a highly effective strategy [34, 35] and should be considered, although these strategies have backfired in some instances (e.g., early attempts at school mandates for the HPV vaccine) [35, 36].

Our findings show that it will also be essential to develop a COVID-19 vaccine plan that addresses the concerns about vaccine safety and efficacy of NLB communities. Any efforts to reach this population will require significant efforts to build trust and confidence that the vaccine is safe and effective. It is essential that historical atrocities such as the Tuskegee Syphilis Study be acknowledged as they have created justifiable mistrust in medicine and in government [37]. Without acknowledgment, it may be easy to "blame the victim" for being "misinformed" and ignore the fact concerns are justified [37]. We also need to acknowledge that the COVID-19 vaccine will be rolled out in the context of recent protests against the killing of unarmed Black people, which has highlighted deeply entrenched racism that devalues Black lives [38]. With these events in mind, vaccination campaigns should be developed in partnership with Black communities and disseminated in a culturally and racially affirming manner. Trusted and racially/ethnically diverse community leaders should deliver clear and consistent messaging, stress that the vaccine is safe and effective, especially since the difference in vaccine intentions in NLB women compared with NLW women was nonsignificant once the belief in vaccine and safety was added to multivariable models. Ensuring that there is sufficient racial/ethnic diversity in vaccine trials may also help to allay concerns that study findings do not apply to all racial/ethnic groups. Additional approaches may include recruiting community health educators from intended audiences to do outreach and education, working with faith-based organizations, and hiring healthcare providers reflective of the population to be on the "front lines" of vaccine delivery. In addition, we should explore ways to engage the services of popular and diverse social media "influencers," an approach that has shown early promise with other health issues [39, 40].

In addition to health messaging, we must prioritize vaccine distribution to the communities that have been disproportionately impacted by the pandemic. Some have raised concerns about how decisions about distribution of the vaccine will be made, since there are insufficient doses to cover the entire population at this time [41]. Moreover, we must not ignore the ongoing need to address underlying structural forces that give rise to health inequities and poorer health among racial/ethnic minorities which increase the risk of adverse consequences of COVID-19. Addressing limited access to healthcare and mitigating other social determinants of health that have produced these inequities (e.g., poverty, racism, etc.) should remain a priority. Without these efforts, the vaccine may further exacerbate inequities in COVID-19 incidence and mortality among these populations.

Research on COVID-19 vaccine acceptability is in its infancy. Additional studies are needed to further understand how the vaccine will be received and perceived among nationally representative samples and we strongly recommend oversampling of racial/ethnic minority population subgroups in these studies. Additionally, recent COVID-19 studies have found that men are more likely to report they would get a vaccine when compared with women [13] and persons with liberal political views had the strongest vaccine intentions followed by moderates, and then conservatives. It is important for future studies to gain a deeper understanding on how demographic variables influence COVID-19 vaccine attitudes and intentions specifically. While there is much to be learned and leveraged from past successful (e.g., smallpox) and less successful vaccine campaigns (e.g., HPV), the current and unique sociopolitical context during which the COVID-19 pandemic is unfolding will require the development novel (racially inclusive and informed) strategies to mitigate mistrust, increase uptake of the vaccine, and reduce cost and access barriers to healthcare.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: None declared.

Authors' Contributions: JDA conceived and designed the study, drafted the initial manuscript. HF made substantial contributions to the design of the work, interpretation of the data, drafted sections of the manuscript, and approved the final submission. NA performed and interpreted the analyses, drafted sections, and approved the final submission. RR drafted sections of the manuscript and approved the final submission.

Ethical Approval: All study procedures were approved by the Institutional Review Board at Tufts University, Medford, MA. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All study participants provided informed consent.

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Welfare of Animals: This article does not contain any studies with animals.

Study Registration: This study was not formally registered.

Analytic Plan Preregistration: The analysis plan was not formally preregistered.

Data availability: Deidentified data from this study are not available in an a public archive. Deidentified data from this study will be made available (as allowable according to institutional IRB standards) by emailing the corresponding author.

Analytic code availability: Analytic code used to conduct the analyses presented in this study are not available in a public archive. They may be available by emailing the corresponding author.

Materials availability: Materials used to conduct the study are not publically available.

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