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Vaccine 39 (2021) 2288–2294

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

COVID-19 vaccine intentions in the United States, a social-ecological framework

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ARTICLE INFO

Article history:
Received 24 September 2020
Received in revised form 23 December 2020
Accepted 24 February 2021
Available online 10 March 2021

Keywords:
Vaccine hesitancy
Social norms
COVID-19
Social-Ecological

ABSTRACT

Background: COVID-19 vaccine hesitancy is a major obstacle for pandemic mitigation. As vaccine hesitancy occurs along multiple dimensions, we used a social-ecological framework to guide the examination of COVID-19 vaccine intentions.
Methods: Using an online survey in the US conducted in July 2020, we examined intentions to obtain a COVID-19 vaccine, once available. 592 respondents provided data, including measures of demographics, vaccine history, social norms, perceived risk, and trust in sources of COVID-19 information. Bivariate and multivariate multinomial models were used to compare respondents who intended to be vaccinated against COVID-19 to respondents who did not intend or were ambivalent about COVID-19 vaccination.
Results: Only 59.1% of the sample reported that they intended to obtain a COVID-19 vaccine. In the multivariate multinomial model, those respondents who did not intend to be vaccinated, as compared to those who did, had significantly lower levels of trust in the CDC as a source of COVID-19 information (aOR = 0.29, CI = 0.17–0.50), reported lower social norms of COVID-19 preventive behaviors (aOR = 0.67, CI 0.51–0.88), scored higher on COVID-19 Skepticism (aOR = 1.44, CI = 1.28–1.61), identified as more politically conservative (aOR = 1.23, CI = 1.05–1.45), were less likely to have obtained a flu vaccine in the prior year (aOR = 0.21, CI = 0.11–0.39), were less likely to be female (aOR = 0.51, CI = 0.29–0.87), and were much more likely to be Black compared to White (aOR = 10.70, CI = 4.09–28.1). A highly similar pattern was observed among those who were ambivalent about receiving a COVID-19 vaccine compared to those who intended to receive one.
Conclusion: The results of this study suggest several avenues for COVID-19 vaccine promotion campaigns, including social network diffusion strategies and cross-partisan messaging, to promote vaccine trust. The racial and gender differences in vaccine intentions also suggest the need to tailor campaigns based on gender and race.

1. Introduction

The death toll from COVID-19 and the incidence of new cases in the United States highlighted the unsuccessful national pandemic response as well as the crucial need for a coordinated and widely-accepted COVID-19 vaccine campaign [13]. However, as previous vaccination efforts and research has documented, vaccine hesitancy is likely to be a major impediment to an effective COVID-19 vaccine program as well as other future vaccination programs [7,9,18,12]. A US national survey conducted in May 2020 found that only slightly more than half of adults (54.3%) intended to obtain a COVID-19 vaccine once available, while a third (29.3%) reported that they were "not sure" if they would get vaccinated [33]. Another poll in December 2020 found that although the rates of vaccine intentions increased, it was unlikely they were at the level that would lead to herd immunity, and rates of COVID-19 vaccine intentions were significantly lower among Black Americans [32]. As COVID-19 vaccine campaign's success depends primarily upon widespread population-level approval and adoption, it is critical to examine factors associated with vaccine hesitancy to

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https://doi.org/10.1016/j.vaccine.2021.02.058
0264-410X/

develop tailored programs to encourage COVID-19 vaccine acceptance and uptake. Moreover, understanding the key attributes of COVID-19 vaccine hesitancy may assist in audience segmenting to identify subgroups for tailored messaging for COVID-19 vaccine promotion campaigns. As vaccine hesitancy occurs along multiple dimensions, we used a social-ecological model (SEM) approach to analyze responses to an online survey and assessed the relationship between COVID-19 vaccine intentions and intrapersonal, interpersonal, institutional, and community-level factors [15].

1.1. Intrapersonal-Level

The intrapersonal-level of the SEM refers to the demographic and behavioral factors that influence engagement in prevention strategies. COVID-19 vaccine hesitancy may be associated with individual-level demographic factors such as race and political ideology [21]. Racial differences in vaccine hesitancy and coverage have been identified in previous vaccine campaigns, which may be in part due to medical mistrust stemming from the legacy of unethical research practices and structural racism within medical and social institutions [6,23–24]. It is critical to examine this disparity in the context of the COVID-19 pandemic, as Black and Latinx Americans have been disproportionately burdened by COVID-19 [22,27,34].

There have been mixed findings on the role of political ideology in previous studies of vaccine hesitancy [4,10,14,26,29]. However, the response to the COVID-19 pandemic has become highly political in the US [2]. Hence, the potential role of political ideology in COVID-19 vaccine attitudes is particularly salient.

The SEM also posits that attitudes and behaviors influence engagement in prevention activities. Attitudes such as the perceived ability to prevent infection and skepticism about the severity of the pandemic may influence COVID-19 vaccine hesitancy [3]. The Precaution Adoption Process Model posits that those who believe they can adequately prevent infection will be less likely to be vaccinated [31]. Previous vaccine behavior has also been found to be associated with current vaccination behaviors [17]; therefore, we sought to assess whether a history of receiving an influenza vaccine was also associated with COVID-19 vaccine intentions.

To better clarify the relationship between behaviors and COVID-19 vaccine intentions, we drew on self-perception and social identity theories. Self-perception theory suggests that people who observe themselves engaging in COVID-19 preventive behaviors may start identifying themselves as being concerned about COVID-19 and hence be more likely to engage in future prevention behaviors, such as obtaining a vaccine [1]. Social identity theory adds a social component, outlining that individuals self-identify within certain social categories or groups may shape their attitudes and influence their behaviors [5]. As such, these theories suggest that promoting a social identity surrounding COVID-19 concern and conscientiousness (e.g., I am part of a group that is concerned about COVID-19 and working to prevent transmission), may increase vaccine acceptance and uptake. We therefore assessed whether those engaging in COVID-19 preventive behaviors, such as social distancing and mask usage, reported greater vaccine intentions. We also assessed handwashing as this behavior may lead to self-perceptions of concern about COVID-19, but it is often a less social behavior than social distancing and mask usage.

1.2. Interpersonal-level

In the SEM, the interpersonal-level indicates the influence of peers and norms within social networks. Social norms influence a wide range of health behaviors, including sexual, dietary, substance use, and physical exercise behaviors. Interpersonal and social processes can diffuse behavioral change through social networks [16]. Through discussing and modeling health behaviors, peers and significant others can demonstrate that they endorse a certain behavior. Such behaviors can appear more prevalent and acceptable, and subsequently, influence other network members' behaviors. Several studies have found that social norms influence HPV vaccine behaviors, with those who perceive that the vaccine is more normative are more likely to become vaccinated [8,30]. We do not know if this association is unique to HPV due to awareness of the sexual transmission of HPV and associated social issues. In this analysis, we also assess how social norms of COVID-19 preventive behaviors may influence vaccine intentions, based on the proportion of social network members who appear to social distance, wear masks, and actively encourage or discourage COVID-19 prevention behaviors.

1.3. Institutional and Comunity-Level

The institutional-level of the SEM refers to institutions that provide populations with information about vaccinations. Perceptions of trustworthiness of COVID-19 information sources may be particularly important in shaping attitudes toward a potential COVID-19 vaccine. Misinformation about the COVID-19 pandemic has been well documented [35], and concerns have been raised about the trustworthiness of sources of COVID-19 information [41]. However, there is little information on the relationship between trust in sources of COVID-19 news and vaccine intentions. Consequently, we examined how trust in COVID-19 health information from the Centers for Disease Control and Prevention (CDC) and from the White House may be linked to vaccine hesitancy. At the community-level, vaccine hesitancy may be influenced by the prevalence of the disease in the community and public policies [15]. Kumar et al. [15] identified risk perception as an indicator of community-level risk on vaccine uptake due to the collective social dynamic in shaping risk perception.

2. Methods

Respondents participated in an online three-wave longitudinal study. The first survey was administered from March 24th-27th. The second May 5th-14th, and the third survey was administered from July 22nd-30th which was the basis for the majority of variables used in the analyses. Study participants were recruited through Amazon's Mechanical Turk (MTurk) service. Study populations recruited through MTurk are not nationally representative, but they have been documented to outperform other opinion samples on several dimensions [36] and have demonstrated reliability [37]. The protocols followed MTurk's best practices [38,40,42]. Eligibility included being age 18 or older, living in the United States, being able to speak and read English, having heard of the coronavirus or COVID-19, and providing written informed consent. To enhance reliability, eligible participants had to pass attention and validity checks embedded in the survey [39]. Participants were compensated $2.50 for completing the first survey, $3.00 for the second, and $3.50 for the third, the equivalent of approximately $11 per hour for each survey. The study protocols were approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

3. Measures

The main outcome variable was, "I am very likely to get a coronavirus vaccine, when available." The response categories were "Strongly agree," "Agree," "Neither agree nor disagree," "Disagree," and "Strongly disagree." These items were trichotomized for anal-

ysis: positive intentions (Strongly agree/Agree), ambivalence (Neither agree nor disagree), and negative intentions (Disagree/Strongly disagree). All survey items, except demographics and political ideology, were obtained from the third survey.

3.1. Intrapersonal-level factors

The response categories for self-reported race/ethnicity included "White," "Non-Hispanic Black," "Asian," "Hispanic," "Mixed," or "Other." Perceived health status was assessed with the question, "In general, would you say that your health is excellent, good, fair, or poor?" For the analyses, the categories of "Excellent" and "Good" were compared to "Fair" and "Poor." History of influenza vaccine was assessed with the question, "Did you get the flu vaccine last year?" Political ideology was assessed with the item, "Where would you place yourself on a scale running from "Very liberal" to "Very conservative?" The response categories were "Very Liberal," Liberal," Slightly Liberal," "Moderate," "Slightly Conservative," "Conservative," and "Very Conservative." Family income was assessed and dichotomized, based on the median, at less than $60,000 versus $60,000 or more. Educational attainment was dichotomized as a Bachelor's degree and higher versus Associate's degree or less.

COVID-19 Skepticism was assessed by the three survey items, "The health risks from coronavirus have been exaggerated," "The coronavirus is a hoax," and "The coronavirus isn't any worse than the flu." The response categories were "Strongly agree," "Agree," "Neither agree nor disagree," "Disagree," and "Strongly disagree." These three items were summed as a scale and had a Cronbach's alpha of 0.85.

The perceived personal risk prevention for COVID-19 was assessed with the item, "I am confident that I can prevent becoming infected with the coronavirus." The response categories were "Strongly agree," "Agree," "Neither agree nor disagree," "Disagree," and "Strongly disagree."

The three COVID-19 prevention behaviors assessed were handwashing, mask usage, and social distancing. These were assessed with the survey items: "How many times do you estimate that you wash your hands every day?" which was dichotomized as 6 or fewer times and 7 or more; "Do you wear a face mask when you are outside?" with the options of "Never," "Sometimes," "Always," which was dichotomized to "Never" versus "Sometimes or Always"; and "Are you trying to spend less time around other people to prevent getting the coronavirus?" with the options of "Never," "Sometimes," and "Always," which was dichotomized to "Never" or "Sometimes" versus "Always."

3.2. Interpersonal-level

Four questions assessed social norms. The injunctive norms of social approval of COVID-19 prevention behaviors were measured by, "My friends encourage me to engage in social distancing" and "My friends would laugh at me if I wore a mask to protect myself from the coronavirus." The response categories were "Strongly agree," "Agree," "Neither agree nor disagree," "Disagree," and "Strongly disagree." The descriptive social norm of perception of peers' concern about COVID-19 was assessed with the statements, "What percent of your friends do you think are socially distancing?" and "What percent of your friends do you think wear masks when they are outside around other people?" The response options were ten categories, with 10% increments from 0 to 10% to 90–100%. Since these questions were on different scales, they were converted to z-scores and added together to form a scale of social norms. The Cronbach's alpha for the scale was 0.77, and the mean inter-item correlation was 0.46.

3.3. Institutional and community level factors

To assess trust in sources of information, a set of questions asked participants, "How much do you trust information from [....] about coronavirus?": (1) the CDC, (2) the White House. Response options were "A great deal," "Quite a bit," "Some," and "Very little or none." As the first two response categories indicated high ratings of trust, responses to trust in information sources were dichotomized as high (a great deal or quite a bit) versus low (some or very little or none). The perceived risk of COVID-19 within the community was assessed with the question, "How likely do you think it is that you will get the coronavirus?" Response options included "Extremely unlikely," "Unlikely," "Neutral," "Likely," and "Extremely likely." For the analysis, the variable was recoded as "Likely" (likely and extremely likely), "Neutral," and "Unlikely" (extremely unlikely and unlikely).

4. Analyses

We used bivariate and multivariate multinomial regression models to evaluate differences between respondents who reported that they did not intend to get the COVID-19 vaccine when available with those who reported that they intended to be vaccinated. The models also allowed us to examine differences between those who were not sure if they would get vaccinated and those who reported that they intended to get the COVID-19 vaccine. Multivariable models assessed correlates of COVID-19 vaccine intentions adjusting for demographic covariates.

In the first step of the multivariate multinomial regression models, all demographic variables, regardless of statistical significance in bivariate associations, were included. In the second step, backward stepwise regression was used to select a final model. It included the variables representing social norms, trust in sources of COVID-19 health information, COVID-19 Skepticism, influenza vaccine history, perceived infection risk, personal risk prevention ability, general health, and the three COVID-19 prevention behaviors. The criterion for retention for the stepwise adjusted multinomial model was $p < .10$. SPSS 27 and Stata 15 were used for analyses.

5. Results

Approximately 59.1% (N = 350) of the sample agreed or strongly agreed with the statement indicating that they intended to obtain a COVID-19 vaccine once available, while 16.7% (N = 99) neither agreed nor disagreed, and 24.2% (N = 143) disagreed or strongly disagreed with the statement (Table 1). Just under half of the sample (N = 260, 43.9%) reported male sex at birth, while 56% (N = 332) reported female sex at birth. The majority of the sample reported "White" race/ethnicity (N = 470, 79.4%) when provided with options of White, Black, Asian, Hispanic, Mixed, and Other; about 6% (N = 38) reported Black race/ethnicity, 8% (N = 47) reported Asian race, and 6% (N = 37) reported Hispanic, mixed, or other race/ethnicity. The mean age of survey respondents was 39.9 (SD 11.4). Approximately half of the sample reported an annual income less than $60,000 (N = 318, 53.7%). Slightly under half of the respondents reported an Associate's degree or less (N = 259, 43.8%).

Participants had a relatively even distribution of political ideology, ranging from "Very liberal" to "Very conservative." The majority of respondents self-reported "Good" or "Excellent" health status (N = 471, 79.6%). Slightly over a third (37%, N = 218) of respondents had previously received an influenza vaccine in the prior year. A lower proportion of participants reported "Low" confidence in being able to prevent themselves from becoming infected with COVID-19 (N = 135, 22.8%) than those who indicated " High" con-

Table 1
Demographic and background factors by intentions to get a COVID-19 vaccine when available.

Variables	N (%) or Mean (SD)			
	Total N=592	Positive (Agree) n=350 (59.1%)	Ambivalent (neither agree nor disagree) n=99 (16.7%)	Negative (Disagree) n=143 (24.2%)
Intrapersonal-level factors				
Race				
White	470 (79.4)	284 (60.4)	79 (16.8)	107 (22.8)
Black	38 (6.4)	11 (28.9)	8 (21.1)	19 (50.0)
Asian	47 (7.9)	28 (59.6)	10 (21.3)	9 (19.1)
Other	37 (6.3)	27 (73.0)	2 (5.4)	8 (21.6)
Sex assigned at birth				
Male	260 (43.9)	157 (60.4)	49 (18.8)	54 (20.8)
Female	332 (56.1)	193 (58.1)	50 (15.1)	89 (26.8)
Age in years	39.9 (11.4)	40.10 (11.8)	38.74 (11.0)	40.29 (10.7)
Education				
Associate's degree or less	259 (43.8)	138 (53.3)	45 (17.4)	76 (29.3)
Bachelor's degree or higher	333 (56.3)	212 (63.7)	54 (16.2)	67 (20.1)
Self-reported health status				
Fair or poor	121 (20.4)	78 (64.5)	17 (14.0)	26 (21.5)
Excellent or good	471 (79.6)	272 (57.7)	82 (17.4)	117 (24.8)
Received flu vaccine: yes	218 (36.8)	169 (77.5)	29 (13.3)	20 (9.2)
Political ideology				
Very liberal	76 (12.8)	56 (73.7)	11 (14.5)	9 (11.8)
Liberal	148 (25.0)	118 (79.7)	14 (9.5)	16 (10.8)
Slightly Liberal	81 (13.7)	52 (64.2)	17 (21.0)	12 (14.8)
Moderate	122 (20.6)	49 (40.2)	27 (22.1)	46 (37.7)
Slightly Conservative	57 (9.6)	33 (57.9)	11 (19.3)	13 (22.8)
Conservative	76 (12.8)	32 (42.1)	12 (15.8)	32 (42.1)
Very Conservative	32 (5.4)	10 (31.3)	7 (21.9)	15 (46.9)
Income				
< $60,000	318 (53.7)	181 (56.9)	54 (17.0)	83 (26.1)
≥ $60,000	274 (46.3)	169 (61.7)	45 (16.4)	60 (21.9)
COVID-19 skepticism scale	5.17 (1.26)	4.18 (1.86)	5.46 (2.25)	7.42 (3.36)
Confidence in preventing COVID-19 infection				
Low	135 (22.8)	80 (59.3)	26 (19.3)	29 (21.5)
Neutral	200 (33.8)	120 (60.0)	37 (18.5)	43 (21.5)
High	257 (43.4)	150 (58.4)	36 (14.0)	71 (27.6)
Spending less time around others	523 (88.3)	336 (64.2)	85 (16.3)	102 (19.5)
Face mask usage				
Never	34 (5.7)	6 (17.6)	5 (14.7)	23 (67.6)
Sometimes	229 (38.7)	111 (48.5)	51 (22.3)	67 (29.3)
Always	329 (55.6)	233 (70.8)	43 (13.3)	53 (16.1)
Handwashing				
Frequent (≥ 7 times daily)	327 (55.2)	205 (62.7)	45 (13.8)	77 (23.5)
Infrequent (≤6 times daily)	265 (44.8)	145 (54.7)	54 (20.4)	66 (24.9)
Interpersonal-level factors				
Social norms scale of preventive behaviors (z-score)	0	0.69 (2.07)	−0.48 (2.47)	−1.37 (2.62)
Institutional and community-level factors				
Trust in CDC				
Low	214 (36.1)	73 (34.1)	40 (18.7)	101 (47.2)
High	378 (63.9)	277 (73.3)	59 (15.6)	42 (11.1)
Trust in White House				
Low	507 (85.6)	308 (60.7)	83 (16.4)	116 (22.9)
High	85 (14.4)	42 (49.4)	16 (18.8)	27 (31.8)
Likelihood of getting COVID-19				
Unlikely	223 (37.7)	110 (49.4)	37 (16.6)	76 (34.1)
Neutral	260 (43.9)	164 (63.1)	50 (19.2)	46 (17.7)
Likely	109 (18.4)	76 (69.7)	12 (11.0)	21 (19.3)

fidence (N = 257, 43.4%). The majority of the sample reported that they were spending less time around others to avoid contracting the virus (N = 523, 88.3%). Over half of the sample reported always wearing a face mask when outside (N = 329, 55.6%), with 39% (N = 229) reporting sometimes wearing a mask and 6% (N = 34) reporting never wearing a mask. Approximately 55% of the sample (N = 327) reported frequent handwashing (≥7 times daily), with 45% of the sample (N = 265) reporting washing their hands fewer than 7 times per day.

Approximately two-thirds (64%, N = 378) of the sample cited high informational trust in the CDC, while 14% (N = 85) cited high informational trust in the White House. Only 18% (N = 109) of respondents felt it was "Likely" that they would get COVID-19, while 44% felt "Neutral," and 38% felt it was "Unlikely" that they would contract the virus.

Table 2 shows the bivariate models of correlates of COVID-19 vaccine intentions. Within intrapersonal-level factors, negative and ambivalent intention of obtaining a COVID-19 vaccine compared with a positive intention were associated with Black race (reference category: White race), lower educational attainment, more conservative political ideology, no past-year influenza vaccine, increased COVID-19 Skepticism, and lower engagement in preventive behaviors, such as spending less time around others and wearing a face mask. Among interpersonal-level factors, the negative and ambivalent intention of obtaining a COVID-19 vaccine were associated with a lower level of perceived social norms of preventive behaviors compared to respondents with positive vaccine intention. At the institutional-level, endorsing lower informational trust in the CDC was associated with both negative and ambivalent vaccine intentions compared to positive intentions.

Table 2
Bivariate and multivariable models of predictors of positive COVID-19 vaccine intentions, N = 592.

		Negative intention (Disagree) Ref: Positive intention (Agree)		Ambivalent intention (Neither agree nor disagree) Ref: Positive intention (Agree)	
		OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Intrapersonal-level factors					
Race^ (Ref: White)		**REF**	**REF**	**REF**	**REF**
	Black	**4.59 (2.11–9.95)**	**10.7 (4.09–28.1)**	**2.61 (1.02–6.72)**	**3.49 (1.28–9.53)**
	Asian	0.79 (0.35–1.79)	0.99 (0.32–1.04)	0.27 (0.06–1.14)	0.31 (0.07–1.40)
	Other	0.85 (0.39–1.87)	1.70 (0.62–4.72)	1.28 (0.60–2.76)	1.49 (0.63–3.49)
Sex assigned at birth^ (Ref: Male)		0.75 (0.50–1.11)	**0.51 (0.29–0.87)**	1.21 (0.77–1.88)	0.96 (0.59–1.57)
Age^		1.00 (0.99–1.02)	1.02 (0.99–1.04)	0.99 (0.97–1.01)	1.00 (0.97–1.02)
Education level^ (Ref: Higher)		**0.57 (0.39–0.85)**	0.76 (0.44–1.32)	0.78 (0.50–1.23)	0.98 (0.58–1.63)
Received flu vaccine ** **(Ref: No)**		**0.17 (0.10–0.29)**	**0.21 (0.11–0.39)**	**0.44 (0.27–0.72)**	**0.49 (0.29–0.82)**
Political Ideology ** **(Ref: Most liberal)**		**1.54 (1.37–1.74)**	**1.23 (1.05–1.45)**	**1.28 (1.12–1.46)**	**1.18 (1.01–1.37)**
Income level^		0.77 (0.52–1.15)	0.80 (0.46–1.38)	0.89 (0.57–1.40)	0.89 (0.54–1.48)
COVID-19 skepticism **		**1.62 (1.48–1.77)**	**1.44 (1.28–1.61)**	**1.30 (1.18–1.44)**	**1.13 (1.00–1.28)**
Self-reported health status ** **(Ref: Poor)**		0.78 (0.47–1.27)	–	0.72 (0.41–1.29)	–
Confidence in preventing infection **		1.17 (0.91–1.50)	–	0.86 (0.65–1.13)	–
Spending less time around others **		**0.10 (0.05–0.20)**	–	**0.41 (0.21–0.80)**	–
Wearing a face mask ** **(Ref: Never)**		**0.30 (0.21–0.41)**	–	**0.45 (0.31–0.66)**	–
Handwashing $\geq$ 7 times a day ** **(Ref: $\leq$ 6 times daily)**		0.83 (0.56–1.22)	–	**0.59 (0.38–0.92)**	–
Interpersonal-level factors					
Social norms scale of preventive behaviors **		**0.45 (0.36–0.56)**	**0.67 (0.51–0.88)**	**0.52 (0.41–0.66)**	**0.63 (0.48–0.81)**
Institutional and community-level factors					
Trust in CDC		**0.11 (0.07–0.17)**	**0.29 (0.17–0.50)**	**0.39 (0.24–0.63)**	**0.57 (0.33–0.98)**
Trust in White House **		**1.71 (1.01–2.90)**	–	1.41 (0.76–2.64)	–
Perceived likelihood of getting the coronavirus **		**0.56 (0.42–0.75)**	–	0.74 (0.54–1.02)	–

Note: ^-Variables entered in the model in step 1. ** Variables entered in backward stepwise model in step 2., Bold = p < .05

Increased informational trust in the White House was associated with increased odds of negative compared to positive vaccine intention; however, informational trust was not significantly associated with vaccine intention in the ambivalent model. Lower perceived likelihood of getting the coronavirus, a community-level indicator, was associated with negative vaccine intentions compared to positive vaccine intentions. This relationship was not significantly associated with ambivalent vaccine intentions compared to positive intentions.

In the multivariate multinominal regression model, several factors were removed from the final stepwise model: self-reported general health status, confidence in preventing infection from the virus, COVID-19 protective behaviors, informational trust in the White House, and perceived likelihood of getting the coronavirus.

As shown in the final adjusted multinomial regression model, compared with positive COVID-19 vaccine intention, negative and ambivalent intentions were significantly associated with multiple domains across the social-ecological model. Within the intrapersonal-level factors, Black participants had significantly increased odds of negative vaccine intentions (aOR = 10.70, CI = 4.09–28.1) and ambivalent vaccine intentions (aOR = 3.49, CI = 1. 28–9.53) compared with White participants. Female sex was significantly associated with reduced negative intention compared with positive intention (aOR = 0.51, CI = 0.29–0.87). More conservative political ideology was associated with negative intention (aOR = 1.23, CI = 1.05–1.45) and ambivalent intention (aOR = 1.18, CI = 1.01–1.37) compared to positive vaccine intention. Similarly, increased COVID-19 Skepticism was associated with negative intention (aOR = 1.44, CI = 1.28–1.61) and ambivalent intention (aOR = 1.13, CI = 1.00–1.28) compared to positive intention. Participants who reported a positive intention to get a vaccine, compared to those who reported a negative and ambivalent intention had lower odds of having received an influenza vaccine in the past year (aOR = 0.21, CI = 0.11–0.39 and aOR = 0.49, CI = 0.29–0.82, respectively). Among interpersonal-level factors, those who reported negative or ambivalent intentions had lower odds of reporting social norms of preventive behaviors (aOR = 0.67, CI = 0.51–0.88 and aOR = 0.63, CI = 0.48–0.81, respectively). At the institutional-level, decreased trust in the CDC was associated with negative intention (aOR = 0.29, CI = 0.17–0.50) and ambivalent intention (aOR = 0.57, CI = 0.33–0.98) compared to positive vaccine intention.

6. Discussion

Comparable to results from recent national US surveys, the findings from this online study indicate that a concerningly large proportion of the population does not intend to obtain a COVID-19 vaccine when it becomes available. While low rates of intended vaccine uptake may severely undermine vaccination efforts to control increasing infection and mortality rates, findings from this cross-sectional study do suggest potential avenues to increase vaccine acceptance and uptake.

On the intrapersonal-level, there was a marked gender difference in vaccine attitudes, with females reporting greater intentions to obtain a COVID-19 vaccine than males. In previous research, there have been mixed findings on gender differences and vaccine hesitancy [11,25,28]; however, these data suggest that vaccination campaigns should consider gender differences in attitudes and acceptance when developing outreach strategies. Our findings show that those who self-identify as Black have significantly lower vaccine intentions, which may reflect a sense of general medical mistrust among the Black community. As disproportionate levels of COVID-19 mortality have been documented among minority communities, it is critical to begin developing strategies to tailor vaccine programs, and larger public health campaigns to effectively address the needs and concerns of Black Americans within their health and social contexts as well as ensure that vaccine campaigns focus on equity for those at the highest risk of COVID-19 mortality. Our current study had a small proportion of Black and Hispanic respondents, highlighting the need for survey and clinical research to oversample these high-risk populations. It is also crucial to develop a more detailed understanding of community-specific attitudes, perceptions, and risks in order to develop tailored vaccine messaging and delivery to communities at high-risk for COVID-19.

In addition, we observed a significant association between more conservative political ideology and negative vaccine intention.

Given the politicization and political polarization of the response to COVID-19, it is important that conservative leaders actively work to promote vaccine uptake among their constituents and the general population. Public health campaigns to improve vaccine uptake may be more effective if messages cater to varying political ideologies.

There was a strong association between a recent history of influenza vaccine and COVID-19 vaccine intentions, independent of sociodemographic factors, political ideology, and COVID-19 Skepticism. Although we do not know the causal relationship between a recent history of influenza vaccine and COVID-19 vaccine intentions, it is plausible that individuals who obtain an influenza vaccine may be more receptive to a COVID-19 vaccine if they see that they do not encounter serious side effects. Moreover, campaigns to increase influenza vaccine uptake may be useful to test and improve methods for developing effective COVID-19 vaccine campaigns. As such, bolstering the influenza vaccine campaign in 2021 and maximizing its acceptance, reach, and widespread uptake may be an important strategy to increase COVID-19 vaccine uptake.

COVID-19 Skepticism was a highly significant predictor of negative and ambivalent vaccine intentions as compared to those who intended to obtain a COVID-19 vaccine. This association was independent of political conservatism. However, it may be difficult to change the attitudes of individuals who endorsed the beliefs that COVID-19 is a hoax or has been exaggerated, as risk communication campaigns have reported mixed findings in increasing vaccine uptake [20,19].

Strategies that promote COVID-19 vaccine norms, such as social network diffusion, may be a promising means of reducing vaccine hesitancy. This study found that participants who did not endorse intentions to obtain a COVID-19 vaccine were significantly less likely to report peers engaging in COVID-19 prevention behaviors or supporting these behaviors. Engaging social networks may be another avenue to promote vaccine uptake norms. For example, highlighting when most people in a community are receiving a COVID-19 vaccine or that most people appreciate others obtaining a vaccine to prevent transmission to vulnerable populations may be effective messages. Encouraging community members to communicate about vaccinations for COVID-19 as well as wearing masks and engaging in social distancing may make COVID-19 prevention more normative and salient, leading to positive vaccine intentions and uptake. Additionally, these messages can encourage a collective social identity around COVID-19 prevention, which may influence behavior change and increase vaccine acceptance. Social network diffusion models typically rely on person-to-person communication between peers. During COVID-19, when face-to-face communication can increase the risk of exposure to the virus, alternative methods of peer communication should be encouraged, such as social media posts or conversation prompts for telephone or text communications.

It is of interest that in the bivariate models, 5 of 6 individual-level prevention behaviors measures were associated with positive vaccine intentions. However, all of these variables became non-significant in the multivariable models. In comparison, the social norms of social distancing and mask wearing retained their statistical significance. These findings highlight the important influence of social factors in COVID-19 vaccine intentions.

Although greater trust in COVID-19 information from the CDC was associated with vaccine intentions, trust in COVID-19 information from the White House was not significantly associated with intended vaccine behavior in multivariable models. Trust in the CDC was moderate in this study, indicating a need to examine reasons for mistrust in the scientific institutions. There are many potential reasons for the lack of public trust in the CDC, including mixed messaging on COVID-19 prevention approaches, testing delays, and contradictory messages from the White House. Certainly, the CDC should have provided greater public health leadership and facilitate community engagement to foster greater social norms of COVID-19 prevention. These data also highlight the importance of the CDC, ensuring that its COVID-19 recommendations are not seen as political or biased to maintain a high level of informational trust. Increased trust in the CDC may be one avenue to improve vaccine intentions.

This study is subject to limitations. Although the validity of MTurk samples has been well established, this sample was not representative of the general US population. Moreover, as COVID-19 is a recent pandemic, there are few validated measures for COVID-related behaviors. In addition, the rapidly changing nature of the pandemic and the effectiveness and side effects among different COVID-19 vaccines may alter vaccination opinions. Further, we did not measure social norms of vaccine behaviors, only social norms of COVID-19 prevention behaviors. Finally, the cross-sectional nature of the analyses, due to only collecting vaccine intentions at one wave, limits the ability to draw causal inferences.

Despite the limitations, study results provide insight into possible avenues of future research and directions for potentially improving COVID-19 vaccine uptake and reach. However, in anticipation of COVID-19 vaccine programs, community-based interventions can begin by improving influenza vaccine acceptance and uptake. It is critically important to develop and implement evidence-based interventions and promotion strategies that can improve COVID-19 vaccine acceptance and reduce vaccine hesitancy, especially among vulnerable and minority populations inequitably affected by the pandemic.

Funding sources

The funding sources are the National Institute on Drug Abuse (R01 DA040488) and Johns Hopkins Alliance for a Healthier World.

Financial disclosures

None

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

Study participants

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