Predictors of COVID-19 vaccine intentions in the United States: the role of psychosocial health constructs and demographic factors

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Abstract

Background: On December 21, 2020, a study was conducted to investigate a range of psychosocial health constructs and demographic variables potentially associated with intentions toward accepting or forgoing the coronavirus (COVID-19) vaccine. Purpose: The goal of the study was to identify predictors of forgoing COVID-19 vaccination at the time of the initial rollout. Methods: A cross-sectional, representative online survey of 350 U.S. residents was conducted using the online crowdsourcing site Prolific to assess vaccine intentions, health attitudes, and demographic information. Variables examined included demographic factors and health constructs corresponding to each of the elements of the health belief model (perceived severity, susceptibility, benefits, barriers, and cues to action), the theory of planned behavior (attitudes, subjective norms, and perceived behavioral control), attitudes toward vaccines in general, and trust in the COVID-19 vaccine approval process. Results: After using hierarchical linear regression to control for demographics, the health constructs uniquely associated with the likelihood to forgo vaccination were perceived barriers, general attitudes toward the COVID-19 vaccine, subjective norms, and trust in the vaccine approval process. Significant demographic predictors of vaccine reluctance included being female, politically conservative, and more religious. Conclusions: The current research identified three demographic factors and four health constructs uniquely associated with vaccine acceptance. These findings reveal that the constructs contained within the health belief model and theory of planned behavior can be used to predict COVID-19 vaccination intentions, and can be supplemented with an assessment of general vaccine attitudes and attitudes toward the vaccine approval process.

Implications

Practice: Public health officials who wish to persuade reluctant Americans to become vaccinated against COVID-19 should focus on increasing positive subjective norms to become vaccinated, to promote trust in the process used to approve the vaccine, and to work to reduce perceived barriers such as the potential health risks of the vaccine.

Policy: COVID-19 vaccine policies should focus on promoting the pro-vaccine attitudes held by the majority of Americans and the relative safety of the vaccine compared to the disease itself. Such messages should directly target the most reluctant demographic groups (women, political conservatives, and the highly religious).

Research: Future research should examine the extent to which social norms to become vaccinated, concerns about the safety of the COVID-19 vaccine, and reluctant demographic groups remain effective predictors of vaccine intentions over time.

INTRODUCTION

A vaccine only has the power to prevent illness when it is widely distributed and publically accepted. Yet our understanding of the factors most relevant to vaccine uptake remains far too limited. More so, the specific nature of each disease and its spread varies widely, as do the factors associated with people's intentions to become vaccinated. The current study was undertaken to explore the psychological and social variables most strongly associated with U.S. residents' behavioral intentions in regard to the COVID-19 vaccine. At the time of the data collection approximately one-third of American adults were actively planning to not become vaccinated [1,2]. Despite broad distribution of the vaccine, decisions to forgo vaccination make the prospect of herd immunity and an end to the COVID-19 epidemic appear nearly out of reach [3]. Therefore, early identification of the populations most reluctant to become vaccinated was deemed to be of critical importance. The current study was undertaken to specifically pinpoint the health constructs and demographic variables most predictive of such vaccine reluctance.

While there are many approaches to studying the potential health constructs predictive of vaccination behavior, no two models have been as effectively employed as the health belief model (HBM) and the theory of planned behavior (TPB). The HBM

proposes that health behavior is largely the consequence of perceptions of susceptibility (the degree to which one feels likely to become infected), severity (the degree to which the illness will have negative ramifications should one become infected), benefits (the degree to which one believes the vaccine will protect against the virus), and barriers (the degree which one feels that there will be negative consequences of becoming vaccinated) [4]. This model also includes "cues to action," behavioral reminders potentially present in one's social environment. While the HBM is primarily focused on attitudes and perceptions, the TPB expands that view to include attitudes toward the behavior (general attitudes toward becoming vaccinated), along with subjective norms (the extent to which peers believe one should become vaccinated), and perceived behavioral control (the predicted ease of becoming vaccinated) [5]. In the TPB, these three factors predict one's behavioral intentions which in term are highly associated with engaging in the behavior itself. The HBM and TPB have been shown across a range of populations to effectively predict intentions toward and the actual uptake of vaccines both generally [6], and more specifically for influenza [7−9], childhood vaccinations [10], the human papillomavirus (HPV) [11−14], and hepatitis A [15]. In regard to COVID-19 specifically, studies have shown that elements of the HBM and TPB have predicted engagement with COVID-19 prevention behaviors, a likely correlate of future vaccine uptake [16,17], and two emerging studies have found that elements of the HBM predicted COVID-19 vaccination acceptability in the United Kingdom [18] and Malaysia [19].

However, two other health constructs not captured by the HBM and TPB that may predict vaccination behaviors include trust in the vaccine development process and attitudes toward vaccines in general. The U.S. COVID-19 vaccines were the two of the fastest produced in human history, the speed of the campaign emphasized by the title "Operation Warp Speed" [20−22]. Concern over this expedited process was likely compounded by a political divide that led many Americans to mistrust either the government, the scientific community, or both [23]. These misgivings have been further bolstered by a relatively small, but vocal group of anti-vaccination protestors who have been increasingly promoting anti-vaccine sentiments on social media [24,25].

While the constructs above have much to offer in their predictive power, so too do demographic factors including an individual's age, gender, ethnicity, education level, political beliefs, and religiosity. For example, feelings of mistrust have been found to be especially high among African Americans due to a history of mistreatment by government scientists and officials [26,27]. Personal ideologies such as political leanings and religiosity also have been shown to significantly correlate with vaccine attitudes [28−30]. Finally, as older individuals, those with underlying medical conditions, and men are more likely to become seriously ill due to COVID-19 [31,32], these factors too were considered for the study.

The current study consisted of an online survey administered to a representative sample of 350 adults in the United States via the online crowdsourcing site Prolific [33]. Our primary research goal was to examine various health constructs (i.e., factors from the TPB and the HBM, trust in the approval process, and attitudes toward vaccines in general) and demographic factors that may predict vaccine intentions. In line with previous studies [6−30], we predicted the variables from the HBM and the TPB, trust in the approval process, attitudes toward vaccines in general, and demographic factors such as gender, political leanings and religious beliefs would be significantly associated with intentions to becoming vaccinated. In addition, our secondary goal was to examine the above named health constructs as predictors of the likelihood of becoming vaccinated after controlling for demographics factors and covariance in order to determine their unique contributions to vaccine intentions.

METHODS

At that time of the data collection (December 21, 2020), the Pfizer-BioNTech COVID-19 Vaccine had been approved exactly one week earlier and was in the beginning stages of distribution, and the Moderna BioNTech COVID-19 vaccine had been approved just three days prior [34,35]. Vaccine uptake intentions were slowly rising in the United States. A Gallup poll taken two weeks' prior had reported that 63% of Americans were willing to be vaccinated, up from a mere 50% in September 2020 and 58% in October 2020 [1], and a poll by the Kaiser Family Foundation showed that 71% of respondents planned to become vaccinated, up from 63% in early September [2]. At the point of recruitment, more than 128,00 Americans, mainly healthcare workers, had received the COVID-19 vaccine [36]. The priorities for vaccinations at that time were frontline healthcare workers and Americans over the age of 74 [37], with states (e.g., Massachusetts [38]) setting plans to distribute the vaccine to adults 65 or older, high-risk individuals, and public-facing employees February-April 2021, and the general public April−June 2021.

Participants

Participants were recruited using quota sampling based on 2020 U.S. census estimates. Specifically, Prolific allowed any U.S. resident over the age of 18 to enroll in the study until a representative sample, by age, gender, and ethnicity was produced. Of the 350 initial respondents originally sampled, 13 (3.7%) were removed from the study for failing an attention-check placed three-quarters of the way through the survey asking participants to specifically select the "somewhat disagree"

option (the second to the left on the 5-point scale). The remaining 337 participants ranged in age from 18 to 81 (*M* = 46.32, *SD* = 16.44). The self-identified gender of the sample was 46.0% cis male, 50.1% cis female, 0.6% transgender male, 1.2% transgender female, 0.9% nonbinary, and 1.2% "other." Participants identified their racial/ethnic identity by selecting all categories that applied as 68.2% White, 13.9% Black or African-American, 8.3% Asian, 3.3% Hispanic or Latinx, 0.9% American Indian or Alaskan Native, 1.5% "other," 3.0% more than one category, and 0.9% did not answer. Education levels varied between being high school graduates (30.6%), college graduates (48.7%), and holding a professional or advanced degree (19.6%), with 1.2% not reporting. On scales ranging from 1 (extremely liberal; not at all religious) to 9 (extremely conservative; extremely religious) participants rated themselves an average of 4.21 (*SD* = 2.46) for political leaning and an average of 4.08 (*SD* = 2.95) on religiosity.

Participants were asked to give their informed consent before taking the survey, completing it in an average time of 6.30 minutes (*SD* = 5.46). Upon finishing the survey, participants were thanked, told more about the study, and paid $1.25 U.S, an average rate of $13.98/hr.

Survey instrument

A web-based, cross-sectional survey was disseminated to U.S. residents. The self-administered questionnaire was available in English and consisted of 50 questions that were internally developed or informed by questions from Krawczyk et al. [11]. The survey was deemed exempt by the Wheaton College (MA) IRB prior to distribution. On the morning of December 21, the Qualtrics survey link was posted on the Prolific site. Participants first reported whether or not they had been vaccinated. Those who had not been vaccinated yet shared their intentions of becoming vaccinated against COVID-19 and then responded to items representing the attitudinal and demographic factors described below.

Measures

Vaccine intentions

Survey items were internally developed and first asked participants if they intended to become vaccinated (yes/no) and how likely they were to choose to become vaccinated when it becomes available to them from 1 = "very unlikely" to 7 = "very likely."

Health constructs

Vaccine intentions were then followed by questions pertaining to the various aspects of the TPB and HBM including perceptions of: *susceptibility*, e.g., "It is likely that I could contract COVID-19 in the future," *severity*, e.g., "If I got coronavirus, it would affect my life significantly," *benefits*, e.g.,

"Receiving the coronavirus vaccine will prevent me from catching COVID-19," *barriers*, e.g., "I believe that receiving the coronavirus vaccine will lead to negative health consequences," *cues to action*, e.g., "I have seen news stories about the importance of getting the coronavirus vaccine," a*ttitudes*, e.g., "I believe that receiving the coronavirus vaccine is a good idea," *subjective norms*, e.g., "Most people who are important to me would think that I should receive the coronavirus vaccine," and *perceived behavior control*, e.g., "If I decide to become vaccinated, I will have the ability to receive the coronavirus vaccine." Each variable was represented by the average of 2–3 items with a rating scale from 1 = "strongly disagree" to 5 = "strongly agree."

Using the same scale, additional items measured participants' *trust in the approval process*, e.g., "The U.S. government will make sure that the vaccine doesn't pose a risk to my health," "I trust the science that says the coronavirus vaccine is safe," and *attitudes towards vaccines in general*, e.g., "In general, I believe vaccines protect people from illness."

Demographics

Demographic variables were recorded last including whether participants worked in various healthcare or public-facing professions, as well as their age, gender, ethnicity, education level, political beliefs, and religiosity. Political beliefs and religiosity were measured on a 1 to 9 scale, with higher scores reflecting greater religiosity and conservative politics. See Table 1 for response options for categorical variables.

Analyses

Our main hypothesis was that health constructs (HBM and TPB variables, trust in the approval process, attitudes toward vaccines in general) and demographic characteristics would significantly predict vaccine intentions. To examine this, we conducted a series of chi-square tests (or Fisher's exact tests when cell sizes were less than five) on all nominal variables and independent samples *t*-tests on interval or ratio variables. Our secondary goal was to explore the health constructs as predictors of the likelihood of getting vaccinated for COVID-19, while controlling for socio-demographic variables and covariance. We conducted a hierarchical linear regression to allow us to examine the unique predictive power of the health constructs on vaccine intentions, while controlling for overlap between the attitudinal variables and the influence of the demographic variables. In our case, hierarchical linear regression was conducted in which demographic factors were listed on the first step, and then the HBM and TPB variables, trust in the approval process, and attitudes toward vaccines in general were listed on the second step. Race and gender variables were dummy coded (cisgender male = 1) and entered into the regression

Table 1 | Comparisons on socio-demographic variables between those who intend to get vaccinated vs. those who do not intend to get vaccinated against COVID-19 (*N* = 337)

Do You Intend to Get the COVID-19 Vaccine?	No	Yes	*t*	χ^2	*p*
Demographics					
Age in years	45.2 (16.4)	46.8 (16.4)	−0.75		.452
Political leaning	5.6 (2.3)	3.6 (2.2)	7.46		<.001
Religiosity	5.0 (3.1)	3.7 (2.8)	3.58		<.001
Race				6.41	.379
White	26%	74%			
Black	39%	61%			
Latinx	25%	75%			
Asian	30%	70%			
American Indian	33%	67%			
Other	60%	40%			
More than one category	40%	60%			
Gender				4.13	.042
Cisgender male	24%	76%			
Cisgender female	34%	66%			
Education				5.18	.075
High school graduate	38%	62%			
College graduate	26%	74%			
Post graduate degree	25%	75%			

Note: Political leaning and religiosity were scored on a 1–9 scale, with higher scores indicating greater religiosity or more conservative politics. The values for both variables reflect the means and standard deviations. Also, gender comparisons were only conducted with cis gendered male and cis gendered female participants because of the few participants who identified themselves as trans male, trans female, or non-binary. Data were collected on December 21, 2020.

equation. Due to the small number of transgender and nonbinary individuals in the sample, comparisons of gender were only run between cisgender male and female participants.

RESULTS

Of the 337 participants in our sample, 14 (4.2%) had already received the first dose of the COVID-19 vaccine. Chi-square and independent samples *t*-tests analyses comparing the professions of those who had received the vaccine and those who had not indicated that individuals who had already been vaccinated were more likely to be working in long-term care facilities (Fisher's exact test *p* = .015) and in jobs that required exposure to large numbers of the general public (e.g., grocery store) [χ^2 (1) = 6.55, *p* =.010]. No other significant differences were found. Of the 323 participants who had not yet received the vaccine, 228 (70.6%) reported that they intended to get the coronavirus vaccine, and 95 (29.4%) reported that they did not intend to get the vaccine.

Regarding our main hypothesis, we compared demographic variables and the health constructs (variables from the HBM and the TPB models, trust in the approval process, general attitudes toward vaccines) between those who intended to get vaccinated with those who did not intend to get vaccinated. Results for demographic characteristics indicated that people who did not intend to get vaccinated were more likely to be politically conservative, more religious, and to be cisgender women. There

were no group differences for age, race, or education. Comparing these groups on their health attitudes and perceptions, results indicated that people who did not intend to get vaccinated scored lower on susceptibility, severity, benefits, cues to action, attitudes, subjective norms, perceived behavioral control, trust in the approval process, and attitudes about vaccines in general, and higher on barriers. See Tables 1 and 2 for all comparisons.

Regarding our second goal, hierarchical linear regression controlling for socio-demographic factors indicated that barriers, attitudes toward the vaccine, subjective norms, and trust in the scientific process were the variables that remained significantly predictive of participants' reported likelihood to receive the COVID-19 vaccine. Specifically, these results suggested that perceiving fewer barriers to getting vaccinated, and having more positive attitudes toward the COVID-19 vaccine, stronger social norms leaning toward receiving the COVID-19 vaccine, and greater trust in the scientific process that led to the approval of the vaccine each predicted a higher reported likelihood of receiving the COVID-19 vaccine. See Table 3 for the results of the hierarchical linear regression.

DISCUSSION

The aim of the current study was to examine the health constructs and demographic variables most strongly associated with vaccine reluctance. Our main hypothesis was supported in that the variables from the HBM and the TPB, alongside trust in the process, attitudes

Table 2 | Comparisons on health construct variables between those who intend to get vaccinated vs. those who do not intend to get vaccinated against COVID-19 (*N* = 337)

Do You Intend to Get the COVID-19 Vaccine?	No	Yes	*t*	χ^2	*p*
Health Constructs					
Health Belief Model					
Susceptibility	3.4 (0.9)	4.1 (0.7)	−6.73		<.001
Severity	3.6 (0.9)	4.4 (0.6)	−8.26		<.001
Benefits	2.8 (1.1)	4.0 (0.7)	−10.40		<.001
Barriers	3.6 (1.0)	1.8 (0.9)	16.39		<.001
Cues to action	2.8 (0.7)	3.5 (0.8)	−6.79		<.001
Theory of Planned Behavior					
Attitudes	2.6 (1.1)	4.6 (0.7)	−15.74		<.001
Subjective norms	2.5 (1.1)	3.8 (0.7)	−10.31		<.001
Perceived behavioral control	3.9 (0.6)	4.1 (0.7)	−2.83		.005
Trust in approval process	2.5 (1.1)	4.2 (0.7)	−14.10		<.001
General vaccine attitudes	3.5 (1.2)	4.5 (0.6)	−8.36		<.001

Note: Data were collected on December 21, 2020. All health construct variables were measured on a 1 to 5 scale, with higher numbers reflecting greater endorsement of the health construct. The numbers reflect the means and standard deviations of each variable.

toward vaccines in general, and demographics were predictive of vaccine intentions. Those who did not intend to get vaccinated reported lower scores on HBM variables (susceptibility, severity, benefits, cues to action), TPB variables (attitudes, subjective norms, perceived behavioral control), trust in the approval process, and attitudes about vaccines in general, and higher on barriers. They also were more politically conservative, more religious, and more likely to be cisgender women. The finding that politically conservative, more religious, and cisgender women are more likely to vaccine reluctant is consistent with previous literature examining vaccine hesitancy and demographic factors [28–30]. Also in keeping with previous studies [6–19], our findings suggest that the HBM and the TPB, along with trust in the vaccine approval process and general vaccine attitudes are highly predictive of COVID-19 vaccine intentions.

Our secondary aim was to explore the unique variance accounted for by the health constructs, while controlling for demographic factors. The exploratory analysis found the health constructs included in the study were able to account for 78% of the variance in vaccine intentions. Most importantly, barriers, attitudes toward the vaccine, subjective norms, and trust in the scientific process were significantly predictive of vaccine intentions, even after controlling for demographic characteristics. These findings strengthen the literature on the predictive power of the HBM and the TPB by underscoring the unique importance of three of the included constructs and by adding the new variable of trust in the vaccine development process. Public health interventions trying to increase people's vaccine intentions should consider focusing more attention on removing perceived barriers to getting vaccinated, strengthening the subjective norm for vaccination, and increasing trust in the scientific process of vaccine development and safety.

Limitations

While the findings above provide insight into COVID-19 vaccine intentions, they must also be considered within the inherent limitations of the methods. For example, while we were able to select an option through Prolific to receive a more representative sample in terms of age, gender, and ethnicity [33], the sample still underrepresented some groups (e.g., Latinx individuals) and overrepresented others (e.g., the highly educated). The survey was only available in English, which limited its potential to reach all U.S. residents. The use of a crowd sourcing site also necessitated that participants be relatively savvy about such platforms and have access to the internet and a computer or tablet device. In addition, geographic location was not recorded. Given that vaccine availability and distribution procedures varied state-to-state, this information might have clarified some of the relationships that were found.

As the COVID-19 vaccine was only available to frontline healthcare workers and those 75 years or older at the time of the data collection, these findings were confined to participants' self-reported intentions. Biases such as social desirability may have led participants to overestimate their likelihood to receive the vaccine. As this was a cross-sectional survey, these data do not reflect participant's eventual real-world behavior. The relationship between intentions and behavior is imperfect, and future research should follow up with these respondents both to see if they followed through on their behavioral intentions and how their attitudes and perceptions may have shifted over time.

CONCLUSION

This study found that demographic factors and the health constructs related to the HBM and TPB continue to be highly effective predictors of health

Table 3 | Hierarchical regression analysis predicting degree of intention to receive the COVID-19 vaccine while controlling for demographic characteristics (N = 337)

Predictors	Step 1			Step 2		
	β	t	p	β	t	p
Demographics						
Age in years	.15	3.00	.003*	.05	1.66	.097
Gender (cisgender male = 1)	.02	4.01	<.001*	.08	2.87	.004*
Education	.11	2.27	.024*	.04	1.55	.123
Political leaning	−.51	−8.98	<.001*	−.050	−1.37	.171
Religiosity	−.04	−.64	.526	.03	.78	.439
Race/ethnicity						
White	.19	.84	.401	.21	1.66	.099
Black	.02	.10	.919	.13	1.28	.202
Latinx	.03	.34	.738	.06	1.10	.274
Asian	.12	.83	.407	.11	1.46	.145
American-Indian	.04	.53	.594	.00	.07	.948
Other	.07	.84	.404	.06	1.38	.170
More than one category	.00	−.04	.967	.05	.86	.391
Health Constructs						
Health Belief Model						
Susceptibility				.04	1.04	.299
Severity				.02	.46	.646
Benefits				.043	1.07	.284
Barriers				−.16	−3.12	.002*
Cues to action				.00	.03	.973
Theory of Planned Behavior						
Attitudes				.44	6.50	<.001*
Subjective norms				.08	2.18	.030*
Perceived behavioral control				.01	.37	.712
Trust in approval process				.14	2.30	.022*
General vaccine attitudes				.05	1.33	.184
R^2		0.314			0.784	
R^2 change		0.314			0.485	
p-value		<.001*			<.001*	

* $p < .05$.
Note: Data were collected on December 21, 2020.

behavior intentions, along with trust in the process and general vaccine attitudes. In addition, our findings suggest a particularly robust relationship between likelihood of vaccine uptake and perceived barriers and subjective norms, with attitudes toward the COVID-19 vaccine, and trust in the approval process being valuable extensions to those models. It may be that as the COVID-19 vaccine becomes more widely distributed that subjective norms will further increase in favor of vaccination. In addition, if the widespread uptake of the vaccine leads to few, if any, serious reactions to the vaccine, then both perceived barriers and subjective norms may improve naturally. Public health officials may wish to specifically reach out to members of the groups identified here as most reluctant to become vaccinated. Women, political conservatives, and the highly religious should be directly targeted with messages promoting the vaccine. In addition, the entire U.S. public should receive messages regarding the benefits and safety of vaccines in general, the existing subjective norms in favor of becoming vaccinated, and reasons for trust in the against COVID-19 vaccine development process. Such approaches will hopefully increase vaccine uptake and ultimately slow the spread of COVID-19 in the Unites States.

Compliance with Ethical Standards

were approved by the First Author's College IRB before any data collection took place.

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 performed by any of the authors.

Transparency Statements

1. This study was not formally registered.
2. The analysis plan was not formally registered.
3. De-identified data from this study are not currently available in a public archive, but are available by request to the corresponding author.
4. There is not analytic code associated with this study.
5. The materials used to conduct this study are available by request to the corresponding author.

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