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## COVID-19 vaccine behaviors and intentions among a national sample of United States adults ages 18–45

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### ABSTRACT

**Background:** Vaccination for SARS-CoV-2, the virus that causes COVID-19 illness, is an important public health tool to reduce hospitalizations and deaths.

**Purpose:** This report focuses on intentions and behaviors related to COVID-19 vaccination among United States (U.S.) adults ages 18–45.

**Methods:** From February 25–March 24, 2021, we conducted an online survey assessing COVID-19 vaccine intentions and behaviors, health beliefs, vaccine attitudes, and sociodemographic characteristics. Participants were adults aged 18–45, living throughout the U.S. with oversampling in Florida, panelists of a research panel company directly or via verified partners, and able to read, write, and understand English. Associations between COVID-19 vaccination uptake, intentions, and other study variables were examined through multivariable logistic and proportional odds regression analyses.

**Results:** Among participants in the final analytic sample ( $n = 2722$ ), 18% reported having received at least one dose of a COVID-19 vaccine. Approximately 31% of unvaccinated participants reported strong intentions to receive a COVID-19 vaccine in the next year, whereas 35% reported strong intentions to receive a COVID-19 vaccine if it were strongly recommended by a healthcare provider. All COVID-19 vaccination outcomes were associated with male gender, sexual minority status, higher levels of education, and previous influenza vaccination. All vaccination intention outcomes were associated with vaccine attitudes and geographic region. Vaccination status and intentions were differentially associated with multiple additional sociodemographic, attitudinal, and/or healthcare experience variables.

**Conclusions:** Several demographic variables, vaccine attitudes, and healthcare experiences were found to contribute to COVID-19 vaccine receipt and intentions. Targeted efforts are necessary to increase uptake of the vaccine in the U.S.

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## 1. Introduction

On March 11, 2020, the World Health Organization (WHO) declared the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes COVID-19 disease, a global pandemic (Hiscott et al., 2020). As of December 2021, WHO reported nearly 265 million cumulative COVID-19 cases and over 5.2 million COVID-19 deaths globally (World Health Organization, 2021). In December 2020, the U.S. Food and Drug Administration (FDA) approved the two-dose Pfizer-BioNTech SARS-CoV-2 vaccine (U.S. Food and Drug Administration, 2021a, 2021b) and the two-dose Moderna vaccine (U.S. Food and Drug Administration, 2021) for emergency use authorization (EUA) in the United States (U.S.) (the former for those aged 16 and older and the latter for those aged 18 and older). The single dose Johnson & Johnson SARS-CoV-2 vaccine was authorized for use in individuals aged 18 and older on February 27, 2021 (U.S. Food and Drug Administration, 2021c). Because the initial vaccine supply was limited (McClung et al., 2020), the Advisory Committee on Immunization Practices (ACIP) recommended a phased approach to vaccination roll-out (Centers for Disease Control and Prevention, 2020). However, these recommendations were nonbinding and states were ultimately responsible for their own local vaccine distribution plans. Therefore, SARS-CoV-2 vaccination has varied based on area of residence (Persad et al., 2021). All states expanded vaccine eligibility to individuals ages 16 and older by April 19, 2021 (Karpman and Zuckerman, 2021).

An ongoing concern that affected efforts to rapidly vaccinate the U.S. population is vaccine hesitancy (Rosenbaum, 2021; Sallam, 2021), that is, delaying or refusing a vaccination despite availability. Vaccine hesitancy can result from a wide range of influences, including socio-demographic factors, low perception of risk, fear of the vaccine, concerns about vaccine safety, and lack of trust in health care workers who administer the vaccine, as well as those responsible for approval of the vaccine (MacDonald and SAGE Working Group on Vaccine Hesitancy, 2015). Common reasons specific to SARS-CoV-2 vaccine hesitancy include concerns about the safety and efficacy given the relatively quick development and production timeline of the vaccine, perception of inconsistent and contradictory information from health authorities, lack of trust in scientific/research institutions, low perceived threat of COVID-19, and belief that a person is already immune due to prior infection (Dodd et al., 2021a; Dodd et al., 2021b; Soares et al., 2021; Troiano and Nardi, 2021; Pickles et al., 2021). Prior literature has also suggested that low health literacy is associated with lower likelihood of utilizing preventive services, including vaccination (Biasio, 2016; Dodd et al., 2021b). A recent study conducted among adults in Australia found that inadequate health literacy predicted lower intentions to obtain the SARS-CoV-2 vaccination (Dodd et al., 2021a; Dodd et al., 2021b). However, the role of health literacy in SARS-CoV-2 vaccine intentions among young and mid-age adults in the U.S. remains largely unknown. In addition, several prior studies have found that younger age was associated with lower willingness to receive the vaccine (Soares et al., 2021; Troiano and Nardi, 2021; Head et al., 2020; Fisher et al., 2020; Dodd et al., 2021a). As of February 25, 2021, the time of survey administration, over 54 million adults aged 18 and older in the U.S. had received at least one dose of the SARS-CoV-2 vaccine and over 28 million were fully vaccinated (2 doses), and by March 24, the numbers had nearly doubled to 98 million and 55 million, respectively (Centers for Disease Control and Prevention, 2021a, 2021b). At the time, to achieve herd immunity, it was recommended that at least 70% of individuals living in the U.S. receive the vaccine (Lippi and Henry, 2021; Frederiksen et al., 2020; Randolph and Barreiro, 2020). More recently, vaccination has been strongly recommended to reduce the spread of current and future variants of the virus (Krause et al., 2021). Thus, it is important to identify factors associated with SARS-CoV-2 vaccine uptake and intentions to receive the vaccine among young and middle-aged adults. The survey for the current study was administered shortly after EUA of the vaccine and amidst early vaccine rollout (February 25–March 24, 2021). The

primary aim of the current study is to examine associations between sociodemographic variables, healthcare experiences, health literacy and numeracy, vaccine attitudes, and SARS-CoV-2 vaccine uptake and intentions among a national sample of U.S. young and mid-age adults.

## 2. Methods

We conducted a cross-sectional, observational online survey among 4000 adults ages 18–45 living throughout the U.S. who were part of a research panel company's panel directly or via verified partners. The primary aims of the overarching study were: 1) to describe sociodemographic factors, vaccine attitudes (i.e., general vaccine attitudes and fear of shots, human papillomavirus [HPV] vaccine-specific attitudes), health beliefs (e.g., perceived risk, self-efficacy, perceived barriers, normative beliefs), health literacy, numeracy, health care experiences, attitudes toward seeking medical care, vaccine discussions and information sources, preparedness for shared decision-making (for individuals ages 27–45), and HPV vaccination behaviors and intentions and relationships between these variables among 18–45 year olds and 2) characterize HPV-related educational intervention preferences among 18–45 year olds. In addition, there were three exploratory aims: 1) among participants with at least one child, to examine the associations between sociodemographics, knowledge, health beliefs, individuals' own HPV vaccination status and intentions, and HPV vaccine behaviors and intentions for one's child, 2) to examine the impact of the COVID-19 pandemic on receipt of health care, HPV vaccination receipt, and HPV vaccination intentions, and 3) to examine potential geographic variations (i.e., overall sample vs. Florida participants vs. Moffitt catchment area participants) using sensitivity analyses. In addition, survey items assessed COVID-19 vaccination behaviors and intentions; these items are the focus of the current manuscript. This study was reviewed and approved by Moffitt's Scientific Review Committee (SRC) and Institutional Review Board (IRB) of record (Advarra) prior to study initiation and was considered exempt given the anonymous nature of the data collection.

### 2.1. Participants

Inclusion criteria were: (1) age 18–45; (2) living in the U.S.; (3) a panelist of a probability-based online panel used to provide large, representative samples for research purposes either directly or via verified partners; (4) have internet access; and (5) able to read, write, and understand English. Recruitment targeted equal stratification between two age strata with half ages 18–26 and half ages 27–45 and two sex at birth strata: male and female. Geographic oversampling targeted 500 participants living in Florida, of whom approximately 250 were targeted in the Moffitt Cancer Center 15-county catchment area. We oversampled in Florida and the Moffitt Cancer Center catchment area with the aim of informing future local and statewide HPV vaccine intervention research and outreach efforts to be undertaken by the Cancer Center. Efforts were made to attempt a nationally representative sample in terms of race/ethnicity for all participants and for geographic region among the approximately 3500 individuals living outside of Florida. Quotas were programmed relative to age and sex at birth. The panel company targeted recruitment email efforts to those groups lacking responses.

### 2.2. Procedures

Potentially eligible individuals were sent emails with up to two reminder emails about the study directly by the panel company. Interested participants clicked on an embedded link in the email and were taken to the Qualtrics survey, which was maintained by Moffitt Cancer Center. Individuals first completed eligibility screening questions. Eligible individuals then proceeded to read a study informational sheet and were asked to provide consent. The 4000 individuals who agreed to

participate completed the anonymous, online survey requiring approximately 30 min (Mean = 30.6 min) via Qualtrics. Following survey completion, participants were provided their incentive directly by the panel company (i.e., reward points that can be redeemed for a variety of gift card types) per the panel company policy. Data were collected from February 25–March 24, 2021. Herein, we report the analyses and findings related to SARS-CoV-2 vaccination behaviors and intentions.

### 2.3. Measures

**Sociodemographic variables.** Sociodemographic variables collected included: age, gender identity, race, ethnicity, education, geographic region (participants' reported state of residence were categorized as belonging to the Midwest, Northeast, South, or East region [U.S. Census Bureau, 2018]), foreign-born status of individual and their parents, income, relationship status, parental status, employment status, sexual orientation, religious service attendance, health insurance status, and health information preferences, among others.

**General vaccine attitudes.** General attitudes toward vaccines were assessed with an 11 item scale (Zimet et al., 2010).

**Health literacy.** Health literacy was assessed by asking participants, "In general, how difficult is it for you to understand written health information?", with the following response options: very easy, somewhat easy, somewhat difficult, very difficult, I don't pay attention to health information, I don't know, and I prefer not to answer (Centers for Disease Control and Prevention, 2016).

**Numeracy.** Numeracy was assessed by asking participants, "In general, how easy or hard do you find it to understand medical statistics?", with the following response options: very easy, easy, hard, and very hard (U.S. Department of Health and Human Services, 2008).

**Healthcare experiences.** A variety of healthcare experience variables were assessed, including having a regular health care provider, seeing a provider in the past year, receiving the flu shot in the past year, receiving a tetanus shot, and having a past cancer diagnosis (Fisher et al., 2013; National Cancer Institute, 2014).

**SARS-CoV-2 vaccination behaviors and intentions.** Vaccination behaviors and intentions was assessed with 4 items. In order to ensure that the participants would understand to which vaccine the items were referring, the SARS-CoV-2 vaccine was called the "COVID-19 vaccine," as it is commonly referred to in the U.S. Vaccine uptake was assessed by asking all participants if they have received any doses of the vaccine. Unvaccinated participants were asked about their likelihood of getting the vaccine in the next year, getting the vaccine in the next year if it was strongly recommended by a healthcare provider, and getting more information about the vaccine (Gerend and Shepherd, 2012; Head et al., 2020), with responses ranging from "very unlikely" (scale as 1) to "very likely" (scale as 7) on a 7-point ordinal scale.

### 2.4. Statistical analysis

Descriptive statistics were calculated for all variables, including frequencies for categorical variables, means, medians, standard deviations, and ranges for continuous variables, and missing observations for all variables. For questions assessing health literacy and numeracy, response options "somewhat easy", "somewhat difficult", and "very difficult" were collapsed and categorized as "not very easy". Additionally, for the literacy-related question, remaining responses (e.g., "I don't pay attention to written health information", "I don't know/Not sure", "I prefer not to answer") were collapsed and categorized as "other". For the vaccine attitudes scale, we calculated the average score of the eleven-item scale.

We conducted a systematic data cleaning process (Arevalo et al., 2022), whereby data from respondents were removed from the final analytic sample if they: 1) submitted their survey in less than ten minutes, 2) responded to all items with identical responses to scaled instruments that contained reverse coding (i.e., "straight lining" on the

HPV knowledge, HPV vaccine knowledge, attitudes about vaccines and fear of shots, and attitudes toward seeking medical care scales), 3) provided contradictory responses, or 4) provided responses determined to be of poor quality to open-ended items (e.g., gibberish, nonsensical, or appearing to be duplicative from the same individual) (Kim et al., 2018; Schonlau and Toepoel, 2015; Newman et al., 2021; Niessen et al., 2016; Meade and Craig, 2012; Burnette et al., 2021; Kennedy et al., 2020; Dupuis et al., 2019). The cleaned sample was used for all subsequent analyses.

Exploratory regression analyses were conducted to examine relationships between potential covariates and outcomes of interest related to SARS-CoV-2 vaccine intentions and behaviors. Backward selection with a significance level to stay of 0.10 was used for all models. Logistic regression and proportional odds models were used as appropriate for categorical and ordinal outcomes, respectively. All analyses were completed using SAS Software, version 9.4.

## 3. Results

Descriptive statistics for the participants in the final analytic sample ( $N = 2722$ ) are found in Table 1. Approximately half of the participants in the final analytic sample were in the 18–26 year old cohort (50.7%). Slightly over half (54.9%) of participants identified as female, and 83.5% classified themselves as straight or heterosexual. The majority of participants were White (71.2%), 11.6% Black, 7.1% Asian, and 10.2% either multiple or other race. Approximately 17% reported Hispanic ethnicity (16.5%). While 93% of the participants reported being born in the U.S., 23.5% reported having a foreign-born parent. Approximately 16% of participants reported completing graduate school, 27.9% completed a bachelor's degree, and 32% completed some college. While nearly one quarter of the participants (24.6%) reported annual income of at least \$100,000, 12.4% reported making less than \$20,000 annually and another 25.1% reported making between \$20,000 and \$50,000. Fifty-four percent of participants reported having a regular healthcare provider, and 72.8% reported a provider visit in the prior year. Forty-four percent of participants reported receiving an influenza vaccine in the prior year, and 52% reported receiving a tetanus shot within the prior decade. Notably, during the COVID-19 pandemic, 11.4% of participants were unemployed, and 16.8% lacked health insurance.

### 3.1. SARS-CoV-2 vaccine behaviors and intentions

At the time of survey completion, 477 participants (17.6%) reported receipt at least one dose of a SARS-CoV-2 vaccine (Table 2). Of those 477 vaccinated individuals, 257 (53.9%) reported receipt of exactly one dose, 212 (44.4%) reported receipt of two doses, and the remaining 8 (1.7%) individuals were either unsure or did not report a specific number of doses. Of the 2236 (82.4%) unvaccinated individuals, 407 (18.3%) reported that they were very unlikely to get a vaccine within the next year, and another 239 (10.8%) reported being somewhat or a little unlikely to get the vaccine in the next year. Similarly, approximately 14% ( $n = 318$ ) reported that they were very unlikely to seek more information on the vaccine, and an additional 262 (11.7%) reported that they were somewhat or a little unlikely to seek more information. While 690 (31%) unvaccinated participants reported that they were very likely to get the vaccine in the next year, a slightly higher percentage (35.0%,  $n = 780$ ) reported being very likely to receive the vaccine if their healthcare provider strongly recommended it. Still, 337 (15.1%) remained very unlikely, with an additional 252 (11.3%) remaining somewhat or a little unlikely to get vaccinated if their healthcare provider strongly recommended the COVID-19 vaccine.

### 3.2. Factors associated with SARS-CoV-2 vaccine receipt

Receipt of a SARS-CoV-2 vaccine relatively early in the vaccine rollout (by February or March 2021) was associated with a number of

**Table 1**  
Descriptive characteristics.

Variable	Level	N = 2722	%
Age	18–26	1381	50.7
	27–45	1341	49.3
Gender identity	Female	1491	54.9
	Male	1186	43.7
	Transgender/other	39	1.4
	Missing	6	–
Race	White	1934	71.2
	Black/African American	314	11.6
	Asian	192	7.1
	Other/more than one race	278	10.2
	Missing	4	–
Ethnicity	Hispanic	447	16.5
	Non-Hispanic	2266	83.5
	Missing	9	–
Born in the United States	No	189	7.0
	Yes	2529	93.0
	Missing	4	–
Either parent born outside the United States	No	2058	76.5
	Yes	633	23.5
	Missing	31	–
Educational attainment	Less than high school	125	4.6
	High school degree/GED	536	19.7
	Some college/associates degree	870	32.0
	Bachelor's degree	757	27.9
	Graduate school	429	15.8
	Missing	5	–
	Annual income	\$0 - \$19,999	331
	\$20,000 - \$49,999	673	25.1
	\$50,000 - \$74,999	558	20.9
	\$75,000 to \$99,999	456	17.0
	\$100,000 or more	658	24.6
	Missing	46	–
Relationship status	Married/partnered	1403	51.6
	Divorced/separated/widowed	130	4.8
	Dating exclusively for >1 week	268	9.9
	Dating but not exclusively for >1 week	62	2.3
	Not currently dating and never been married	857	31.5
	Missing	2	–
	Employment status	Employed	1975
	Unemployed	310	11.4
	Homemaker/student	367	13.5
	Disabled/retired/other	66	2.4
	Missing	4	–
Sexual orientation	All others	441	16.5
	Straight/heterosexual	2225	83.5
	Missing	56	–
Have any form of health insurance	No	457	16.8
	Yes	2259	83.2
	Missing	6	–
Religious service frequency in past 12 months	Never	1406	51.8
	Less than once a month	643	23.7
	Once a month or more, but less than once a week	329	12.1
	Once a week or more	337	12.4
	Missing	7	–
Preference to receive health information in a language other than English	No	2516	92.5
	Yes	204	7.5
	Missing	2	–
Parental or guardian status	No	1596	58.7
	Yes	1123	41.3
	Missing	3	–
Geographic region	Midwest	583	21.4
	Northeast	435	16.0
	South	1072	39.4
	West	632	23.2
	Health literacy (ease or difficulty understanding written health information)	Very easy	952
	Not very easy	1630	60.1
	Other	131	4.8

**Table 1 (continued)**

Variable	Level	N = 2722	%
Health numeracy (ease or difficulty understanding medical statistics)	Missing	9	–
	Very easy	610	22.5
	Not very easy	2107	77.5
Have a regular health care provider	Missing	5	–
	No	1245	45.8
	Yes	1473	54.2
	Missing	4	–
Receipt of health care in the past 12 months	None	737	27.2
	At least 1 time	1977	72.8
	Missing	8	–
Receipt of the seasonal flu shot in past 12 months	No	1519	55.8
	Yes	1203	44.2
Receipt of a tetanus shot in the past 10 years	Don't know/not sure	301	11.1
	No	1005	36.9
	Yes	1416	52.0
Personal history of cancer	No	2539	93.4
	Yes	179	6.6
	Missing	4	–
Average score on vaccine attitudes scale	Mean	4.30	
	Median	4.27	
	Minimum	1	
	Maximum	6	
	Std dev	0.94	
	Missing	0	

**Table 2**  
Outcome Variables: SARS-CoV-2 behaviors and intentions.

Variable	Level	N = 2722	%
Receipt of any doses of the COVID-19 vaccine	No	2236	82.4
	Yes	477	17.6
	Missing	9	–
Likelihood of trying to get more information about a COVID-19 vaccine	Level	N = 2236	%
	Very unlikely	318	14.2
	Somewhat unlikely	139	6.2
	A little unlikely	123	5.5
	Neither unlikely nor likely	271	12.1
	A little likely	276	12.4
	Somewhat likely	411	18.4
Likelihood of receiving a COVID-19 vaccine in the next year	Very likely	695	31.1
	Missing	3	–
	Very unlikely	407	18.3
	Somewhat unlikely	142	6.4
	A little unlikely	97	4.4
	Neither unlikely nor likely	288	13.0
	A little likely	253	11.4
Likelihood of receiving a COVID-19 vaccine in the next year if your healthcare provider strongly recommended it	Somewhat likely	346	15.6
	Very likely	690	31.0
	Missing	13	–
	Very unlikely	337	15.1
	Somewhat unlikely	132	5.9
	A little unlikely	120	5.4
	Neither unlikely nor likely	297	13.3
Likelihood of receiving a COVID-19 vaccine in the next year if your healthcare provider strongly recommended it	A little likely	235	10.5
	Somewhat likely	329	14.8
	Very likely	780	35.0
	Missing	6	–

covariates. Higher odds of receiving at least one dose of the vaccine related to gender identity (male [adjusted odds ratio (aOR) 1.46, 95% CI 1.15–1.84] compared to female), higher education, especially graduate school education (aOR 6.33, 95% CI 2.16–18.57) or bachelor's degree (aOR 3.39, 95% CI 1.17–9.84) compared to less than high school, sexual minority status (aOR 1.42, 95% CI 1.03–1.95), religious



observance (example aOR 1.44, 95% CI 1.09–1.89 for attending religious services less than once a month vs. never), preferring health information in a language other than English (aOR 2.33, 95% CI 1.60–3.37), high self-reported health literacy (aOR 1.41, 95% CI 1.09–1.82), visiting a healthcare provider over the past year (aOR 1.38, 95% CI 1.02–1.86), and receiving an influenza vaccine in the past year (aOR 2.86, 95% CI 2.24–3.64). By contrast, being unemployed (aOR 0.24, 95% CI 0.12–0.49) or a homemaker or student (aOR 0.68, 95% CI 0.46–1.00) compared to being employed, and earning lower or middle annual income (aOR 0.64, 95% CI 0.45–0.92 for \$20,000 - \$49,999 compared to \$100,000 or more; aOR 0.72, 95% CI 0.52–1.00 for \$50,000–\$74,999 and aOR 0.74, 95% CI 0.53–1.02 for \$75,000–\$99,999) were associated with lower odds of being vaccinated. Model details are shown in Table 3.

3.3. Factors associated with SARS-CoV-2 vaccine intentions

Among unvaccinated individuals, greater self-reported intentions of getting a SARS-CoV-2 vaccine in the next year were associated with positive vaccine attitudes (aOR 3.70, 95% CI: 3.33–4.11), gender identity – particularly male gender (aOR 1.23, 95% CI: 1.04–1.46), higher levels of education including bachelor's degree (aOR 1.74, 95% CI: 1.18–2.55) or graduate school (aOR 2.82, 95% CI: 1.82–4.37), non-heterosexual sexual orientation (aOR 1.55, 95% CI: 1.23–1.95), and receiving the influenza vaccine in the past year (aOR 1.90, 95% CI: 1.60–2.27). Lower likelihood of intentions to receive the vaccine was related to U.S.-born status (aOR 0.64, 95% CI: 0.47–0.88), being a parent (aOR 0.81, 95% CI 0.68–0.96), and high health literacy (aOR 0.74, 95% CI: 0.62–0.88). Vaccine intentions varied by geographic region and were lower for participants living in the South (aOR 0.61, 95% CI: 0.50–0.76), Midwest (aOR 0.66, 95% CI: 0.52–0.85), or Northeast (aOR 0.81, 95% CI 0.62–1.05) compared to the West (see Table 4).

3.4. Factors associated with SARS-CoV-2 vaccine intentions with healthcare provider recommendation

Additionally, unvaccinated participants were asked their intentions of getting the SARS-CoV-2 vaccine when it was strongly recommended by their healthcare provider. Details are provided in Table 5. Results were similar, with higher reported vaccination intention odds associated with positive vaccine attitudes (aOR 3.96, 95% CI:3.55–4.42), male gender (aOR 1.32, 95% CI: 1.11–1.57), higher education (aOR 1.83, 95% CI 1.21–2.77 for bachelor's degree vs. less than high school; aOR 2.55, 95% CI 1.60–4.08 for graduate education), non-heterosexual sexual orientation (aOR 1.71, 95% CI: 1.34–2.17), receiving the flu vaccine (aOR 1.85, 95% CI: 1.54–2.22), and geographic region, with the highest intentions in the West (Table 5). High self-reported health literacy was similarly negatively associated with vaccine intentions (aOR 0.75, 95% CI 0.63–0.90). However, parental status, was no longer in the model. Additionally, unlike the model for vaccination intentions without a strong provider recommendation, employment and income were predictors in this model. Odds ratios increased with each income group, with the highest odds corresponding to the highest income group (>\$100 k). Unemployed participants, homemakers, and students were associated with higher self-reported odds of seeking a vaccine if their healthcare provider strongly recommended it compared to employed participants. Finally, unlike the intentions model lacking provider recommendation, which was associated with participant U.S.-born status, this model for intentions with strong provider recommendation was instead associated with having a parent born outside of the U.S. (aOR 1.30, 95% CI 1.07–1.59).

3.5. Factors associated with seeking additional SARS-CoV-2 vaccine information

Finally, higher self-reported likelihood of seeking additional

**Table 3**  
Predictors of SARS-CoV-2 vaccine receipt in multivariable analysis.\*\*\*

Covariate	Level	Odds ratio (95% CI)	OR p-value	Overall p-value
Gender identity	Male	1.46 (1.15–1.84)	<b>0.002</b>	<b>0.006</b>
	Transgender/other	0.83 (0.23–2.97)	0.772	
	Female	–	–	
Educational attainment	High school degree/GED	1.77 (0.60–5.23)	0.301	<b>&lt;0.001</b>
	Some college/associates degree	2.48 (0.86–7.13)	0.092	
	Bachelor's degree	3.39 (1.17–9.84)	<b>0.025</b>	
	Graduate school	6.33 (2.16–18.57)	<b>&lt;0.001</b>	
	Less than high school	–	–	
Annual income	\$0 - \$19,999	0.98 (0.61–1.56)	0.927	0.063
	\$20,000 - \$49,999	0.64 (0.45–0.92)	<b>0.015</b>	
	\$50,000 - \$74,999	0.72 (0.52–1.00)	0.053	
	\$75,000 to \$99,999	0.74 (0.53–1.02)	0.069	
	\$100,000 or more	–	–	
Employment status	Unemployed	0.24 (0.12–0.49)	<b>&lt;0.001</b>	<b>&lt;0.001</b>
	Homemaker/student	0.68 (0.46–1.00)	0.051	
	Disabled/retired/other	0.48 (0.18–1.28)	0.144	
	Employed	–	–	
Sexual orientation	All others	1.42 (1.03–1.95)	<b>0.031</b>	<b>0.031</b>
	Straight/heterosexual	–	–	
Health insurance status	Insured	1.50 (0.99–2.29)	0.057	0.057
	Uninsured	–	–	
Religious service attendance	Less than once a month	1.44 (1.09–1.89)	<b>0.009</b>	0.056
	Once a month or more, but less than once a week	1.27 (0.90–1.78)	0.176	
	Once a week or more	1.04 (0.72–1.50)	0.846	
	Never	–	–	
Preference to receive health information in a language other than English	Yes	2.33 (1.60–3.37)	<b>&lt;0.001</b>	<b>&lt;0.001</b>
	No	–	–	
Health literacy (ease or difficulty understanding written health information)	Very easy	1.41 (1.09–1.82)	<b>0.009</b>	<b>0.021</b>
	Other	0.78 (0.36–1.71)	0.538	
Health numeracy (ease or difficulty understanding medical statistics)	Very easy	1.28 (0.97–1.70)	0.082	0.082
	Not very easy	–	–	
Receipt of health care in the past 12 months	At least 1 time	1.38 (1.02–1.86)	<b>0.034</b>	<b>0.034</b>
	None	–	–	
Receipt of the seasonal flu shot in past 12 months	Yes	2.86 (2.24–3.64)	<b>&lt;0.001</b>	<b>&lt;0.001</b>
	No	–	–	

\* Number of observations in the original data set = 2722. Number of observations used = 2577.

\*\* Bold indicates that the p-value was less than 0.05.

**Table 4**  
Predictors of likelihood to get a SARS-CoV-2 vaccine in the next year in multivariable analysis.<sup>a</sup>

Variable	Level	Odds ratio estimate	95% Wald confidence limits		Overall p-value
Gender identity	Male vs. female	1.23	1.04	1.46	<b>0.038</b>
Gender	Transgender/other vs. female	1.41	0.70	2.87	
U.S. born	Yes vs. no	0.64	0.47	0.88	<b>0.006</b>
Education	High school degree/GED vs. less than high school	0.97	0.66	1.42	<b>&lt;0.001</b>
	Some college/associates degree vs. less than high school	0.96	0.66	1.39	
	Bachelor's degree vs. less than high school	1.74	1.18	2.55	
	Graduate school vs. less than high school	2.82	1.82	4.37	
Sexual orientation	All others vs. straight/heterosexual	1.55	1.23	1.95	<b>&lt;0.001</b>
Parental status	Yes vs. no	0.81	0.68	0.96	<b>0.017</b>
Geographic region	Midwest vs. west	0.66	0.52	0.85	<b>&lt;0.001</b>
	Northeast vs. west	0.81	0.62	1.05	
	South vs. west	0.61	0.50	0.76	
Health literacy	Very easy vs. not very easy	0.74	0.62	0.88	<b>0.003</b>
	Other vs. not very easy	0.91	0.64	1.30	
Flu shot receipt in past year	Yes vs. no	1.90	1.60	2.27	<b>&lt;0.001</b>
Average score on vaccine attitudes scale		3.70	3.33	4.11	<b>&lt;0.001</b>

<sup>a</sup> Bold indicates that the p-value was less than 0.05.

information on the SARS-CoV-2 vaccine (Table 6) was associated with male gender (aOR 1.26, 95% CI 1.07–1.49), higher education (with increasing odds ratios for each level), income (with lower information seeking for all levels below \$100,000 annually), non-heterosexual orientation (aOR 1.47, 95% CI 1.17–1.84), prior year influenza vaccine (aOR 1.44, 95% CI 1.21–1.71), having a regular healthcare provider (aOR 1.16, 95% CI 0.99–1.36), and positive vaccine attitudes (aOR 2.84, 95% CI:2.58–3.14); Lower likelihood of information seeking was associated with being U.S.-born (aOR 0.69, 95% CI 0.51–0.93), and geographic region, particularly the Midwest (aOR 0.72, 95% CI 0.56–0.91), South (aOR 0.82 95% CI 0.67–1.01), or Northeast (aOR 0.80, 95% CI 0.62–1.04) compared to the West.

#### 4. Discussion

The primary goal of the current analyses were to examine associations between sociodemographic variables, healthcare experiences, health literacy, numeracy, vaccine attitudes, and SARS-CoV-2 vaccine uptake and intentions among young and mid-age adults in the U.S. At the time these data were collected, 17.6% of participants reported that they had received at least one dose of a SARS-CoV-2 vaccine. This finding was consistent with a Household Pulse Survey conducted in March 2021 which reported vaccination rates of 17% among adults ages 18–25 (Adams et al., 2021). Among unvaccinated young and mid-age adults, nearly one-quarter reported that they were somewhat or very unlikely to receive the vaccine in the next year, and nearly one-fifth

**Table 5**  
Predictors of likelihood to get a SARS-CoV-2 vaccine in the next year with a strong healthcare provider recommendation in multivariable analysis.

Variable	Level	Odds ratio estimate	95% Wald confidence limits		Overall <sup>a</sup>
Gender identity	Male vs. female	1.32	1.11	1.57	<b>0.002</b>
	Transgender/other vs. female	1.96	0.92	4.18	
Parent born outside of U.S.	Yes vs. no	1.30	1.07	1.59	<b>0.008</b>
Education	High school degree/GED vs. less than high school	1.15	0.77	1.71	<b>&lt;0.001</b>
	Some college/Associate's degree vs. less than high school	1.01	0.69	1.49	
	Bachelor's degree vs. less than high school	1.83	1.21	2.77	
	Graduate school vs. less than high school	2.55	1.60	4.08	
Annual income	\$0 - \$19,999 vs. \$100,000 or more	0.70	0.51	0.96	0.072
	\$20,000 - \$49,999 vs. \$100,000 or more	0.70	0.54	0.91	
	\$50,000 - \$74,999 vs. \$100,000 or more	0.79	0.61	1.03	
	\$75,000 to \$99,999 vs. \$100,000 or more	0.89	0.67	1.17	
Employment status	Unemployed vs. employed	1.49	1.15	1.94	<b>0.003</b>
	Homemaker/student vs. employed	1.41	1.10	1.81	
	Disabled/retired/other vs. employed	1.32	0.77	2.26	
Sexual orientation	All others vs. straight/heterosexual	1.71	1.34	2.17	<b>&lt;0.001</b>
Geographic region	Midwest vs. west	0.74	0.58	0.95	<b>0.019</b>
	Northeast vs. west	0.88	0.67	1.16	
	South vs. west	0.72	0.58	0.90	
Health literacy	Very easy vs. not very easy	0.75	0.63	0.90	<b>0.008</b>
	Other vs. not very easy	0.88	0.61	1.28	
Flu shot receipt in past year	Yes vs. no	1.85	1.54	2.22	<b>&lt;0.001</b>
Average score on vaccine attitudes scale		3.96	3.55	4.42	<b>&lt;0.001</b>

<sup>a</sup> Bold indicates that the p-value was less than 0.05.

reported that they were somewhat or very unlikely to seek more information about the vaccine. Similarly, the March 2021 Household Pulse Survey revealed that approximately 24% of young adults surveyed reported they probably or definitely would not receive the SARS-CoV-2 vaccine (Adams et al., 2021). Other studies have also reported significant rates of hesitancy to receive the vaccine (Fisher et al., 2020; Daly and Robinson, 2020; Khubchandani et al., 2021), although ours was among the first studies conducted after a vaccine was approved for use and distribution. Our findings indicated that even in the context of a strong provider recommendation, around 26% of the participants were still unlikely (very unlikely, somewhat unlikely, or a little unlikely) to

**Table 6**  
Predictors of likelihood to try to get more information about a SARS-CoV-2 vaccine in multivariable analysis.

Variable	Level	Odds ratio estimate	95% Wald confidence limits		Overall p-value <sup>a</sup>
Gender identity	Male vs. female	1.26	1.07	1.49	0.015
	Transgender/other vs. female	1.47	0.75	2.91	
U.S. born	Yes vs. no	0.69	0.51	0.93	<b>0.016</b>
Education	High school degree/ GED vs. less than high school	1.12	0.76	1.64	<b>&lt;0.001</b>
	Some college/ Associate's degree vs. less than high school	1.22	0.84	1.76	
	Bachelor's degree vs. less than high school	1.67	1.13	2.46	
	Graduate school vs. less than high school	2.51	1.61	3.90	
Annual income	\$0 - \$19,999 vs. \$100,000 or more	0.76	0.57	1.03	0.053
	\$20,000 - \$49,999 vs. \$100,000 or more	0.69	0.54	0.88	
	\$50,000 - \$74,999 vs. \$100,000 or more	0.76	0.59	0.98	
	\$75,000 to \$99,999 vs. \$100,000 or more	0.75	0.58	0.98	
Sexual orientation	All others vs. straight/heterosexual	1.47	1.17	1.84	<b>&lt;0.001</b>
Geographic region	Midwest vs. west	0.72	0.56	0.91	<b>0.047</b>
	Northeast vs. west	0.80	0.62	1.04	
	South vs. west	0.82	0.67	1.01	
Have a regular health care provider	Yes vs. no	1.16	0.99	1.36	0.068
Current flu shot	Yes vs. no	1.44	1.21	1.71	<b>&lt;0.001</b>
Average score on vaccine attitudes scale		2.84	2.58	3.14	<b>&lt;0.001</b>

<sup>a</sup> Bold indicates that the p-value was less than 0.05.

get the SARS-CoV-2 vaccine. This highlights the need to further explore factors toward vaccine acceptability and to craft appropriate information for decision-making among individuals with concerns about the vaccine.

It is possible that trust in the vaccine may have begun to increase following full FDA approval of the vaccine, as these data were collected following EUA approval (February 25–March 24, 2021). By February 25, 2021, 5.6% of individuals aged 18–24 had received at least one dose of the vaccine and 3.2% had completed the series, 10.8% of individuals aged 25–39 had received at least one dose and 6.8% had completed the series, and 13.4% of individuals aged 40–49 years had received at least one dose and 8.3% had completed the series (Centers for Disease Control and Prevention, 2021a, 2021b). By March 24, 2021, 13.0% of individuals aged 18–24 had received at least one dose of the vaccine and 5.7% had completed the series, 21.3% of individuals aged 25–39 had received at least one dose and 11.0% had completed the series, and 28.0% of individuals aged 40–49 had received at least one dose and 14.1% had completed the series (Centers for Disease Control and Prevention, 2021a, 2021b). During the time of survey administration, accessibility to the vaccine was highly variable due to the inconsistencies in prioritization of groups for COVID-19 vaccination and rate of vaccine rollout between individual U.S. states. While all U.S. states prioritized healthcare workers and those in long-term care facilities as directed by federal guidelines, many states did not include essential workers in priority lists. Additionally, there was variability across states in prioritization of individuals with underlying medical conditions and socially vulnerable groups, such as those living in congregate settings (e.g., assisted living facilities, homeless shelters, correctional facilities). The omission of socially vulnerable groups from

priority lists as per Federal guidelines may have resulted in barriers to vaccine access for this population throughout the U.S. (Jain et al., 2021). As of November 1, 2021, U.S. vaccination rates among young and mid-age adults was 55.9% of individuals aged 18–24, 60.1% of individuals aged 25–39, and 68.6% of individuals 40–49 years (vaccinated with at least two doses) (Centers for Disease Control and Prevention, 2021a, 2021b), respectively.

Our findings of SARS-CoV-2 vaccine hesitancy are consistent with a Texas study examining SARS-CoV-2 vaccine hesitancy among low-income women, which also found high rates of hesitancy regardless of physician recommendation. Women who were hesitant wanted to learn more about the vaccine and proof that it worked before they chose to accept it (Berenson et al., 2021). These are interesting findings considering that prior studies have found a doctor's recommendation to be one of the most significant predictors in vaccination behaviors (Head et al., 2020). In this case, health care providers have an opportunity to address patients' concerns and questions about the safety and efficacy of the SARS-CoV-2 vaccine and counsel patients on the importance of getting the vaccine. In addition, given the role of vaccine attitudes in decision-making, efforts should combat misinformation (Pickles et al., 2021), depoliticize the vaccine and the pandemic, consistently highlight the benefits, safety, and efficacy of the vaccine, and utilize plain language in multiple languages, and discuss how the vaccine is a highly effective way to protect oneself and others from serious COVID-19 illness, hospitalization, and death. In addition, ensuring that the vaccine is equitably available in convenient locations in myriad neighborhood locations/settings (e.g., mobile sites, libraries, neighborhood centers, etc.) will also be important to increasing uptake. The significant proportion of individuals who remain hesitant raises a major challenge of ensuring that enough of the population will be vaccinated to achieve herd immunity (Fisher et al., 2020) and to reduce the likelihood of development and spread of variants (Krause et al., 2021). Therefore, it is an utmost priority for public health professionals to improve overall trust in the vaccine.

Our findings revealed that several sociodemographic and health behavior variables were associated with likelihood of receipt of a SARS-CoV-2 vaccine and intentions to seek more information on or receive the vaccine within the next year. A number of healthcare-related variables, including having health insurance, visiting a healthcare provider in the last year, and receiving an influenza vaccine in the past year were associated with receipt of a vaccine relatively early in the vaccine roll-out. This may suggest that individuals with access to healthcare are more likely to engage in preventive health behaviors, including receipt of the SARS-CoV-2 vaccine. This is consistent with other literature that found that positive health behaviors tend to cluster together and those who engage in one preventive behavior are likely to engage in another as well (Kasting et al., 2020).

Additionally, having a high school degree or GED, low to moderate income (\$20,000 to \$99,999), and being in an employment class other than employed were associated with lower odds of being vaccinated relatively early in the vaccine roll-out. These findings are consistent with prior studies which also reported that lower education (Head et al., 2020; Khubchandani et al., 2021), unemployment status (Daly and Robinson, 2020), and low income (Khubchandani et al., 2021) were associated with lower acceptance rates of the SARS-CoV-2 vaccine and/or intentions to receive the SARS-CoV-2 vaccine (Malik et al., 2020). It may also be that the relationship between vaccine status and employment was due to individuals receiving the vaccine through their employer. Further, our findings interestingly indicated that high self-reported health literacy (i.e., difficulty in understanding written health information) and numeracy (i.e., difficulty in understanding medical statistics) were associated with early receipt of the vaccine, but high health literacy was associated with lower vaccine intentions among the unvaccinated. Targeted vaccine communication strategies should take into account the levels of health literacy and health status among those who have not been vaccinated, as well as address the specific



concerns or misconceptions they may have about the vaccine.

The SARS-CoV-2 pandemic has highlighted multiple health and structural inequities in the U.S., with racial and ethnic minorities experiencing higher rates of hospitalization, admission to an intensive care unit, and death in the first year of the pandemic compared to White individuals (Acosta et al., 2021). Another study found an interaction between race/ethnicity and educational attainment related to death from COVID-19 (Chen et al., 2021). Furthermore, there are noted disparities in vaccine access with individuals in counties with higher degrees of social vulnerability than those with less social vulnerability (Barry et al., 2021; Hughes et al., 2021). Identifying trusted information sources who can build confidence in the vaccine and increase acceptability among socially and economically disadvantaged groups will also be a key factor in improving vaccine uptake rates (Lazarus et al., 2021).

Evidence-based communication strategies should be utilized to address the underlying reasons for negative perceptions of the SARS-CoV-2 vaccine. For example, it is imperative to ensure that spreading misinformation is avoided and that messaging to community members from socially and economically disadvantaged groups is thoughtful and reliable in order to improve trust in both the vaccine and in healthcare professionals and health officials. Participants in the current study were more likely to seek out the vaccine or more information if they had positive attitudes about vaccines in general. Thus, messaging aimed at increasing vaccine uptake should emphasize the benefits of vaccination, including that being vaccinated means not only protecting oneself, but others as well, and that vaccines are safe and effective.

#### 4.1. Limitations

To the best of our knowledge, this is among the first reports of SARS-CoV-2 vaccine intentions and behaviors following EUA and amid early vaccine roll-out collected from a large national sample of young and mid-age adults. However, this study had several limitations to consider. First, the data are cross-sectional, meaning causality cannot be inferred. Second, even though we sought to include participants who were nationally representative, participation was limited to those ages 18–45, Ipsos panelists, those who can speak, read, and understand English, and those with internet access, which may limit generalizability. Additionally, some participants ( $n = 1278$ , 32.0%) were deemed to have unreliable survey responses and removed from our final analytic sample, which could have introduced unavoidable sampling bias if their true but unknown answers differ systematically from respondents who fill out the survey in good faith. It is possible that our data cleaning procedures may not have identified all cases of unreliable data. Further, we did not assess SARS-CoV-2 vaccine-specific knowledge, information sources, and attitudes. Lastly, this study is limited by the constantly changing context of SARS-CoV-2 vaccine information and availability as the survey was administered shortly after EUA of the SARS-CoV-2 vaccine.

#### 5. Conclusions

Overcoming the COVID-19 pandemic will be largely dependent on widespread vaccine uptake. Our findings indicated that there are a number of variables associated with early SARS-CoV-2 vaccine receipt and intentions to receive the vaccine. Among a sample of diverse U.S. adults, about one-sixth had received the vaccine, and about one-fourth of unvaccinated adults reported being unlikely to receive the vaccine or seek out more information about the vaccine. Lower educational attainment, lower income, and having an employment status other than employed were associated with lower vaccine receipt. Conversely, receiving regular health care or other preventive services and health insurance were associated with higher likelihood of vaccine receipt, along with high self-reported literacy and numeracy. Within individuals who were unvaccinated, intentions to receive the COVID-19 vaccine were associated with positive vaccine attitudes, gender identity, education, income, sexual orientation, geographic location, health literacy,

and receipt of a seasonal influenza vaccine. Public health officials and health care providers should assess the multitude of factors related to SARS-CoV-2 vaccine receipt and intentions to identify individuals who may benefit from targeted educational interventions aimed at increasing vaccine uptake.

#### Statement of human rights

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.

#### CRediT authorship contribution statement

**Naomi C. Brownstein:** Methodology, Data curation, Writing – original draft, Writing – review & editing, Funding acquisition. **Harika Reddy:** Data curation, Writing – original draft. **Junmin Whiting:** Methodology, Software, Formal analysis, Data curation, Writing – review & editing. **Monica L. Kasting:** Writing – review & editing, Funding acquisition. **Katharine J. Head:** Writing – review & editing, Funding acquisition. **Susan T. Vadaparampil:** Writing – review & editing, Funding acquisition. **Anna R. Giuliano:** Writing – review & editing. **Clement K. Gwede:** Writing – review & editing. **Cathy D. Meade:** Writing – review & editing. **Shannon M. Christy:** Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing, Project administration, Supervision, Funding acquisition.

#### Declaration of Competing Interest

The authors have no conflicts of interest to declare.

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