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Factors associated with COVID-19 vaccination intentions among adults in the deep South

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ABSTRACT

The recent approval of several COVID-19 vaccines signals progress toward controlling the pandemic. Although social distancing and masking have been effective, vaccines are an important additional measure of protection to reduce COVID-19 spread. Adequate uptake is essential to reach herd immunity, estimated to be approximately 67%. However, vaccine hesitancy, the fast-tracked nature of the COVID-19 vaccines, and misinformation circulating through various forms of media have contributed to lower vaccination intention than desired. The current research study developed an online survey conducted via Facebook to explore the attitudes and perceptions of adult Alabama residents about COVID-19 and the COVID-19 vaccines. Of the 3,781 respondents, only 44.3% reported intent to receive a vaccine, with a large proportion reporting they were unsure (28.1%). Lack of intention to vaccinate was associated with low educational attainment, low COVID-19 knowledge levels, low income, and African American race. The current survey also explored participants' influenza vaccine behavior as this information can also be used to inform successful COVID-19 vaccine distribution. Of the respondents, 56% report receiving the yearly influenza vaccine and the majority receive it at a pharmacy or healthcare provider office. This informs likely successful locations for COVID-19 vaccine distribution. Appropriate education targeted to populations most likely to refuse COVID-19 vaccination is essential to promote uptake. The information collected from the current study should be utilized to inform effective and efficient vaccine distribution strategies.

1. Introduction

SARS-CoV-2 is a novel coronavirus, a respiratory virus first identified in Wuhan, China in December 2019, and the cause of COVID-19 [1]. The first case in the United States (US) was confirmed on January 20, 2020 [2]. The U.S. has since sustained almost 30 million cases and over 500,000 deaths, with over 500,000 cases and over 10,000 deaths in Alabama, alone [3,4]. These numbers continue to rise, indicating the ongoing presence of COVID-19 [3,4].

COVID-19 is spread primarily through respiratory droplets by individuals nearby;[5] however, evidence shows the virus can also spread via airborne transmission as far as 10 m [6]. Current estimates place the mortality rate for those with symptomatic infections at between 2.3% and 7.2%, with acute respiratory distress syndrome (ARDS) as the leading cause of death [7]. This is roughly 10 times higher than the seasonal flu [8]. Unlike the seasonal flu, the COVID-19 virus appears to cause long term disability as well. Sometimes referred to as "Post-COVID Syndrome" (PCS), survivors may experience fatigue, body aches, shortness of breath, headache, hair loss, rash, and trouble sleeping, with some experiencing severe damage to the cardiovascular and respiratory systems [9,10]. Despite extensive, ongoing research, much remains unknown about COVID-19.

Preventive measures such as widespread masking and social distancing have demonstrated effectiveness in slowing but not halting the spread of COVID-19. Vaccination is a necessary intervention to slow the pandemic [11,12]. Mass vaccination, even for those who have been infected, is the key to safely reaching herd immunity. Approximately 67% of the population needs to be vaccinated to achieve herd immunity for COVID-19 [13]. Achieving this milestone in the United States will be difficult due to challenges associated with vaccination. These challenges include structural barriers and costs associated with the vaccine such as transportation, childcare, and administrative costs. While significant progress

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has been made in eliminating these barriers, vaccination still requires a personal decision on the part of the individual to accept vaccination.

Vaccine hesitancy, the unwillingness to accept a recommended vaccine in a timely fashion, is well-documented barrier to vaccination in the US [14–16]. Reasons for vaccine hesitancy include concerns about vaccine safety, including concern over potentially harmful ingredients, belief that healthy lifestyle and diet is sufficient to prevent disease, low perceived risk of disease, preference for natural immunity, mistrust of pharmaceutical companies, the government, and mainstream media, concerns of "overloading" the immune system, religious beliefs, limited belief in vaccine efficacy, and fear of injections [17,18]. Due to the rapid development and approval of the COVID-19 vaccines, concerns regarding the vaccine's safety profile may be amplified. Previous research has shown influenza vaccine uptake is positively influenced by past uptake, perceived benefits, social norms, and perceived social responsibility [18]. Currently, only 14% of the U.S. population is fully vaccinated while 25.7% have received at least one dose [19]. Among Alabama adults, 12.0% are fully vaccinated while 20.8% have received at least one dose [19,20]. Vaccine acceptance increases with increasing income and education level and those of African American descent express greater hesitancy compared with Whites [21]. These trends hold true even among healthcare workers [21].

The purpose of the current study was to determine factors associated with COVID-19 vaccine intentions in a population of adult Alabama residents, in order to inform the development of targeted behavioral and clinical interventions to reduce hesitancy and increase uptake.

2. Methods

2.1. Survey development

An electronic survey was developed using Research Electronic Data Capture (REDCap) software to identify Alabama residents' knowledge, attitudes, and perceptions regarding COVID-19 and the COVID-19 vaccines, as well as intention to receive a vaccine [22]. The survey was available for 17 days in November 2020 and took approximately 15 min to complete. Before initiating the survey, individuals were required to acknowledge receipt of, and agreement to, informed consent. People were eligible to participate if they were current residents of Alabama, 18 or older, English-speaking, and had a Facebook account. Participants were recruited using demonstrated effective methods through Facebook advertising strategies [23,24]. The study was approved by the University of South Alabama Institutional Review Board (PROTOCOL: 20–402).

2.2. Measures

The primary outcome of interest was intent to receive COVID-19 vaccination when presented with the opportunity. Participants were given the response options: "Yes," "No," or, "Don't know/Not sure," to the question, "When an FDA-approved vaccine for COVID-19 becomes available, will you get it?" Explanatory measures included *demographics* (age, sex, race, educational attainment, marital status, income, employment, health insurance, healthcare engagement, general attitudes regarding vaccine acceptability, rurality), *influenza vaccine behaviors/attitudes* (history of influenza vaccination, influenza vaccine intentions of self as well as dependents, motivators/barriers to vaccine receipt, typical location of vaccine receipt, effect of COVID-19 pandemic on influenza vaccine intentions), *COVID-19 knowledge* (assessed by 11 agree/disagree statements), *COVID-19 perceptions/beliefs* (assessed by 15, 5-point Likert scale questions with responses ranging from 'Strongly Disagree' to 'Strongly Agree'), *preventive behaviors* (assessed by 8, 5-point Likert scale questions referring to participation in each behavior *due to COVID-19* in the two weeks prior, with responses ranging from 'Very Frequently' to 'Never'), *personal COVID-19 impact* (history of positive tests, subjective likelihood of contracting COVID-19 in the next 6 months), and *COVID-19 vaccine influences* (location of vaccine receipt and motivators of self). Measures included on the final survey consisted of original questions and measures adapted from previous studies [18]. Due to small sample sizes, the race categories, "American Indian or Alaska Native," "Asian," "More than one race," and, "Other," were combined to form the "Other" category used for analysis. Similarly, "Some school" and "High school graduate" were combined in the education attainment category, "Unemployed" and "Disabled" were combined in the employment status category, "Very poor" and "Poor" were combined in the health rating category, and "Very liberal" and "Liberal" were combined, as were "Very conservative" and "Conservative," in the political views category. Rurality was determined by Rural-Urban Commuting Area designations of participants' provided zip code ("urban" designated by codes 1–3 and "rural" by codes 4–10) [25]. A summary score was created for the 11 knowledge questions by calculating the sum of correct responses. Sums for participants with unanswered questions were adjusted to 11 based on percent correct (excluding participants with>3 omitted responses). A preventive practices summary score was also created to assess the frequency by which participants engaged in preventive behaviors such as hand washing, wearing a face mask in public or small gatherings, avoidance of grocery shopping or dining in-person, wearing gloves, frequent disinfection of surfaces, and avoiding gatherings of 10 or more people. Responses were categorized numerically (1 = "Very frequently" and 5 = "Very Rarely") and the mean score recorded for the 8 assessed practices. Means were then grouped by quintile to create 5 even bins for analysis. At survey completion, participants had the option to be entered into a drawing for one of 200 Visa gift cards each worth $25. Survey responses were not linked to any identifying information.

2.3. Recruitment strategy and advertisement design

Facebook's advertising platform was used to distribute the survey and recruit participants based on prior studies' demonstrated success and the majority of Alabama's population older than 18 years of age being registered on Facebook (61.2%-71.4%) [23,24,26]. Facebook runs advertisements across multiple channels and applications, including Facebook and Instagram feeds, Facebook Messenger, user stories, and on apps within the Facebook Audience Network. To mitigate the overrepresentation of females and individuals of European descent common to survey research, the current advertising strategy oversampled men and minorities [27].

A total of three advertisements were designed, composed of: a brief overview of the survey, a single image, a headline reading, "Alabama COVID-19 Survey," and a website URL that would take the participant to the survey (Fig. 1). Images varied by advertisement, depending on the targeted audience. Images were pilot tested on local individuals who met the inclusion criteria (n = 33).

2.4. Advertising campaign

The advertisements were live for a total of 17 days. Ad 1 ran unaltered for the full 17 days, amassing 2,633 clicks on a budget of $1,440.39. Ad 2, targeting males, also ran for the full 17 days, but the image was changed on the third day to boost advertisement interaction. Ad 2 amassed 2,607 clicks on a budget of

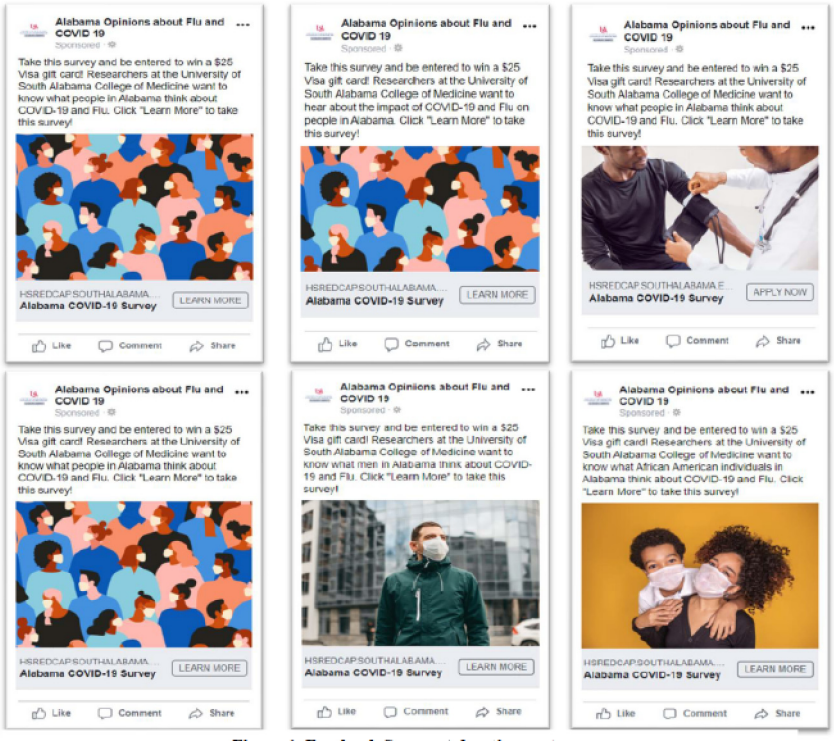

Fig. 1. Facebook Survey Advertisements. Top row, from left to right: initial forms of Ads 1, 2, and 3. Bottom row, from left to right: final forms of Ads 1, 2, and 3 (Ad 1 format unchanged).

$1,379.11. Ad 3 was created on the fifth day to appeal more to ethnic minorities who were not responding well to Ads 1 and.

2.5. It ran for 12 days, amassing 1,086 clicks on a budget of $955.56

Throughout the advertising campaign, comments from Facebook users on the advertisements were hidden to reduce bias due to COVID-19's polarizing nature. Participants were encouraged to Facebook Message the ad's home page if communication with the study team was needed.

2.6. Statistical analysis

There were 3,952 survey respondents out of 6,326 advertisement link clicks (62.5% survey completion rate). Of these, 3,781 were included in the study (41 did not meet the Alabama residency requirement and 130 were excluded for not responding to the primary outcome of interest. Bivariate measures were assessed via χ^2 analyses to compare vaccination intent to respondents' demographic characteristics and responses to key survey questions. Multinomial logistic regression analyses were performed to assess determinants of vaccine hesitancy using the response of "Don't know/Not sure" for COVID-19 vaccination intent as the referent group. Both unadjusted and adjusted Odds Ratios (ORs) with 95% Wald confidence intervals (CI) were obtained and reported. Adjusted ORs (AORs) were adjusted for demographic information via complete case analysis. There were few missing data for most variables, with the exception of income (16% missing), age (9%) and political views (10%). AORs were not adjusted for income due to the high number of missing responses and the tendency for those responses to be missing not at random. Multicollinearity was assessed using a variance inflation factor (VIF) threshold of 2.5. Statistical significance was determined at $p < 0.05$; however, to mitigate the potentially increased risk of Type I error due to multiple testing, results were interpreted at the stricter level of $p < 0.001$. All statistics were performed via SAS Studio 3.1 (Cary, NC, USA).

3. Results

Of the 3,781 eligible respondents, the majority self-identified as female (65.3%) and White (88.6%). Black/African American respondents made up 6.0% of responses. Mean age was 54.5 years old (standard deviation: 15.4). The majority of participants (88.7%) had completed at least some college. Most respondents reported full-time employment (45.4%) or retirement (32.3%) and an annual household income of at least $50,000 before taxes (67%). Nearly 95% of respondents reported having health insurance. Over half (67.5%) of participants had health care visits at least twice a year, and 87.7% reported having a primary care provider for most of their healthcare. Over half (60.3%) reported their health as "good" (Table 1).

The majority of respondents reported they receive an influenza vaccine annually (61.8%) and cited prevention, recommendation by a healthcare provider, belief in the importance of vaccines, and preventing severe disease as the most common reasons for vaccination. Among participants who did not get an annual influenza vaccine, the most common reasons were: concerns about efficacy, side effects, and ingredients, as well as not believing they are at risk for influenza (Table 2). 66.4% of respondents reported they had already received an influenza vaccine or planned to be vaccinated this season. Additionally, 27.6% indicated that the COVID-19 pandemic made them more likely to get the influenza vaccine this year (Table 1). Participants were most likely to receive an influenza vaccine from their healthcare provider or at a pharmacy and indicated similar preferences for COVID-19 vaccination location (Table 2).

Table 1
Participant characteristics.

Variable (N = 3781)		N (%)
Age		
	18–34	445 (13.0)
	35–49	772 (22.5)
	50–64	1167 (34.0)
	65+	1049 (30.6)
Rural vs Urban zip code		
	Urban	2944 (78.6)
	Rural	803 (21.4)
Gender		
	Female	2470 (66.1)
	Male	1267 (33.9)
Race		
	White	3302 (90.8)
	Black or African American	198 (5.4)
	Other	136 (3.7)
Education		
	Graduate degree	947 (25.2)
	College graduate	1328 (35.3)
	Some college	1060 (28.2)
	Some school or high school graduate	422 (11.2)
Do you currently have health insurance?		
	Yes	3517 (94.4)
	No	210 (5.6)
Do you currently have a primary health care provider or clinic where you go for most of your healthcare?		
	Yes	3272 (87.7)
	No	460 (12.3)
How frequently do you see a healthcare provider?		
	4 + times per year	749 (20.3)
	2–3 times per year	1745 (47.2)
	1 time per year	648 (17.5)
	< 1 time per year	554 (15.0)
How would you rate your general health?		
	Excellent	704 (18.7)
	Good	2266 (60.3)
	Fair	686 (18.2)
	Poor	103 (2.7)
What is your marital status?		
	Married/living together	2592 (70.1)
	Never married	376 (10.2)
	Divorced or separated	493 (13.3)
	Widowed	236 (6.4)
Annual household income		
	Less than $20,000	262 (8.2)
	$20,000-$34,999	384 (12.1)
	$35,000-$49,000	402 (12.6)
	$50,000-$74,999	683 (21.4)
	$75,000-$99,000	584 (18.3)
	$100,000 or more	870 (27.3)
Employment status		
	Full-time employed/homemaker	1887 (51.3)
	Part-time employed	267 (7.3)
	Unemployed or disabled	293 (8.0)
	Student	55 (1.5)
	Retired	1176 (32.0)
How would you describe your political views?		
	Liberal	781 (23.0)
	Moderate	925 (27.2)
	Conservative	1694 (49.8)
Do you usually get a flu vaccine?		
	Yes	2326 (61.9)
	No	1430 (38.1)
Have you had or do you plan to get the flu vaccine this year?		
	Yes	2499 (66.4)
	No	1065 (28.3)
	Don't know/Not sure	198 (5.3)
How has the COVID-19 pandemic affected your likelihood of getting the flu vaccine this year?		
	Made me more likely to get it	1021 (27.6)
	Has not affected my likelihood	2432 (65.6)
	Made me less likely to get it	252 (6.8)
Have you ever tested positive for COVID-19?		
	No	3485 (92.8)
	Yes	272 (7.2)

How likely do you think it is that you could get COVID-19 in the next 6 months?		
	Very likely	339 (9.2)
	Somewhat likely	1690 (45.9)
	Not very likely	1010 (27.4)
	Very unlikely	469 (12.7)
	I have already had COVID-19	172 (4.7)
When an FDA-approved vaccine for COVID-19 becomes available, will you get it?		
	Yes	1676 (44.3)
	No	1044 (27.6)
	Don't know/not sure	1061 (28.1)

Both younger (18–34) and older (65 +) participants reported increased intention to vaccinate compared with those aged 35–49 and 50–64 (47.0% and 54.1% vs. 33.9% and 41.8%, respectively). Respondents living in rural areas were evenly split between the answer choices regarding COVID-19 vaccine intention and almost 10% more of those living in urban areas reported intention to vaccinate (46.3% vs. 37.4%). Race was a major factor and almost twice as many whites as African Americans reported intention to vaccinate (46.2% vs. 23.0%) and almost half (49.0%) of African American respondents were undecided. Among participants with post-graduate degrees, 60.7% reported intention to receive a COVID-19 vaccine vs. 45.6% of college graduates and 29.9% of those with a high school education or less. Almost half (49.0%) of participants without insurance reported not planning to receive a COVID-19 vaccine. (Table 3)

Unadjusted and adjusted ORs comparing "Yes" and "No" versus "Don't know/Not sure" are summarized in Table 4. Notable demographic factors influencing vaccine intention included education level and political views. Lower educational attainment was associated with an increased likelihood of "No" versus "Don't know/Not sure" (high school education or less versus graduate school AOR: 2.02, 95% CI: 1.33–3.05), and a decreased likelihood of "Yes" (AOR: 0.39, 95% CI: 0.28–0.55). Moderate or conservative political views were also associated with an increased likelihood of "No" versus liberal views (moderate AOR: 3.30, 95% CI: 1.93–5.64; conservative AOR: 7.85, 95% CI: 4.64–13.29) and a decreased likelihood of "Yes" (moderate AOR: 0.48, 95% CI: 0.36–0.62; conservative AOR: 0.28, 95% CI: 0.21–0.37).

Attitudes towards COVID-19 vaccination were highly correlated with attitudes towards the influenza vaccine. Respondents who said "No" to COVID-19 vaccine intention were over 9 times more likely to say "No" to having received or planning to receive an influenza vaccine this season (AOR: 9.07, 95% CI: 7.11–11.59) and almost 5 times more likely to say that the COVID-19 pandemic made them less likely to receive an influenza vaccine this year (AOR: 4.7, 95% CI: 2.69–8.21). Additionally, there was a high association with strong disagreement to the statement "COVID-19 is deadlier than the flu" (AOR: 19.44, 95% CI: 11.82–31.98). The opposite trends were observed for respondents who said "Yes" to COVID-19 vaccine intention.

Failure to engage in preventive behaviors was strongly associated with "No" responses (AOR: 12.67, 95% CI: 8.04–19.98) and negatively associated with "Yes" responses (AOR: 0.22, 95% CI: 0.14–0.33). A low knowledge composite score was also strongly associated with "No" responses (0–6 versus 11; AOR: 14.26, 95% CI: 8.66–23.48) and negatively associated with "Yes" responses (AOR: 0.10, 95% CI: 0.05–0.23). Specific knowledge questions demonstrating the highest association with "No" versus "Don't know/Not sure" included disagreeing with the statements "individuals should quarantine after exposure to someone with COVID-19" (AOR: 4.27, 95% CI: 3.10–5.88), "COVID-19 can live on surfaces such as counters and doorknobs" (AOR: 2.96, 95% CI: 2.19–4.00), "COVID-19 can cause lasting health issues even after recovery from the illness" (AOR: 3.92, 95% CI: 2.72–5.65), and "people with COVID-19 can infect others days before they start having symptoms" (AOR: 3.60, 95% CI: 2.54–5.11). Of those who responded "No" to vaccination intention, 70.4% (N = 707) disagreed that wearing a face mask helps to prevent the spread of COVID-19 (AOR: 6.79, 95% CI: 5.11–9.01).

Participants who replied "No" to COVID-19 vaccination intent were also more likely to strongly disagree with several statements about beliefs surrounding COVID-19, including "I am worried about spreading COVID-19 to others" (AOR: 12.71, 95% CI: 7.78–10.76), "COVID-19 is a serious disease" (AOR: 19.5, 95% CI: 10.48–36.29), "People do not take COVID-19 seriously enough" (AOR: 13.11, 95% CI: 8.08–21.25), and "I am worried about getting COVID-19" (AOR: 11.92, 95% CI: 7.34–19.34). Participants who replied "Yes" were more likely to strongly disagree that COVID-19 is a political issue (AOR: 2.08, 95% CI: 1.56–2.78).

4. Discussion

The current study focused on factors associated with COVID-19 vaccine intentions in a population of adult Alabama residents using an online, social media-based survey. The goal of this study was to identify these factors to facilitate development of targeted behavioral and clinical interventions to reduce vaccine hesitancy and increase uptake. Notable findings included the association between conservative political viewpoints, and lower COVID-19 knowledge level with less intention to vaccinate, as well as the association between intention to receive the influenza vaccine with intention to receive a COVID-19 vaccine.

>1 in 4 of the respondents did not believe that COVID-19 was deadlier than influenza. Further, over half of those stated they would not receive a COVID-19 vaccine. Paradoxically, over 5% of all respondents stated the pandemic made them less likely to get an influenza vaccine. This seemingly contradictory finding could be due to the politicized nature of the coronavirus pandemic; approximately half of respondents in this study reported a belief that COVID-19 is a political issue—consistent with other surveys [28,29]. Inconsistent messaging regarding COVID-19 infections and vaccines from the those in positions of power may have discouraged trust in vaccination. Self-reported conservatives were more likely than individuals identifying with other political views to report no intention to receive a COVID-19 vaccine, a finding which may reflect the timing of this survey but is in conflict with other surveys which indicate that belief in authority correlates with intent to receive the influenza vaccination [30]. Polarization across party lines has been seen with some influenza vaccine campaigns, with liberals more willing to be vaccinated than conservatives during the most recent swine flu scare and in current Kaiser Family Foundation Polls [31,32]. Our findings suggest that, in Alabama, political party identification is more important than trust in the government when estimating vaccination intent. To avoid this same issue in the future, public health messaging by the media and government officials should avoid fueling potentially damaging

Table 2
Participant attitudes towards the flu vaccine and location preferences for flu and COVID-19 vaccination.

Variable (N = 3781)	N (%)
Why do you get a flu shot?	
Required for work/school	251 (10.8)
To prevent flu	1797 (77.3)
Healthcare provider recommends it	892 (38.3)
Family/friends recommend it	237 (10.2)
Incentives/gift cards	180 (7.7)
Vaccines are important	1046 (45.0)
If you get the flu, it won't be as bad if you have had a flu shot	983 (42.3)
I don't want to risk getting others sick	779 (33.5)
I am immunosuppressed	146 (6.3)
I am considered at risk	392 (16.9)
Other	63 (2.7)
Prefer not to answer	4 (0.2)
Why do you not get a flu shot?	
I do not support vaccinations of any kind	85 (5.9)
I do not think flu shots are effective	524 (36.6)
It has made me feel bad in the past	308 (21.5)
Cost	39 (2.7)
Health insurance does not cover it	6 (0.4)
No convenient places for me to get it	14 (1.0)
No convenient times for me to get it	23 (1.6)
I am concerned I will get the flu from the vaccine	109 (7.6)
I don't get the flu so I don't need the vaccine	200 (14.0)
I have never gotten the flu vaccine	296 (20.7)
I don't like needles/it hurts	64 (4.5)
I am concerned about side effects	237 (16.6)
I don't think I will get very sick from the flu	179 (12.5)
Concerned about vaccine ingredients	243 (17.0)
Healthcare provider does not recommend it	17 (1.2)
Allergic to vaccine ingredients	81 (5.7)
I don't think about it/I forget	170 (11.9)
Other	106 (7.4)
Prefer not to answer	32 (2.2)
Where are you most likely to get a flu shot?	
Healthcare provider/regular clinic	1242 (41.7)
Urgent care	72 (2.4)
Health department	155 (5.2)
Chain pharmacy (Walgreen's, CVS, etc.)	810 (27.2)
Independent/community pharmacy	172 (5.8)
Pharmacy within a store (Wal-Mart, Publix, etc.)	768 (25.8)
My job	464 (15.6)
None of the above	228 (7.7)
Other	22 (0.7)
Prefer not to answer	24 (0.8)
Where would you be most likely to get a COVID-19 vaccine, if it were available?	
My healthcare provider/regular clinic	1974 (69.0)
Urgent care	334 (11.7)
Health Department	509 (17.8)
Chain pharmacy (such as Walgreen's, CVS, etc.)	938 (32.8)
Independent or community pharmacy	338 (11.8)
Pharmacy within a store (such as Wal-Mart, Publix, Target, etc)	739 (25.8)
Drive-thru vaccine clinic	546 (19.1)
None of the above	30 (1.0)
Other	132 (4.6)
Prefer not to answer	79 (2.8)

and dangerous attitudes. Regarding the current pandemic, our data suggest that individuals with conservative or moderate viewpoints may be in greatest need of targeting for pro-vaccine education to increase uptake; in the current sample, these groups expressed the greatest indecision toward receiving a COVID-19 vaccine.

Low COVID-19 knowledge levels were strongly associated with no intention to vaccinate, consistent with previous studies [33–35]. In addition, those with the lowest summary scores of the knowledge questions were more likely to say "No" to vaccine intent after adjusting for educational level. Misbeliefs about COVID-19 severity were also strongly correlated with intention to vaccinate. Disagreeing with the following phrases: "COVID-19 is a serious disease," "I am worried about spreading COVID-19 to others," "I am worried about getting COVID-19," and, "People do not take COVID-19 seriously enough," were all highly associated with no intention to receive a COVID-19 vaccine. This is consistent with other surveys which have demonstrated that participants without concern about the severity of the disease do not view the vaccine as a priority [36,37]. Our study also found higher educational attainment to be an important influencer of vaccination intent, consistent with the literature [38]. The interaction between knowledge level and education level and their influence on vaccine intentions for COVID-19 specifically have not been thoroughly explored [39]. Previous studies have demonstrated an association between low income and lack of intention to vaccinate, which may provide some explanation as income is strongly related to education level [34,38,40]. These results demonstrate the need for improved education about COVID-19, including the mechanisms of spread and sequelae, and implicate the need for targeted messaging to low-income populations in order to improve vaccine uptake.

The racial association of lower intention to vaccinate among African American participants reported here is also supported by previous work [35,36,41,42]. This is likely due in part to income and educational attainment disparities among African Americans compared to Whites [43]. However, the history of mistreatment at the hands of the medical community of this population, especially in Alabama, cannot be ignored [44–47]. Mistrust has already been documented relative to COVID-19 severity and vaccination in this population [48]. Lower intention to vaccinate and already lower uptake by African Americans could exacerbate the already present COVID-19 disparities in this population [44,49,50]. Our results underscore the need for targeted messaging and access for this population.

A high correlation was found between intention to receive an influenza vaccine and intention to receive a COVID-19 vaccine. The exploration of this relationship highlights attitudes that could be used both to reduce vaccine hesitancy as well as assist in identifying the best locations for COVID-19 vaccine distribution. Three of the top five reported reasons given to get the influenza vaccine included healthcare provider (HCP) recommendation; not wanting to give the illness to others; to lessen the severity of influenza should an individual get it. Strong HCP recommendations for vaccine receipt is a well-known positive driver of increased vaccine uptake, and these recommendations should be emphasized to increase COVID-19 vaccine uptake as well [51]. The desire to be protected from giving influenza to others illustrates a civic duty among this sample of Alabama residents that could be stressed by both the media and healthcare workers to increase receipt of the COVID-19 vaccine [52]. Approximately 4 out of 10 respondents stated that they receive an influenza vaccine in order to lessen the severity of the disease if they get it, offering another opportunity for messaging. The use of incentives is controversial with only larger incentives (i.e. $100 or more) being shown to increase general vaccine uptake [21]. Money may be better spent on targeted messaging.

The places survey respondents most reported getting an influenza vaccine were at a healthcare provider's office or clinic (42%) and at a pharmacy (up to 59%). These results were the same as locations noted for where participants stated they would be most likely to receive a COVID-19 vaccine, for reasons of convenience and ease of access [53]. The desire to recreate this for the COVID-19 vaccination efforts may be due to an increased comfort level in a familiar clinic or pharmacy coupled with the discomfort of the novel activity of receiving an injection in a car. Only 19% of

Table 3
Participant characteristics and survey frequencies according to intention to vaccinate.

	Plan to receive COVID-19 vaccine (N = 3,781)			
	Yes (%)	No (%)	Don't know/Not sure (%)	p-value
Age				
18–34	209 (13.7)	126 (13.3)	110 (11.5)	<0.0001
35–49	262 (17.2)	306 (32.3)	204 (21.3)	
50–64	488 (32.0)	335 (35.3)	344 (35.9)	
65+	568 (37.2)	181 (19.1)	300 (31.3)	
Rural vs Urban zip code				
Urban	1362 (81.9)	758 (73.4)	824 (78.3)	<0.0001
Rural	300 (18.1)	247 (26.6)	229 (21.7)	
Gender				
Female	1100 (33.9)	602 (41.4)	768 (26.6)	<0.0001
Male	563 (66.1)	426 (58.6)	278 (73.4)	
Race				
White	1526 (92.9)	881 (90.4)	895 (87.8)	<0.0001
Black or African American	47 (2.9)	54 (5.5)	97 (9.5)	
Other	69 (4.2)	40 (4.1)	27 (2.6)	
Education				
Graduate degree	575 (34.4)	149 (14.4)	223 (21.2)	<0.0001
College graduate	606 (36.3)	348 (33.7)	374 (35.5)	
Some college	364 (21.8)	363 (35.1)	333 (31.6)	
Some school or high school graduate	126 (7.5)	173 (16.7)	123 (11.7)	
Do you currently have health insurance?				
Yes	1615 (96.8)	907 (89.8)	995 (94.9)	<0.0001
No	53 (3.2)	103 (10.2)	54 (5.1)	
Do you currently have a primary health care provider or clinic where you go for most of your healthcare?				
Yes	1505 (90.4)	837 (82.5)	930 (88.4)	
No	160 (9.6)	178 (17.5)	122 (11.6)	
How frequently do you see a healthcare provider?				
4 + times per year	361 (21.8)	160 (15.9)	228 (21.9)	<0.0001
2–3 times per year	840 (50.8)	371 (37.0)	534 (51.4)	
1 time per year	274 (16.6)	204 (20.3)	170 (16.4)	
< 1 time per year	178 (10.8)	269 (26.8)	107 (10.3)	
How would you rate your general health?				
Excellent	266 (16.0)	280 (27.0)	158 (15.0)	<0.0001
Good	1038 (62.3)	589 (56.7)	639 (60.5)	
Fair	319 (19.2)	146 (14.1)	221 (20.9)	
Poor	42 (2.5)	23 (2.2)	38 (3.6)	
What is your marital status?				
Married/living together	1135 (68.4)	756 (75.3)	701 (67.9)	0.0005
Never married	193 (11.6)	76 (7.6)	107 (10.4)	
Divorced or separated	215 (13.0)	124 (12.4)	154 (14.9)	
Widowed	117 (7.0)	48 (4.8)	71 (6.9)	
Annual household income				
Less than $20,000	109 (7.5)	69 (8.1)	84 (9.7)	0.0103
$20,000-$34,999	149 (10.2)	106 (12.4)	129 (14.9)	
$35,000-$49,000	176 (12.1)	112 (13.1)	114 (13.1)	
$50,000-$74,999	308 (21.1)	192 (22.4)	183 (21.1)	
$75,000-$99,000	282 (19.3)	158 (18.4)	144 (16.6)	
$100,000 or more	436 (29.9)	220 (25.7)	214 (24.7)	
Employment status				
Full-time employed/homemaker	720 (43.4)	620 (62.2)	547 (53.5)	<0.0001
Part-time employed	117 (7.0)	78 (7.8)	72 (7.0)	
Unemployed or disabled	124 (7.5)	87 (8.7)	82 (8.0)	
Student	41 (2.5)	7 (0.7)	7 (0.7)	
Retired	658 (39.6)	204 (20.5)	314 (30.7)	
How would you describe your political views?				
Liberal	584 (36.8)	32 (3.5)	165 (18.1)	<0.0001
Moderate	470 (29.6)	172 (19.1)	283 (31.0)	
Conservative	532 (33.5)	698 (77.4)	464 (50.9)	
Have you had or do you plan to get the flu vaccine this year?				
Yes	1532 (91.8)	221 (21.3)	746 (70.6)	<0.0001
No	76 (4.6)	772 (74.5)	217 (20.5)	
Don't know/Not sure	61 (3.7)	43 (4.2)	94 (8.9)	
How has the COVID-19 pandemic affected your likelihood of getting the flu vaccine this year?				
Made me more likely to get it	700 (42.3)	42 (4.1)	279 (26.9)	<0.0001
Has not affected my likelihood	930 (56.2)	789 (77.9)	713 (68.8)	
Made me less likely to get it	25 (1.5)	182 (18)	45 (4.3)	
Have you ever tested positive for COVID-19?				
No	1568 (93.8)	948 (91.8)	969 (92.0)	0.0729
Yes	103 (6.2)	85 (8.2)	84 (8.0)	
Frequency of engagement in preventative measures, composite score:				
Very frequently	434 (25.9)	63 (6.0)	214 (20.2)	<0.0001
Somewhat frequently	525 (31.3)	70 (6.7)	259 (24.4)	
Occasionally	394 (23.5)	91 (8.7)	210 (19.8)	

(*continued on next page*)

Table 3 (*continued*)

	Plan to receive COVID-19 vaccine (N = 3,781)			
	Yes (%)	No (%)	Don't know/Not sure (%)	p-value
Rarely	258 (15.4)	233 (22.4)	256 (24.1)	
Never	64 (3.8)	585 (56.1)	122 (11.5)	
Knowledge Questions:				
It can take 2–14 days for coronavirus symptoms to appear in an infected person.				
Agree	1647 (98.9)	869 (89.0)	1021 (97.6)	<0.0001
Disagree	19 (1.1)	107 (11.0)	25 (2.4)	
Individuals should quarantine after exposure to someone positive for COVID-19.				
Agree	1610 (96.8)	575 (58.0)	939 (90.2)	<0.0001
Disagree	54 (3.2)	416 (42.0)	102 (9.8)	
COVID-19 can live on surfaces, such as counters and doorknobs.				
Agree	1514 (91.9)	646 (66.1)	895 (87.5)	<0.0001
Disagree	134 (8.1)	332 (33.9)	128 (12.5)	
COVID-19 can cause lasting health issues even after recovery from the illness.				
Agree	1587 (96.9)	631 (67.3)	937 (93.0)	<0.0001
Disagree	51 (3.1)	307 (32.7)	70 (7.0)	
Wearing a face mask helps to prevent the spread of COVID-19.				
Agree	1560 (94.3)	297 (29.6)	825 (81.4)	<0.0001
Disagree	94 (5.7)	707 (70.4)	189 (18.6)	
People infected with COVID-19 who do not have the symptoms cannot spread the virus.				
Agree	170 (10.3)	264 (28.3)	109 (10.6)	<0.0001
Disagree	1484 (89.7)	669 (71.7)	919 (89.4)	
Most people with COVID-19 will have severe or critical symptoms.				
Agree	105 (6.4)	60 (5.9)	95 (9.1)	0.0064
Disagree	1541 (93.6)	957 (94.1)	945 (90.9)	
COVID-19 can spread through respiratory droplets of infected people.				
Agree	1652 (99.3)	861 (87.4)	1033 (98.9)	<0.0001
Disagree	11 (0.7)	124 (12.6)	11 (1.1)	
Underlying medical conditions increase your risk for developing a severe case of COVID-19.				
Agree	1646 (98.8)	891 (88.8)	1016 (97.0)	<0.0001
Disagree	20 (1.2)	112 (11.2)	31 (3.0)	
People with COVID-19 can infect others days before they start having symptoms.				
Agree	1599 (97.7)	645 (68.4)	929 (92.7)	<0.0001
Disagree	38 (2.3)	298 (31.6)	73 (7.3)	
If you are wearing a mask it is not necessary to social distance.				
Agree	77 (4.7)	338 (37.4)	109 (10.7)	<0.0001
Disagree	1574 (95.3)	565 (62.6)	907 (89.3)	
Knowledge composite score				
11	1160 (69.5)	186 (19.1)	580 (56.2)	<0.0001
>8–10	446 (26.7)	296 (30.5)	336 (32.6)	
>6–8	49 (2.9)	229 (23.6)	79 (7.7)	
0–6	14 (0.8)	261 (26.9)	37 (3.6)	
Belief statements:				
COVID-19 is deadlier than seasonal flu.				
Strongly Agree	992 (59.3)	94 (9.1)	401 (38.0)	<0.0001
Agree	409 (24.4)	108 (10.4)	254 (24.1)	
Neutral	141 (8.4)	181 (17.5)	227 (21.5)	
Disagree	106 (6.3)	328 (31.6)	131 (12.4)	
Strongly Disagree	26 (1.6)	326 (31.4)	42 (4.0)	
I am worried about spreading COVID-19 to others.				
Strongly Agree	600 (35.9)	61 (5.9)	219 (20.8)	<0.0001
Agree	669 (40.0)	127 (12.3)	367 (34.9)	
Neutral	191 (11.4)	192 (18.6)	225 (21.4)	
Disagree	155 (9.3)	336 (32.5)	181 (17.2)	
Strongly Disagree	56 (3.4)	319 (30.8)	61 (5.8)	
COVID-91 is a serious disease.				
Strongly Agree	1216 (72.8)	139 (13.4)	564 (53.5)	<0.0001
Agree	353 (21.1)	266 (25.7)	328 (31.1)	
Neutral	56 (3.4)	254 (24.6)	102 (9.7)	
Disagree	27 (1.6)	197 (19.1)	44 (4.2)	
Strongly Disagree	18 (1.1)	178 (17.2)	17 (1.6)	
People do not take COVID-19 seriously enough.				
Strongly Agree	1033 (61.7)	137 (13.3)	453 (42.8)	<0.0001
Agree	394 (23.6)	98 (9.5)	250 (23.6)	
Neutral	117 (7.0)	208 (20.2)	180 (17.0)	
Disagree	92 (5.5)	298 (29.0)	134 (12.7)	
Strongly Disagree	37 (2.2)	288 (28.0)	41 (3.9)	
I am worried about getting COVID-19.				
Strongly Agree	513 (30.8)	65 (6.3)	201 (19.1)	<0.0001
Agree	638 (38.2)	87 (8.4)	324 (30.8)	
Neutral	305 (18.3)	146 (14.1)	251 (23.9)	
Disagree	158 (9.5)	283 (27.4)	210 (20.0)	
Strongly Disagree	54 (3.2)	452 (43.8)	66 (6.3)	

Table 3 (*continued*)

	Plan to receive COVID-19 vaccine (N = 3,781)			
	Yes (%)	No (%)	Don't know/Not sure (%)	p-value
COVID-19 is a political issue.				
Strongly Agree	257 (15.5)	559 (54.4)	204 (19.4)	<0.0001
Agree	327 (19.8)	242 (23.6)	237 (22.6)	
Neutral	169 (10.2)	98 (9.5)	179 (17.0)	
Disagree	258 (15.6)	63 (6.1)	165 (15.7)	
Strongly Disagree	644 (38.9)	65 (6.3)	265 (25.2)	

Table 4
Variables associated with responses of "Yes" or "No" to intention to vaccinate.

Variable	Unadjusted Analyses			Adjusted Analyses[a]		
	Yes OR [95% CI]	No OR [95% CI]	p-value	Yes AOR [95% CI]	No AOR [95% CI]	p-value
Age						
18–34	*ref*	*ref*	<0.0001	*ref*	*ref*	0.0022
35–49	0.68 [0.5–0.91]	1.31 [0.96–1.79]		0.77 [0.55–1.08]	1.13 [0.77–1.67]	
50–64	0.75 [0.57–0.98]	0.85 [0.63–1.14]		0.87 [0.63–1.20]	0.72 [0.49–1.07]	
65+	1 [0.76–1.31]	0.53 [0.38–0.72]		0.62 [0.41–0.93]	0.59 [0.35–0.97]	
Rural vs Urban zip code						
Urban	*ref*	*ref*	<0.0001	*ref*	*ref*	0.0461
Rural	0.79 [0.65–0.96]	1.3 [1.06–1.59]		0.86 [0.69–1.07]	1.21 [0.93–1.57]	
Gender						
Female	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Male	1.41 [1.19–1.68]	1.95 [1.62–2.35]		1.56 [1.27–1.92]	1.53 [1.19–1.96]	
Race						
White	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Black or African American	0.28 [0.2–0.41]	0.57 [0.4–0.8]		0.27 [0.18–0.40]	0.87 [0.55–1.37]	
Other[b]	1.5 [0.95–2.36]	1.51 [0.92–2.47]		1.31 [0.79–2.18]	1.28 [0.69–2.35]	
Highest educational attainment						
Graduate degree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
College graduate	0.63 [0.51–0.77]	1.39 [1.08–1.79]		0.69 [0.54–0.86]	1.20 [0.87–1.66]	
Some college	0.42 [0.34–0.53]	1.63 [1.26–2.11]		0.45 [0.35–0.58]	1.51 [1.08–2.10]	
High school graduate or less	0.4 [0.3–0.53]	2.11 [1.54–2.87]		0.39 [0.28–0.55]	2.02 [1.33–3.05]	
Do you currently have health insurance?						
Yes	0.6 [0.41–0.89]	2.09 [1.49–2.94]	<0.0001	*ref*	*ref*	0.9192
No	*ref*	*ref*		0.92 [0.57–1.50]	1.03 [0.65–1.61]	
Do you currently have a primary health care provider or clinic where you go for most of your healthcare?						
Yes	*ref*	*ref*	<0.0001	*ref*	*ref*	0.8735
No	0.81 [0.63–1.04]	1.62 [1.26–2.08]		1.07 [0.78–1.47]	0.97 [0.68–1.38]	
How frequently do you see a healthcare provider?						
4 + times per year	*ref*	*ref*	<0.0001	*ref*	*ref*	0.2634
2–3 times per year	0.99 [0.81–1.21]	0.99 [0.78–1.26]		1.08 [0.85–1.36]	0.81 [0.59–1.10]	
1 time per year	1.02 [0.79–1.31]	1.71 [1.28–2.28]		1.07 [0.79–1.46]	0.88 [0.60–1.28]	
< 1 time per year	1.05 [0.78–1.41]	3.58 [2.65–4.84]		1.48 [1.03–2.14]	1.01 [0.67–1.52]	
How would you rate your general health?						
Poor	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Fair	1.47 [0.94–2.3]	1.52 [0.9–2.59]		1.37 [0.77–2.43]	0.87 [0.42–1.81]	
Good	1.31 [0.82–2.09]	1.09 [0.62–1.91]		1.42 [0.81–2.48]	1.20 [0.60–2.43]	
Excellent	1.52 [0.94–2.46]	2.93 [1.68–5.1]		1.26 [0.69–2.29]	2.13 [1.02–4.46]	
What is your marital status?						
Married/living together	*ref*	*ref*	0.0006	*ref*	*ref*	0.0341
Never married	1.11 [0.86–1.44]	0.66 [0.48–0.9]		1.11 [0.80–1.54]	0.56 [0.36–0.86]	
Divorced or separated	0.86 [0.69–1.08]	0.75 [0.58–0.97]		1.16 [0.89–1.52]	0.81 [0.57–1.13]	
Widowed	1.02 [0.75–1.39]	0.63 [0.43–0.92]		1.08 [0.75–1.58]	1.22 [0.74–2.03]	
Annual household income						
Less than $20,000	*ref*	*ref*	0.0108	*ref*	*ref*	0.1123
$20,000-$34,999	0.89 [0.62–1.29]	1 [0.66–1.51]		1.11 [0.69–1.77]	0.83 [0.46–1.47]	
$35,000-$49,000	1.19 [0.82–1.72]	1.2 [0.79–1.81]		1.46 [0.90–2.37]	1.41 [0.78–2.54]	
$50,000-$74,999	1.3 [0.92–1.82]	1.28 [0.88–1.86]		1.45 [0.90–2.34]	1.27 [0.70–2.28]	
$75,000-$99,000	1.51 [1.07–2.14]	1.34 [0.9–1.97]		1.47 [0.88–2.45]	1.83 [0.98–3.43]	
$100,000 or more	1.57 [1.13–2.18]	1.25 [0.86–1.81]		1.56 [0.93–2.61]	1.23 [0.65–2.33]	
Employment status						
Full-time employed/homemaker	*ref*	*ref*	<0.0001	*ref*	*ref*	0.0009
Part-time employed	1.23 [0.9–1.69]	0.96 [0.68–1.34]		1.45 [1.00–2.10]	1.14 [0.73–1.79]	
Unemployed or disabled	1.15 [0.85–1.55]	0.94 [0.68–1.29]		1.51 [1.04–2.21]	1.08 [0.69–1.68]	
Student	4.45 [1.98–9.99]	0.88 [0.31–2.53]		4.32 [1.62–11.49]	0.76 [0.19–3.13]	
Retired	1.59 [1.34–1.9]	0.57 [0.46–0.71]		1.60 [1.19–2.16]	0.90 [0.62–1.32]	

(*continued on next page*)

Table 4 (*continued*)

Variable	Unadjusted Analyses			Adjusted Analyses[a]		
	Yes OR [95% CI]	No OR [95% CI]	p-value	Yes AOR [95% CI]	No AOR [95% CI]	p-value
How would you describe your political views?						
Liberal	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Moderate	0.47 [0.37–0.59]	3.13 [2.05–4.78]		0.48 [0.36–0.62]	3.30 [1.93–5.64]	
Conservative	0.32 [0.26–0.4]	7.75 [5.22–11.52]		0.28 [0.21–0.37]	7.85 [4.64–13.29]	
Have you had or do you plan to get the flu vaccine this year?						
Yes	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
No	0.17 [0.13–0.22]	12.01 [9.71–14.85]		0.19 [0.14–0.25]	9.07 [7.11–11.59]	
Don't know/Not sure	0.32 [0.23–0.44]	1.54 [1.04–2.28]		0.34 [0.23–0.49]	1.29 [0.83–2.00]	
How has the COVID-19 pandemic affected your likelihood of getting the flu vaccine this year?						
Made me more likely to get it	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Has not affected my likelihood	0.52 [0.44–0.62]	7.35 [5.23–10.32]		0.59 [0.48–0.72]	2.60 [1.77–3.80]	
Made me less likely to get it	0.22 [0.13–0.37]	26.85 [16.95–42.53]		0.42 [0.23–0.78]	4.70 [2.69–8.21]	
Have you ever tested positive for COVID-19?						
No	*ref*	*ref*	0.0741	*ref*	*ref*	0.2868
Yes	0.76 [0.56–1.02]	1.03 [0.76–1.42]		0.76 [0.54–1.07]	0.91 [0.61–1.36]	
Preventative measures composite score						
Very frequently	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Somewhat frequently	1 [0.8–1.25]	0.92 [0.62–1.35]		1.03 [0.79–1.34]	1.01 [0.64–1.60]	
Occasionally	0.93 [0.73–1.17]	1.47 [1.01–2.14]		0.81 [0.61–1.06]	1.91 [1.22–2.99]	
Rarely	0.5 [0.39–0.63]	3.09 [2.22–4.31]		0.40 [0.30–0.53]	2.51 [1.65–3.81]	
Never	0.26 [0.18–0.36]	16.29 [11.57–22.93]		0.22 [0.14–0.33]	12.67 [8.04–19.98]	
Knowledge Questions:						
It can take 2–14 days for coronavirus symptoms to appear in an infected person.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.47 [0.26–0.86]	5.03 [3.22–7.84]		0.49 [0.24–1.00]	3.03 [1.65–5.60]	
Individuals should quarantine after exposure to someone positive for COVID-19.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.31 [0.22–0.43]	6.66 [5.24–8.47]		0.27 [0.18–0.40]	4.27 [3.10–5.88]	
COVID-19 can live on surfaces, such as counters and doorknobs.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.62 [0.48–0.8]	3.59 [2.86–4.51]		0.51 [0.37–0.69]	2.96 [2.19–4.00]	
COVID-19 can cause lasting health issues even after recovery from the illness.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.43 [0.3–0.62]	6.51 [4.93–8.6]		0.39 [0.25–0.60]	3.92 [2.72–5.65]	
Wearing a face mask helps to prevent the spread of COVID-19.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.26 [0.2–0.34]	10.39 [8.44–12.8]		0.25 [0.18–0.35]	6.79 [5.11–9.01]	
People infected with COVID-19 who do not have the symptoms cannot spread the virus.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	1.04 [0.8–1.34]	0.3 [0.24–0.38]		1.2 [0.90–1.61]	0.38 [0.28–0.53]	
Most people with COVID-19 will have severe or critical symptoms.						
Agree	*ref*	*ref*	0.0068	*ref*	*ref*	0.2234
Disagree	1.48 [1.11–1.97]	1.6 [1.15–2.24]		1.25 [0.89–1.77]	1.40 [0.91–2.17]	
COVID-19 can spread through respiratory droplets of infected people.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.63 [0.27–1.45]	13.52 [7.25–25.22]		0.37 [0.14–0.99]	8.91 [4.29–18.51]	
Underlying medical conditions increase your risk for developing a severe case of COVID-19.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.4 [0.23–0.7]	4.12 [2.74–6.19]		0.38 [0.20–0.72]	4.27 [2.49–7.31]	
People with COVID-19 can infect others days before they start having symptoms.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	0.3 [0.2–0.45]	5.88 [4.47–7.74]		0.23 [0.14–0.37]	3.60 [2.54–5.11]	
If you are wearing a mask it is not necessary to social distance.						
Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Disagree	2.46 [1.81–3.33]	0.2 [0.16–0.26]		2.94 [2.05–4.21]	0.34 [0.25–0.47]	
Knowledge composite score						
11	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
>8–10	0.66 [0.56–0.79]	2.75 [2.19–3.45]		0.65 [0.53–0.79]	2.09 [1.58–2.77]	
>6–8	0.31 [0.21–0.15]	9.04 [6.67–12.26]		0.28 [0.18–0.42]	5.80 [3.93–8.57]	
0–6	0.19 [0.10–0.35]	21.99 [15.01–32.21]		0.10 [0.05–0.23]	14.26 [8.66–23.48]	
Belief statements:						
COVID-19 is deadlier than seasonal flu.						
Strongly Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Agree	0.65 [0.54–0.79]	1.81 [1.32–2.49]		0.64 [0.51–0.80]	1.59 [1.08–2.33]	
Neutral	0.25 [0.2–0.32]	3.4 [2.53–4.58]		0.26 [0.19–0.34]	2.61 [1.80–3.79]	
Disagree	0.33 [0.25–0.43]	10.68 [7.89–14.45]		0.31 [0.22–0.43]	7.04 [4.79–10.35]	
Strongly Disagree	0.25 [0.15–0.41]	33.11 [22.37–49]		0.20 [0.11–0.36]	19.44 [11.82–31.98]	
I am worried about spreading COVID-19 to others.						
Strongly Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Agree	0.67 [0.54–0.81]	1.24 [0.88–1.76]		0.60 [0.47–0.75]	1.45 [0.96–2.20]	
Neutral	0.31 [0.24–0.4]	3.06 [2.17–4.32]		0.28 [0.21–0.38]	2.56 [1.67–3.92]	
Disagree	0.31 [0.24–0.41]	6.66 [4.76–9.33]		0.27 [0.19–0.37]	5.18 [3.39–7.91]	
Strongly Disagree	0.34 [0.23–0.5]	18.77 [12.66–27.85]		0.26 [0.16–0.41]	12.71 [7.78–20.76]	

Table 4 (*continued*)

Variable	Unadjusted Analyses			Adjusted Analyses[a]		
	Yes OR [95% CI]	No OR [95% CI]	p-value	Yes AOR [95% CI]	No AOR [95% CI]	p-value
COVID-91 is a serious disease.						
Strongly Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Agree	0.5 [0.42–0.6]	3.29 [2.57–4.21]		0.52 [0.42–0.64]	3.05 [2.23–4.16]	
Neutral	0.25 [0.18–0.36]	10.1 [7.52–13.58]		0.22 [0.15–0.33]	7.90 [5.37–11.62]	
Disagree	0.28 [0.17–0.46]	18.17 [12.48–26.45]		0.26 [0.15–0.46]	10.35 [6.39–16.76]	
Strongly Disagree	0.49 [0.25–0.96]	42.48 [24.98–72.25]		0.36 [0.17–0.76]	19.50 [10.48–36.29]	
People do not take COVID-19 seriously enough.						
Strongly Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Agree	0.69 [0.57–0.84]	1.3 [0.96–1.75]		0.63 [0.50–0.79]	1.32 [0.91–1.92]	
Neutral	0.29 [0.22–0.37]	3.82 [2.9–5.04]		0.24 [0.17–0.32]	3.11 [2.17–4.45]	
Disagree	0.3 [0.23–0.4]	7.35 [5.56–9.72]		0.26 [0.18–0.37]	5.82 [4.00–8.48]	
Strongly Disagree	0.4 [0.25–0.63]	23.23 [15.9–33.93]		0.36 [0.21–0.63]	13.11 [8.08–21.25]	
I am worried about getting COVID-19.						
Strongly Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Agree	0.77 [0.62–0.95]	0.83 [0.58–1.2]		0.62 [0.48–0.80]	0.85 [0.55–1.31]	
Neutral	0.48 [0.38–0.6]	1.8 [1.27–2.54]		0.40 [0.30–0.53]	1.54 [1.01–2.37]	
Disagree	0.29 [0.23–0.38]	4.17 [2.99–5.81]		0.25 [0.18–0.35]	3.84 [2.51–5.87]	
Strongly Disagree	0.32 [0.22–0.48]	21.18 [14.47–30.99]		0.25 [0.16–0.41]	11.92 [7.34–19.34]	
COVID-19 is a political issue.						
Strongly Agree	*ref*	*ref*	<0.0001	*ref*	*ref*	<0.0001
Agree	1.1 [0.85–1.4]	0.37 [0.29–0.47]		1.18 [0.88–1.59]	0.41 [0.30–0.56]	
Neutral	0.75 [0.57–0.99]	0.2 [0.15–0.27]		0.81 [0.58–1.13]	0.25 [0.17–0.37]	
Disagree	1.24 [0.95–1.62]	0.14 [0.1–0.19]		1.48 [1.07–2.04]	0.20 [0.13–0.31]	
Strongly Disagree	1.93 [1.53–2.43]	0.09 [0.07–0.12]		2.08 [1.56–2.78]	0.14 [0.09–0.21]	

a. Adjusted for age, rural vs urban, gender, race, education, insurance, rating of general health, marital status, employment status, 2020–21 flu vaccine receipt/intent, and prior positive COVID-19 diagnosis.
b. Includes American Indian or Alaska Native, Asian, more than one race, or "other"

respondents stated they would be most likely to get a COVID-19 vaccine at a drive-through site. Increasing vaccine availability in these familiar sites could increase uptake in hard-to-reach populations. Those who are unsure about receiving a COVID-19 vaccine may be more inclined to get it from the relative comfort of a trusted healthcare provider or pharmacist.

Concern about side effects and ingredients of the influenza vaccines were two of the top five reasons to not receive an influenza vaccine annually (16.6% and 17.0% respectively). Perceived safety of a vaccine has proven to be an indicator of uptake, and both side effects and ingredients of a vaccine can influence an individual's perception of that vaccine's safety [54,55]. The COVID-19 vaccines, especially the second shot of the Pfizer vaccine, are known for relatively severe side effects, especially fever, chills, muscle aches, and fatigue. Concern about vaccine side effects and ingredients could affect uptake of a particularly novel and comparatively "rushed" COVID-19 vaccine, even though it has passed all safety protocols. HCP reassurance for the safety and rigorous testing of the COVID-19 vaccines could help alleviate some of these concerns.

Limitations to this study included low response rates for African American race and male sex, possibly leading to an overestimation of willingness to be vaccinated. The relatively high levels of missing data (>5%) for income, political views, and age may have also affected the outcomes. To mitigate the effect of missing data on the analyses, income and political views were not included in the adjusted regression model. It is likely that any bias due to remaining missing values was negligible [56]. Additionally, this study had a much higher percentage (60.5%) of participants who identified as having a college degree than the Alabama population (25%) [56]. This could be due to the survey medium, as a higher portion of adults with a college degree (74%) use Facebook compared with those with a high school diploma or less (61%) [54]. However, it is likely that any bias due to under-representation of populations with lower educational attainment was towards the null among those who responded "No" to vaccination intent [55,56]. The time frame the survey was open may also have affected the results. Election confusion, vaccine rollouts, and other major events occurred simultaneous with the survey. Due to these events occurring in close proximity some answers may have reflected more polarizing attitudes on certain topics than would have otherwise been documented. Finally, due to the rapid onset of the pandemic, no fully validated instruments specifically assessing COVID-19 vaccination had been developed at the time of the current study, though validated measures were used whenever possible.

5. Conclusion

Ensuring adequate COVID-19 vaccination in the U.S. is and will likely continue to be challenging. Individual attitudes and perceptions are extremely influential on uptake. Previous research has identified populations most likely to refuse the vaccine and thus requiring the most intervention to improve uptake. Our research confirms these findings are also accurate in the state of Alabama, while also adding avenues to increase COVID-19 vaccine uptake through analysis of influenza vaccine attitudes. Future research should explore the efficacy of vaccine education and uptake programs among populations identified to be hesitant toward the COVID-19 vaccines. Additionally, strategies to persuade those who are undecided should be studied as this is a major segment of the population and vaccinating them is essential to reaching herd immunity and ending the pandemic.

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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.

References

[1] CDC. About COVID-19. Centers for Disease Control and Prevention. Accessed March 23, 2021, 2021. https://www.cdc.gov/coronavirus/2019-ncov/cdcresponse/about-COVID-19.html

[2] Harcourt J, Tamin A, Lu X, et al. Severe Acute Respiratory Syndrome Coronavirus 2 from Patient with Coronavirus Disease, United States. *Emerg Infect Dis*. Jun 2020;26(6):1266-1273. doi:10.3201/eid2606.200516

[3] CDC. United States COVID-19 Cases and Deaths by State. Centers for Disease Control and Prevention. Accessed March 25, 2021, 2021. https://covid.cdc.gov/covid-data-tracker/#cases_casesper100klast7days

[4] ADPH. Alabama's COVID-19 Data and Surveillance Dashboard 2021. Alabama Department of Public Health. Accessed March 25, 2021, 2021. https://alpublichealth.maps.arcgis.com/apps/opsdashboard/index.html#/6d2771faa9da4a2786a509d82c8cf0f7

[5] CDC. How COVID-19 Spreads. Centers for Disease Control and Prevention. Accessed March 23, 2021, 2021. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html

[6] Morawska L, Cao J. Airborne transmission of SARS-CoV-2: The world should face the reality. Environ Int. 2020;139:105730. https://doi.org/10.1016/j.envint.2020.105730.

[7] Milovanovic L, Hessey E, Sebastianski M, Keto-Lambert D, Vandermeer B, Bagshaw SM, et al. Epidemiology, clinical characteristics and treatment of critically ill patients with COVID-19): a protocol for a living systematic review. BMJ Open 2021;11(1):e042008. https://doi.org/10.1136/bmjopen-2020-042008.

[8] Basu A. Estimating The Infection Fatality Rate Among Symptomatic COVID-19 Cases In The United States. Health Aff (Millwood) Jul 2020;39(7):1229–36. https://doi.org/10.1377/hlthaff.2020.00455.

[9] WHO. What we know about long-term effects of COVID-19. Accessed March 23, 2021, 2021. https://www.who.int/docs/default-source/coronaviruse/risk-comms-updates/update-36-long-term-symptoms.pdf?sfvrsn=5d3789a6_2#:~:text=%E2%80%A2%20Most%20people%20with%20COVID,have%20lasting%20health%20effects

[10] Xiong W, Kwan P, Zhou D, Del Felice A, Duncan JS, Sander JW. Acute and late neurological complications of COVID19: the quest for evidence. *Brain*. Dec 1 2020;143(12):e99. doi:10.1093/brain/awaa294

[11] CDC. Science Brief: Community use of cloth masks to control the spread of SARS-CoV-2. Accessed March 23, 2021, 2021. https://www.cdc.gov/coronavirus/2019-ncov/more/masking-science-sars-cov2.html

[12] Matrajt L, Leung T. Evaluating the Effectiveness of Social Distancing Interventions to Delay or Flatten the Epidemic Curve of Coronavirus Disease. *Emerg Infect Dis*. Aug 2020;26(8):1740-1748. doi:10.3201/eid2608.201093

[13] Kwok KO, Lai F, Wei WI, Wong SYS, Tang JWT. Herd immunity - estimating the level required to halt the COVID-19 epidemics in affected countries. J Infect 2020;80(6):e32–3. https://doi.org/10.1016/j.jinf.2020.03.027.

[14] McClure CC, Cataldi JR, O'Leary ST. Vaccine Hesitancy: Where We Are and Where We Are Going. Clin Ther 2017;39(8):1550–62. https://doi.org/10.1016/j.clinthera.2017.07.003.

[15] Dubé E, Gagnon D, Nickels E, Jeram S, Schuster M. Mapping vaccine hesitancy–country-specific characteristics of a global phenomenon. Vaccine 2014;32(49):6649–54. https://doi.org/10.1016/j.vaccine.2014.09.039.

[16] Dubé E, Vivion M, MacDonald NE. Vaccine hesitancy, vaccine refusal and the anti-vaccine movement: influence, impact and implications. Expert Rev Vacc Jan 2015;14(1):99–117. https://doi.org/10.1586/14760584.2015.964212.

[17] Larson HJ, Jarrett C, Eckersberger E, Smith DM, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. Vaccine 2014;32(19):2150–9. https://doi.org/10.1016/j.vaccine.2014.01.081.

[18] Schmid P, Rauber D, Betsch C, Lidolt G, Denker M-L, Cowling BJ. Barriers of Influenza Vaccination Intention and Behavior - A Systematic Review of Influenza Vaccine Hesitancy, 2005–2016. PloS One 2017;12(1):e0170550.

[19] CDC. COVID-19 Vaccinations in the United States. Accessed March 25, 2021, 2021. https://covid.cdc.gov/covid-data-tracker/#vaccinations

[20] NYT. See How the Vaccine Rollout is Going in Your Country and State. Accessed March 28, 2021, 2021. https://www.nytimes.com/interactive/2020/us/covid-19-vaccine-doses.html

[21] Lin C, Tu P, Beitsch LM. Confidence and Receptivity for COVID-19 Vaccines: A Rapid Systematic Review. *Vaccines (Basel)*. Dec 30 2020;9(1)doi:10.3390/vaccines9010016

[22] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. Apr 2009;42(2):377-81. doi:10.1016/j.jbi.2008.08.010

[23] Shaver LG, Khawer A, Yi Y, et al. Using Facebook Advertising to Recruit Representative Samples: Feasibility Assessment of a Cross-Sectional Survey. *J Med Internet Res*. Aug 19 2019;21(8):e14021. doi:10.2196/14021

[24] Ali SH, Foreman J, Capasso A, Jones AM, Tozan Y, DiClemente RJ. Social media as a recruitment platform for a nationwide online survey of COVID-19 knowledge, beliefs, and practices in the United States: methodology and feasibility analysis. BMC Med Res Methodol 2020;20(1). https://doi.org/10.1186/s12874-020-01011-0.

[25] USDA. Rural-Urban Commuting Area Codes. Accessed March 23, 2021, 2021. https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx#:~:text=The%20rural%2Durban%20commuting%20area,%2C%20urbanization%2C%20and%20daily%20commuting.&text=Whole%20numbers%20(1%2D10),primary%20(largest)%20commuting%20flows

[26] Facebook. Audience Insights. Accessed March 20, 2021, 2021. https://www.facebook.com/business/insights/tools/audience-insights

[27] Topolovec-Vranic J, Natarajan K. The Use of Social Media in Recruitment for Medical Research Studies: A Scoping Review. *J Med Internet Res*. Nov 7 2016;18(11):e286. doi:10.2196/jmir.5698

[28] Hornsey MJ, Finlayson M, Chatwood G, Begeny CT. The effect of political identity, conspiracist ideation and presidential tweets on vaccine hesitancy. *Journal of Experimental Social Psychology*. 2020:88

[29] Daly M, Robinson E. Willingness to Vaccinate Against COVID-19 in the U.S.: Representative Longitudinal Evidence From April to October 2020. Am J Prev Med 2021;60(6):766–73.

[30] Mesch GS, Schwirian KP. Confidence in government and vaccination willingness in the USA. *Health Promot Int*. Jun 2015;30(2):213-21. doi:10.1093/heapro/dau094

[31] Pogue K, Jensen JL, Stancil CK, et al. Influences on Attitudes Regarding Potential COVID-19 Vaccination in the United States. *Vaccines (Basel)*. Oct 3 2020;8(4)doi:10.3390/vaccines8040582

[32] Hamel L, Kirzinger A, Lopes L, et al. KFF COVID-19 Vaccine Monitor: May 2021. Kaiser Family Foundation. Accessed December 5, 2021, 2021. https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-may-2021/

[33] Thigpen CL, Funk C. Most Americans expect a COVID-19 vaccine within a year; 72% say they would get vaccinated. Accessed March 20, 2021, 2021. https://www.pewresearch.org/fact-tank/2020/05/21/most-americans-expect-a-covid-19-vaccine-within-a-year-72-say-they-would-get-vaccinated/

[34] Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: How many people would get vaccinated? *Vaccine*. Sep 29 2020;38(42):6500-6507. doi:10.1016/j.vaccine.2020.08.043

[35] Smyton R, McAndrew J. Only 57 percent of Americans say they would get a COVID-19 vaccine. Accessed March 20, 2021, 2021. https://now.tufts.edu/news-releases/only-57-percent-americans-say-they-would-get-covid-19-vaccine

[36] Wong LP, Alias H, Wong PF, Lee HY, AbuBakar S. The use of the health belief model to assess predictors of intent to receive the COVID-19 vaccine and willingness to pay. Human Vacc Immunotherapeut 2020;16(9):2204–14. https://doi.org/10.1080/21645515.2020.1790279.

[37] Khubchandani J, Sharma S, Price JH, Wiblishauser MJ, Sharma M, Webb FJ. COVID-19 Vaccination Hesitancy in the United States: A Rapid National Assessment. J Community Health 2021;46(2):270–7. https://doi.org/10.1007/s10900-020-00958-x.

[38] Demographic trends and economic well-being. Accessed March 21, 2021, 2021. https://www.pewresearch.org/social-trends/2016/06/27/1-demographic-trends-and-economic-well-being/

[39] Robinson E, Jones A, Lesser I, Daly M. International estimates of intended uptake and refusal of COVID-19 vaccines: A rapid systematic review and meta-analysis of large nationally representative samples. Vaccine 2021;39(15):2024–34. https://doi.org/10.1016/j.vaccine.2021.02.005.

[40] Fisher KA, Bloomstone SJ, Walder J, Crawford S, Fouayzi H, Mazor KM. Attitudes Toward a Potential SARS-CoV-2 Vaccine : A Survey of U.S Adults. Ann Intern Med 2020;173(12):964–73. https://doi.org/10.7326/m20-3569.

[41] Adams LB, Richmond J, Corbie-Smith G, Powell W. Medical Mistrust and Colorectal Cancer Screening Among African Americans. J Community Health Oct 2017;42(5):1044–61. https://doi.org/10.1007/s10900-017-0339-2.

[42] Powell W, Richmond J, Mohottige D, Yen I, Joslyn A, Corbie-Smith G. Medical Mistrust, Racism, and Delays in Preventive Health Screening Among African-American Men. Behav Med 2019;45(2):102–17. https://doi.org/10.1080/08964289.2019.1585327.

[43] Kolar SK, Wheldon C, Hernandez ND, Young L, Romero-Daza N, Daley EM. Human Papillomavirus Vaccine Knowledge and Attitudes, Preventative Health Behaviors, and Medical Mistrust Among a Racially and Ethnically Diverse Sample of College Women. J Racial Ethn Health Disparities Mar 2015;2(1):77–85. https://doi.org/10.1007/s40615-014-0050-2.

[44] Bogart LM, Ojikutu BO, Tyagi K, Klein DJ, Mutchler MG, Dong Lu, et al. COVID-19 Related Medical Mistrust, Health Impacts, and Potential Vaccine Hesitancy Among Black Americans Living With HIV. J Acquir Immune Defic Syndr 2021;86(2):200–7.

[45] Walker AS, Singhvi A, Holder J, Gebeloff R, Avila Y. Pandemic's Racial Disparities Persist in Vaccine Rollout. Accessed March 21, 2021, https://www.nytimes.com/interactive/2021/03/05/us/vaccine-racial-disparities.html?action=click&module=Top%20Stories&pgtype=Homepage

[46] Kullar R, Marcelin JR, Swartz TH, Piggott DA, Macias Gil R, Mathew TA, et al. Racial Disparity of Coronavirus Disease 2019 in African American Communities. J Infect Dis 2020;222(6):890–3. https://doi.org/10.1093/infdis/jiaa372.

[47] Paterson P, Meurice F, Stanberry LR, Glismann S, Rosenthal SL, Larson HJ. Vaccine hesitancy and healthcare providers. Vaccine 2016;34(52):6700–6. https://doi.org/10.1016/j.vaccine.2016.10.042.

[48] CDC. Similarities and Differences between Flu and COVID-19. Accessed March 21, 2021, https://www.cdc.gov/flu/symptoms/flu-vs-covid19.htm#:~:text=COVID%2D19%20seems%20to%20spread,in%20the%20different%20sections%20below

[49] Gupta A, Evans GW, Heragu SS. Simulation and optimization modeling for drive-through mass vaccination–A generalized approach. Simul Model Pract Theory 2013;37:99–106.

[50] Galarce EM, Minsky S, Viswanath K. Socioeconomic status, demographics, beliefs and A(H1N1) vaccine uptake in the United States. Vaccine 2011;29 (32):5284–9. https://doi.org/10.1016/j.vaccine.2011.05.014.
[51] Kennedy A, Lavail K, Nowak G, Basket M, Landry S. Confidence about vaccines in the United States: understanding parents' perceptions. Health Aff (Millwood) 2011;30(6):1151–9. https://doi.org/10.1377/hlthaff.2011.0396.
[52] Jakobsen JC, Gluud C, Wetterslev J, Winkel P. When and how should multiple imputation be used for handling missing data in randomised clinical trials – a practical guide with flowcharts. BMC Med Res Methodol 2017;17(1). https://doi.org/10.1186/s12874-017-0442-1.
[53] Research ES. County-level Data Sets. Accessed March 20, 2021, https://www.ers.usda.gov/data-products/county-level-data-sets/
[54] Gramlich J. 10 facts about Americans and Facebook. Accessed March 21, 2021, https://www.pewresearch.org/fact-tank/2019/05/16/facts-about-americans-and-facebook/
[55] Paul E, Steptoe A, Fancourt D. Attitudes towards vaccines and intention to vaccinate against COVID-19: Implications for public health communications. LancetReg Health Eur 2021;1:100012. https://doi.org/10.1016/j.lanepe.2020.100012.
[56] Szilagyi PG, Thomas K, Shah MD, Vizueta N, Cui Y, Vangala S, et al. National Trends in the US Public's Likelihood of Getting a COVID-19 Vaccine. JAMA 2020;325(4):396. https://doi.org/10.1001/jama.2020.26419.