Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Trust in a COVID-19 vaccine in the U.S.: A social-ecological perspective

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1. Introduction

On an individual level, one dimension of trust that may be common to COVID-19 and other vaccines is the overall reluctance to obtain vaccinations due to fear of serious side effects. For example, there are well-studied individuals and social groups that endorse antivaccine attitudes and have negative views of any vaccine (Dubé et al., 2015; Larson et al., 2014). These individuals express concerns about the product, including potential side effects and the purity of the vaccine ingredients (Smith, 2017). According to a report on vaccine confidence from the 2015 U.S. National Vaccine Advisory Committee, a survey among health care providers revealed that up to 85% of physicians encountered guardians who plan to refuse one or more recommended vaccines for children, citing concern about adverse effects and misinformation on vaccine safety (National Vaccine Advisory Committee Report, 2015).

Due to historical and current interpersonal and systemic racism in the U.S., much of which is propagated at a government and policy level, racial differences in vaccine trust and lower levels of trust among African Americans may also be observed (Quinn et al., 2016; Solomon and Castro, 2019; Feagin, 2014; Bogart et al., 2020; Ferdinand and Reddy, 2020). For example, an online survey on COVID-19 vaccine attitudes among U.S. adults from Marks, 2020 found that vaccine acceptability differed significantly by sociodemographic characteristics such as race (Reiter et al., 2020). Indeed, it has been well-documented that African Americans report distrust in government as a salient reason for vaccine hesitancy (Quinn et al., 2016).

Another dimension of trust in a COVID-19 vaccine is the social acceptance of a potential vaccine among peers and social network members. Individuals' attitudes and behaviors are influenced by their social network members, but research on vaccine hesitancy and trust in vaccines is usually focused on individual-level analyses. However, there is some extant research on the role of social norms in influencing vaccine uptake, with several studies on social norms and HPV vaccines (Quinn et al., 2017; de Visser et al., 2011; Stout et al., 2020; de Bruine de Bruin et al., 2019). One mixed methods study suggested that subjective norms, which are perceptions of behaviors that individuals believe are important and that others approve or disapprove of, influence vaccine uptake among White and African American adults in the U.S., while another study found that subjective social norms were associated with trust in flu vaccines among Whites and African Americans (Freimuth et al., 2017). Currently, there is no published literature on how social norms may influence COVID-19 vaccine trust.

A further dimension of vaccine trust is based on perceptions of vaccine makers. In the United States, pharmaceutical companies are the most poorly regarded industry (McCarthy, 2019). This perception may be due in part to their role in the ongoing opioid epidemic of exagerating of benefits, downplaying of risks, aggressive marketing, and failure to warn the public of the addictive nature of the narcotics (Jones et al., 2018; Compton and Jones, 2019; Marks, 2020). This well-documented role in the opioid epidemic is likely to have led to mistrust in pharmaceutical companies' ability to distribute safe and effective COVID-19 vaccines. In addition to trust in pharmaceutical companies, societal trust in science may have further eroded throughout the fragmented response to the COVID-19 pandemic in the United States. The Centers for Disease Control and Prevention (CDC) has been criticized for the slow development and rollout of public COVID-19 testing and ambiguous school reopening guidelines. Indeed, a Pew Research poll conducted in late April 2020 found that public trust in science is low, with only 52% of Democrats and 27% of Republicans reporting confidence in their belief that scientists act in the best interest of the public (Funk et al., 2020).

Trust in governmental policymakers is a fourth dimension of trust that may affect public perception of a potential COVID-19 vaccine. A global survey on potential acceptance of a COVID-19 vaccine from June 2020 found that countries with high vaccine acceptance tended to be nations with strong trust in central governments, such as China and South Korea (Lazarus et al., 2020). In many countries, including the U.S., the response to COVID-19 has become highly political, and levels of

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trust in the government are at a historic low (Pew Research Center, 2019). A survey in July 2020 among U.S. adults found that potential vaccines endorsed by the CDC and WHO were associated with increases in willingness to receive a vaccine as compared with an endorsement by President Trump (Kreps et al., 2020). Depressed public trust in the government is likely to diminish confidence in the government's ability to adequately oversee and regulate the COVID-19 vaccine development and testing process. It is important to note that trust in the government may differ by political affiliation at both an individual and administration level. Historically, political conservatives in the U.S. tend to have higher distrust in government; however, a Republican administration may increase the level of trust in the government among conservatives (Morisi et al., 2019). There has been substantial research on COVID-19 misinformation and the role of social media in disseminating COVID-19 misinformation (Center for Informed Democracy & Social Cybersecurity, 2020). However, there is a dearth of research on trusted sources of COVID-19 information, particularly how perceptions of the trustworthiness of COVID-19 information from federal government agencies may be linked to trust in a COVID-19 vaccine.

SARS-CoV-2 vaccination is a critical component for ending the COVID-19 pandemic. More than 40 vaccine candidates are currently under development, with over 15 currently in Phase 3 trials (Corum et al., 2020; World Health Organization (WHO), 2020a, 2020b). As of mid-December 2020, the Pfizer-BioNTech vaccine (BNT162b2) vaccine was reported to have 95.0% efficacy and was approved for use in multiple countries, while the Moderna vaccine (mRNA-1273) had reached 94.5% efficacy and was approved for emergency use in the United States (Corum et al., 2020). Widespread uptake of safe, effective, and recommended COVID-19 vaccines can reduce the spread of the virus and increase the proportion of the population that has immunity to severe illness. However, previous research has identified vaccine hesitancy, defined by the WHO as the "delay in acceptance or refusal of vaccines despite availability of vaccine services," as a major obstacle to achieving widespread vaccination (Friedrich, 2019; Larson et al., 2016; WHO, 2020). Moreover, vaccine hesitancy was named a top ten threat to global health by the WHO in 2019 (Friedrich, 2019; Larson et al., 2016). Concerningly, U.S. national polls suggest that there are suboptimal levels of intentions of obtaining the COVID-19 vaccine, when available, with only 54% of respondents reporting that they intended to obtain a COVID-19 vaccine in May of 2020 (NORC Center Poll, 2020). Vaccine hesitancy surrounding a potential COVID-19 vaccine is not unique to the U.S.-context. Studies in Australia, Italy, and England also suggest high rates of COVID-19 vaccine hesitancy (Palamenghi et al., 2020; Freeman et al., 2020; Rhodes et al., 2020). Vaccine hesitancy is influenced by many factors (Larson et al., 2014). However, one key attribute of vaccine hesitancy is trust in the vaccine (Larson et al., 2013; American Academy of Arts and Sciences, 2014; MacDonald, 2015).

As often utilized in the literature on trust in a vaccination context, we conceptualized trust as a "relationship that exists between individuals, as well as between individuals and a system, in which one party accepts a vulnerable position, assuming the best interests and competence of the other, in exchange for a reduction in decision complexity (Larson et al., 2018)." Vaccine trust may have multiple dimensions. The 2015 U.S. National Vaccine Advisory Committee report defines vaccine confidence as "the trust that parents or health-care providers have (1) in the recommended immunizations, (2) in the provider(s) who administers vaccines, and (3) in the process that leads to vaccine licensure and the recommended vaccination schedule." This concept of trust in a vaccine may encompass perceptions of the product itself, of providers who are involved in administering the vaccine, and of policymakers, which comprise government officials, health systems, and the research community involved in approving and endorsing the vaccine (Quinn et al., 2019; Larson et al., 2014). A population survey of U.S. adults in May 2020 found that individuals were more likely to accept a COVID-19 vaccine if they thought their healthcare provider would recommend vaccination (Reiter et al., 2020). A global survey of potential acceptance of a COVID-19 vaccine likewise found that trust in government was strongly associated with vaccine acceptance (Lazarus et al., 2020). Vaccine trust is an important area of study as it has been found to be associated with vaccination uptake, with a study by Quinn et al. (2019) finding that trust was a strong and independent predictor of flu vaccine uptake. A review of qualitative studies on vaccine hesitancy also found that trust was a major factor in vaccine decisions (Majid, 2020). However, research surrounding vaccine trust is limited, as pointed out by a systematic review by Larson et al. (2018): after screening 19,643 abstracts, Larson et al. (2018) identified only 35 articles related to vaccine trust. In addition, over half of these studies did not explicitly measure trust, while only 20% were qualitative, and none used mixed methods. The authors concluded that the majority of such studies have only implicitly examined vaccine trust and that vaccine trust remains a severely understudied area. Given the tumultuous political climate surrounding the COVID-19 pandemic and potential vaccination campaigns, it is critical to characterize current vaccine trust and public perceptions to maximize the reach and effectiveness of campaigns. The goal of this study was to characterize perceptions of trust in a potential COVID-19 vaccine among a U.S.-based study population. We apply a social-ecological framework to model health behavior in a mixed methods study, using this lens to guide our analyses on correlates and dimensions of COVID-19 vaccine trust.

To understand the determinants of COVID-19 vaccine trust the current study used a mixed methods study design and a social ecological framework. First, individual, social, and societal-level factors associated with COVID-19 trust, were identified and characterized through bivariate and multivariate regression analyses. Second, qualitative approaches were used to provide an in-depth understanding of factors that drive vaccine trust and identify primary concerns that may lead to mistrust.

2. Methods

2.1. Study population

Study respondents participated in an online four-wave longitudinal study that began in March, 2020. This study aimed to examine individual, social, and societal-level fluctuations amidst the rapidly-changing landscape of the pandemic. Study periods occurred every few months and aimed to capture changes in scientific knowledge of infection, extent of infectious spread, and progress in vaccine development. The analysis primarily employed quantitative and qualitative data from the third survey administered from July 22nd-29th since questions on vaccine trust were assessed only starting in the third wave of the survey. The third survey was administered after Russia announced the approval of a COVID-19 vaccine, but before the FDA commissioner suggested that there may not be a need to complete Phase 3 trials before approval. At this point of data collection, the U.S. FDA had released ambiguous statements about the vaccine approval process as well as alerted the public of temporary discontinuation of vaccine trials. To test the robustness of the study findings, we also prospectively used the wave three variables to predict levels of vaccine trust at wave four. The fourth wave of the study was administered from November 18th - 28th, which was after Pfizer- BioNTech (November 9th) and Moderna (November 16th) presented preliminary Phase 3 data indicating that their COVID-19 vaccines were over 90% effective. There were 586 valid surveys at wave four and 522 individuals who completed both wave three and wave four surveys.

Study participants were recruited through Amazon's Mechanical Turk (MTurk) service. This approach is regularly used by health researchers, as it allows for a diverse sample to be collected in a rapid and timely fashion (Créquit et al., 2018). As research has indicated, MTurk provides better quality data in less time than other methods for recruiting convenience samples (Chandler and Shapiro, 2016). Study populations recruited through MTurk are not nationally representative,

but have been documented to outperform other opinion samples on several dimensions (such as attracting populations like young individuals interested in news, Hispanic and Asian respondents, and individuals from several industries and geographic locations that parallel national, professionally-collected samples) (Huff and Tingley, 2015). Studies using MTurk have also demonstrated good reliability (Follmer et al., 2017). The protocols followed MTurk's best practices, which included ensuring participant confidentiality, protecting study integrity, generating unique completion codes, integrating attention-checks throughout the survey, repeating study-specific qualification questions, and removing disqualified participants (Chandler and Shapiro, 2016; Strickland and Stoops, 2019; Young and Young, 2019). Moreover, despite COVID-19, the demographic characteristics of Mturk appear to be stable (Moss et al., 2020). Eligibility included being age 18 or older, living in the United States, being able to speak and read English, having heard of the coronavirus or COVID-19, and providing written informed consent. Additionally, to enhance reliability, eligible participants had to pass attention and validity checks embedded in the survey (Rouse, 2015). Participants were compensated $2.50 for completing the first survey, $3.00 for the second, $3.50 for the third, and $4.00 for the fourth which was equivalent of approximately $12 per hour. The study protocols were approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

2.2. Measures

The primary quantitative outcome was vaccine trust, which was assessed with the question, "I would not trust a vaccine for the coronavirus." The response options were "Strongly agree," "Agree," "Neither agree nor disagree," "Disagree," and "Strongly disagree." The responses of "Strongly agree," "Agree," and "Neither agree nor disagree," were compared with those who responded, "Disagree," and "Strongly disagree." A sub-analysis then examined the difference between those who responded "Neither agree nor disagree" compared to those who endorsed "Disagree" or "Strongly disagree" responses.

To examine the reasons for COVID-19 vaccine mistrust, we asked a secondary open-ended question, "Why would you not trust a vaccine for the coronavirus?" This question was asked only of participants who responded, "Neither agree nor disagree," "Agree," and "Strongly agree" to the primary question, "I would not trust a vaccine for the coronavirus" ($N = 242$).

2.2.1. Individual-level perception, attitude, and behavioral factors

The perceived severity of COVID-19 was assessed with the question, "If I got the coronavirus, it is likely that I would die from it?" The perceived personal risk prevention for COVID-19 was assessed with the item "There's not much you can do to prevent getting the coronavirus." The response categories were "Strongly agree," "Agree," "Neither agree nor disagree," "Disagree," and "Strongly disagree." Risk prevention was assessed with the question, "Are you trying to spend less time around other people to prevent getting the coronavirus."

The response categories for self-reported race/ethnicity included "White," "Black," "Asian," "Hispanic," "Mixed," or "Other." Due to small sample size, "Hispanic," "Mixed," and "Other" were collapsed. Political ideology was assessed with the question, "Where would you place yourself on a scale running from "Very liberal" to "Very conservative?" The response categories were "Very liberal," Liberal," Slightly liberal," "Moderate," "Slightly conservative," "Conservative," and "Very conservative. Political party affiliation was assessed with the standard question, "Do you consider yourself Republican, Democrat, Independent, or Other?" Family income was assessed and dichotomized, based on the median, at less than $60,000 versus $60,000 or more. Educational attainment was dichotomized as a Bachelor's degree and higher versus Associate's degree or less.

2.2.3. Social-level factors

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

2.2.4. Societal-level factors

To assess trust in sources of information, a set of questions asked participants, "How much do you trust information from [….] about coronavirus?": (1) the CDC, (2) the White House, (3) Johns Hopkins University, (4) major news outlets such as CNN, (5) your State Health Department. Response options were "A great deal," "Quite a bit," "Some," and "Very little or none." As the first two response categories indicated high ratings of trust, responses to trust in information sources were dichotomized as high (a great deal or quite a bit) versus low (some or very little or none).

Qualitative measure: Respondents who reported that they did not trust or were ambivalent about trusting a vaccine (neither agreed or disagreed, agreed or strongly agreed with the statement "I would not trust a vaccine for the coronavirus") were asked the open-ended question, "Why would you not trust a vaccine for the coronavirus?"

2.3. Analyses

2.3.1. Quantitative analyses

We used bivariate logistic regression models to evaluate differences between respondents who reported high and low levels of COVID-19 vaccine trust. Multivariable models assessed the relationship between COVID-19 vaccine trust, adjusting for sociodemographic covariates. Of the 594 respondents at wave three, 2 respondents (representing 0.34% of the original sample) were missing responses for one or more items and removed from the analyses. All sociodemographic variables and other variables with a p-value <0.20 were included in the final adjusted model (Bursac et al., 2008; Mickey and Greenland, 1989). To assess the stability and robustness of the findings, we first examined the relationship between the level of vaccine trust at wave three (July 2020) and wave four (November 2020). We then conducted a multivariable logistic regression model with the same wave three covariates using the trust outcome at wave four.

2.3.2. Qualitative analyses

For the open-ended question, two coders independently developed thematic codes based on the responses. These codes were subsequently compared, and a set of coding themes were developed. The items were then coded independently, and disagreement was addressed by consensus with the assistance of a third coder who also reviewed the thematic codes.

2.3.3. Quantitative analyses of the thematic codes

For the four codes that had 10% or more of the responses, we used a Fisher's exact test to examine differences in themes among those who responded "Neither agree nor disagree" to the statement "I would not trust a vaccine for the coronavirus" compared to those who endorsed "Agree" or "Strongly Agree" responses.

3. Results

3.1. Quantitative findings

Descriptive statistics are reported in Table 1. Over half of the sample ($N = 350$, 59.1%) reported high trust in a potential COVID-19 vaccine, while 40.9% ($N = 242$) reported low trust. Approximately 56% ($N = 332$) reported female sex at birth. The majority of the sample was "White" race/ethnicity ($N = 470$, 79.4%). The mean age of the survey respondents was 39.9 (SD 11.4). Slightly more than half of the respondents reported obtaining a Bachelor's degree or higher ($N = 333$, 56.3%). Participants had a relatively even distribution of political ideology, ranging from "Very liberal" to "Very conservative."

Table 1
Trust in COVID-19 vaccine.

Variables	Low trust ($n = 242$) % or Mean (*SD*)	High trust ($n = 350$) % or Mean (*SD*)	Total ($n = 592$) % or Mean (*SD*)
Age	40.3 (10.8)	39.6 (11.9)	39.9 (11.4)
Race			
White	81.0	78.3	79.4
Black	9.9	4.0	6.4
Asian	5.4	9.7	7.9
Other	3.7	8.0	6.3
Sex assigned at birth			
Male	38.4	.7	43.9
Female	61.6	52.3	56.1
Income			
<$60,000	43.8	48.0	46.3
>$60,000	56.2	52.0	53.7
Education level	51.7	59.4	56.3
Associate's degree or less	48.3	40.6	43.7
Bachelor's degree or higher			
Not much can be done to prevent getting the coronavirus			
Strongly agree	2.5	1.7	2.0
Agree	9.1	4.0	6.1
Neither agree nor disagree	18.6	8.6	12.7
Disagree	51.2	50.6	50.8
Strongly disagree	18.6	35.1	28.4
Likely to die from coronavirus			
Strongly agree	2.9	2.6	2.7
Agree	7.0	7.1	7.1
Neither agree nor disagree	33.5	33.4	33.4
Disagree	29.8	42.3	37.2
Strongly disagree	26.9	14.6	19.6
Trying to spend less time around others	80.2	94.0	88.3
Trust in sources of COVID-19 information			
High trust in the CDC	42.6	78.6	63.9
High trust in the White House	17.4	12.3	14.4
High trust in State Health Department	44.6	77.1	63.9
High trust in the mainstream news	20.2	44.0	34.3
High trust in Johns Hopkins University	56.6	90.0	76.4
Political ideology			
Very conservative	9.1	2.9	5.4
Conservative	19.0	8.6	12.8
Slightly conservative	9.5	9.7	9.6
Moderate	28.9	14.9	20.6
Slightly Liberal	12.4	14.6	13.7
Liberal	12.0	34.0	25.0
Very Liberal	9.1	15.4	12.8
Political affiliation			
Republican	28.9	17.7	22.3
Democrat	27.3	54.3	43.2
Independent	36.4	25.7	30.1
Other	7.4	2.3	4.4
Social Norm scale of COVID-19 prevention behaviors	−0.3 (1.1)	0.2 (0.9)	0.0 (1.0)

Bivariate analyses (Table 2) indicated that vaccine trust was significantly associated with individual sociodemographic and behavioral factors. Men had increased vaccine trust compared with women (OR = 1.46, CI:1.05–2.04), while participants who reported non-Hispanic Black race had decreased odds of vaccine trust compared with White race (OR = 0.42, CI:0.21–0.82). Democrats had increased odds of vaccine trust compared with Republicans (OR = 3.25, CI:2.09–5.06). Similarly, increasingly conservative political affiliation was associated with decreased vaccine trust (OR = 0.71, CI:0.64–0.78).

Factors related to individual behaviors and beliefs were also significantly related to vaccine trust. Individuals who agreed with the belief that "Not much can be done to prevent getting the coronavirus" had greater odds of vaccine trust (OR = 1.61, CI:1.33–1.95). Vaccine trust was also significantly associated with social and societal factors in bivariate analyses: high trust in Johns Hopkins University, state health departments, mainstream news sources, and the CDC as sources of COVID-19 information were all positively associated with vaccine trust.

Table 2
Logistic regression models of trust in a COVID-19 vaccine.

	Wave 3 ($N = 592$) OR (95% CI)	Wave 3 ($N = 592$) aOR (95% CI)	Wave 4* ($N = 522$) aOR (95% CI)
Race (Ref: White)	REF	REF	REF
Non-Hispanic Black	**0.42 (0.21–0.82)**	**0.25 (0.11–0.57)**	**0.22 (0.08–0.56)**
Asian	1.86 (0.96–3.62)	1.71 (0.75–3.91)	1.04 (0.45–2.41)
Other	**2.22 (1.02–4.80)**	2.34 (0.93–5.89)	1.56 (0.63–3.87)
Age	0.99 (0.98–1.01)	1.00 (0.98–1.02)	1.01 (0.99–1.03)
Sex assigned at birth (Ref: female)	**1.46 (1.05–2.04)**	**2.01 (1.32–3.07)**	**2.38 (1.53–3.69)**
Income Level (Ref: Low)	1.18 (0.85–1.65)	1.24 (0.81–1.90)	1.27 (0.82–1.97)
Education Level (Ref: Low)	1.37 (0.99–1.91)	0.89 (0.59–1.36)	0.97 (0.63–1.50)
Trust in sources of COVID-19 information			
Johns Hopkins University	**6.90 (4.48–10.62)**	**2.69 (1.49–4.86)**	**3.67 (1.92–7.92)**
State health department	**4.19 (2.93–5.98)**	**1.96 (1.20–3.19)**	1.37 (0.83–2.28)
The mainstream news	**3.09 (2.12–4.52)**	1.15 (0.72–1.85)	1.09 (0.67–1.77)
The White House	0.67 (0.42–1.06)	0.66 (0.36–1.21)	0.60 (0.31–1.17)
The CDC	**4.95 (3.45, 7.10)**	**1.86 (1.14–3.05)**	**2.01 (1.20–3.35)**
Trying to spend less time around others	**0.26 (0.15–0.44)**	0.84 (0.42–1.68)	0.80 (0.37–1.74)
Likelihood of dying from coronavirus	0.88 (0.74–1.05)	1.12 (0.90–1.39)	1.12 (0.88–1.41)
Not much can be done to prevent getting the coronavirus	**1.61 (1.33–1.95)**	1.25 (0.99–1.58)	1.18 (0.92–1.51)
Political ideology (Ref: Very liberal)	**0.71 (0.64–0.78)**	**0.78 (0.65–0.93)**	**0.83 (0.69–0.99)**
Political affiliation (Ref: Republican)	REF	REF	REF
Democrat	**3.25 (2.09–5.06)**	0.88 (0.41–1.90)	0.74 (0.33–1.64)
Independent	1.15 (0.74–1.81)	0.54 (0.28–1.02)	0.43 (0.21–0.86)
Other	0.50 (0.20–1.24)	**0.25 (0.08–0.74)**	0.90 (0.29–2.83)
Social Norm scale of COVID-19 prevention behaviors	**1.81 (1.51–2.17)**	**1.31 (1.05–1.64)**	**1.32 (1.04–1.68)**

Note. All sociodemographic variables and other variables with a p-value < 0.20 were included in aOR model.

In addition, reporting higher levels of social norms for COVID-19 preventive behaviors was associated with increased vaccine trust (OR = 1.81, CI:1.51–2.17).

Compared with the bivariate analyses, multivariable regression analyses (Table 2) revealed similar associations of sociodemographic, social, and societal factors associated with vaccine trust. Compared with White participants, Non-Hispanic Black participants had lower odds of vaccine trust (aOR = 0.25, CI:0.11–0.57) adjusting for other factors. Men had significantly higher odds of vaccine trust than women (aOR = 2.01, CI:1.32–3.07). Increasingly conservative political ideology was independently associated with low vaccine trust (aOR = 0.78, CI:0.65–0.93). Compared with Republican political affiliation, Democratic affiliation was no longer significant in the multivariable model; however, "Other" political affiliation was associated with lower vaccine trust (aOR = 0.25, CI:0.08–0.74). Participants who agreed that "Not much can be done to prevent getting the coronavirus" had greater odds of vaccine trust in the adjusted model (aOR = 1.25, CI:0.99–1.58). As in the bivariate models, age, income, and education level were not significantly associated with vaccine trust. In addition, greater normalization of preventive behaviors in one's social network was independently and significantly associated with increased vaccine trust in the adjusted model (aOR = 1.31, CI:1.05–1.64).

Informational trust in news sources was also significantly associated with vaccine trust in multivariable analyses. Those reporting trust in news from JHU had greater odds of vaccine trust (aOR = 2.69, CI 1.49–4.86). Similarly, those with greater trust in state health department information sources (aOR = 1.96, CI 1.20–3.19) and the CDC (aOR = 1.86, CI 1.14–3.05) had greater odds of vaccine trust, while trust in the mainstream news was no longer significant in a model that adjusted for other factors. Interestingly, trust in the White House was not significantly associated with vaccine trust in bivariate nor multivariate analyses.

Among participants who completed both the wave three and four surveys, we found that there was high stability in the level of trust in a COVID-19 vaccine between July and November 2020, with 83.5% of the respondents maintaining their prior level of trust (34.5% low trust and 49.0% high trust). The final multivariate logistic model used the wave four levels of trust as an outcome. As shown in Table 2, there was a remarkable similarity in the adjusted odds ratios models at wave three and wave four. A post hoc analysis revealed a significant correlation between four of the variables that measured levels of trustworthiness in COVID-19 new sources (CDC, Johns Hopkins University, major news outlets such as CNN, and the State Health Department). These correlations may help to explain why some of these variables were not significant in the multivariable models.

Table 3
Qualitative themes in reasons for not trusting a COVID-19 vaccine (n = 227).

Code	Theme	Examples
1	**Too new:** no knowledge of long-term side effects or safety (28.2%)	*"This is a rushed vaccine that won't have enough time to be tested properly. Nobody really knows what will be in it or what the LONG term effects of it could be."* *"I would not feel comfortable with any vaccine without having seen more research and long term trial results to gauge the safety of the product."*
2	**Vaccine skepticism:** distrust in vaccines in general, distrust in a flu vaccine, vaccine source (13.2%)	*"Any vaccine is just putting the virus into your body and "hoping" your body fights it off. Why would I want to put the virus into my body I am 68 and have never had a flu shot."* *"People get flu shots but still wind up getting the flu. I don't see why a coronavirus would be any different."*
3	**Compromised immune systems:** unable to get some vaccines or get sick from vaccines, or prefer natural immunity (3.5%)	*"Shots tend to make me very, very sick … I would be concerned that I'd need to be hospitalized for the coronavirus if I got the vaccine."* *"It may compromise my immune system in other ways and I believe in natural immunity."*
4	**General skepticism:** general indecisiveness and lack of trust (4.4%)	*"I don't want to be the guinea pig for this vaccine."* *"I am not anti-vax but since there is still so much that is unknown about the virus, I wouldn't trust the vaccine at the beginning. There is still too much to learn to even know if this is vaccine worthy for healthy individuals like myself."*
5	**Vaccine fast-tracking:** belief that the vaccine is being distributed too soon without adequate testing, data, or proof of success (56.8%)	*"I would feel the need to wait and see how the vaccine affected the people who are willing to get it first. I feel it is being developed very quickly and under a large amount of pressure."* *"I worry that a vaccine for the coronavirus is being rushed and not tested properly to make sure that it is safe. I would rather researchers take their time and ensure that the virus did not have any unforeseen side-effects that may appear down the road that are worse than what the virus may do. I just think it may not be safe due to time constraints."*
6	**Profit distrust:** distrust of "Big Pharma," emphasis on profit aspect (5.3%)	*"It is not being carefully or tested well. It is a race to make money, when the medical field should be promoting healthy living, and not a dependence on a vaccine."* *"I don't trust the FLU vaccine and haven't ever received it, why would I get a vaccine that Bill Gates is all giddy about?"*
7	**Current government distrust:** lack of trust in the current administration, re-election scam (6.6%)	*"I don't trust the current administration to utilize an effective vaccine that would not cause other side effects or problems … I feel that any vaccine that is put out soon has been rushed to market … could cause permanent damage to people."* *"I will not trust one that is rushed by this administration in order to look like they've accomplished something that they haven't. We've seen enough of that."*
8	**Virus strain/mutation:** modifications would be necessary due to mutations or new strains (8.8%)	*"I think that it mutates too fast for a vaccination to be very effective for long."* *"The coronavirus continues to mutate so it is hard to know if the vaccine would be effective for any new strains that are created over time."*
9	**Vaccine contents**: unsure what is in the vaccine (5.3%)	*"I don't trust any vaccine that the government gives you. Who knows what's in it?"* *"Some people say there are bad substances in the vaccine on purpose. I would be worried I might have a reaction."*
10	**Doubt in efficacy:** belief that one may still become infected (12.3%)	*"I doubt that it will be very effective, just like the limited effectiveness of the flu vaccine."* *"I would want to see the effectiveness of it at first. I would wait to see what happens to the first wave of people to get the vaccine to see what happens before I decide to get it or not."*
11	**Other** (7.9%)	*"The history of the US government and how it has intentionally spread diseases to the Native Americans and my people makes me very wary of vaccinations of any kind."* *"Micro chipping and tracking … I have no idea what is in it."* *"I never get the flu vaccine as I am young and not immunocompromised. The risks of the vaccine may outweigh the risks of coronavirus for someone in my age group. Coronavirus is largely benign for most people. It has been overhyped."*

3.2. Qualitative findings

There were 242 participants (41% of the sample) who reported that they did not trust or were ambivalent about trusting a vaccine. Each of these participants was then asked the open-ended question, "Why would you not trust a vaccine for the coronavirus?" for 227 respondents provided responses (94%). Twenty-two thematic codes were developed; however, 11 codes were endorsed by only 2% or fewer respondents and therefore placed in an "other"' category, which consisted of 8% responses. 346 coded responses were identified for a mean of 1.52 codes per respondent. Out of the 11 final codes, only 4 had 10% or more, and 9 with 5% or more.

Table 3 summarizes the 11 themes. The most frequent theme, which was mentioned by 56.8% of the subsample, was Theme 5, The vaccine was being distributed too soon without adequate testing, data, or proof of success. The second most frequent theme was Theme 1, No knowledge of long term side effects, how safe it is, with 28.2% reporting this sentiment. An example of this sentiment was the statement, "I would not feel comfortable with any vaccine without having seen more research and long term trial results to gauge the safety of the product." There were 13.2% coded with Theme 2, Prefer natural immunity/doesn't like or trust vaccines in general. An example of this theme was the sentiment, "Any vaccine is just putting the virus into your body and "hoping" your body fights it off. Why would I want to put the virus into my body." Theme 10, Doubts its efficacy, thinks they would still get COVID, had 12.3% mentions. An example of this theme was the statement, "I doubt that it will be very effective, just like the limited effectiveness of the flu vaccine." The other themes (Table 3) had less than 10% of the responses. The responses in the "other" theme category varied widely, with many having only one entry.

3.3. Quantitative analyses based on qualitative coding

In quantitative analyses, we examine the relationship between the coded responses and the level of COVID-19 vaccine trust for the codes with 10% or more (Themes 1, 2, 5, and 10) to ensure that there was adequate statistical power. In these analyses, those who reported that they agreed or strongly agreed with the statement "I would not trust a vaccine for the coronavirus" were compared to those who neither agreed or disagreed with the statement.

Individuals who expressed Theme 2 (prefers natural immunity/doesn't like or trust vaccines) appear to indicate an antivaccine perspective. Of those who agreed or strongly agreed to the statement of not trusting a COVID-19 vaccine, 20% endorsed this theme as compared with 2% of respondents in the ambivalent category (neither agreed or disagreed) ($p<.001$, Fisher Exact test). In an analysis of Theme 5 (concern about vaccine fast-tracking), among those who agreed or strongly agreed with the statement that they did not trust a COVID-19 vaccine, 50% endorsed this theme compared with 66% of respondents who reported that they neither agreed or disagreed (ambivalent) with the statement ($p<.05$, Fisher Exact test). There were no significant differences when comparing the low trust group with the ambivalent group, for Theme 1 (no knowledge of long term side effects, how safe it is, too new) or Theme 10 (doubts efficacy, thinks that they would still get COVID).

4. Discussion

Given that the rollout of a widespread and effective COVID-19 vaccination program is a critical part of mitigating disease spread and ending the pandemic, it is concerning that the current study identified that a large proportion of individuals have low trust in a COVID-19 vaccine and tend to distrust vaccine testing and approval processes. While vast resources have been made available by the U.S. government with Project Warp Speed to develop a COVID-19 vaccine quickly, various studies among national U.S. population samples have also indicated this widespread and concerning lack of trust surrounding the accelerated vaccine approval process. In the U.S., the COVID-19 pandemic and the public health response have become widely politicized (Hart and Soroka, 2020; Allcott et al., 2020). These actions have severely diminished trust in the public health infrastructure, including vaccine development, testing, and approval processes, as have conspiracy theories and misinformation on social media (Jean-Jacques et al., 2012; Center for Informed Democracy & Social Cybersecurity, 2020).

In the bivariate analyses, our results suggested that individuals who reported greater trust in COVID-19 information from the CDC, state health departments, mainstream news, and a university well-known for disseminating COVID-19 data were also more likely to trust a COVID-19 vaccine. These results were attenuated in the multivariable models due to significant correlations among all news sources except the White House. These data suggest that state health departments, research universities, and the CDC should provide timely information about COVID-19 vaccines. To maximize reach, this information should be widely disseminated across networks and platforms with high user volumes. Moreover, to address low rates of trust in the COVID-19 vaccine, vaccination promotion efforts should both involve and be informed by health professionals, including physicians, nurses, pharmacists, community health workers, and mental health therapists, who have ongoing relationships with patients and likely have increased capacity to build trust. However, the increasing utilization of telemedicine throughout the ongoing pandemic may pose an unforeseen barrier in that it may be more difficult for healthcare professionals to have effective conversations in a virtual setting with patients to encourage COVID-19 vaccine acceptance.

The models of the level of trust at wave four (November 2020) were remarkably similar to the model that utilized the level of trust at wave three (July 2020). There was only one variable, trust in one of the news sources, that became not statistically significant, which was due in part, to the correlations among four of the news sources. Interestingly, our results also indicated that Democrats had higher levels of trust as compared to Republicans in bivariate analyses, but this association was no longer significant in the multivariable model when political conservatism was added. In the multivariable model, political conservatism was strongly associated with lower COVID-19 vaccine trust. This may indicate that vaccine trust is more complex of an issue than just the partisan divide between Democrats and Republicans, as political ideology appears to be a stronger predictor of vaccine trust than political affiliation. This finding may be due in part to political polarization and greater distrust of government among conservatives (Baumgaertner et al., 2018; Morisi et al., 2019; Pew Research Center, 2019). In considering this, efforts must be made to facilitate trust among people with more conservative ideologies. These efforts might include conducting targeted outreach or disseminating information within particular networks or on media platforms that are more utilized by those who identify with more conservative political ideologies. In addition, individuals who more strongly perceived social norms of engaging in COVID-19 prevention behaviors (social distancing and mask usage) tended to have higher trust in the COVID-19 vaccine. As such, public health campaigns and public policies that widely promote and normalize COVID-19 prevention behaviors may enhance public perceptions of social norms surrounding COVID-19 prevention and lead to greater COVID-19 vaccine trust.

From our quantitative analyses, we also observed a racial/ethnic difference in vaccine trust, with Black Americans expressing significantly lower levels of trust than White Americans. This finding aligns with previous literature on medical mistrust and overall mistrust in government (Kolar et al., 2015; Westergaard et al., 2014; Pew Research Center, 2019). This finding, along with the racial disparities in COVID-19 mortality, indicates that it is imperative to develop vaccine programs that consider racial differences in vaccine trust. In addition, we found a gender difference in vaccine trust, with lower trust among women. Due to traditional gender roles, women more often than men are gatekeepers to children's medical care, including vaccines, and this

finding of a gender difference suggests the need to tailor public health campaigns and recommendations to health care providers based on gender disparities in vaccine trust (Ranji and Calganicoff, 2018).

Findings from our qualitative analyses suggest that the speed of COVID-19 vaccine development is of great concern. Moreover, this concern was more pronounced among those who had ambivalent attitudes about vaccine trust than those with negative vaccine trust attitudes. As it is likely that it will be easier to promote vaccine uptake among the ambivalent group compared to those with low trust in a COVID-19 vaccine, campaigns to promote vaccine uptake should address this concern. The second most frequent concern mentioned in the open-ended question was that of side effects and safety, which is likely to be exacerbated by an expedited approval process. These findings suggest that it is essential to adequately address questions about how side effects are monitored, typical and atypical side effects, and why the vaccines are unlikely to produce unknown side effects. One approach that can be employed to mitigate concern over side effects may be to standardize and frame information on side effects in terms of relative side effects, such as presenting the risk of the same side effects from other widely-used medications, rather than emphasizing low absolute risk.

4.1. Limitations

There are some limitations to the current study. The primary analyses were cross-sectional. Also, survey responses are subject to social desirability and other response biases. Bias could have been introduced in the operationalization of certain measures, such as using a negatively-worded question to assess COVID-19 vaccine trust rather than a positively-worded question. Moreover, though the respondents were similar to demographic characteristics found in other online surveys, we did not have a representative sample. There was also an insufficient number of minorities, older adults, or those with health conditions that place them at risk for severe COVID-19 illness for sub-analyses of these important groups. The measure of trust in "mainstream news media" may have also been subject to substantial variation in individual interpretation, as coverage of COVID-19 differed significantly among major news media and networks.

5. Conclusions

In general, the data from the current study suggest that there are significant levels of COVID-19 vaccine distrust that must be addressed to ensure maximum uptake of any COVID-19 vaccine in the U.S.. The speed of vaccine approval, insufficient communication about vaccine development, testing, and approval processes, and the polarization of public health and medical regulatory bodies may have facilitated distrust of a COVID-19 vaccine. These concerns urgently need to be addressed by vaccine makers, the CDC, FDA, and the public health community. It is also critical that a vaccine rollout is perceived to be equitable.

Finally, the majority of the concerns expressed by respondents can be viewed as legitimate and not merely based on a lack of knowledge, which has often been how the antivaccine movement has been portrayed. It is the responsibility of policymakers, health officials, and the research community to articulate the vaccine approval process clearly, various types of vaccines, prevalence of side effects, and ongoing processes for monitoring side effects. Moreover, given the major disparities in the COVID-19 mortality based on age, race, and health conditions, approved vaccines could emphasize that a vaccine is also a means to protect older adults and vulnerable populations if a large enough proportion of the population is vaccinated, which may be of particular importance if there is a differential effectiveness among COVID-19 vaccines. A better understanding of rates, changes in rates, and reasoning behind vaccine trust is paramount to increasing vaccine uptake among various population demographics and ultimately curtailing the COVID-19 pandemic.

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Credit author statement

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Appendix A. Supplementary data

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References

Allcott, H., Boxell, L., Conway, J., Gentzkow, M., Thaler, M., Yang, D.Y., 2020. Polarization and Public Health: Partisan Differences in Social Distancing during the Coronavirus Pandemic. NBER Working Paper w26946.

American Academy of Arts and Sciences, 2014, April. Public Trust in Vaccines: Defining a Research Agenda. American Academy of Arts and Sciences. Retrieved from. https://www.amacad.org/content/publications/publication.aspx?d=1454.

Baumgaertner, B., Carlisle, J.E., Justwan, F., 2018. The influence of political ideology and trust on willingness to vaccinate. PloS One 13 (1), e0191728.

Bogart, L.M., Ojikutu, B.O., Tyagi, K., Klein, D.J., Mutchler, M.G., Dong, L., et al., 2020 Nov 09. COVID-19 related medical mistrust, health impacts, and potential vaccine hesitancy among Black Americans living with HIV. J. Acquir. Immune Defic. Syndr. PMID: 33196555.

Bruine de Bruin, W., Parker, A.M., Galesic, M., Vardavas, R., 2019. Reports of social circles' and own vaccination behavior: a national longitudinal survey. Health Psychol. 38 (11), 975.

Bursac, Z., Gauss, C.H., Williams, D.K., Hosmer, D.W., 2008. Purposeful selection of variables in logistic regression. Source Code Biol. Med. 3, 17. https://doi.org/10.1186/1751-0473-3-17.

Center for Informed Democracy & Social Cybersecurity, 2020. Coronavirus Misinformation and Disinformation Regarding Coronavirus in Social Media. Carnegie Mellon University. Retrieved from. https://www.cmu.edu/ideassocia l-cybersecurity/research/coronavirus.html.

Chandler, J., Shapiro, D., 2016. Conducting clinical research using crowdsourced convenience samples. Annu. Rev. Clin. Psychol. 12.

Compton, W.M., Jones, C.M., 2019. Epidemiology of the US opioid crisis: the importance of the vector. Ann. NY Acad. Sci 1451, 130–143.

Corum, J., Grady, D., Wee, S.L., Zimmer, C., 2020. Coronavirus Vaccine Tracker. The New York Times. Retrieved from. https://www.nytimes.com/interactive/2020/science/coronavirus-vaccine-tracker.html.

Créquit, P., Mansouri, G., Benchoufi, M., Vivot, A., Ravaud, P., 2018. Mapping of crowdsourcing in health: systematic review. J. Med. Internet Res. 20 (5), e187.

de Visser, R., Waites, L., Parikh, C., Lawrie, A., 2011. The importance of social norms for uptake of catch-up human papillomavirus vaccination in young women. Sex. Health 8 (3), 330–337.

Dubé, E., Gagnon, D., MacDonald, N.E., 2015. Strategies intended to address vaccine hesitancy: review of published reviews. Vaccine 33 (34), 4191–4203.

Follmer, D.J., Sperling, R.A., Suen, H.K., 2017. The role of MTurk in education research: advantages, issues, and future directions. Educ. Res. 46 (6), 329–334.

Freeman, D., Waite, F., Rosebrock, L., Petit, A., Causier, C., East, A., et al., 2020. Coronavirus conspiracy beliefs, mistrust, and compliance with government guidelines in England. Psychol. Med. 1–30.

Freimuth, V.S., Jamison, A.M., An, J., Hancock, G.R., Quinn, S.C., 2017. Determinants of trust in the flu vaccine for African Americans and Whites. Soc. Sci. Med. 193, 70–79.

Friedrich, M.J., 2019. WHO's top health threats for 2019. J. Am. Med. Assoc. 321 (11), 1041-1041.

Funk, C., Kennedy, B., Johnson, C., 2020 May 21. Trust in Medical Scientists Has Grown in U.S., but Mainly Among Democrats. Pew Research Center. Retrieved from. https://www.pewresearch.org/science/2020/05/21/trust-in-medical-scientists-has-grown-in-u-s-but-mainly-among-democrats/.

Hart, P.S., Chinn, S., Soroka, S., 2020. Politicization and Polarization in COVID-19 News Coverage. Science Communication. https://doi.org/10.1177/1075547020950735, 1075547020950735.

Huff, C., Tingley, D., 2015. "Who are these people?" Evaluating the demographic characteristics and political preferences of MTurk survey respondents. Research & Politics 2 (3), 2053168015604648.

Jean-Jacques, M., Persell, S.D., Thompson, J.A., Hasnain-Wynia, R., Baker, D.W., 2012. Changes in disparities following the implementation of a health information technology-supported quality improvement initiative. J. Gen. Intern. Med. 27 (1), 71–77.

Jones, M.R., Viswanath, O., Peck, J., Kaye, A.D., Gill, J.S., Simopoulos, T.T., 2018. A brief history of the opioid epidemic and strategies for pain medicine. Pain and therapy 7 (1), 13–21.

Kolar, S.K., Wheldon, C., Hernandez, N.D., Young, L., Romero-Daza, N., Daley, E.M., 2015. Human papillomavirus vaccine knowledge and attitudes, preventative health behaviors, and medical mistrust among a racially and ethnically diverse sample of college women. Journal of racial and ethnic health disparities 2 (1), 77–85.

Kreps, S., Prasad, S., Brownstein, J.S., Hswen, Y., Garibaldi, B.T., Zhang, B., Kriner, D.L., 2020. Factors associated with US adults' likelihood of accepting COVID-19 vaccination. JAMA network open 3 (10) e2025594-e2025594.

Larson, H., Leask, J., Aggett, S., Sevdalis, N., Thomson, A., 2013. A multidisciplinary research agenda for understanding vaccine-related decisions. Vaccines 1 (3), 293–304.

Larson, H.J., Jarrett, C., Eckersberger, E., Smith, D.M., Paterson, P., 2014. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature. 2007–2012. Vaccine 32 (19), 2150–2159.

Larson, H.J., De Figueiredo, A., Xiahong, Z., Schulz, W.S., Verger, P., Johnston, I.G., et al., 2016. The state of vaccine confidence 2016: global insights through a 67-country survey. EBioMedicine 12, 295–301.

Larson, H.J., Clarke, R.M., Jarrett, C., Eckersberger, E., Levine, Z., Schulz, W.S., Paterson, P., 2018. Measuring trust in vaccination: a systematic review. Hum. Vaccines Immunother. 14 (7), 1599–1609.

Lazarus, J.V., Ratzan, S.C., Palayew, A., et al., 2020. A global survey of potential acceptance of a COVID-19 vaccine. Nat. Med. https://doi.org/10.1038/s41591-020-1124-9. Retrieved from:

MacDonald, N.E., 2015. Vaccine hesitancy: definition, scope and determinants. Vaccine 33 (34), 4161–4164.

Majid, U., Ahmad, M., 2020. The factors that promote vaccine hesitancy, rejection, or delay in parents. Qual. Health Res. 30 (11), 1762–1776.

Marks, J.H., 2020. Lessons from corporate influence in the opioid epidemic: toward a norm of separation. J. bioeth. Inq. 17 (2), 173–189.

McCarthy, Justin, 2019, September 3. Big Pharma Sinks to the Bottom of U.S. Industry Rankings. *Gallup*. Retrieved from. https://news.gallup.com/poll/266060/big-pharma-sinks-bottom-industry-rankings.aspx.

Mickey, R.M., Greenland, S., 1989. The impact of confounder selection criteria on effect estimation [published correction appears in Am J Epidemiol 1989 Nov;130(5): 1066]. Am. J. Epidemiol. 129 (1), 125–137. https://doi.org/10.1093/oxfordjournals.aje.a115101.

Morisi, D., Jost, J.T., Singh, V., 2019. An asymmetrical president-in-power effect. Am. Polit. Sci. Rev. 113 (2), 614–620.

Moss, A.J., Rosenzweig, C., Robinson, J., Litman, L., 2020. Demographic stability on mechanical Turk despite COVID-19. Trends Cognit. Sci. 24 (9), 678–680. https://doi.org/10.1016/j.tics.2020.05.014.

National Vaccine Advisory Committee, 2015. Assessing the state of vaccine confidence in the United States: recommendations from the national vaccine advisory committee. Publ. Health Rep. 573–595.

Palamenghi, L., Barello, S., Boccia, S., Graffigna, G., 2020. Mistrust in biomedical research and vaccine hesitancy: the forefront challenge in the battle against COVID-19 in Italy. Eur. J. Epidemiol. 1–4.

Pew Research Center, 2019, April 11. Public Trust in Government: 1958-2019. Pew Research Center. Retrieved from. https://www.pewresearch.org/politics/2019/04/11/public-trust-in-government-1958-2019/.

Quinn, S., Jamison, A., Musa, D., Hilyard, K., Freimuth, V., 2016. Exploring the continuum of vaccine hesitancy between African American and white adults: results of a qualitative study. PLoS currents 8.

Quinn, S.C., Hilyard, K.M., Jamison, A.M., An, J., Hancock, G.R., Musa, D., Freimuth, V. S., 2017. The influence of social norms on flu vaccination among African American and White adults. Health Educ. Res. 32 (6), 473–486.

Quinn, S.C., Jamison, A.M., An, J., Hancock, G.R., Freimuth, V.S., 2019. Measuring vaccine hesitancy, confidence, trust and flu vaccine uptake: results of a national survey of White and African American adults. Vaccine 37 (9), 1168–1173.

Reiter, P.L., Pennell, M.L., Katz, M.L., 2020. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? Vaccine 38 (42), 6500–6507.

Rhodes, A., Hoq, M., Measey, M.A., Danchin, M., 2020. Intention to vaccinate against COVID-19 in Australia. Lancet Infect. Dis. https://doi.org/10.1016/S1473-3099(20)30724-6. S1473-3099(20)30724-6.

Rouse, S.V., 2015. A reliability analysis of Mechanical Turk data. Comput. Hum. Behav. 43, 304–307.

Smith, T.C., 2017, July. Vaccine rejection and hesitancy: a review and call to action. In: Open Forum Infectious Diseases, vol. 4. Oxford University Press, 3.

Solomon, D., Maxwell, C., Castro, A., 2019. Systemic Inequality: Displacement, Exclusion, and Segregation, vol. 7. Center for American Progress.

Stout, M.E., Christy, S.M., Winger, J.G., Vadaparampil, S.T., Mosher, C.E., 2020. Self-efficacy and HPV vaccine attitudes mediate the relationship between social norms and intentions to receive the HPV vaccine among college students. J. Community Health 45 (6), 1187–1195. https://doi.org/10.1007/s10900-020-00837-5.

Strickland, J.C., Stoops, W.W., 2019. The use of crowdsourcing in addiction science research: Amazon Mechanical Turk. Exp. Clin. Psychopharmacol 27 (1), 1.

Westergaard, R.P., Beach, M.C., Saha, S., Jacobs, E.A., 2014. Racial/ethnic differences in trust in health care: HIV conspiracy beliefs and vaccine research participation. J. Gen. Intern. Med. 29 (1), 140–146.

World Health Organization (WHO), 2020a. *Draft Landscape of COVID-19 Candidate Vaccines* (Publication). https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines.

World Health Organization (WHO), 2020b. *Vaccine Hesitancy: What It Means and what We Need to Know in Order to Tackle it* (Presentation). https://www.who.int/immunization/research/forums_and_initiatives/1_RButler_VH_Threat_Child_Health_gvirf16.pdf?ua=1.

Young, J.A., Young, K.M., 2019. Don't get lost in the crowd: best practices for using Amazon's mechanical Turk in behavioral research. Journal of the Midwest Association for Information Systems| 2019 (2), 7.