



Identities as predictors of vaccine hesitancy during the COVID-19 pandemic

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Abstract

Vaccine hesitancy is variable across individuals and contexts. Theoretical work suggests that group membership should differentially affect attitudes and behavior related to COVID-19 vaccines, as individuals draw on their identities and experiences relevant to their social groups to deal with uncertainty concerning the vaccines. The present work uses longitudinal survey data to explore how identity predicted vaccination attitudes in the U.S. before COVID-19 vaccines were widely available and which role-based or contextual variables influenced early vaccination decisions. We replicate these patterns in hesitancy with a larger and more racially diverse sample and identify whether encouragement from people with shared identities was important when participants made the decision to be vaccinated. Before the vaccines were widely available, higher

SES predicted less hesitancy toward the COVID-19 vaccines, while being Black and/or having more conservative political orientation predicted more hesitancy. More conservative political orientation was a predictor of vaccine hesitancy across racial identities. While rationale for mistrust may vary by identity, vaccine trust is a significant predictor of early vaccination, and it is influenced by local norms surrounding the COVID-19 vaccines. Encouragement from shared group members was more important for women, liberal individuals, and younger individuals in making the decision to be vaccinated.

INTRODUCTION

The successful development of COVID-19 vaccines was a major advance in the effort to slow the spread of the disease. However, vaccine rollout in the U.S. encountered setbacks that were evident by the summer of 2021 when the vaccine was widely available for the adult population. At that time only approximately 68% of adults (176.2 million individuals) were fully vaccinated (Centers for Disease Control & Prevention, 2022a). Vaccine hesitancy, that is, refusing or delaying vaccination, can leave individuals vulnerable to serious illness even when protection from vaccines is available. Vaccine hesitancy varies considerably between individuals and in different contexts (Larson et al., 2015) and poses a challenge to public health efforts to combat disease. In order to understand these challenges and to better prepare for future public health emergencies, it is critical to pinpoint the factors that contribute to COVID-19 vaccine hesitancy in the U.S. in order to reduce health disparities and protect vulnerable individuals and groups.

To begin to understand factors underlying vaccine hesitancy, it is important to consider how uncertainty during the development and rollout of the vaccine may have affected people's attitudes. In the U.S., Pfizer and BioNTech proposed the first COVID-19 vaccine for emergency use authorization (EUA) in November 2020 (Pfizer, 2020). Even before their development and emergency use launch, COVID-19 vaccines were the subject of intense discussion. Prominent U.S. health organizations described vaccines as a likely solution to the pandemic as early as the summer of 2020 (Mayo Clinic, 2020). In these early releases of information about the vaccines, the vaccine development timeline and which vaccine technology was to be used remained unknown, leading to some ambiguity about what the vaccine would look like and when it would be available. Additionally, the appearance of an accelerated timeline of vaccine development and testing (Mayo Clinic, 2020) was a possible contributor to uncertainty about the safety of the vaccine.

Group membership may relate to attitudes about adopting an uncertain and novel intervention such as the COVID-19 vaccine, a concept that is supported by previous theoretical work. The uncertainty-identity theory of group membership (Hogg et al., 2008) posits that people use group membership to resolve epistemic uncertainty. Groups can shape our behavior through prescriptive attitudes and norms that are especially salient for those who highly identify with that group (Wellen et al., 1998). Self-categorization theory posits that a part of one's self-concept is defining oneself through social identity or group membership (Hornsey, 2008). When we self-categorize

with a given group, we can act based on group emotions in addition to just our own (Mackie et al., 2008).

Confronted with the newly developed COVID-19 vaccine, many individuals may have referred to their group memberships when forming attitudes about the vaccine and choosing whether to receive it. Indeed, research conducted during 2020 indicated that women, Black individuals, individuals without a college degree, and more politically conservative individuals had higher levels of COVID-19 vaccine hesitancy compared to other groups (Callaghan et al., 2021; Daly & Robinson, 2021) and that Republicans were drivers of an increase in vaccine hesitancy over time (Fridman et al., 2021). News reports on the vaccine reiterated these differences (Leonhardt, 2021).

Some group-based differences in attitudes toward the COVID-19 vaccine, including racial identity-based differences, have multiple causes. In a 2020 Pew Research study, Black Americans were less trusting of medical scientists and doctors (Gramlich & Funk, 2020). This mistrust may derive from the historical legacy of discrimination and ongoing mistreatment of Black Americans by the U.S. medical and public health systems. One widely cited historical example is the Tuskegee Syphilis Study, conducted between 1932 and 1972, in which antibiotic treatment was intentionally and unethically withheld from Black men who had been diagnosed with syphilis (Park, 2017). Black Americans have been shown to experience longer wait times, less pain mitigation, fewer of the standard procedures for care, and higher mortality in emergency and critical care settings in the U.S. (Breathett et al., 2018; Joynt et al., 2013; Kumar et al., 2014). Viewing the U.S. medical system as an outgroup that directly threatens one's ingroup may result in heightened ingroup emotions that could influence behavior (Mackie et al., 2008). In addition to knowledge of active harm against group members, fundamental cause theory (Hatzenbuehler et al., 2013) suggests that some factors, such as stigma from a marginalized identity, will be associated with worse health outcomes across diseases. In the case of COVID-19, this could mean that, despite the government's push for a resolution to the pandemic, members of marginalized groups might expect that they will not be given the same access as others to services or high-quality care. This may also result in a reduced willingness to get or trust the COVID-19 vaccines because of heightened mistrust around the quality of vaccines distributed to these groups or the anticipated response to side effects in these communities. This could apply to multiple marginalized groups, from racial minorities to individuals of lower socioeconomic status (SES). This is important because trust in healthcare and the COVID-19 vaccine itself has been linked to attitudes, behavioral intentions, and uptake of the COVID-19 vaccine (Liu & Chu, 2022).

There may also be particular factors that impact women's likelihood to get or trust the COVID-19 vaccines. Work done before the launch of the vaccines suggested that women were more hesitant about getting the vaccine (Trueblood et al., 2021). The authors of that study speculated that this relationship might be explained by greater risk aversion among women. However, risk aversion does not explain women's subsequent behavior. When vaccines were made available, women were vaccinated at higher rates than men, as shown by data collected at vaccination sites early in the vaccine rollout (Ungar, 2021). Role-based factors, such as overrepresentation in high-risk professions and caregiver responsibilities, may lead some women to be vaccinated to protect family members and others in their care. Women took on increased caretaking burdens during the pandemic and, along with other marginalized groups, were more likely to hold jobs that required continuing to work in-person rather than remotely (Fulcher & Dinella, 2023-a).

Though many existing analyses look at each group membership as a separate factor, it is important to recognize that the overlap of these social categories in any given individual may create different attitudinal outcomes. For example, Black women face unique inequities compared to Black men or White women (Crenshaw, 1989), including specific inequities within medical

when it is available to you?; 1 = not at all likely, 7 = extremely likely). At Time 7 onward, a response of 7 also includes those who indicated that they had already gotten the vaccine. All participants, including those who received their vaccine, were also asked about their likelihood to trust the vaccine using a similar scale (*How likely would you be to trust that a COVID vaccine available to you is safe and effective?*; 1 = not at all likely, 7 = extremely likely).

The survey included a question about the participant's biological sex, including "Other" as well as male and female options. However, due to sample size restrictions, the following analyses include only binary sex categories. Due to the theoretical rationale that these differences are role-based rather than biologically based, we expect differences between these groups to come from differences in gender identity. We are assuming here that participants identify as the gender associated with their biological sex. This is supported by post-hoc analyses from October 2021 with the same sample of participants that indicate that the roles associated with gender, such as 'mother' or 'husband,' commonly come to mind when participants are asked to think about who they are during COVID-19. Because of sample size constraints, these analyses only include participants who identified their race/ethnicity among four categories: Asian or Pacific Islander, Black or African American, Hispanic or Latino/a, or White or Caucasian.

Socioeconomic status, which typically encompasses education, income, and occupation (American Psychological Association, 2021), is defined here by a composite measure averaging income, years of education, and subjective SES ($\alpha = .70$), all of which had similar directional effects on vaccine attitudes. Political orientation was measured as an average of two 1–7 Likert scale questions regarding social and economic political beliefs, wherein larger numbers indicate a more conservative political orientation. (*How would you describe your political orientation with regard to social issues? How would you describe your political orientation with regard to economic issues?*; 1 = very liberal, 7 = very conservative ($r = .84$).

First, we used ordinal regression models run in the MASS package in R (R Core Team, 2021; Venables & Ripley, 2002) to analyze whether gender, race, SES, political orientation, and age were predictors of likelihood to get and likelihood to trust the vaccine. For this analysis, the first seven timepoints were analyzed (through March 28, 2021), because after this time point the dependent variables on vaccine attitudes became skewed ($\text{skew} > \pm 1.5$) as COVID-19 vaccines started to become widely available to the public and many participants got vaccinated. For participants who completed Time 1–Time 7 ($N = 302$), two ordinal regressions were run at every time point to assess which identities predict likelihood to get the vaccine and likelihood to trust the vaccine, respectively. Due to sample size restrictions, this regression only considered each group membership as a predictor separately and did not include intersectionality between groups. This first model does not show trajectories of these attitudes over time, but rather static snapshots of which identities are predictive at which time points. Observations with missing data were removed from analyses.

Second, for participants who completed Time 1–Time 12 ($N = 208$), we constructed a growth model to detail changes in these groups' vaccine attitude trajectories over time. Mixed model analysis using SPSS Version 28 assessed whether there are significant differences in both groups' initial vaccine likelihood and vaccine trust as well as differences in the growth rates of these trajectories, which would suggest different trends in trust and likelihood between these groups. This mixed model analysis uses restricted maximum likelihood estimation to account for missing data.

Based on previous research showing increased medical mistrust among Black Americans (Gramlich & Funk, 2020) along with well-documented healthcare disparities for Black women in particular, we hypothesized that Black women would report a lower likelihood that they would get the vaccine and report lower trust in the vaccine than women of other racial identities. Specifically, because White women might share gender-based reasons for hesitancy with Black women

but are less likely to have experienced race-based discrimination in the medical system, comparing these groups could add to our understanding of the effects of discrimination on vaccine hesitancy. To do this, we performed additional analyses to compare attitudes around vaccination among women who self-identified as Black or White.

RESULTS

Ordinal regression analysis

Results of the ordinal regression models for likelihood of getting the vaccine and trust in the vaccine can be seen in Tables 1 and 2, respectively. We describe identities as consistent predictors if their coefficient was statistically significant at multiple timepoints with the same directionality.

Higher SES is a consistent positive predictor of likelihood to get and likelihood to trust the vaccine. Being a woman is a negative predictor of likelihood of getting the vaccine and trust in the vaccine in earlier time points, suggesting more overall hesitancy, but at later time points is only negatively predictive of trust, supporting data collected at vaccination sites that showed women have been getting more vaccines than men (Ungar, 2021). Self-identifying as Black is a relatively consistent negative predictor of the likelihood of getting the vaccine and trust in the vaccine. Being more politically conservative is a consistently negative predictor of likelihood to get the vaccine and becomes a consistent significant negative predictor of trust in the vaccine starting in November 2020, when the U.S. elected Joe Biden President. That was also the month that the COVID-19 vaccine was submitted for EUA with high-risk populations (Pfizer, 2020). Age becomes a consistently significant positive predictor of both likelihood of getting the vaccine and trust in the vaccine in January 2021, as older individuals became eligible for the COVID-19 vaccine.

Mixed model analysis

Mixed model analysis shows that the average reported likelihood of getting the vaccine increased significantly over the 12-month period we examined. Gender ($\beta = -.632, p = .030$) and SES ($\beta = .388, p < .001$) were significant in explaining overall likelihood of getting vaccinated, showing similar patterns to the ordinal regressions in which women were less likely to get the vaccine and higher SES individuals were more likely to get the vaccine. There is evidence that more conservative political orientation was related negatively to within-individual change in likelihood of getting the vaccine ($\beta = -.033, p < .001$), meaning that conservatives didn't change their attitudes about getting the vaccine as much as liberals did. Although conservative individuals became more likely to get the vaccine over this year, their rate of increase was less than their liberal counterparts, resulting in a deeper political divide over time in this attitude.

There was also a significant increase in the average reported trust in the COVID-19 vaccine over the same 12-month period. SES ($\beta = .294, p < .001$) and Hispanic ethnicity ($\beta = -1.491, p = .019$) were significant in explaining trust in the vaccine, with higher SES and non-Hispanic individuals being more likely to trust the vaccine than lower SES and Hispanic respondents. Individuals trusted the vaccine more with succeeding iterations of the survey. More conservative political orientation was related negatively to within-individual change in vaccine trust ($\beta = -.053, p < .001$). This means that as for vaccine likelihood, conservative individuals' trust in the vaccine did not increase as much over this time period as did liberals' trust in the vaccine.

TABLE 1 Regression coefficients of SES, gender, race, political orientation, and age as predictors of likelihood to get vaccine

	Time 1 (9/2020)	Time 2 (10/2020)	Time 3 (11/2020)	Time 4 (12/2020)	Time 5 (1/2021)	Time 6 (2/2021)	Time 7 (3/2021)
SES	.29***	.30***	.34***	.36***	.38***	.35***	.34***
Gender (W)	-.59**	-.59**	-.58**	-.22	-.28	-.15	-.33
Asian	.29	.00	-.13	-.33	-.12	-.04	.26
Black	-.77	-.82*	-1.13**	-1.13**	-.92*	-.74	-.95*
Hispanic	-.51	-1.57*	-.29	-.60	-.37	-.18	-.21
Political Orientation (More conservative)	-.19**	-.18**	-.28***	-.38***	-.43***	-.46***	-.51***
Age	.00	.00	.02*	.02	.02*	.03**	.03**

* $p < .05$,

** $p < .01$,

*** $p < .001$.

TABLE 2 Regression coefficients of SES, gender, race, political orientation, and age as predictors of likelihood to trust vaccine

	Time 1 (9/2020)	Time 2 (10/2020)	Time 3 (11/2020)	Time 4 (12/2020)	Time 5 (1/2021)	Time 6 (2/2021)	Time 7 (3/2021)
SES	.21**	.24**	.26**	.21**	.27**	.27**	.22**
Gender (W)	-.64**	-.48*	-.53*	-.36	-.47*	-.50*	-.66**
Asian	.06	.01	-.09	.00	-.15	-.21	.01
Black	-.79*	-1.02**	-1.22**	-1.07**	-.98*	-.94*	-.64
Hispanic	-.57	-1.01	-.77	-.85	-1.22*	-1.08	-.44
Political Orientation (More conservative)	-.03	-.05	-.16**	-.28**	-.31**	-.38**	-.39**
Age	.00	.00	.01	.01	.02*	.02**	.02**

* $p < .05$,
 ** $p < .01$,
 *** $p < .001$.

Hypothesized intersectional interactions

We created a grand mean of reported likelihood of getting the vaccine summarizing this attitude across all 12 timepoints. Looking at Black and White women across the whole sample ($N = 59$ Black women, 349 White women), there was a significant difference in likelihood of getting the vaccine, with Black women (Mean = 4.49) reporting a lower likelihood of getting the vaccine than White women (Mean = 5.43), $t(79) = -3.16$, $p = .002$. Similarly, we created a grand mean of trust in the vaccine. We found a significant difference in vaccine trust, with Black women (Mean = 4.12) having lower trust in the vaccine trust than White women (Mean = 4.85), $t(79) = -2.90$, $p = .005$.

DISCUSSION

These analyses show that at multiple timepoints before the vaccine was widely available, various identities or group memberships predicted differences in COVID-19 vaccine attitudes. Women reported both lower likelihood of getting the vaccine and lower trust in the vaccine than men at earlier time points, but only less trust in later time points. Women ultimately ended up being vaccinated at a similar rate to men in our sample (80.3% of women vs. 79.8% of men at Time 12). With other groups, these two attitudes generally had similar patterns to one another, so the discrepancy for women between their trust in the vaccine and the likelihood they would get the vaccine is unique. Health-related risk-taking preferences and occupation type may contribute to this difference. The fact that jobs disproportionately held by women in our sample put them at greater risk of infection might explain vaccine uptake despite lower levels of trust. COVID-19 impacts have led to caretaking responsibilities being disproportionately taken on by women (Fulcher & Dinella, 2023-b). If getting the vaccine to protect others in the household is important, then this may be another reason behind women often getting vaccinated even when their trust in the vaccine was low. These motivations will be examined in Study 2.

Our results also show that higher SES is a consistently positive predictor of likelihood to get vaccinated and trust the COVID-19 vaccine. Having more years of college completed is positively related with trust in science (Nadelson et al., 2014), so level of education may play a role in how individuals took in scientific communication about the vaccine. Again, understanding workplace dynamics may also uncover more about this relationship. Jobs more common among low SES individuals may offer less flexible time off to be vaccinated, and their employers may be less likely to encourage their workers to be vaccinated.

Self-identifying as Black is a relatively consistent negative predictor of vaccine trust and likelihood. The intersectional analyses between Black and White women indicated that Black women have lower levels of trust and likelihood compared to White women. These results are consistent with research that suggests that COVID-19 vaccine hesitancy is higher in the Black community (e.g., Callaghan et al., 2021). Black women continue to face exacerbated negative health outcomes (Fulcher & Dinella, 2023-a; Geyton & Johnson, *in press*). Future research should aim to understand what can be done to address this community's specific health concerns. Study 3 begins to address this question by assessing whether encouragement from shared group members was important for people who decided to be vaccinated.

More conservative political orientation was a static predictor of more negative attitudes about the COVID-19 vaccine, and it also was associated with changes in vaccine attitudes over time,

with the attitudes of more conservative participants becoming more negative for both vaccine likelihood and vaccine trust compared to other groups. Pandemic protective behaviors have been widely politicized in the media (Hart et al., 2020). With other identities, group differences in hesitancy and trust might be expected to lessen as the solutions to the pandemic became less ambiguous with the introduction of vaccines. However, in a politicized climate, the divide grew more polarized as protective behaviors became a signal of political group membership. Differences over time may also have been influenced by the fact that there was an election during this time period leading to a change in the political party of the President, which may have changed each party's messaging about the vaccines. Because the U.S. government has been a source of COVID-19 information throughout the pandemic, a change in the Presidential party may have changed public opinion of these efforts, because there was a change in perception of which political party was leading the vaccine development and rollout efforts.

Older age was a significant predictor of reduced vaccine hesitancy and greater trust at later time points once vaccines started to become available. This may come from the fact that in the U.S. (as elsewhere), the vaccine rollout was based on predetermined risk factors for severe COVID-19. One of these factors was age, and so the vaccine was made available to older adults before younger adults, possibly increasing their vaccination likelihood and trust sooner.

In Study 2, we look deeper into these impacts of age and group membership by assessing which participants were early adopters of the vaccine and what factors were associated with their early vaccination.

Study 2

In Study 2, we analyze whether and how early participants got one of the COVID-19 vaccines. We define early vaccination as being vaccinated when the majority of our sample did, that is, in the first month when the vaccine was available to all U.S. adults. We assess the predictive-ness for early vaccination of the factors introduced in the previous section including job risk and workplace encouragement, caretaking responsibilities, vaccine trust, and general health risk-taking. Because group norms are influential in identity-based decision-making (Wellen et al., 1998), we also assess the impact of people's perceptions of local norms surrounding vaccination. The longitudinal dataset did not contain questions about norms coming from specific reference groups; however, it did contain questions asking about norms from one's local area. Within the U.S., spatial analyses have suggested that certain regional demographic makeups (e.g., per capita income, percentage of Republican voters) influence COVID-19 vaccination rates (Mollalo & Tatar, 2021; Pallathadka et al., 2022). Thus, these local norms surrounding vaccination likely reflect the demographic makeup of participants' regions.

METHODS

Study 2 analyzes data from the same longitudinal sample used in Study 1. Starting in Time 7 (March 28, 2021), we began asking participants if they already had been vaccinated against COVID-19. At this time, 39% of the participants in our study had been vaccinated. By Time 8 (April 27, 2021), 65% of the participants had been vaccinated. This timeline aligns with the vaccine rollout in the U.S. because April 2021 was when the vaccine was made available to all adults in the U.S. In our sample, the percentage of vaccinated individuals stayed relatively constant immediately

following this point, as shown by the fact that by Time 9 (May 27, 2021), 69% of the participants had been vaccinated. Because of this, we focus on whether participants were vaccinated or not by Time 8. Additionally, we focus our analysis on those who were making the decision about whether to be vaccinated in Time 8 (VT8) and exclude from this analysis those participants who were vaccinated by Time 7. Demographics of these samples will be discussed in the results section.

Participants provided their occupations in Time 1. To standardize these occupations and assess risk factors, we used a team of coders to link these self-reported occupations to corresponding O*NET (Occupational Information Network) occupation codes (National Center for O*NET Development, 2021), and then we linked these codes in turn to O*NET's measures of job-related COVID-19 risk factors. We specifically use a measure of how much one is typically exposed to disease at one's job (Sample Mean = 14.6 (range 0–100), SD = 18.4) and how much physical proximity to others one has at one's job (Sample Mean = 53.4 (range 0–100), SD = 12.7) (National Center for O*NET Development, 2021). Additionally, we use Dingel and Neiman's (2020) binary classification of teleworkability—the ability to do one's job remotely—among O*NET job codes, which revealed that 31% of the jobs in our sample were non-teleworkable. These three measures, teleworkability (TiR), exposure to disease (EDN), and physical proximity (PhP), make up a factor measuring job risk (Rsk).

In Time 12 (August 25, 2021), we asked participants a question about whether the vaccine was encouraged at their workplace (VE): *My workplace encourages me to get a COVID-19 vaccine* (1 = strongly disagree, 7 = strongly agree; Sample Mean = 4.3, SD = 2.3). We also asked at this time-point whether participants were required to be vaccinated at their workplace. Because only 14.6% of participants were required to be vaccinated at this time, using the question about encouragement in this analysis offers more variability in response. This measure is used to assess workplace encouragement (Enc).

Participants were asked at Time 9 (May 27, 2021) about their caretaking responsibilities (C.9): *Do you have caregiving responsibilities? (i.e. children, relatives)* (Yes/No; 29% had caregiving responsibilities). This measure is used to assess caretaking responsibilities (Car).

To further investigate differences in vaccine attitudes, we used the Health and Safety Risk-Taking portion of the Domain Specific Risk-Taking scale (DOSPERT; Blais & Weber, 2006). This 6-item scale measuring levels of general health-related risk-taking, or health risk behavior, was included at Time 3 (November 23, 2020) (HRB). Participants were asked whether they would engage in situations such as *Driving a car without wearing a seatbelt* (1 = extremely unlikely, 7 = extremely likely). The items are averaged to create a composite score ($\alpha = .73$, Sample Mean = 1.9, SD = 1.0). This measure is used to assess health and safety risk taking (HS).

Additional measures collected at Time 7 provide a snapshot of participants' views right before making the decision to be vaccinated. To assess personal attitudes, we used the Time 7 vaccine trust variable (Sample Mean = 4.8, SD = 2.0) discussed in Study 1 (TV) to measure vaccine trust (Trs). To assess perceived social norms surrounding vaccination (i.e., the participants' perception of others' attitudes), we asked these questions: *What proportion of people in your local area do you think will take a COVID-19 vaccine when it is made available to them?* (0–100; Sample Mean = 67.5, SD = 16.5) and *What proportion of people in your local area do you think believe that taking a COVID-19 vaccine is the right thing to do?* ($r = .89$, 0–100; Sample Mean = 68.0, SD = 16.6) These two measures, VLA and VLR, respectively, create the factor measuring local norms at Time 7 (Nrm).

Using the variables discussed above, we built a structural equation model using the lavaan package (v.6–9; Rosseel, 2012) predicting whether participants were vaccinated or not at Time 8 (Vcc). The loadings used in the model were job risk (Rsk), presence of caregiving responsibilities (Car); job encouragement (Enc), Time 7 vaccine trust (Trs); local norms at Time 7 (Nrm); and the

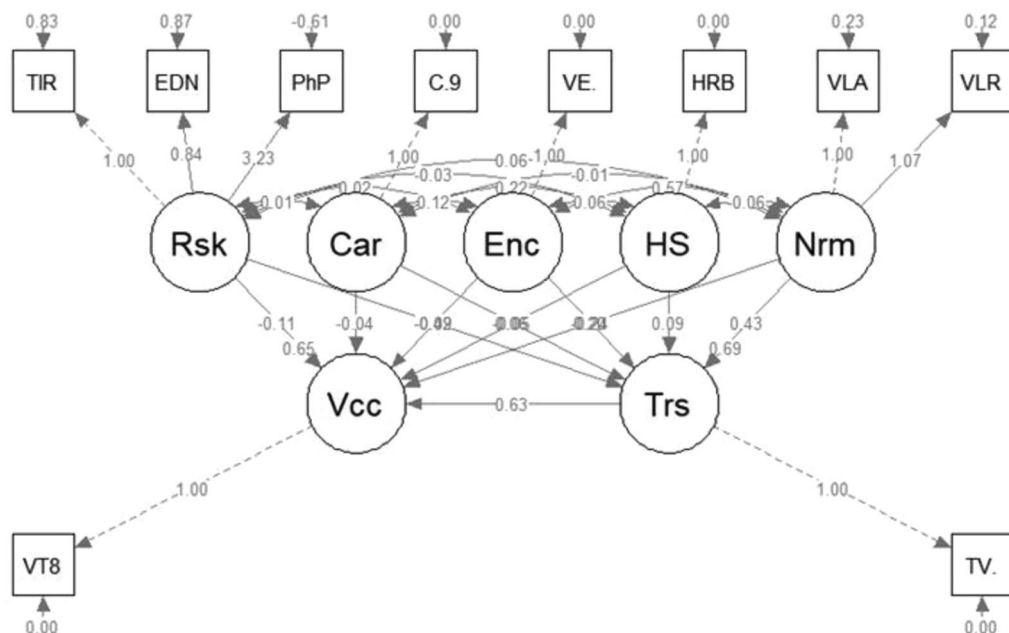


FIGURE 1 Pathways assessed in structural equation model on vaccination at Time 8 and Vaccine Trust Rsk = job risk, Car = caregiving responsibilities, Enc = job encouragement, HS = health and safety risk measure, Nrm = local norms at Time 7, Vcc = vaccinated or not at Time 8, Trs = Time 7 vaccine trust. Boxes indicate the survey questions that were used to create these factors. Details in methods

health and safety risk measure (HS). We assess all of these predictors on Vcc and also assess a potential pathway between these predictors, namely, that earlier trust may be influenced by these job-related, caretaking, normative, and health risk factors. See Figure 1 for a visual representation of the pathways assessed.

RESULTS

What identities characterized the people who got vaccinated early? When looking at only the individuals who made the decision to be vaccinated at Time 8, we see slight differences in the demographics of those who were vaccinated versus those who remained unvaccinated. 45.5% of the remaining women and 44.1% of the remaining men got vaccinated. 74.7% of the people getting vaccinated at this timepoint were White. Those vaccinated had a higher SES level than the unvaccinated group (Mean = 4.7 vs. Mean = 4.4, range 1–8.3), and a more liberal political orientation (Mean = 2.9 vs. Mean = 4.2, range 1–7). They were also slightly younger on average than the unvaccinated group (Mean = 47.3 vs. 48.5). Note that this does not include those who were vaccinated in Time 7. Individuals vaccinated in Time 7 were 56% Women/44% men, 88% White, had a mean SES level of 5.2, a mean political orientation of 3.2, and a mean age of 56.8.

What individual factors predicted who would get vaccinated early? The structural equation model showed that for the path using all predictor variables to predict vaccination at Time 8 (April 27, 2021), the only significant predictor is Time 7 (March 28, 2021) vaccine trust ($\beta = .626, p < .001$). Time 7 vaccine trust is in turn significantly predicted by Time 7 local norms ($\beta = .431, p = .046$).

DISCUSSION

By April 2021 (Time 8), the majority of participants in our study were vaccinated, and this proportion had largely leveled off by May 2021. The structural equation model assessing factors that predict vaccination by April shows that the key significant predictor was self-reported vaccine trust in the previous month, which itself was predicted by perceived local norms. Neither vaccination nor vaccine trust was predicted by other role-based contextual factors such as levels of encouragement from one's job or caretaking responsibilities. They also were not predicted by a personal level of general health and safety risk-taking. While encouragement from one's workplace was not a significant predictor, it is important to note that access to the vaccines may still vary depending on one's job. When asking about workplace attitudes on vaccination in Time 12, we asked whether people perceived that their workplace offered time off to get a COVID-19 vaccine: *My workplace offers time off to get a COVID-19 Vaccine* (1 = strongly disagree, 7 = strongly agree; Sample Mean = 3.9, SD = 2.4). In an ordinal regression using the same identities in Study 1 as predictors of this variable, higher SES positively predicts ability to get time off to be vaccinated ($\beta = .36, p < .001$).

A key finding in the structural equation model is that vaccine trust alone was an important factor in the decision to be vaccinated. The influence of local norms on vaccine trust is consistent with the idea that group membership shapes decision making in a situation of uncertainty. The demographic makeup of regions in the U.S. has been linked to vaccination rate (Mollalo & Tatar, 2021; Pallathadka et al., 2022), so these local norms are likely to differ by region as a function of identity. In the absence of personal vaccine knowledge, looking to similar others in the community is a simple heuristic one can use to assess trust in the vaccine. The questions assessed in this model measured norms in participants' local areas, but it would be important to verify whether social influence is stronger when the people conveying the norm information share specific identities with the target, which is examined in Study 3. This could be especially relevant when thinking about members of marginalized groups that may mistrust the medical system. Aside from the variables discussed here, hesitancy may also come from other sources including individual-level factors such as one's medical history.

Study 3

This study uses data from a larger sample, measured at a single time point and specifically designed to be more racially diverse than the original longitudinal sample, to more deeply understand two ongoing questions from our first two studies. First, because the subpopulation in Study 1 was not sufficiently diverse to allow us to explore the influence of multiple types of identity intersections, we replicate the patterns of vaccine hesitancy found in Study 1 with an intersectional lens. Second, because local social norms were seen to be predictive of trust and early vaccination in turn, we further examine which specific shared groups gave important encouragement regarding the COVID-19 vaccine. Given that many of the groups who tended to have lower levels of trust were marginalized in some way, could encouragement from shared group members be especially important for their attitudes and behaviors regarding vaccination?

METHODS

In January 2022, 1,908 participants completed a survey via Academic Prolific that included questions about COVID-19 vaccination attitudes, COVID-19 symptoms and testing, and information on identity and demographics. After removing participants who failed an attention check, 1,555 participants remained. To ensure that the sample would reflect a wider array of intersectional identities, sampling was directed towards people who evenly identified as Asian or Pacific Islander (25%), Hispanic or Latino/a (24%), White or Caucasian (28%), and Black or African American (23%). In this sample, we asked participants to identify both their sex and their gender. Gender was measured using Hauptert's (2019) transgender-inclusive scale. Across all participants, 97% identified their gender as being either a man or a woman (53% women), so these will be the categories we assess when analyzing gender as there is not sufficient statistical power to look at other genders.

By January 2022, COVID-19 vaccines had been available to all U.S. adults for many months. Additionally, a booster dose of the vaccines developed by Pfizer-BioNTech and Moderna was recommended for all U.S. adults, with the timing of the booster dependent on which company's vaccine one had gotten for their original dose (Centers for Disease Control & Prevention, 2022b). Within this sample, 85% had received at least one dose of a COVID-19 vaccine.

We measured participants' recalled levels of vaccine hesitancy by asking this question: *How hesitant were you to get the COVID-19 vaccine after it was made available to you?* (1 = not at all, 7 = very hesitant). The responses to this question were moderately positively correlated with the question *How long in weeks did you wait to get the COVID-19 vaccine after it was made available to you?* ($r = .43$) and the difference in months between the questions *In what month did you receive the first dose of the COVID-19 vaccine?* and *In what month were you eligible for the first dose of the COVID-19 vaccine?* ($r = .41$), suggesting that their recalled level of hesitancy corresponded reasonably well to their actual behavior. Because collection of this data was designed to be evenly distributed across the largest racial groups in our longitudinal sample, we ran ordinal regressions for each of these racial groups to assess the predictiveness of gender, SES, political orientation, and age on self-reported pre-vaccination hesitancy.

To assess whether encouragement of people with shared identities or group memberships factored into the vaccination decisions of participants, participants who had received at least one dose of the COVID-19 vaccine were asked *How important was the encouragement of the following groups for you in getting the COVID-19 vaccine?* (0 = not at all important, 10 = extremely important). Participants were asked this question about members of their shared gender, race, SES, political orientation, age, family, and workplace/profession. We assess mean levels of the importance of different group encouragement across all participants to understand whether one group was rated as most encouraging overall. Additionally, we performed between-subjects analyses to understand whether encouragement from others within one's group was particularly important based on how people identify within that category.

RESULTS

The results of the ordinal regressions assessing identity predictors of vaccine hesitancy by race can be found in Table 3. Across all racial groups, more conservative political orientation is the only statistically significant predictor of recalled vaccine hesitancy. This is consistent with the results of Study 1, in which more conservative political orientation was a consistently negative

TABLE 3 SES, gender, political orientation, and age by race as predictors of past vaccine hesitancy

	Asian	Hispanic	White	Black
SES	.03	-.16	-.11	.01
Gender (W)	-.14	-.29	.17	-.32
Political orientation (more conservative)	.53***	.69***	.52***	.35***
Age	.01	-.02	-.02**	-.01

* $p < .05$,

** $p < .01$,

*** $p < .001$.

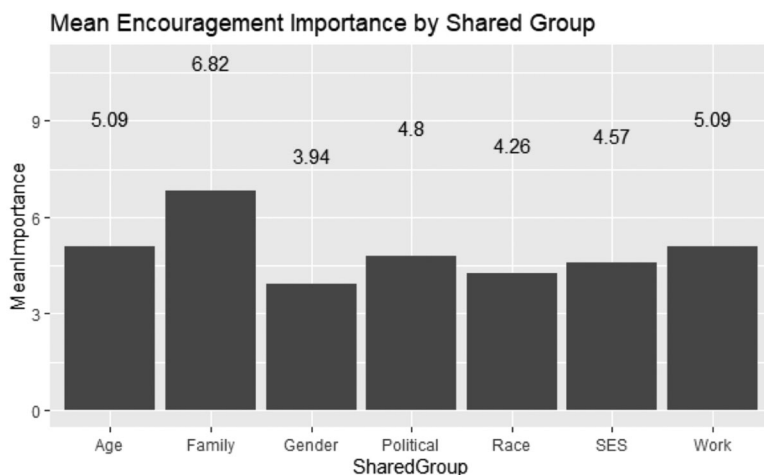


FIGURE 2 Mean levels of importance from encouragement of shared group members

predictor of likelihood to get and trust the vaccine. Here, we see that higher SES has a minimal effect as a predictor of past vaccine hesitancy among Asian American and Black participants but is a negative predictor of hesitancy among Hispanic and White participants (which corresponds to being a positive predictor of getting the vaccine in Study 1). In Study 1, being a woman was a relatively consistent negative predictor of trust towards the vaccine, though women did not differ from men in likelihood to get the vaccine after it became available. Here, we see that being a woman was a positive predictor of past hesitancy only among the White sample, whereas it was a negative predictor of past hesitancy among other groups. In Study 1, being older was a positive predictor of likelihood to get and trust the vaccine. Consistently, here older age is primarily a negative predictor of past hesitancy and is statistically significant only in the White sample.

Figure 2 shows the mean ratings of importance of encouragement for each shared group across the entire subset of participants who reported being vaccinated (one shot or more). Encouragement from family was the most important type of encouragement overall. The correlations between the importance of encouragement for all groups within participants were generally moderate and positive, indicating that participants who found encouragement important tended to believe that encouragement was important across these different groups with which they had shared identities.

Figures S1A–E in the supplemental materials shows versions of this chart split by group membership within each identity. We focus there on the particular encouragement that people in different groups say they got from their own corresponding groups (e.g., how important was encouragement to women from other women?). Women (Mean = 4.47) found encouragement from their shared gender more important than men did (Mean = 3.34), $t(1217) = 6.46$, $p < .001$. Liberals (Mean = 5.34) found encouragement from their shared political group more important than conservatives did (Mean = 3.72), based on a mean split of overall political orientation, $t(887) = 8.70$, $p < .001$. Younger individuals (Mean = 5.49) found encouragement from their shared age group more important than older individuals did (Mean = 4.60), again based on a mean split of age (Mean = 46.19), $t(1156) = 4.76$, $p < .001$. There were not significant differences across race or SES level. There were also no significant differences between identities (e.g., men and women did not differ in their overall importance placed on encouragement across groups).

DISCUSSION

This diverse sample taken at a single time point showed trends similar to those found in the longitudinal study (Study 1). Namely, this analysis reiterates the importance of political identity on one's response to the COVID-19 vaccine. Politicization of vaccine hesitancy was consistent across all racial identities, suggesting that this issue should be addressed at large across the U.S. population.

For participants who decided to be vaccinated against COVID-19, encouragement from family had, on average, the highest importance placed on it versus the encouragement of other groups. However, for participants in some groups, encouragement from someone with a shared identity in that group was particularly important. Women more than men placed importance on the encouragement of people from their shared gender. Additionally, liberals valued the encouragement of their shared group members more than conservatives did. It is important to note that these questions were asked of people who chose to be vaccinated. Potentially, conservatives did not give as much encouragement to their shared group members to be vaccinated, as they did not increase their trust in the vaccine over time in the same way liberals did. Our questions did not address active discouragement of vaccination, which could have been present among conservatives as well as other groups. While we did not find significant differences in importance of encouragement based on racial identities in this sample ($p = .11$), norms coming from racial identity-specific reference groups are likely to be more influential, with other research suggesting that Black Americans' perceived norms among members of their shared race strengthened the perception that important others would be vaccinated, and thus vaccination intentions among an unvaccinated sample (Zhuang, 2022).

General discussion

The current research contributes to the understanding of how identity and group membership has influenced vaccine attitudes across time during the COVID-19 pandemic. The findings discussed here are consistent with demographic differences in COVID-19 vaccine hesitancy that were forecasted before vaccine availability and discussed in news reports following the vaccines' launch. Our findings indicate that many of these identity-related predictors, such as the positive relationship between SES and vaccine attitudes and the negative relationship between Black identity and vaccine attitudes, have been consistent over time during the pandemic. Gender showed a significant relationship with attitudes around vaccination, with women showing less trust in vaccines throughout the survey but only lower actual vaccination likelihood at earlier time points in the survey. Additionally, our results show that political orientation was a consistent predictor of vaccine attitudes (more conservative being more negative), with the divide between political group attitudes growing deeper over time. The importance of political orientation was replicated in a sample which included greater representation of racial minority groups. While there were some differences in the predictiveness of SES, gender, and age across race, more conservative political orientation was a significant positive predictor of recalled vaccine hesitancy across the sample.

One implication of our findings is that ensuring trust in COVID-19 vaccines is particularly important because vaccine trust was the primary predictor of getting vaccinated early. Because this trust varies by identity, we strove to understand whether this variation is driven by role-based factors that may be differentially split across the population, such as job or caretaking inequities,

by traits that may vary across groups, such as general health risk taking, and by different norms that one may be exposed to given the groups in one's local area. Of these factors, we found that local norms particularly influence vaccine trust such that the proportion of people in an individual's local area who that individual thought likely to get and approve of getting a COVID-19 vaccine is a positive predictor of whether that individual was vaccinated once the vaccine was authorized for all adults in the U.S.

Because social influence via perceived norms plays an important role in building vaccine trust, we also investigated the impact of more direct forms of social influence by asking our larger sample about the encouragement they received to get the vaccine—which of the groups they belonged to were important to them when they made the decision to be vaccinated? Overall, encouragement from one's family was the most important. Beyond this general pattern, for groups that showed differences in their likelihood to get and trust the vaccine, some identities, including women, liberals, and younger people in our research sample, placed more importance on their shared group's encouragement than others.

These results suggest that vaccine uptake efforts can be helped by asking people with shared identities or at the local level to encourage each other to get vaccinated. This strategy could add an important policy lever to improve vaccination and booster rates against COVID-19, or for future pandemics. This could be particularly important for low SES individuals who are more likely to work jobs in close proximity to others and less likely to be vaccinated, as they could continue to suffer disproportionately from COVID-19 infections later in the pandemic. Ensuring vaccine access for such at-risk groups is of course also vital—encouragement is useless if there is no way to follow through with action. Finally, while vaccine likelihood differences were not significant between genders after the vaccines became available, political groups continued to divide further in terms of their vaccine attitudes and to have a strong impact on vaccination behavior, consistent across race and ethnicity. This result indicates that, in the longer term, when new vaccines are developed, it is of the utmost importance that they are not presented in a politicized way.

Limitations

A limitation of this work is the longitudinal study's smaller sample sizes across race and ethnicity. While the sample began as an overall representative sample of the U.S. population, attrition affected the sample sizes of racial minority groups more severely because these sample sizes were smaller to begin with. Additionally, when considering the intersectionality of multiple identities and group memberships as we do here, this attrition further reduces the sample size available to compare differences. (See Tables S1A–C for additional information about demographics in this sample.) To ameliorate this issue, we ran a study using a sample specifically targeted to be more racially diverse. However, there are still limitations to generalizability in that we considered only broad racial categories that had a sizable presence in the original longitudinal sample. Similarly, we consider only binary gender throughout these analyses, and so these analyses may not generalize to individuals who identify outside the traditional gender binary.

Another potential limitation of this work is that the measures of vaccine attitudes and behavior are self-reported. Replication of findings within our work across the two samples, as well as the correlation between multiple measures of recalled vaccine hesitancy in Study 3, support that these measures are being answered consistently. However, these analyses are correlational, and causal relationships between these variables cannot be determined with this work.

Future directions

While we have discussed here the role of identity and group membership in the formation of vaccine attitudes, many other variables may come into play during an individual's vaccination decision. Individual-level health risks and medical history likely also factor into the decision to be vaccinated. The media that people are exposed to regarding COVID-19 is also important, especially because news media are a source of political polarization (Fridman et al., 2021; Hart et al., 2020). This media exposure may provide norms that contrast with those of one's local area or groups, which could be an additional source of encouragement to get the vaccine or could detract from the encouragement one has received from other groups.

Because booster shots against COVID-19 have been authorized for all U.S. adults, including updated booster shots in 2022 (Centers for Disease Control & Prevention, 2022b) another area for future study is whether similar patterns of hesitancy will affect the response to booster vaccines as they become needed. Our analyses suggest strategies to encourage booster uptake and can also be used at a larger scale to assess whether the patterns of hesitancy we describe will persist across the U.S. population into the future.

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DATA AVAILABILITY STATEMENT

Data is available through the Open Science Framework: https://osf.io/qnwev/?view_only=9b5dd63cc7d3431ab2d4def7edcad093

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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