

Quantifying Racial and Ethnic Disparities in U.S. COVID-19 Vaccine Acceptance and Uptake

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**Abstract**

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**Background**

Racial and ethnic minority groups in the United States face a greater risk of COVID-19 infection and mortality relative to non-Hispanic White individuals. Despite this elevated risk, early evidence from the first months of COVID-19 vaccine distribution suggests that racial and ethnic minority groups were underrepresented in the vaccinated population. However, previous analyses by race-ethnicity have not considered variation in patterns of inequality by geography, have focused only on the largest race-ethnicity groups, and have not distinguished between vaccine access and vaccine acceptance as drivers of vaccination rates. Comprehensive, current estimates of vaccine uptake and vaccine acceptance by race-ethnicity and geography are needed to inform interventions that increase vaccination rates equitably across all communities.

**Methods**

Using data from a large online survey of United States adults collected in May 2021 (n = 731,640), we produced estimates of vaccine uptake and vaccine acceptance by state for six race-ethnicity categories. We projected vaccine acceptance under counterfactual scenarios in which an intervention eliminates hesitancy due to common concerns for each state-race-ethnicity group.

**Findings**

Relative to non-Hispanic White populations, vaccine uptake was lower among non-Hispanic Black or African American, Hispanic or Latino, and non-Hispanic Native American or Alaska Native populations in the majority of states. In contrast, rates of vaccine acceptance were higher for non-Hispanic Black or African American and Hispanic or Latino populations relative to non-Hispanic White populations in a majority of states. Of the 50 state-race-ethnicity groups with the largest gap between acceptance and

uptake, 30 were Hispanic or Latino populations, while 17 were non-Hispanic Black or African American populations. Removing hesitancy attributable to concern regarding side effects would result in the highest level of vaccine acceptance across nearly all state-race-ethnicity groups.

### **Interpretation**

Six months since the initial Emergency Use Authorization of the COVID-19 vaccine, Non-Hispanic Black or African American, Hispanic or Latino, and non-Hispanic Native American or Alaska Native populations continue to receive the COVID-19 vaccine at a lower rate than non-Hispanic White individuals. The large gap between uptake and acceptance rates among Non-Hispanic Black or African American and Hispanic or Latino groups suggests that interventions that address barriers to vaccine access—rather than those that target vaccine hesitancy—may currently be most important in ensuring equitable rates of vaccination by race-ethnicity.

## Introduction

In February of 2021, the CDC released figures tracking the demographic characteristics of individuals vaccinated during the first month of the U.S. COVID-19 vaccination program, which began in December 2020 after the Emergency Use Authorization of two COVID-19 vaccines. In these first months, 60.4% of vaccines were administered to non-Hispanic White individuals, who at that point accounted for 55.8% of all COVID-19 cases nationally (Painter et al., 2021; CDC COVID Data Tracker, 2021). In contrast, several minority racial and ethnic groups were underrepresented in vaccine statistics despite overrepresentation in COVID-19 case statistics. For example, only 5.4% of vaccines were distributed to non-Hispanic Black or African American individuals, who accounted for 12.2% of all COVID-19 cases. Hispanic or Latino individuals received 11.5% of all vaccinations, despite accounting for 20.8% of COVID-19 cases (Painter et al., 2021; CDC COVID Data Tracker, 2021). Media reports and early survey evidence highlighted elevated vaccine hesitancy among racial and ethnic minority communities as a potential driver of these disparities in vaccine uptake (Kaiser Family Foundation, 2021; Salmon et al., 2021; Nguyen et al., 2021).

Disparities in vaccination rate by race-ethnicity in the U.S. are not unique to the COVID-19 vaccine. Similar inequalities—driven by a combination of disparate vaccine access and disparate vaccine hesitancy—have been documented in vaccination rates against measles, influenza, and pertussis (Salmon et al., 2021; Quinn et al., 2017). These disparities produce risks not only to unvaccinated individuals, but also to the communities in which they reside: racial and ethnic disparities in vaccination often lead to social and geographic clustering of undervaccination, undermining population-level immunity in racial and ethnic minority communities (Salmon et al., 2021). Quantifying the extent of racial and ethnic disparities in COVID-19 vaccine hesitancy and access is therefore important in ensuring that all social and geographic groups are able to experience community-level immunity.

Despite the importance of tracking vaccination rates by race-ethnicity, information on race and ethnicity is often missing in official tallies of vaccinated individuals at both the national and state level. In the initial CDC report, race-ethnicity information was missing for 48.1% of vaccinated individuals; this missingness rate has decreased only modestly to 42.8% as of June 2021 (CDC COVID Data Tracker, 2021; Krieger et al., 2021). In vaccination tallies collated by individual states through June 2021, five states were missing race-ethnicity data for over 20% of vaccinated individuals, and three states did not report

any information on race-ethnicity (Kaiser Family Foundation, 2021). This missingness limits the utility of official vaccination records in tracking racial and ethnic inequalities, particularly when considering disparities by state or in small race-ethnicity groups.

This study leverages results of a large national survey to quantify disparities in vaccine uptake and vaccine acceptance by race-ethnicity and state through May 2021. We also characterize the drivers underlying remaining vaccine hesitancy in each state-race-ethnicity group, projecting vaccine acceptance under counterfactual scenarios in which an intervention eliminates hesitancy due to common concerns. By considering disparities by geography and race-ethnicity simultaneously, we highlight the specific populations left behind by current vaccine distribution programs, demonstrating inequalities previously masked by national-level estimates. Quantifying vaccine acceptance and vaccine uptake together allows us to attribute these disparities to underlying inequality in vaccine demand or vaccine access, highlighting the type of interventions most key in improving vaccine equity in each community.

## Methods

### Data sources

This study relies on the results of the U.S. COVID-19 Symptom Survey, a survey administered daily to a random sample of adult Facebook users residing in the United States (Delphi Group, 2021). As of May 31, 2021, the survey had approximately 49,000 weekly survey responses. The survey instrument is available to users in English, Spanish, Brazilian Portuguese, Vietnamese, French, and simplified Chinese. Although the survey is administered to a random sample of Facebook users, survey weights are available that adjust results to be representative of the broader U.S. adult population. Calculation of these weights has been described previously (Barkay et al., 2020). To preserve confidentiality of responses, microdata including information on race and ethnicity is not publicly available. Instead, we obtained tabulated results by race, ethnicity, and state through the Delphi Epidata API (<https://cmu-delphi.github.io/delphi-epidata/>, downloaded on June 4, 2021). In these tables, aggregated results are censored if fewer than 100 respondents fall into a given state-race-ethnicity category.

Data regarding COVID-19 mortality was downloaded from the National Center for Health Statistics (NCHS) database of deaths involving COVID-19 by race and Hispanic origin group (<https://data.cdc.gov/NCHS/Provisional-COVID-19-Deaths-by-Race-and-Hispanic-O/ks3g-spdg>, downloaded June 23, 2021). This dataset has been updated weekly since January 1, 2020 with all deaths involving COVID-19 (defined as ICD-10 code U07.1). Data is stratified by race-ethnicity, 10-year age group, and state, and deaths counts between 1 and 9 are suppressed to comply with NCHS confidentiality standards.

Survey participants self-reported race-ethnicity in separate questions regarding race and ethnicity, and were permitted to select multiple race categories. In NCHS data, race-ethnicity was coded on the death certificate by the funeral director through separate questions regarding race and ethnicity. In both data sources, the selection of multiple race categories was permitted. For the purposes of this analysis, race and ethnicity were collapsed into the following race-ethnicity categories. Survey data for the Non-Hispanic Other or Multiracial group was not publically available, and results for this group are not presented in this analysis.

- Hispanic or Latino
- Non-Hispanic American Indian or Alaska Native
- Non-Hispanic Asian
- Non-Hispanic Black or African American
- Non-Hispanic Native Hawaiian or Pacific Islander
- Non-Hispanic Other or Mutliracial
- Non-Hispanic White

### Characteristics of the study sample

The May 2021 wave of the COVID-19 Symptom Surveys included 731,640 participants who gave non-missing answers to the two survey items regarding vaccine uptake and acceptance (Table 1). The majority of participants were younger than 65 (63.73%) and identified their gender as female (56.61%). Respondents most commonly identified themselves as Non-Hispanic White (64.71%), followed by Hispanic or Latino (10.56%), non-Hispanic Black or African American (10.56%), non-Hispanic Asian (2.25%), non-Hispanic American Indian or Alaska Native (0.72%), and non-Hispanic Native Hawaiian or

Pacific Islander 0.18%). The majority of participants reported educational attainment greater than a high school degree (85.06%), and 6.31% of respondents reported employment as healthcare workers.

## Analysis

All survey responses spanning May 1, 2021 to May 31, 2021 were aggregated to create metrics of vaccine uptake, acceptance, and hesitancy during May 2021. The rate of vaccine uptake was defined as the weighted percentage of respondents who received at least one dose of the COVID-19 vaccine. The rate of vaccine acceptance was defined as the weighted percentage of respondents who would definitely or probably choose to be vaccinated if a vaccine were available to them, plus the weighted percentage of respondents who had received at least one vaccine dose. Similar aggregates were calculated for January 2021 using survey responses during the January 1, 2021 - January 31, 2021 period. Mortality rates were age-standardized using the national-level age structure reported in 2019 U.S. Census Bureau estimates after imputing any suppressed death counts as 1 (United States Census Bureau, 2020).

When analyzing beliefs underlying vaccine hesitancy, hesitant respondents were defined as those who indicated that they would “Yes, probably”, “No, probably not”, or “No, definitely not” be vaccinated if a vaccine were available to them. Hesitant individuals were allowed to indicate more than one reason underlying their hesitancy. The fraction of individuals expressing a reason for hesitancy was calculated as the weighted proportion of hesitant individuals who cited a reason for hesitancy. In order to calculate the proportion of the population who would accept the vaccine under a counterfactual scenario in which a given reason for hesitancy were eliminated, we multiplied the proportion of hesitant individuals expressing a reason by the proportion of the population who would “No, probably not”, or “No, definitely not” accept the vaccine, then added this fraction to the existing estimate of vaccine acceptance.

## Results

### Vaccine uptake

While the non-Hispanic White population had the highest rate of vaccine uptake at the national level, rates ranged substantially by both race-ethnicity and geography (Figure 1A). By state, uptake ranged

from 68.15% (Mississippi, 66.58-69.72) to 99.33% (District of Columbia, 98.69-99.98) among non-Hispanic White individuals, 62.99% (Tennessee, 59.1-66.89) to 88.24% (District of Columbia, 82.11-94.37) among Hispanic or Latino individuals, 74.11% (Wisconsin, 68.65-79.56) to 87.73% (District of Columbia, 83.72-91.73) among non-Hispanic Black or African American individuals, 89.88% (Indiana, 85.16-94.6) to 98.03% (Connecticut, 96.22-99.85) among non-Hispanic Asian individuals, 60.45% (Texas, 53.66-67.25) to 85.14% (Arizona, 80.92-89.36) among non-Hispanic American Indian or Alaska Native individuals, and 82.33% (Hawaii, 78.02-86.63) to 83.62% (California, 79.6-87.64) among non-Hispanic Native Hawaiian or Pacific Islander individuals. Relative to the non-Hispanic White population, uptake was lower among non-Hispanic Black or African American populations in 24/37 states, Hispanic or Latino populations in 44/46 states, and non-Hispanic Native American or Alaska Native populations in 13/16 states. However, these lower rates of vaccination were not uniform across geographies; a cluster of states in the southern region of the country—including Mississippi, Alabama, Arkansas, Georgia, and Texas—saw higher uptake among non-Hispanic Black or African American communities. Uptake among non-Hispanic Asian populations exceeded rates among non-Hispanic White populations in 26/26 states.

Although Hispanic or Latino and Non-Hispanic Black or African American communities had lower rates of vaccination relative to non-Hispanic White communities in many states, these two race-ethnicity groups made the most dramatic gains in uptake over time. Considering the percent change in uptake from January 2021 to May 2021 in each state-race-ethnicity population, 19 of the 50 populations with the greatest changes were non-Hispanic Black or African American communities, and 27 of 50 were Hispanic or Latino communities (Figure 2A). In both of these race-ethnicity groups, states with the largest changes included many locations in the U.S. South. In contrast, gains in uptake were generally less pronounced in non-Hispanic White populations: of the 50 state-race-ethnicity populations with the lowest percent change in uptake over the same time period, 20 populations were non-Hispanic White communities.

In many state-race-ethnicity populations where rates of vaccination exceeded rates among the non-Hispanic White population, the population's elevated relative risk of COVID-19 mortality far exceeded this increase in relative vaccine uptake (Figure 3A). In the 3 states (Alaska, Arizona, and Montana) where non-Hispanic American Indian or Alaska Native populations had rates of vaccine uptake greater than those in the non-Hispanic White population, the relative risk of mortality exceeded the relative rate of

vaccine uptake by at least a factor of 4 in every state. Similarly, although non-Hispanic Asian populations saw higher rates of vaccine uptake relative to non-Hispanic White populations in 26 states, relative mortality rates exceeded relative rates of vaccine uptake in 23 of these states.

### Vaccine acceptance

Disparities in vaccine acceptance by race-ethnicity were generally less marked than disparities in uptake. Rates of vaccine acceptance ranged from 74.42% (Mississippi, 72.6-76.23) to 99.12% (District of Columbia, 98.21-100.03) among non-Hispanic White individuals, 77.11% (Oklahoma, 72.84-81.39) to 93.13% (Maryland, 91.25-95.01) among Hispanic or Latino individuals, 82.38% (Wisconsin, 76.45-88.3) to 92.19% (District of Columbia, 88.15-96.22) among non-Hispanic Black or African American individuals, 92.62% (Indiana, 87.85-97.4) to 99.07% (Maryland, 97.9-100.24) among non-Hispanic Asian individuals, 59.38% (Texas, 50.62-68.13) to 92.12% (New Mexico, 88.43-95.8) among non-Hispanic American Indian or Alaska Native individuals, and 89.35% (California, 85.29-93.41) to 90.77% (Hawaii, 86.72-94.81) among non-Hispanic Native Hawaiian or Pacific Islander individuals (Figure 1B). In contrast to rates of vaccine uptake, rates of vaccine acceptance were higher for non-Hispanic Black or African American and Hispanic or Latino populations relative to non-Hispanic White populations in a majority of states (27/41 Hispanic or Latino populations, 23/34 non-Hispanic Black or African American populations). Similar to the pattern of vaccine uptake, elevated rates of vaccine acceptance in these two race-ethnicity groups were particularly pronounced in the U.S. South, and non-Hispanic Asian populations had rates of acceptance exceeding those in non-Hispanic White populations in all 23 states with sufficient data.

Mirroring trends in increases in vaccine uptake, Hispanic or Latino and non-Hispanic Black or African American populations experienced the most pronounced gains in vaccine acceptance from January 2021 to May 2021 (Figure 2B). Of the 50 state-race-ethnicity populations with the greatest percent changes in vaccine acceptance, 34 of these populations were non-Hispanic Black or African American communities, and 12 of these populations were Hispanic or Latino communities. While the magnitude of these increases in acceptance varied across geographies in the Hispanic or Latino group, large gains in non-Hispanic Black or African American populations occurred consistently across locations, ranging from 25.94% (Washington) to 47.47% (Alabama). The smallest gains were made in non-Hispanic White communities, who made up 35 of the 50 state-race-ethnicity populations with the lowest percent changes in acceptance.

While increased vaccine acceptance typically correlated to increased vaccine uptake at the state-race-ethnicity level, gaps between acceptance and uptake varied by race-ethnicity (Figure 3B). Of the 50 state-race-ethnicity groups with the largest gap between acceptance and uptake, 30 were Hispanic or Latino populations, while 17 were non-Hispanic Black or African American populations. In contrast, Non-Hispanic Asian and Non-Hispanic White populations generally experienced smaller differences: of the 50 state-race-ethnicity populations with the smallest difference between acceptance and uptake, 30 were Non-Hispanic White groups, and 17 were Non-Hispanic Asian groups. At high levels of vaccine acceptance, Hispanic or Latino groups had particularly low levels of uptake relative to other race-ethnicity groups. Hispanic or Latino populations with vaccine acceptance levels between 90-95% had levels of uptake as low as 78.56% (Delaware) and only as high as 84.40% (Massachusetts). In contrast, at that same range of acceptance, uptake ranged from 87.10% (California) to 90.80% (Massachusetts) among non-Hispanic White populations and 89.88% (Indiana) to 92.13% (Nevada) among non-Hispanic Asian populations.

### Counterfactual vaccine hesitancy scenarios

The most common reasons for vaccine hesitancy were similar across state-race-ethnicity groups, with concern regarding side effects ranking as the most commonly cited reason for hesitancy in 20/22 states in the Hispanic or Latino group, 1/1 states for the Non-Hispanic American Indian or Alaska Native group, 16/17 states in the non-Hispanic Black or African American group, and 46/49 states in the non-Hispanic White group. Similarly, out of all of our counterfactual scenarios, removing hesitancy attributable to side effects would result in the highest level of vaccine acceptance across nearly all state-race-ethnicity groups (Figure 4). However, the extent to which any one reason for hesitancy explained low levels of vaccine acceptance varied substantially by geography. Under a counterfactual scenario with no hesitancy due to concern regarding side effects, vaccine acceptance in California would range from 93.44% among non-Hispanic Black or African American individuals to 98.64% among non-Hispanic Asian individuals, the highest acceptance rate of any state-race-ethnicity group under this scenario. In contrast, under the same scenario, acceptance in Oklahoma would range from 84.75% among Non-Hispanic American Indian or Alaska Native individuals—the lowest national rate under this scenario—to 88.04% among Hispanic or Latino individuals.

In addition to disparities in the level of hesitancy left unexplained, the effect of our counterfactual scenarios on inequality in acceptance rates by race-ethnicity also varied by location. Under a scenario without hesitancy due to side effect concerns, the gap in acceptance between the lowest and highest race-ethnicity groups would narrow in California from a 10.20 percentage point difference to a difference of 5.20 points between non-Hispanic Black or African American and non-Hispanic Asian communities (Figure 4). Mississippi would experience a similar reduction, moving from a 13.29 point difference to a 4.90 point difference between non-Hispanic Black or African American groups and non-Hispanic White groups. In contrast, this same counterfactual would result in minimal change in disparities by race-ethnicity in Oklahoma, where the gap between acceptance between the non-Hispanic American Indian or Alaska Native population and non-Hispanic White population would shift only slightly (8.57% to 6.37%).

## Discussion

Our analysis of vaccine uptake in May 2021 confirms that racial and ethnic disparities in vaccination rates have persisted, including particularly low rates among Hispanic or Latino and non-Hispanic Black or African American adults (Kaiser Family Foundation, 2021). Additionally, we find little evidence of elevated vaccination rates among the state-race-ethnicity populations which have experienced the highest rates of COVID-19 mortality. Although Hispanic or Latino and non-Hispanic Black or African American communities made some of the greatest gains in vaccine uptake since the initial months of vaccine distribution, the persistence of lower rates of vaccination in the communities with highest rates mortality suggests that efforts to prioritize vaccination for racial-ethnic groups at highest risk of severe COVID-19 outcomes have not been fully successful.

The pronounced gap between vaccine acceptance and uptake in many Hispanic or Latino, non-Hispanic Black or African American, and non-Hispanic American Indian or Alaska Native populations suggests that disparities in vaccine access, rather than differential vaccine hesitancy, likely drives these disparities in vaccine uptake. Our state-level analysis demonstrates that by May 2021, acceptance rates among Hispanic or Latino, non-Hispanic Black or African American, and non-Hispanic Asian adults were similar to or greater than those among non-Hispanic White adults in many states. This finding contrasts to initial predictions that vaccine acceptance among racial and ethnic minority groups would trail

acceptance among non-Hispanic White communities: numerous analyses prior to the Emergency Use Authorization or in the first months of vaccine distribution demonstrated higher vaccine hesitancy among non-Hispanic Black or African American adults, Hispanic or Latino adults, and non-Hispanic Asian adults (Kaiser Family Foundation, 2021; Salmon et al., 2021; Nguyen et al., 2021; Niño et al., 2021; Khubchandani et al, 2021; Viswanath et al., 2021).

These earlier disparities in vaccine acceptance suggested that ensuring broad access to culturally and linguistically appropriate information regarding vaccine safety and efficacy would be a key step in eliminating disparities in vaccination rates by race-ethnicity. While interventions targeting vaccine hesitancy were likely important in producing the dramatic gains in acceptance we observed among non-Hispanic Black or African American and Hispanic or Latino communities in the January 2021-May 2021 period, the large gap between uptake and acceptance rates in these two groups as of May 2021 suggests that interventions that address vaccine access factors may currently be most important in ensuring equitable rates of vaccination. Prior analysis have found that Hispanic or Latino and non-Hispanic Black or African American respondents were more likely than respondents of other racial-ethnic groups to cite access factors—including uncertainty regarding eligibility requirements, difficulty traveling to a vaccination site, lack of time, financial limitations, fear of missing work due to side effects, and lack of health insurance—as barriers to vaccination (Kaiser Family Foundation, 2021; Latkin et al., 2021; Woko et al., 2021, Callaghan et al., 2021). High vaccine acceptance rates can only result in similarly high vaccination rates if public health interventions target these structural barriers to health, many of which also produce racial-ethnic health disparities beyond the realm of COVID-19 (Gee and Ford, 2011).

Although vaccine acceptance exceeds 70% in the majority of state-race-ethnicity groups, some populations still report substantial hesitancy towards the COVID-19 vaccine. Our data does not support differences by race-ethnicity in the specific concerns driving this residual hesitancy, instead finding that an intervention addressing worries about adverse side effects would be most effective in increasing vaccine acceptance across the majority of state-race-ethnicity populations. However, our data does not include information on factors which have previously been shown to differentially drive vaccine hesitancy in minority racial and ethnic groups, including perceptions of racial fairness, previous experiences of discrimination, and past negative experiences with healthcare (Quinn et al., 2017;

Khubchandani et al., 2021). Our counterfactual analysis demonstrates that in many states, addressing only the drivers of hesitancy included in our analysis would leave large proportions of currently hesitant individuals still uncertain about pursuing vaccination, or would fail to narrow current race-ethnicity gaps in hesitancy levels. Additional data on the drivers of vaccine hesitancy—including data which more explicitly addresses the relationship between structural racism, racial-ethnic social inequalities, and racial-ethnic inequalities in hesitancy—will be necessary to inform interventions that more specifically target the concerns of vaccine hesitant individuals (Krieger, 2021).

### Limitations

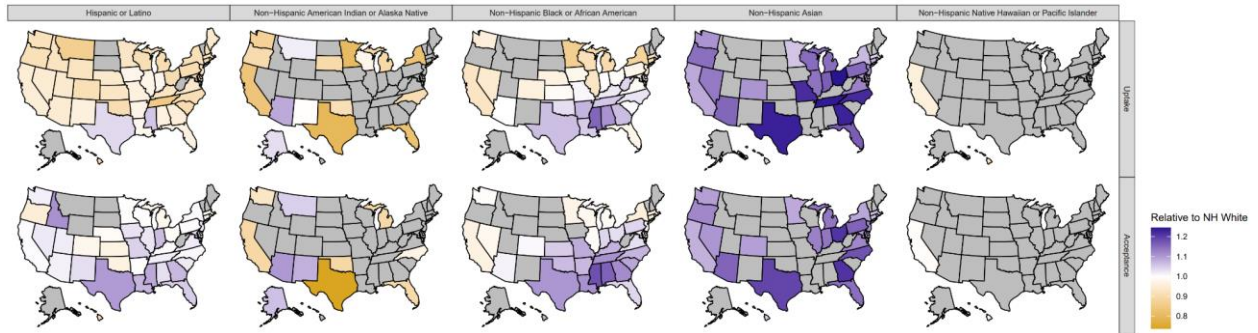
In both the COVID-19 Symptom Survey and NCHS mortality data, data is suppressed in some race-ethnicity-state categories when the number of respondents falls below 100 or the number of deaths falls between 1 and 9. This censoring limits the ability of this analysis to identify vaccine uptake, vaccine hesitancy, and COVID-19 mortality disparities among race-ethnicity groups who represent a small minority in a given state, particularly limiting our ability to document inequalities among non-Hispanic American Indian or Alaska Native and non-Hispanic Native Hawaiian or Pacific Islander groups. Though survey weights are available to adjust for differences between the population who responded to the COVID-19 Symptom Survey and the U.S. adult population, these weights rely on assumptions regarding the demographics of survey non-respondents, and may not fully correct for the differences between these two populations. Additionally, although survey responses are anonymous, social desirability bias may have produced overestimates of vaccine acceptance in communities where vaccination is positively valued. Finally, our counterfactual scenarios of vaccine hesitancy assume that the elimination of one driver of hesitancy would produce vaccine acceptance among individuals who indicated that multiple reasons underlie their vaccine hesitancy. Due to the availability of aggregated data, we also assume when producing these counterfactual estimates that the the proportion of individuals describing their vaccine intention as “Yes, probably”, “No, probably not”, or “No, definitely not” who cite a reason for hesitancy is similar to the proportion of individuals indicating “No, probably not” or “No, definitely not” who cite the same reason.

## Conclusions

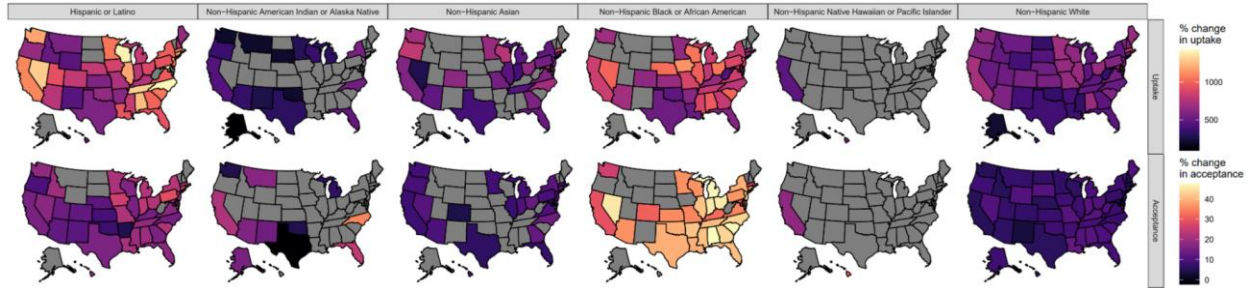
Six months since the initial Emergency Use Authorization of the COVID-19 vaccine, Non-Hispanic Black or African American, Hispanic or Latino, and non-Hispanic Native American or Alaska Native populations continue to receive the COVID-19 vaccine at a lower rate than non-Hispanic White individuals in many states. Our results indicate that the persistence of these disparities is largely due to inequality in vaccine access, rather than low rates of vaccine acceptance in racial and ethnic minority communities. We demonstrate that the interventions required to achieve near-universal vaccine uptake are not homogenous across race-ethnicity or geography. In order to achieve equitable vaccination rates across all populations, community-specific interventions that address structural barriers to vaccine access among racial and ethnic minority groups are urgently needed.

## Figures and Tables

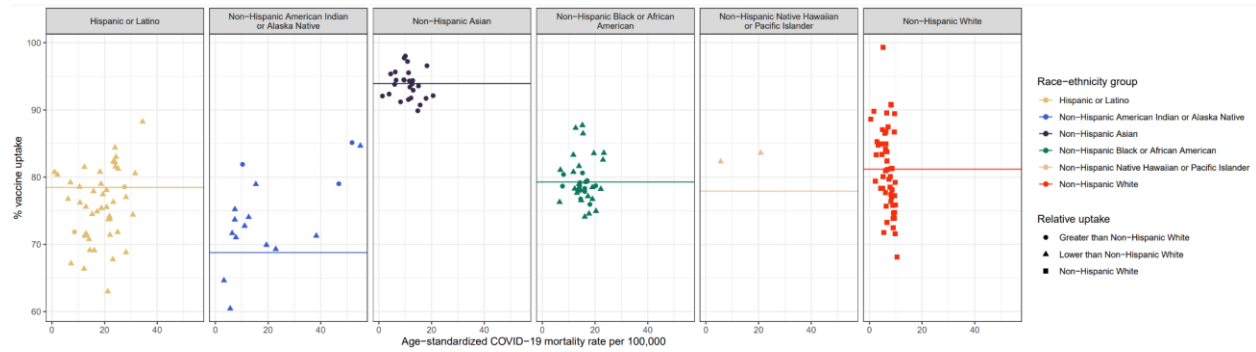
**Figure 1:** Relative vaccine uptake and acceptance by race-ethnicity group in May 2021. Rates are shown relative to rates in the non-Hispanic White (NH White) population in each state. States with insufficient data are indicated in grey.



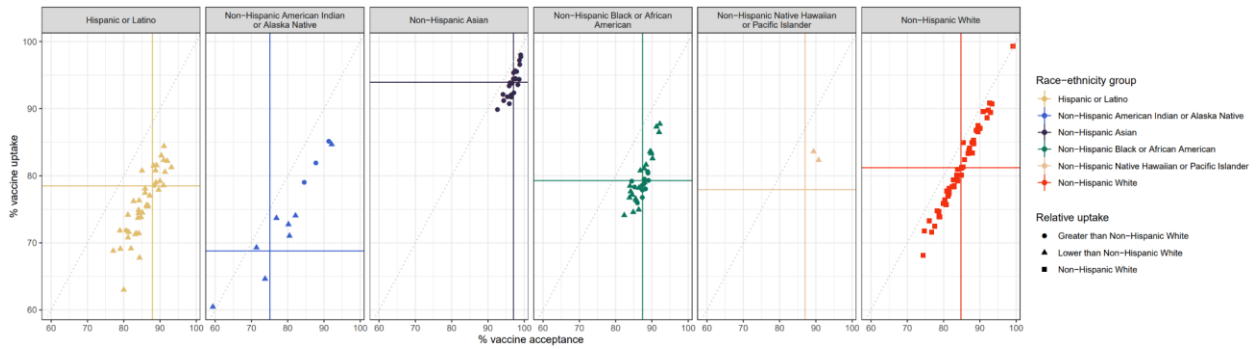
**Figure 2:** Percent change in uptake and acceptance from January 2021 to May 2021 by race-ethnicity group. States with insufficient data are indicated in grey.



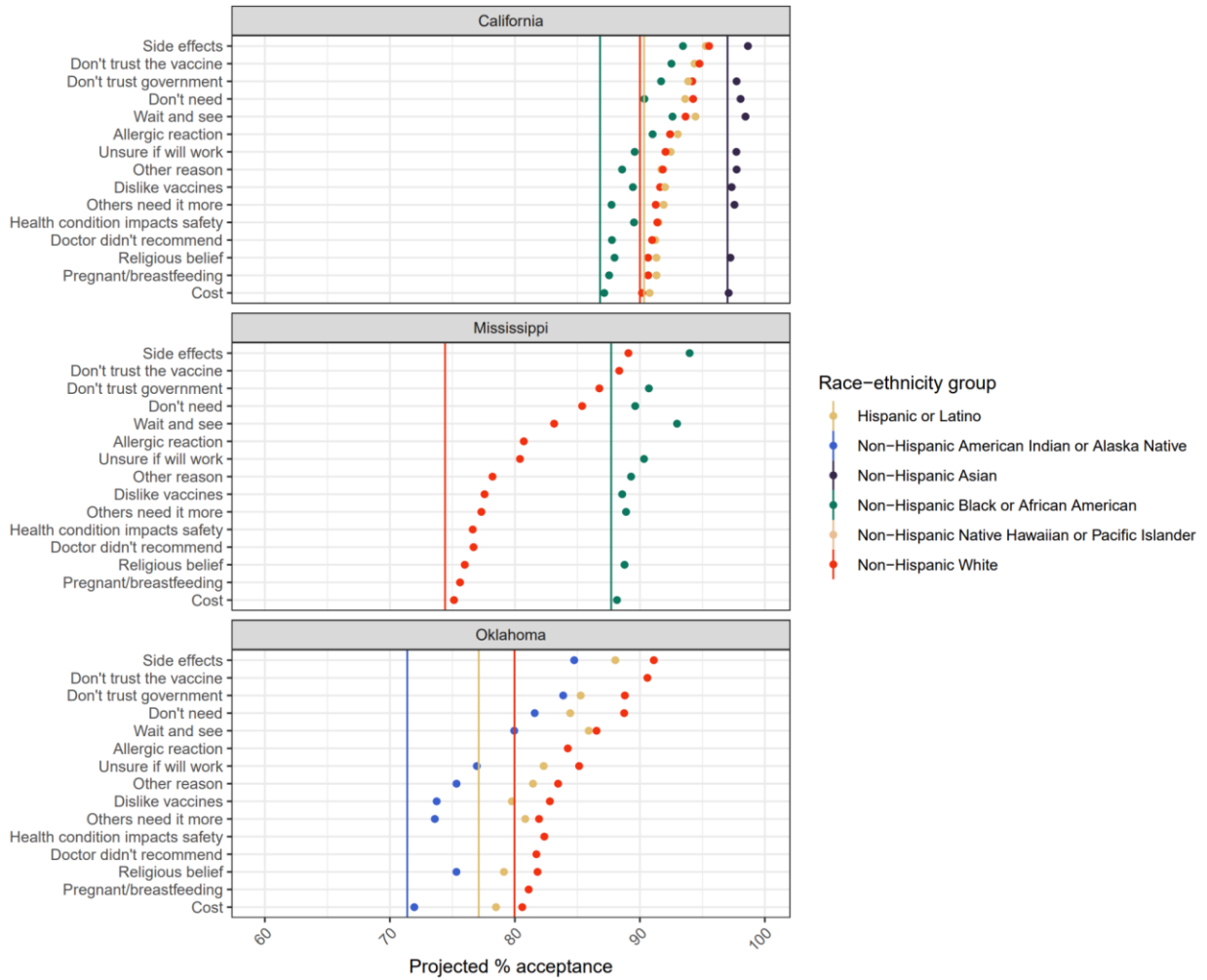
**Figure 3a:** Percent vaccine uptake and age-standardized COVID-19 mortality rate per 100,000 by race-ethnicity group and state as of May 2021. Horizontal lines indicate the national average value of percent vaccine uptake for each race-ethnicity group. State-race-ethnicity groups with vaccination rates greater than the rate among non-Hispanic White individuals in that state are shown as circles, and groups with vaccination rates lower than non-Hispanic White individuals in that state are shown as triangles. State-race-ethnicity groups with insufficient data for either mortality rate or vaccination rate are not shown.



**Figure 3b:** Percent vaccine uptake and acceptance by race-ethnicity group and state as of May 2021. Horizontal lines indicate the national average value of percent vaccine uptake for each race-ethnicity group, while vertical lines indicate the national average value of percent vaccine acceptance. State-race-ethnicity groups with vaccination rates greater than the rate among non-Hispanic White individuals in that state are shown as circles, and groups with vaccination rates lower than non-Hispanic White individuals in that state are shown as triangles. State-race-ethnicity groups with insufficient data for either mortality rate or acceptance rate are not shown.



**Figure 4:** Projected percent vaccine acceptance under counterfactual scenarios addressing common reasons for vaccine hesitancy by race-ethnicity in three states. Vertical lines indicate current percent vaccine acceptance in May 2021.



**Table 1:** Sample characteristics of respondents to the U.S. COVID-19 Symptom Survey (May 1, 2021 to May 31, 2021).

Variable		Percent who received vaccine (SE)	Percent who would accept vaccine or received vaccine (SE)	Sample size (%)
<i>Age group</i>	18-24	68.17 (0.31)	78.35 (0.34)	22897 (3.13 %)
	25-44	75.18 (0.1)	81.12 (0.11)	183963 (25.14 %)
	45-64	81.43 (0.08)	85.64 (0.08)	259384 (35.45 %)
	>64	90.35 (0.07)	92.46 (0.08)	183978 (25.15 %)
	Missing	66.48 (0.17)	77.2 (0.18)	81418 (11.13 %)
<i>Gender</i>	Female	82.18 (0.06)	87.01 (0.06)	414216 (56.61 %)
	Male	78.88 (0.09)	83.88 (0.1)	222190 (30.37 %)
	Other	60.86 (0.54)	67.17 (0.65)	8256 (1.13 %)
	Missing	65.15 (0.16)	75.53 (0.18)	86978 (11.89 %)
<i>Race-ethnicity group</i>	Hispanic or Latino	78.47 (0.15)	87.91 (0.15)	77278 (10.56 %)
	Non-Hispanic American Indian or Alaska Native	68.79 (0.64)	75.08 (0.74)	5232 (0.72 %)
	Non-Hispanic Asian	93.94 (0.19)	97 (0.16)	16474 (2.25 %)
	Non-Hispanic Black or African American	79.27 (0.21)	87.42 (0.21)	38189 (5.22 %)
	Non-Hispanic Native Hawaiian or Pacific Islander	77.93 (1.14)	87.05 (1.15)	1332 (0.18 %)
	Non-Hispanic White	81.2 (0.06)	84.79 (0.06)	473447 (64.71 %)
	Other/more than one race or missing	66.02 (0.14)	75.23 (0.16)	119688 (16.36 %)
<i>Educational attainment</i>	Less than high school	67.17 (0.33)	81 (0.34)	19844 (2.71 %)
	High school graduate or equivalent	70.21 (0.14)	79.17 (0.16)	103854 (14.19 %)
	Some college	76.98 (0.09)	82.09 (0.1)	234372 (32.03 %)
	Four-year degree	86.75 (0.09)	89.41 (0.1)	158464 (21.66 %)
	Post-graduate degree	89.45 (0.09)	91.11 (0.1)	125759 (17.19 %)
	Missing	67.22 (0.16)	77.67 (0.17)	89347 (12.21 %)
<i>Occupation</i>	Healthcare worker	84.4 (0.17)	86.99 (0.2)	46184 (6.31 %)
	Non-healthcare employment	77.93 (0.08)	82.21 (0.09)	289947 (39.63 %)
	Missing or not employed	77.76 (0.07)	84.92 (0.07)	395509 (54.06 %)
<i>Comorbidities</i>	Heart disease	80.32 (0.17)	84.64 (0.17)	55996 (7.65 %)
	Obese	83.94 (0.09)	88.46 (0.09)	152187 (20.8 %)
	Current smoker	66.7 (0.17)	75.49 (0.18)	73352 (10.03 %)
	Currently pregnant	48.88 (0.78)	58.41 (0.88)	4153 (0.57 %)
	Diabetes	84.42 (0.12)	88.71 (0.12)	86373 (11.81 %)

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