Willingness to Receive the COVID-19 Vaccine in California: Disparities by Race and Citizenship Status

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Abstract
Although it is widely acknowledged that racialized minorities may report lower COVID-19 vaccine willingness compared to non-Hispanic white individuals, what is less known, however, is whether the willingness to receive the COVID-19 vaccine also differs by citizenship. Understanding disparities in vaccine willingness by citizenship is particularly important given the misleading rhetoric of some political leaders regarding vaccine eligibility by citizenship status. This study used the 2020 California Health Interview Survey (n = 21,949) to examine disparities in vaccine willingness by race/ethnicity and citizenship among Asian, Latinx, and non-Hispanic white individuals. Overall, 77.7% of Californians indicated that they were willing to receive the COVID-19 vaccine if it was made available. However, there were distinct differences by race/ethnicity and citizenship. Asian people, regardless of citizenship, had the highest predicted probability of vaccine willingness, accounting for demographic, socioeconomic, and health factors. Non-citizen Latinx and non-citizen non-Hispanic white people had higher predicted probabilities of vaccine willingness compared to their US-born counterparts, accounting for demographic, socioeconomic, and health factors. Our results reveal that although vaccine willingness may be high among non-citizen individuals, it may not necessarily translate into actual vaccine uptake. Furthermore, while individual-level factors may account for some of the differences in vaccine willingness by race/ethnicity and citizenship, other institutional and structural barriers prevent vaccine uptake.

Keywords COVID-19 · Vaccination · Race/ethnicity · Citizenship · Health equity

Introduction
COVID-19 vaccine disparities in CA are evident by race/ethnicity, with Black and Latinx individuals experiencing lower vaccination rates than their White and Asian counterparts [1]. However, while racial disparities are well known, a paucity of research examines the degree to which racial subgroups of varying citizenship statuses fare in COVID-19 vaccine willingness. Immigrants and racialized minorities have an elevated risk of COVID-19 infection, morbidity, and mortality [2] due to social and occupational factors that lead to differential exposure, such as being employed in public-facing jobs in essential industries and low access to health care [3]. Given the multiple intertwining COVID-19 risk factors that vulnerable groups experience, it is crucial to understand whether beliefs and willingness regarding the COVID-19 vaccines among racialized minorities vary across immigration statuses.

Previous studies have found that even before the COVID-19 pandemic, immigrants experienced disparities in vaccination compared to those born in the USA [4]. For example, vaccination coverage was lower among foreign-born compared to US-born individuals in pneumococcal, HPV, and Tdap, even after accounting for confounding factors [4]. While vaccination rates were generally lower among foreign-born people, differences were starker among noncitizens, with Hispanic/Latinx noncitizens having the lowest coverage for several vaccines. Other work has also documented racial-ethnic disparities in vaccination rates for diseases like the flu, with the most pervasive disparities found between Black and Latinx adults compared to Whites [5, 6]. Given the variation in vaccination...
rates, it is imperative to consider the attitudes toward the vaccine within citizenship status and by race/ethnicity.

Preexisting deterrents to preventive health care services, such as language barriers, financial limitations, and low health insurance rates [7, 8], are now compounded by a turbulent US political environment [9], mistrust in health care in marginalized communities [10], and the novelty of the COVID-19 vaccine [11]. In particular, the implementation of the new public charge rule, which went into effect just before the pandemic began in February 2020, led to a decline in enrollment in safety-net programs (i.e., Medicaid, WIC, and SNAP) among US-born children, particularly in regions with a higher share of noncitizens. Specifically, 260,000 fewer people were covered in children’s Medicaid coverage occurred after the public charge announcement by then-President Donald Trump [12]. This specific public charge rule broadened the criteria by which noncitizen immigrants could become ineligible for permanent resident status. In this case, any nonpermanent resident immigrant could be denied permanent residency if they received public benefits such as food assistance, housing, or Medicaid [12]. Given that the public charge rule was implemented a month before the national state of emergency went into effect, it is plausible that immigrants without legal status may have feared accessing health care and preventive services, including immunization against SARS-CoV2.

Along with the political environment, organizational barriers to getting vaccinated have been cited at vaccination sites nationwide. While the COVID-19 vaccine is free and accessible to everyone regardless of health insurance or legal status [13], various businesses administering the vaccine require patients to provide a Social Security number or health insurance information [14]. The resulting obstacles are more consequential for vulnerable subgroups, such as undocumented immigrants, who are less likely to advocate for themselves.

Overall, there is a need for a more comprehensive understanding of the willingness and attitudes toward the COVID-19 vaccine among racial minorities of distinct citizenship statuses. These data can inform the tailoring of vaccination programs and communication strategies to improve vaccination uptake among marginalized communities at the intersection of race/ethnicity and citizenship status. To address these gaps, this study examines differences in the willingness to receive the COVID-19 vaccine by citizenship status and race/ethnicity among a representative sample of Californians.

Methods

We used data from the public use 2020 California Health Interview Survey (CHIS) \(n = 21,949\). The CHIS is an annual survey intended to provide state-wide estimates of the health, social, and economic profiles of all Californians.

The 2020 CHIS is a particularly novel dataset to study the effects of the COVID-19 pandemic because it was immediately redesigned during CA’s “work from home” orders to include questions about the effects of the pandemic [15]. The redesign of the questionnaire at the onset of the pandemic allowed the CHIS to provide real-time data on the social and health effects of the pandemic. We restrict our data to the 2020 iteration as it is the most currently available data of the CHIS. Of the 21,949 people who completed the 2020 CHIS, we restrict our analysis to 20,536 individuals who had complete data on all of the variables of interest outlined below. Since these data are de-identified, public use data, they are not human subjects research and do not require Institutional Review Board approval.

Outcome Vaccine willingness was our outcome variable of interest and was asked as follows: “If a vaccine becomes available for COVID-19, would you get it?” Two response categories were available and were coded as 0 = no and 1 = yes.

Independent Variable Participants’ race/ethnicity and citizenship status were the independent variable of interest. The CHIS provides separate variables for participants’ self-identified race/ethnicity and citizenship status. We combined both variables to create the following nine categories: “0 = US-born White,” “1 = naturalized White,” “2 = non-citizen White,” “3 = US-born Latinx,” “4 = naturalized Latinx,” “5 = noncitizen Latinx,” “6 = US-born Asian,” “7 = naturalized Asian,” and “8 = noncitizen Asian.” In our preliminary analyses, we attempted to examine vaccine willingness among Black and African American people, American Indian and Alaska Native people, Native Hawaiians, and Pacific Islander people, in addition to people who identified as “other races” or as “multiracial.” However, sample sizes for certain groups (e.g., noncitizen Black) were small, thereby leading to unstable estimates. We acknowledge that this is a limitation of this study and that more work is needed to include those who do not identify as non-Hispanic White, Latino, or Asian.

Covariates We account for four sets of covariates that could explain the association between vaccine uptake, race/ethnicity, and citizenship. Our demographic factors included age category (18–34 years old, 35–49 years old, 50–64 years old, and 65+ years old) and gender (female or male). Given privacy concerns, the public-use version of the CHIS did not provide additional categories for other gender identities.

Social and socioeconomic factors included family type (single with no kids, married with no kids, married with kids, and single with kids), urbanicity (urban or rural), educational attainment (less than high school, high school
Graduate, associate’s degree, bachelor’s degree, or more), employment status (currently employed versus not), and whether participants had a usual source of care other than the emergency room. We also examined the federal poverty level (FPL) but only presented its distribution in the univariate and bivariate analyses (> 100% FPL vs. not) due to issues of collinearity with other socioeconomic predictors.

We examined three types of COVID-19-related factors: whether participants experienced racial discrimination due to the COVID-19 pandemic, whether participants work in “essential work,” and whether participants worked from home due to the COVID-19 pandemic.

Finally, we examined physical health factors that could influence vaccine uptake. These factors included whether participants were overweight or obese, were diagnosed with diabetes, were diagnosed with heart disease, or were diagnosed as pre-hypertensive/hypertensive according to their doctor.

**Analysis Plan** We began our analysis by first examining the weighted univariate distribution of vaccine uptake, demographic, social, socioeconomic, COVID-19, and health factors. Next, we examined the characteristics of the sample by race/ethnicity and citizenship status. Differences in each factor by race/ethnicity and citizenship were determined using a chi-square test. For our multivariable analyses, we examined a series of five nested binary logistic regressions. Model 1 examined the bivariate relationship between vaccine willingness and race/ethnicity and citizenship status. Model 2 introduced demographic factors as possible confounders in the association between vaccine willingness and race/ethnicity and citizenship status. Model 3 included social and socioeconomic factors as alternative explanatory variables for differences in vaccine willingness. Model 4 examined the additional associations of COVID-19-related factors as explanatory factors for vaccine willingness. Finally, model 5 included health factors as additional confounding factors. To provide ease of interpretation in disparities in vaccine willingness by race/ethnicity and citizenship status, we calculated predicted probabilities using the “margins” command in Stata. We also conduct pairwise comparisons of predicted probabilities by race/ethnicity and citizenship status using the “pwcompare” command in Stata and adjust for multiple comparisons using the Sidak method [16]. All data cleaning, recoding, and analysis were done using Stata Version 17.0 [17]. All analyses were weighted to be representative of the Californian population using the methods recommended by CHIS [18]. To summarize, these weights account for both the telephone and web data collection methods used by the CHIS in addition to the oversampling of certain minoritized groups to provide estimates for all counties, large and small, in CA. Furthermore, the weighting procedure accounts for the differential probability of selection of households, non-response, and sample differences among less-represented groups. Weights are based on 2010 Census stratum counts projections. Weighted analyses with the CHIS use Jackknife variance estimation calculation with replicate weights in order to produce reliable estimates that are representative of the Californian population [18].

**Results**

Table 1 presents the weighted sample characteristics of the 2020 CHIS. Overall, 77.7% of participants indicated that they would receive the COVID-19 vaccine if it was available. However, there were distinct differences in vaccine willingness by race and citizenship status (p < 0.001). In general, vaccine willingness was highest among US-born people within each race/ethnic group, except for Hispanic/Latinx people, where vaccine willingness was highest among non-citizen Hispanic/Latinx people. When examining differences in vaccine willingness by race/ethnicity, Asian people had the highest vaccine willingness, followed by non-Hispanic White and Hispanic/Latinx respondents. Interestingly, vaccine willingness was lowest among naturalized Hispanic/Latinx people.

The majority of the sample was between 18 and 34 years old (30.6%), female (50.8%), and single without kids (39.6%). For socioeconomic factors, most participants had at least a bachelor’s degree (41.0%), were currently employed (55.0%), and had a usual source of healthcare other than the emergency room (76.0%). Approximately 1.6% of the sample indicated that they had experienced discrimination based on their race within the context of the COVID-19 pandemic, yet US-born Asian respondents were 3.5 times more likely to report experiences of racial discrimination during the pandemic (7.2%). Moreover, while 17.3% of all participants indicated that they were “essential workers,” US-born Latinxs were more likely (22.5%) to report being “essential workers.” Approximately 22.2% of participants indicated that they worked from home, yet noncitizen Latinxs were less likely to report being able to work from home (7.1%).

Table 2 presents the weighted binary logistic regression results of the association of vaccine willingness and citizenship status and race/ethnicity. In the crude bivariate model (model 1), all Hispanic/Latinx groups had lower odds of COVID-19 vaccine willingness compared to US-born non-Hispanic White people. In comparison, noncitizen White (OR = 1.57, 95% CI = 1.10, 2.25), US-born (OR = 1.87, 95% CI = 1.45, 2.43) and naturalized Asian (OR = 1.35, 95% CI = 1.06, 1.72) people had higher odds of COVID-19 vaccine willingness compared to US-born White people.

Model 2, which included age category and gender as demographic confounders, showed similar results to model
Table 1  Weighted sample characteristics by race and citizenship status, 2020 California Health Interview Survey (CHIS), \( n = 20,536 \)

| Variables                                      | Total (\( n = 20,536 \)) | Asian US-born (\( n = 870 \)) | Asian Naturalized (\( n = 1438 \)) | Asian Non-citizen (\( n = 437 \)) | Hispanic/Latinx US-born (\( n = 2769 \)) | Hispanic/Latinx Naturalized (\( n = 1049 \)) | Hispanic/Latinx Non-citizen (\( n = 499 \)) | Non-Hispanic White US-born (\( n = 12,452 \)) | Non-Hispanic White Naturalized (\( n = 793 \)) | Non-Hispanic White Non-citizen (\( n = 229 \)) | P-value |
|------------------------------------------------|---------------------------|-------------------------------|-------------------------------------|-----------------------------------|--------------------------------------------|---------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|---------|
| Demographic factors                            |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               |         |
| Age category                                    |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               | <0.001  |
| 18–34 years                                     | 30.6                      | 56.6                          | 11.1                                | 47.0                              | 53.6                                       | 15.0                                        | 26.1                                           | 22.2                                           | 18.5                                           | 27.8                                           | <0.001  |
| 35–49 years                                     | 25.2                      | 23.3                          | 27.2                                | 29.6                              | 24.6                                       | 26.4                                        | 42.4                                           | 20.6                                           | 19.2                                           | 41.1                                           |         |
| 50–64 years                                     | 23.3                      | 10.6                          | 33.9                                | 18.8                              | 12.5                                       | 36.5                                        | 25.9                                           | 25.4                                           | 27.0                                           | 12.9                                           |         |
| 65+ years                                       | 20.9                      | 9.6                           | 27.8                                | 4.6                               | 9.3                                        | 22.1                                        | 5.6                                            | 31.8                                           | 35.3                                           | 18.2                                           |         |
| Female gender                                   | 50.8                      | 56.0                          | 54.4                                | 45.5                              | 49.8                                       | 51.0                                        | 51.2                                           | 51.1                                           | 44.8                                           | 49.6                                           | 0.033   |
| Social factors                                  |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               |         |
| Family type                                     |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               | <0.001  |
| Single, no kids                                 | 39.6                      | 59.5                          | 27.8                                | 36.3                              | 46.5                                       | 27.0                                        | 24.8                                           | 43.4                                           | 34.7                                           | 30.4                                           |         |
| Married, no kids                                | 30.5                      | 18.9                          | 43.4                                | 23.2                              | 16.4                                       | 38.3                                        | 22.9                                           | 37.1                                           | 45.7                                           | 35.2                                           |         |
| Married with kids                               | 20.4                      | 15.3                          | 25.5                                | 32.5                              | 18.5                                       | 25.0                                        | 34.7                                           | 15.3                                           | 17.7                                           | 30.2                                           |         |
| Single with kids                                | 9.5                       | 6.2                           | 3.3                                 | 8.0                               | 18.6                                       | 9.7                                         | 17.7                                           | 4.2                                            | 2.0                                            | 4.3                                            |         |
| Living in rural area                            | 11.7                      | 3.2                           | 5.3                                 | 3.5                               | 9.3                                        | 8.6                                         | 11.5                                           | 17.6                                           | 6.8                                            | 3.7                                            | <0.001  |
| Socioeconomic factors                           |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               |         |
| Educational attainment                          |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               | <0.001  |
| Less than high school                           | 16.0                      | 2.6                           | 18.0                                | 16.5                              | 108.0                                      | 43.9                                        | 55.0                                           | 3.7                                            | 15.5                                           | 9.0                                            |         |
| High school graduate                            | 21.6                      | 7.1                           | 12.8                                | 14.5                              | 27.5                                       | 22.1                                        | 22.5                                           | 22.3                                           | 14.3                                           | 12.4                                           |         |
| Some college                                    | 15.9                      | 15.5                          | 8.8                                 | 8.5                               | 21.2                                       | 12.4                                        | 11.3                                           | 17.0                                           | 13.7                                           | 12.7                                           |         |
| Associates degree                               | 5.5                       | 4.5                           | 4.3                                 | 2.2                               | 8.4                                        | 3.0                                         | 1.0                                            | 6.2                                            | 4.4                                            | 2.4                                            |         |
| Bachelor’s degree or more                       | 41.0                      | 70.3                          | 56.2                                | 58.2                              | 32.1                                       | 18.6                                        | 10.2                                           | 50.9                                           | 52.2                                           | 63.6                                           |         |
| Currently employed                              | 55.0                      | 63.7                          | 54.9                                | 55.1                              | 57.0                                       | 55.0                                        | 58.6                                           | 52.2                                           | 51.0                                           | 59.4                                           | 0.003   |
| FPL \( \geq 100\% \)                            | 86.5                      | 91.3                          | 90.2                                | 79.4                              | 81.8                                       | 79.9                                        | 70.4                                           | 93.4                                           | 93.1                                           | 96.9                                           | <0.001  |
| Has usual source of care                        | 76.0                      | 81.8                          | 91.3                                | 76.0                              | 81.0                                       | 83.9                                        | 71.7                                           | 89.3                                           | 90.2                                           | 81.9                                           | <0.001  |
| COVID-19-related factors                        |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               |         |
| Experience discrimination based on race and COVID-19 | 1.6                      | 7.2                           | 2.7                                 | 3.8                               | 1.8                                        | 0.8                                         | 3.0                                            | 0.6                                            | 0.3                                            | 0.6                                            | <0.001  |
| Works as an “essential worker”                  | 17.3                      | 17.1                          | 12.8                                | 12.1                              | 22.5                                       | 18.7                                        | 19.0                                           | 15.4                                           | 10.0                                           | 9.6                                            | <0.001  |
| Works from home                                 | 22.2                      | 41.1                          | 24.4                                | 27.3                              | 23.2                                       | 14.2                                        | 7.1                                            | 24.6                                           | 18.8                                           | 28.2                                           | <0.001  |
| Physical health factors                         |                           |                               |                                     |                                   |                                            |                                             |                                               |                                               |                                               |                                               |         |
| Overweight or obese                             | 61.3                      | 42.9                          | 39.5                                | 43.7                              | 68.3                                       | 73.2                                        | 78.3                                           | 57.9                                           | 58.4                                           | 50.2                                           | <0.001  |
1. Hispanic/Latinx groups, regardless of citizenship, continued to have lower odds of vaccine willingness compared to US-born White individuals. US-born and naturalized Asian people continued to have higher odds of vaccine willingness compared to US-born White people.

Results remained similar when accounting for social and socioeconomic factors (model 3), with a couple of exceptions. Non-citizen Latinx people now had similar odds of vaccine willingness when compared to US-born White people. Following US-born and naturalized Asian people, Non-citizen Asian people had marginally higher odds of vaccine willingness when compared to US-born White people (OR = 1.37, 95% CI = 0.95, 1.97). These trends seen for all groups remained robust when accounting for COVID-19-related factors (model 4) and health factors (model 5).

Figure 1 presents a visualization of the predicted probabilities of vaccine hesitancy by race and citizenship status (based on Table 2, model 5, fully adjusted for demographic, social, socioeconomic, COVID-19, and health factors). In addition, we conducted pairwise comparisons to evaluate if differences in the predicted probability of vaccine willingness by race and citizenship status group were statistically significant using the Sidak method. In general, we see that vaccine willingness is similar among all Asian people regardless of citizenship status (US-born vs. naturalized Asian: p = 1.000; US-born vs. noncitizen Asian: p = 1.000; naturalized vs. non-citizen Asian: p = 1.000). In contrast, there are distinct differences between US-born and non-citizen groups for non-Hispanic White and Latinx groups.

Starting with Latinx people first, we see that vaccine willingness is significantly higher among non-citizen Latinx people than among US-born Latinx (p = 0.010). A similar trend is seen between noncitizens and US-born non-Hispanic White. Non-citizen White individuals had higher vaccine willingness than US-born White individuals, albeit not statistically significant when accounting for multiple comparisons (p = 0.328).

When comparing race/ethnic and citizenship groups, US-born Asian people had significantly higher vaccine willingness compared to US-born White (p = 0.006), US-born Latinx people (p < 0.001), and naturalized Latinx (p < 0.001). In addition, naturalized Asian (p < 0.001) and noncitizen Asian (p = 0.019) people had significantly higher vaccine willingness compared to US-born Latinx. Finally, non-citizen White people had higher vaccine willingness compared to US-born Latinx (p = 0.001) and naturalized Latinx (p = 0.014). Overall, vaccine willingness was lowest among US-born Latinx people, while vaccine willingness was highest among US-born Asian and non-citizen White people.

**Discussion**

Our results reveal the varied disparities in COVID-19 vaccine willingness by both race/ethnicity and citizenship status. Overall, we found that at least 70% of Californians were

| Variables | US-born | Naturalized | Non-citizen |
|-----------|---------|-------------|------------|
| Diabetes diagnosed by doctor | 10.7 | 8.2 | 8.2 |
| Heart disease diagnosed by doctor | 6.5 | 5.1 | 3.6 |
| Prehypertension or hypertension diagnosed by doctor | 32.1 | 29.7 | 26.0 |

**Table 1** (continued)
### Table 2  Weighted multivariable binary logistic regression of COVID-19 vaccine willingness on immigration status and race, 2020 California Health Interview Survey (n = 20,536)

| Variables                          | Model 1 | OR  | 95% CI         | Model 2 | OR  | 95% CI         | Model 3 | OR  | 95% CI         | Model 4 | OR  | 95% CI         | Model 5 | OR  | 95% CI         |
|------------------------------------|---------|-----|----------------|---------|-----|----------------|---------|-----|----------------|---------|-----|----------------|---------|-----|----------------|
| Citizenship status and race        |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| US-born White                      | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                |
| Naturalized White                  | 0.94    | 0.69–1.28 |                | 0.91    | 0.67–1.24 |                | 0.94    | 0.69–1.29 |                | 0.97    | 0.70–1.33 |                | 0.98    | 0.71–1.35 |                |
| Noncitizen White                   | 1.57*   | 1.10–2.25 |                | 1.66**  | 1.15–2.39 |                | 1.62*   | 1.11–2.35 |                | 1.65**  | 1.14–2.38 |                | 1.62*   | 1.12–2.35 |                |
| US-born Latinx                     | 0.52*** | 0.46–0.59 |                | 0.56*** | 0.49–0.63 |                | 0.66*** | 0.58–0.76 |                | 0.67*** | 0.58–0.77 |                | 0.67*** | 0.58–0.77 |                |
| Naturalized Latinx                 | 0.49*** | 0.42–0.58 |                | 0.51*** | 0.43–0.59 |                | 0.76**  | 0.64–0.92 |                | 0.77**  | 0.64–0.93 |                | 0.76**  | 0.64–0.92 |                |
| Noncitizen Latinx                  | 0.55*** | 0.44–0.68 |                | 0.60*** | 0.48–0.76 |                | 1.09    | 0.85–1.40 |                | 1.14    | 0.89–1.47 |                | 1.15    | 0.90–1.47 |                |
| US-born Asian                      | 1.87*** | 1.45–2.43 |                | 2.05*** | 1.55–2.70 |                | 1.80*** | 1.57–2.37 |                | 1.78*** | 1.34–2.34 |                | 1.74*** | 1.32–2.29 |                |
| Naturalized Asian                  | 1.35*   | 1.06–1.72 |                | 1.38**  | 1.09–1.75 |                | 1.44**  | 1.14–1.83 |                | 1.46**  | 1.15–1.85 |                | 1.41**  | 1.11–1.79 |                |
| Noncitizen Asian                   | 1.13    | 0.79–1.60 |                | 1.22    | 0.86–1.74 |                | 1.37+   | 0.95–1.97 |                | 1.39+   | 0.97–2.00 |                | 1.36+   | 0.95–1.95 |                |
| Demographic factors                |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| Age category                       |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| 18–34 years old                    | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                |
| 35–49 years old                    | 0.96    | 0.82–1.12 |                | 1.02    | 0.87–1.19 |                | 1.02    | 0.88–1.20 |                | 1.02    | 0.87–1.18 |                | 1.09    | 0.91–1.30 |                |
| 50–64 years old                    | 1.00    | 0.85–1.19 |                | 1.10    | 0.92–1.31 |                | 1.13    | 0.94–1.34 |                | 1.19    | 0.91–1.30 |                | 1.09    | 0.91–1.30 |                |
| 65+ years old                      | 1.42*** | 1.20–1.68 |                | 1.62*** | 1.37–1.92 |                | 1.72*** | 1.45–2.04 |                | 1.59*** | 1.33–1.90 |                | 1.59*** | 1.33–1.90 |                |
| Gender                             |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| Male                               | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                |
| Female                             | 0.80*** | 0.71–0.89 |                | 0.78*** | 0.70–0.87 |                | 0.77*** | 0.69–0.86 |                | 0.77*** | 0.69–0.86 |                | 0.77*** | 0.69–0.86 |                |
| Social and socioeconomic factors   |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| Family type                        |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| Single, no kids                    | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                |
| Married, no kids                   | 0.95    | 0.81–1.11 |                | 0.95    | 0.81–1.11 |                | 0.95    | 0.82–1.11 |                | 0.95    | 0.82–1.11 |                | 0.95    | 0.82–1.11 |                |
| Married with kids                  | 0.76**  | 0.62–0.92 |                | 0.75**  | 0.62–0.91 |                | 0.77**  | 0.63–0.93 |                | 0.77**  | 0.63–0.93 |                | 0.77**  | 0.63–0.93 |                |
| Single with kids                   | 1.08    | 0.88–1.32 |                | 1.08    | 0.89–1.32 |                | 1.10    | 0.90–1.33 |                | 1.10    | 0.90–1.33 |                | 1.10    | 0.90–1.33 |                |
| Urbanicity                         |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| Urban                              | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                |
| Living in rural area               | 0.81**  | 0.72–0.92 |                | 0.83**  | 0.73–0.94 |                | 0.84**  | 0.74–0.95 |                | 0.84**  | 0.74–0.95 |                | 0.84**  | 0.74–0.95 |                |
| Educational attainment             |         |     |                |         |     |                |         |     |                |         |     |                |         |     |                |
| Less than high school              | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                | Ref     |     |                |
| High school graduate               | 1.49**  | 1.18–1.89 |                | 1.50**  | 1.18–1.91 |                | 1.51*** | 1.19–1.92 |                | 1.51*** | 1.19–1.92 |                | 1.51*** | 1.19–1.92 |                |
| Some college                       | 1.54*** | 1.26–1.89 |                | 1.51*** | 1.24–1.85 |                | 1.53*** | 1.25–1.87 |                | 1.53*** | 1.25–1.87 |                | 1.53*** | 1.25–1.87 |                |
| Associates degree                  | 1.78*** | 1.39–2.28 |                | 1.74*** | 1.35–2.23 |                | 1.75*** | 1.36–2.26 |                | 1.75*** | 1.36–2.26 |                | 1.75*** | 1.36–2.26 |                |
| Bachelor's degree or more          | 3.17*** | 2.57–3.91 |                | 2.88*** | 2.33–3.56 |                | 2.91*** | 2.34–3.61 |                | 2.91*** | 2.34–3.61 |                | 2.91*** | 2.34–3.61 |                |
| Variables                                      | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|-----------------------------------------------|---------|---------|---------|---------|---------|
|                                               | OR 95% CI | OR 95% CI | OR 95% CI | OR 95% CI | OR 95% CI |
| Employment status                             |         |         |         |         |         |
| Currently unemployed                          | Ref     | Ref     | Ref     | Ref     | Ref     |
| Currently employed                            | 0.96    | 0.86–1.08 | 0.91    | 0.80–1.03 | 0.92    | 0.80–1.04 |
| Has usual source of care                      | Ref     | Ref     | Ref     | Ref     | Ref     |
| Does not have usual source of care            | 1.29**  | 1.08–1.54 | 1.27**  | 1.07–1.52 | 1.26*   | 1.05–1.51 |
| COVID-related factors                         |         |         |         |         |         |
| Experience of discrimination based on race and COVID-19 |         |         |         |         |         |
| Did not experience discrimination based on race and COVID-19 | Ref     | Ref     | Ref     | Ref     |
| Experienced discrimination based on race and COVID-19 | 0.95    | 0.61–1.48 | 0.96    | 0.61–1.49 |
| Essential worker status                       |         |         |         |         |         |
| Not an “essential worker”                     | Ref     | Ref     | Ref     | Ref     |
| Works as an “essential worker”                | 1.03    | 0.88–1.21 | 1.03    | 0.87–1.20 |
| Work from home status due to COVID-19          |         |         |         |         |         |
| Does not work at home                         | Ref     | Ref     | Ref     | Ref     |
| Works at home due                             | 1.52*** | 1.31–1.77 | 1.52*** | 1.31–1.77 |
| Health-related factors                        |         |         |         |         |         |
| Weight status                                 |         |         |         |         |         |
| Not overweight or obese                       | Ref     | Ref     |         |         |         |
| Overweight or obese                           | 0.89+   | 0.78–1.01 |         |         |         |
| Diabetes status                               |         |         |         |         |         |
| No diabetes diagnosed by doctor               | Ref     | Ref     |         |         |         |
| Diabetes diagnosis by doctor                  | 1.36**  | 1.11–1.66 |         |         |         |
| Heart disease status                          |         |         |         |         |         |
| No heart disease diagnosed by doctor          | Ref     | Ref     |         |         |         |
| Heart disease diagnosed by doctor             | 1.08    | 0.84–1.39 |         |         |         |
| Hypertension status                           |         |         |         |         |         |
| No pre-hypertension/hypertension diagnosed by doctor | Ref     | Ref     |         |         |         |
| Pre-hypertension/hypertension diagnosed by doctor | 1.04    | 0.92–1.17 |         |         |         |
| Constant                                      | 4.59*** | 4.28–4.92 | 4.71*** | 4.04–5.49 | 1.89*** | 1.42–2.52 |
|                                               |         |         |         |         |         |

+, p < 0.10, *, p < 0.05, **, p < 0.01, and ***, p < 0.001. Ref., reference category
The lower vaccine willingness among Latinx individuals as a whole is also concerning, especially given that Latinx immigrants comprise a large share of the essential workforce. These lower rates of willingness to get vaccinated may be related to institutional and structural barriers for workers that may not allow Latinx immigrants to take paid time off to receive the vaccine. For example, Latinx immigrants are more likely to work in precarious industries where employer abuse is pervasive [25] and taking time off from work is difficult [26]. Another explanation may be Latinx Californians’ fear of immigration enforcement and becoming a public charge. For instance, a recent study found that exposures to immigration enforcement, such as avoidance of health and social services due to immigration fears or experiences of detention or deportation, were associated with a lower likelihood of accepting the COVID-19 vaccine among a sample of undocumented young adults in CA [27]. Alternatively, some Latinx people may have a general mistrust due to discrimination by medical providers or histories of racial discrimination [22, 28, 29]. Thus, although vaccine willingness may be slightly higher among non-citizen Latinx compared to US-born and naturalized Latinx people, structural barriers may ultimately affect the actual uptake of the COVID-19 vaccine.

Finally, while the willingness to receive the COVID-19 vaccine was generally high among non-Hispanic White individuals, it was interesting to see that rates were lowest among US-born Whites, despite accounting for educational attainment. The lower willingness rates among US-born individuals, in general, could be related to potential political views on vaccination. In the USA, race/ethnicity has become a key predictor of voting behavior and political affiliation, whereby White voters are more likely to lean Republican [30]. Given the politicization of the COVID-19 pandemic, political views are a significant factor in vaccine resistance. For instance, political ideology is associated with vaccine uptake, whereby regions with a higher share of Republicans have a lower share of individuals who have received the COVID-19 vaccine [30, 31]. Unfortunately, the 2020 CHIS did not include questions related to political preferences.

These results are balanced by a number of additional limitations. First, as previously mentioned in our methods, we were unable to examine vaccine willingness disparities among Black, Indigenous, Native Hawaiian, Pacific Islander, and multi-racial populations. Previous work has noted the disheartening toll that COVID-19 has had among these communities [32, 33], which may encourage these communities to be more willing to receive the COVID-19 vaccine. However, future work should examine how issues of citizenship and immigration affect the Black community, especially.

Second, given our use of public data, we are unable to examine how vaccine willingness may differ within ethnic subgroups (e.g., Mexican and Filipino). Although we
provide our reports in the aggregate, it is possible that vaccine willingness may vastly differ between certain subgroups depending on the impact COVID-19 has had on them.

Finally, there may be some other unmeasured factors that we were unable to account for in our analysis. As previously mentioned, we were unable to examine the role that political preferences or policies such as “public charge” may have in explaining differences in vaccine willingness by race and citizenship. Furthermore, while CHIS is intended to be representative of all of CA, we are unable to examine how larger area-level factors could affect vaccine willingness.

However, this study provides two key contributions to the literature on COVID-19 vaccine health inequities by race, ethnicity, and citizenship. First, although previous studies have examined COVID-19 inequities by race and ethnicity [10, 11, 28] or have speculated how there may be disparities by citizenship [8, 9, 12, 27, 34], our study provides a detailed look at how willingness to vaccinate may be different by race/ethnicity and citizenship. Examining the intersections of race, ethnicity, and citizenship allows us to examine how potential vulnerability compounds to produce health inequities [35]. Second, our results provided the first look into the general willingness of individuals to become vaccinated against COVID-19 prior to vaccination is available. This is important as the USA continues to deal with upsurges in COVID-19 and future outbreaks.

Conclusion

Overall, our study found that COVID-19 vaccine willingness at the beginning of the pandemic among Asian, Latinx, and non-Hispanic White individuals was high. However, there were distinct differences by citizenship status. Although the high rates of willingness to receive the COVID-19 vaccine are encouraging, they may not translate into actual uptake. As booster doses and COVID-19 antiviral treatment (i.e., Paxlovid) become available, it is important to consider some of the large institutional and structural barriers that may prevent vaccine willingness from becoming vaccine uptake. Finally, it is important to remove these barriers to ensure that vaccine uptake is equitable for all.

Author Contribution AMB conceptualized the study, led the data analysis and interpretation, wrote the methods, results, discussion, and conclusion, and prepared the manuscript for submission. AYHR supported AMB in the data analysis and interpretation, wrote the introduction, and edited the manuscript for clarity.

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Declarations

Ethics Approval Because this study is an observational study using de-identified public use data, it does not fit the definition of “human subjects research.” Thus, institutional review board approval was not required.

Competing Interests The authors declare no competing interests.

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