Racial/ethnic and nativity disparities in U.S. Covid-19 vaccination hesitancy during vaccine rollout and factors that explain them

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A B S T R A C T

While research has begun to investigate disparities in Covid-19 vaccine hesitancy between White, Black and Hispanic adults, no nationally representative studies to date have accounted for Hispanic immigrants as a unique group or fully investigated the reasons behind racial/ethnic and nativity disparities. We make these contributions by substantively drawing from what is known about the ways that immigrant fear and structural racism create conditions that produce countervailing forces that are likely to contribute to racial/ethnic and nativity disparities in vaccine hesitancy. We use OLS regression and decomposition techniques to analyze data from 1936 18–65 year-old United States (U.S.) adults who participated in the COVID-19 and its Implications for American Communities (CIAC) study during February and March 2021, a period of time that coincides with early stages of the U.S. vaccine roll-out effort that pre-dated universal adult eligibility for Covid-19 vaccination. Results indicate that U.S.-born Black adults are more vaccine hesitant than U.S.-born White adults. This disparity is largely due to differences in anti-vaccine beliefs. U.S.-born Hispanic adults are less vaccine hesitant than U.S.-born White adults in adjusted OLS regression models and personal experiences with Covid-19 drive this difference. There were not significant differences between foreign-born Hispanic and U.S.-born White adults in vaccine hesitancy. These findings suggest that foreign-born Hispanic adults did not drive early disparities in vaccine hesitancy and that alleviating concerns about anti-vaccine beliefs and utilizing personal stories have important roles in preventing future racial/ethnic disparities in Covid-19 vaccine hesitancy as new Covid-19 vaccines and booster shots are rolled out. Study findings may also have implications for reducing racial/ethnic disparities in the uptake of other new vaccines.

1. Introduction

During the ongoing Covid-19 pandemic, U.S. Hispanic and Black adults have faced a greater burden of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections, hospitalizations, and deaths than White adults (Coughlin et al., 2020; Ferguson et al., 2022; Krieger et al., 2020; Mackey et al., 2021). Yet, recent national studies that analyze data at different time periods ranging from prior to Covid-19 vaccine availability through the first three months of 2021 when vaccines first became available found racial/ethnic disparities in Covid-19 vaccine hesitancy. Black adults are consistently more vaccine hesitant than White adults and evidence is mixed about Hispanic-White disparities in vaccine hesitancy (Callaghan et al., 2021; Latkin et al., 2021a, 2021b; Liu and Li, 2021; Nguyen et al., 2021; Savoia et al., 2021).

On a national scale, this developing body of research is missing studies that distinguish between U.S.-born and foreign-born Hispanic adults, groups that differ from each other and other racial/ethnic groups with respect to socioeconomic status and acculturation, both of which can influence Hispanic vaccine hesitancy (e.g., Moran et al., 2017). Also missing are nationally representative studies that attempt to explain *why* racial/ethnic disparities are evident by drawing from the bourgeoning body of research on general Covid-19 vaccine hesitancy (or lack thereof) due to factors such as common reasons for anti-vaccine beliefs (Romer and Jamieson, 2020) and personal experiences with Covid-19 (Caserotti et al., 2021; Diament et al., 2022). These advances are needed to better understand underlying racial/ethnic disparities in Covid-19 vaccine hesitancy and whether different public health messages are needed for foreign-born Hispanic and U.S.-born Hispanic, Black and White adults.

The current study makes these advances. We analyze nationally representative data from adults ages 18–65 collected from February 12 - March 3, 2021 using a survey fielded by Elite Research as part of the study, "COVID-19 and Its Implications for American Communities" (CIAC). The survey captures Covid-19 experiences including diagnosis, prevention behaviors, vaccine hesitancy, and whether participants had friends or family members who had or died from Covid-19. Given the survey's time frame, the current study provides a snapshot of racial/ethnic and nativity disparities in vaccine hesitancy relatively early in vaccine roll-out efforts and prior to the time of universal adult eligibility for Covid-19 vaccination on April 19, 2021. Results have import for understanding disparities in early Covid-19 vaccine hesitancy and why and how racial/ethnic disparities in the adoption of other new vaccines may emerge in an era where vaccine hesitancy is growing (Broniatowski et al., 2020; Dubé et al., 2021; Kennedy, 2020), Covid-19 variants will likely require new vaccines in the future (Murray and Piot, 2021), and new vaccines for other diseases will emerge in the future. Moreover, as federal guidelines continue to change on Covid-19 booster shots, study results may also offer insights in the reasons why the share of Covid-19 vaccinated Hispanic and Black adults who received booster shots lags behind the share of Covid-19 vaccinated White adults as of April 2022 (Ndugga et al., 2022).

2. Background

2.1. Racial/ethnic disparities in Covid-19 mortality and vaccine hesitancy

The 2020 U.S. life expectancy decline of 1.5 years masks stark racial/ethnic disparities that were overwhelmingly due to Covid-19 mortality (Arias et al., 2021). Among White women, life expectancy fell by 1.1 year of life compared to declines among Black and Hispanic women that were roughly twice as large. Among men, disparities were even greater with life expectancy declining by 1.3 years for White men, 3.3. years for Black men, and 3.7 years for Hispanic men.

The 2020 life expectancy and mortality estimates reflect deaths in a year where much was still being learned about Covid-19 transmission and treatment. In addition, vaccines were not available as a preventative tool for avoiding Covid-19 disease, hospitalization and death until the last few weeks of December. Universal adult eligibility for Covid-19 vaccines would follow this initial milestone four months later, thus making vaccines an important tool for not only combatting Covid-19 infections in the U.S. but also the widespread racial/ethnic disparities in deaths documented above.

Unfortunately, studies conducted on Covid-19 vaccine hesitancy prior to and during initial roll-outs indicated racial/ethnic disparities. Black adults reported more vaccine hesitancy than White adults in a nationally-representative study conducted on vaccine intentions in May–June 2020, a few months after the beginning of the pandemic, but this study reported no significant differences in vaccine intentions between White and Hispanic adults (Callaghan et al., 2021). Later studies pre-dating the time of the data collection efforts of our study also found Black-White disparities in vaccine hesitancy but findings were less consistent about Hispanic-White disparities (Latkin et al., 2021a; Liu and Li, 2021; Nguyen et al., 2021; Savoia et al., 2021). In a nationally representative May 2020 study of vaccine hesitancy (Latkin et al., 2021a) and a study that utilized a smartphone app to collect data on vaccine hesitancy from January–February 2021, Hispanic adults reported more vaccine hesitancy than White adults (Nguyen et al., 2021). Conversely, an analysis of data collected by the U.S. Census Bureau as part of the Household Pulse Surveys from January 2021–March 2021 found that Hispanic adults reported <u>less</u> vaccine hesitancy than White adults and that overall hesitancy among white and Hispanic adults declined slightly across the months studied (Liu and Li, 2021). Finally, in a study of data collected from occupational groups who were a priority for vaccination in December 2020 when vaccines were rolled out in the U.S., there were no significant differences in vaccination intention

between Hispanic adults and adults in other racial/ethnic groups (Savoia et al., 2021).

To our knowledge, the studies just cited represent the national-level studies of racial/ethnic disparities in Covid-19 vaccine hesitancy that were conducted using data collected prior to or at a similar time to when data for our study were collected. As such, they present a picture of vaccine hesitancy disparities at a time when Covid-19 vaccines were in development, very new, and/or limited in availability to certain priority groups. Investigating factors that explain racial/ethnic disparities in early Covid-19 vaccine hesitancy is critical for eliminating them through targeted intervention efforts. This knowledge also has relevance for understanding why racial/ethnic disparities are emerging in Covid-19 booster shot uptake (Ndugga et al., 2022) and why future disparities may emerge in the adoption of other new vaccines for Covid-19 variants and other diseases in an era of rising vaccine hesitancy.

2.2. Immigrant fear and racism: creating conditions that exacerbate and dampen disparities in vaccine hesitancy

One primary goal of this study is investigating whether the disaggregation of foreign-born and U.S.-born Hispanic adults will shed light on the mixed evidence about Hispanic-White disparities in vaccine hesitancy. Although mixed evidence could at least in part derive from differences in the timing of data collection efforts, data collection methods, sample differences, and other discrepancies such as the way that questions about vaccine hesitancy are worded, failing to disaggregate foreign-born and U.S.-born Hispanic adults may also muddy findings about Hispanic adults' degree of vaccine hesitancy relative to White adults. Clark et al. (2021) document a wide range of reasons why Covid-19 vaccination in immigrant communities may be especially difficult, including several factors that may make vaccine hesitancy more salient for foreign-born Hispanic adults than their U.S.-born peers. For example, undocumented foreign-born Hispanic adults may avoid vaccination due to fear of deportation or registration of information that could lead to deportation in the future. Moreover, given the recent political climate, foreign-born adults faced greater fear of being labeled as "public charges" if they received free vaccines. This is because of proposed rules that would have limited eligibility for obtaining status as a lawful permanent resident or U.S. citizen.

Along with decoupling foreign-born and U.S.-born adults, we will also investigate underlying reasons for racial/ethnic and nativity differences in vaccine hesitancy. One important consideration is the abundant evidence about the history and ongoing structural racism in the U.S. health care system and medical research, which has been documented extensively (see for example, Feagin and Bennefield, 2014; McLemore et al., 2018; Novak et al., 2018; Washington, 2016).

There are many reasons why this historical legacy has implications for exacerbating racial/ethnic disparities in Covid-19 vaccine hesitancy during roll-out efforts. For example, in general, there is skepticism among underrepresented, racialized minority groups about the safety and efficacy of new products of medical research, including vaccines (Clark et al., 2021). With respect to the Covid-19 vaccine, Black and Hispanic adults were more likely than White adults to believe that the Covid-19 vaccine can lead to illness (Latkin et al., 2021a) and to question vaccine efficacy and safety (Latkin et al., 2021b).

Medical distrust due to the legacy of racism in health care and medical research has also led Black and Hispanic adults to weigh the pros and cons of vaccination. They must consider their historical treatment by those in medical institutions and concerns with vaccine efficacy and safety against the backdrop of the heavy death toll of friends and family members from Covid-19 (Corbie-Smith, 2021). This mortality and grief burden may dampen racial/ethnic disparities in vaccine hesitancy because personal experience with loss (and hospitalizations) due to Covid-19 may illuminate disease risk. Of course, it should be noted that the mortality burden of Black and Hispanic adults is also largely the result of general racism and discrimination in the U.S., which produces

biological aging and pre-existing conditions associated with Covid-19 deaths (Geronimus, 2021).

The general legacy of racism, discrimination and unequal opportunities in the U.S. may dampen racial/ethnic disparities in vaccine hesitancy in another way. Black and Hispanic adults—and Hispanic foreign-born adults, in particular—are more likely than White adults to work in occupational sectors that increase their risk of and experiences with Covid-19 disease, hospitalization, and death (Goldman et al., 2021; Riley et al., 2021). This may lead them to be more willing to be vaccinated for protection against Covid-19.

Two additional considerations when investigating racial/ethnic disparities in Covid-19 vaccine hesitancy include socioeconomic status and political attitudes. Markers of socioeconomic disadvantage such as low incomes and low levels of educational attainment, which are positively associated with vaccine hesitancy (Fisher et al., 2020; Kricorian et al., 2022), are more likely to be found among Black and Hispanic adults relative to White adults. Conservative political attitudes are also positively associated with vaccine hesitancy (Latkin et al., 2021b), but are less likely to be expressed among Black and Hispanic adults than more moderate and liberal political attitudes (The Pew Research Center, 2021). As such, socioeconomic status may be a factor that exacerbates racial/ethnic disparities whereas political attitudes may diminish them.

2.3. The current study

In this study, the two primary contributions are our investigation of whether patterns of Covid-19 vaccine hesitancy among foreign-born and U.S.-born Hispanic adults are similar to those seen among U.S.-born White adults and our analysis of underlying reasons for racial/ethnic and nativity disparities in vaccine hesitancy when U.S.-born White adults are compared to U.S.-born Black, U.S.-born Hispanic and foreign-born Hispanic adults. We make the latter contribution by using regression decomposition techniques (described in detail below) to investigate racial/ethnic and nativity disparities in vaccine hesitancy. These analyses will examine how disparities are shaped by common Covid-19 anti-vaccine beliefs that may differ between groups as a result of racism in medicine and medical research; inequitable experiences with Covid-19 mortality, disease, and death that result from racism more generally; and other known factors associated with Covid-19 vaccine hesitancy including political attitudes (Latkin et al., 2021b) and educational attainment (Kricorian et al., 2022). The analysis will also account for age (Troiano and Nardi, 2021) and gender (Latkin et al., 2021b; Liu and Li, 2021), which early in the pandemic produced less vaccine hesitancy among older adults and men relative to women.

Given the studies cited in the previous section, we expect to find a baseline difference in Covid-19 vaccine hesitancy between foreign-born Hispanic and U.S.-born White adults, with the former group reporting more hesitancy. We are not sure whether to expect U.S.-born Hispanic adults to also report more Covid-19 vaccine hesitancy than U.S.-born White adults. On the one hand, because they do not face risks related to migration status when considering Covid-19 vaccination, U.S.-born Hispanic adults' vaccine hesitancy may be similar to U.S.-born White adults. On the other, regardless of nativity, there is evidence that Hispanic adults face racism in health care and medical research (e.g. Novak et al., 2018). This may lead to hesitancy among Hispanic individuals who are foreign-born and U.S.-born, with the only thing separating them being the degree to which they are more vaccine hesitant than U.S.-born White adults. Finally, disparities between U.S.-born Black and White adults observed early in the pandemic and during early vaccine roll-out consistently find U.S.-born Black adults to be more Covid-19 vaccine hesitant (Callaghan et al., 2021; Latkin et al., 2021a; Liu and Li, 2021; Nguyen et al., 2021; Savoia et al., 2021). We expect to find the same baseline pattern.

Expectations about underlying reasons for Covid-19 vaccine hesitancy disparities are more nuanced because decomposition results divide differences in vaccine hesitancy into parts that are <u>explained</u> by

group differences in anti-vaccine beliefs, Covid-19 risks and experiences, political beliefs, age, sex, and education, and these group compositional differences can offset one another. Thus, as we allude to in the previous section, group differences in anti-vaccine beliefs could exacerbate hesitancy but be offset by group differences in education and/or Covid-19 risks and experiences that reduce hesitancy, but we cannot predict exactly how all of the explanatory factors we will explore may compound and offset one another to produce racial/ethnic and nativity disparities.

That said, the studies cited previously lead us to expect that Covid-19 risks and experiences may play an important role in understanding disparities in vaccine hesitancy between U.S.-born White and both U.S.-born and foreign-born Hispanic adults. Hispanic individuals continue to represent a larger share of Covid-19 cases relative to their share of the total population (Black individuals make up a similar share of cases relative to their population share and White individuals make up a lower share of cases relative to their population share) and their age-adjusted risk of Covid-19 infection and deaths is higher than U.S.-born Black and White peers (Hill and Artiga, 2022). This may dampen Covid-19 vaccine hesitancy that is produced by other factors such as anti-vaccine beliefs. Conversely, disparities in vaccine hesitancy between U.S.-born White and Black adults may be largely due to anti-vaccine beliefs, with Covid-19 risks and experiences having a relatively small offsetting role given the long historical U.S. legacy of medical mistreatment of Black individuals and the impact this has on their trust of new medical technology like Covid-19 vaccines.

3. Methods

3.1. Sample information

The CIAC study was designed to learn about consequences of the COVID-19 pandemic for the lives of U.S. individuals and families. The nationally-fielded online survey was distributed to a random sample of 15,000 adults with access to an internet connection through various electronic devices. Racial/ethnic minorities and foreign-born individuals were oversampled. In total, 3753 adults participated in the survey and 3029 were valid respondents who met the study's eligibility requirements of being 18–65-year-old U.S. residents. The overall response rate of 25% and valid response rate of 20.2% are typical of online surveys. Sample weights allow researchers analyzing CIAC data to produce population-representative estimates. We confirmed this by comparing U.S. Census Bureau estimates of the U.S. population's sociodemographic background to weighted estimates of the CIAC sample and subsamples of U.S.-born Black, White, U.S.-born Hispanic and foreign-born Hispanic adults.

We constrain analysis to U.S.-born White and Black adults (for brevity, "White" and "Black") and Hispanic adults disaggregated into the foreign- and U.S.-born (N = 2603). We exclude other ethnic and immigrant groups from analyses because supplementary analyses indicated that low sample sizes precluded us from producing reliable estimates for them. We also constrained our analysis to adults who were not yet vaccinated (N = 1992) and then to respondents with no missing data on study variables (N = 1936). We did not multiply impute missing values because only 56 cases had missing data.

3.2. Measures

Our outcome is a 5-point scale indicating vaccine hesitancy ranging from a low of certain plans for vaccination to a high of no plans to be vaccinated with midrange responses of being very likely, likely or less likely to be vaccinated. We treat vaccine hesitancy as a continuous variable but supplementary models estimated vaccine hesitancy as a dichotomous variable comparing individuals who reported being less likely or that they did not plan to take the vaccine to individuals who were likely, very likely or certainly planned to take the vaccine. Results

from supplementary models were substantively similar to results presented here.

Primary independent variables indicate race/ethnicity and nativity. Respondents self-identified as White, Black, U.S-born Hispanic, or foreign-born Hispanic adults. Note that the CIAC survey asked respondents about "Hispanic" ethnicity, which allowed for comparability with Census terminology and data. This is why we use the term "Hispanic" in the current study and manuscript. We acknowledge, though, that there is debate about the use of the term "Hispanic" as opposed to "Latino," "Latina," and/or "Latinx" ethnicity and whether these terms are interchangeable.

Our analysis includes many measures that may help to explain racial/ethnic and nativity disparities in vaccine hesitancy. This includes five Covid-19 vaccine hesitancy beliefs (1 = yes): the government is not telling the truth about the vaccine, people of my race/ethnicity should be concerned about the vaccine, the vaccine was developed too quickly, the vaccine causes infertility, and the vaccine gives people Covid-19. Including each belief in statistical models as separate indicators or as a scale indicating the number of anti-vaccine beliefs produced substantively similar results. We also have measures of heightened risk of Covid-19 including employment outside of the home (1 = yes) and having health conditions that increase the risk of severe Covid-19 disease (1 = yes); a measure of having at least one friend or family member who had or died from Covid-19 (1 = yes); and liberal political leaning versus conservative or moderate leaning (1 = yes) in statistical models. Our analysis also accounts for college degree attainment (1 = yes), sex (1 = male), and a continuous measure of age (18–65).

3.3. Analytic strategy

We first produce descriptive statistics characterizing the total sample and racial/ethnic and nativity subsamples. We then estimate three weighted OLS regression models. Model 1, includes only measures of race/ethnicity and nativity. Model 2 then adjusts results from Model 1 for age, sex, and education. Model 3 then additionally adjusts for anti-vaccine beliefs and Covid-19 risks and experiences. These models begin to offer insights into reasons behind racial/ethnic and nativity disparities in Covid-19 vaccine hesitancy.

We then employ regression decomposition techniques (Jann, 2008) to show the degree to which group prevalence of anti-vaccine beliefs, covid-related risks and experiences, political beliefs, and demographic characteristics explain differences in vaccine hesitancy between White adults and other racial/ethnic and nativity groups. The decomposition uses sample means to measure group differences in the prevalence of anti-vaccine beliefs, Covid-19 risks and experiences, political beliefs, age, sex, and education, and regression coefficients to gage how these factors are related to vaccine hesitancy. For example, the difference in average vaccine hesitancy ($\overline{H}$) between White and foreign-born Hispanic adults is expressed as:

$$\overline{H}^2 - \overline{H}^1 = \sum_{j=1}^{J} \overline{\beta}_j \left(\overline{X}_j^2 - \overline{X}_j^1 \right) + \sum_{j=1}^{J} \overline{\overline{X}}_j \left(\beta_j^2 - \beta_j^1 \right),$$

where superscript "1" denotes foreign-born Hispanic adults and "2" denotes White adults; β_j^1 and β_j^2 are coefficients from OLS regression models predicting vaccine hesitancy estimated separately for each group; $\overline{\beta}_j = (\beta_j^1 + \beta_j^2)/2$; $\overline{X}_j^1$ and $\overline{X}_j^2$ are group-specific means for each predictor; and $\overline{\overline{X}}_j = (\overline{X}_j^1 + \overline{X}_j^2)/2$. The first term on the right-hand side is the difference in hesitancy explained by compositional differences (i.e., differences in means) and the second term is the unexplained portion (i. e., differences in coefficients).

Together results from OLS regression and regression decomposition provide two important but different pieces of information. OLS regression results show differences in the average degree of vaccine hesitancy between racial/ethnic groups <u>net</u> of model covariates whereas

decomposition results divide vaccine hesitancy differentials between White adults and the other subgroups into parts that are <u>explained</u> by group differences in anti-vaccine beliefs, Covid-19 risks and experiences, age, sex, and education. Note that compositional differences obtained using decomposition techniques can offset one another. For example, a group might have more anti-vaccine beliefs and greater Covid-19 risk than Whites. The former would likely raise the group's hesitancy relative to Whites while the latter would reduce it. The decomposition also produces a residual that cannot be explained by group differences in measured factors. The residual derives from differences in the sizes of coefficients in the group-specific OLS models. For example, one group may be more sensitive to covid-related risks than Whites, meaning that their coefficients for Covid-19 risks are larger (in the negative direction) than among Whites. All things equal, this difference would lead to the group having lower vaccine hesitancy.

4. Results

Table 1, results column 1 shows weighted sample characteristics. Among respondents, 61.8% self-identified as White, 14.5% as Black, 6.1% as foreign-born Hispanic, and 17.5% as U.S.-born Hispanic (does not sum to 100% due to rounding). The average level of vaccine hesitancy was 2.9, or close to 3, which indicates respondents likely to get the vaccine. Out of the 5 response options, 30.3% of respondents reported certain plans to be vaccinated and 26.2% reported that they did not plan to be vaccinated.

The average number of anti-vaccine beliefs reported by respondents is 1.0, with the most widely held belief being that the government cannot be trusted to tell the truth about vaccine risks (41.5% of respondents responded affirmatively). Almost half (48.7%) of respondents reported knowing someone who had or died of Covid-19, 49.5% reported working outside of the home, and 30.2% reported a health condition that places them at risk of Covid-19. Only 27.7% of respondents reported liberal political leanings.

Table 1, columns 2–5 present weighted descriptive statistics for study subsamples. Statistically significant differences are denoted with alphabetical superscripts. For brevity, we only discuss significant racial/ ethnic and nativity differences in vaccine hesitancy, anti-vaccine beliefs, and Covid-19 risks and experiences.

Average vaccine hesitancy is significantly higher among Black adults (3.2) relative to White (2.9) and U.S.-born Hispanic (2.8) adults. Black adults are also significantly less likely to report that they will certainly get vaccinated than White adults (21.6% vs. 33.1%). White and Hispanic adults report similar average levels of vaccine hesitancy regardless of nativity. U.S.-born Hispanic adults (28.6%) are significantly less likely than White adults (33.1%) to report that they will certainly get vaccinated, but this is offset by U.S.-born Hispanic adults (17.2%) being significantly more likely than Whites (11.1%) to report being very likely to get vaccinated.

Black adults report significantly more anti-vaccine beliefs than the other three groups, and both Black and U.S.-born Hispanic adults are significantly more likely to report specific anti-vaccine beliefs than White adults (the one exception is beliefs about vaccines and infertility). Relative to White adults, foreign-born Hispanic adults are also significantly more likely to believe that the government is not telling the truth about vaccine risks (52.7% vs 37.6%). Foreign-born (74.7%) and U.S.-born (61.7%) Hispanic adults are more likely to report having a friend or family member who had or died of Covid-19 compared to 51.2% of Black and 42% of White adults. These group differences are statistically significant. There are no significant differences in employment outside of the home, but a greater percentage of Black adults (34.5%) report health conditions that put them at risk of Covid-19 relative to White (29.8%) and U.S.-born Hispanic adults (26.1%). Foreign-born Hispanic adults also report significantly more health conditions than U.S.-born Hispanic adults.

Table 2 presents results from OLS regression models estimating

Table 1
Sample characteristics.

	All	U.S.-born White	U.S.-born Black	Foreign-born Hispanic	U.S.-born Hispanic
Race/ethnicity and nativity					
U.S.-born White (%)	61.8				
U.S.-born Black (%)	14.5				
Foreign-born Hispanic (%)	6.1				
U.S.-born Hispanic (%)	17.5				
Vaccine hesitancy					
Vaccine Hesitancy (mean, range 1–5)	2.9	2.9 [b]	3.2 [a,d]	3.0	2.8 [b]
(1) Certainly plan to take the vaccine (%)	30.3	33.1 [b,d]	21.6 [a,d]	27.2	28.6 [a,b]
(2) Very likely to take the vaccine (%)	12.5	11.1 [d]	12.8 [d]	12.0	17.2 [a,b]
(3) Likely to take vaccine (%)	17.9	17.3	18.7	19.5	18.9
(4) Less likely to take vaccine (%)	13.1	12.3 [b]	17.2 [a,d]	15.6	11.7 [b]
(5) Do not plan to take vaccine (%)	26.2	26.1	29.8 [d]	25.7	23.6 [b]
Anti-vaccine beliefs					
Number anti-vaccine beliefs (mean, range 0–5)	1.0	0.9 [b,c,d]	1.4 [a,c,d]	1.1 [a,b]	1.1 [a,b]
Government not telling truth about risks (%)	41.5	37.6 [b,c,d]	51.4 [a,d]	52.7 [a]	43.3 [a,b]
Vaccine causes infertility (%)	12.6	11.7 [d]	11.0 [d]	11.3 [d]	17.7 [a,b,c]
People my race/ethnicity must be careful (%)	17.8	14.0 [b,d]	32.6 [a,c,d]	18.2 [b]	18.9 [a,b]
Vaccine gives people Covid-19 (%)	14.9	12.9 [b,d]	21.1 [a,c]	11.8 [b]	17.8 [a]
Vaccine developed too quickly (%)	30.5	28.6 [b,d]	37.3 [a,c]	25.0 [b,d]	33.5 [a,c]
Covid-19 risks and experiences					
Friends/family had Covid-19 or died of Covid-19 (%)	48.7	42.0 [b,c,d]	51.2 [a,c,d]	74.7 [a,b,d]	61.7 [a,b,c]
Employed outside home (%)	49.5	49.8	49.9	54.4	46.7
Health condition puts respondent at risk (%)	30.2	29.8 [b]	34.5 [a,d]	35.9 [d]	26.1 [b,c]
Other demographic characteristics					
Male (%)	46.4	48.1 [b]	42.8 [a]	46.8	43.5
Age (mean, range 18–65)	40.9	43.3 [b,c,d]	38.3 [a,d]	39.7 [a,d]	35.1 [a,b,c]
College+ (%)	23.9	28.6 [b,c,d]	18.1 [a,c]	11.8 [a,b]	16.4 [a]
Liberal political leanings (%)	27.7	23.2 [b,d]	38.1 [a,c]	22.8 [b,d]	36.9 [a,c]
Observations	1936	802	611	92	431

Notes: Estimates are means or percentages as indicated in the Table. The data were collected as part of the COVID-19 and its Implications for American Communities (CIAC) survey in February and March 2021. The sample is restricted to unvaccinated adults ages 18–65 who identify as U.S.-born White, U.S.-born Black, U.S.-born Hispanic, or foreign-born Hispanic (N = 1936). Significant pairwise group differences (p < .10) are indicated with superscripts: (a) different from U.S.-born White adults, (b) different from U.S.-born Black adults, (c) different from foreign-born Hispanic adults, and (d) different from U.S.-born Hispanic adults.

average vaccine hesitancy by race/ethnicity and nativity net of other covariates. Before accounting for any compositional differences between groups or any confounding variables, Model 1 indicates that vaccine hesitancy among Black adults was significantly higher than White adults and U.S.-born Hispanic adults, while vaccine hesitancy among U.S.-born and foreign-born Hispanic adults was not significantly different, nor was either groups' hesitancy relative to White adults. This is consistent with the descriptive findings in Table 1.

After we adjust these results for sex, age and education in Model 2, the difference between Black and White adults is reduced to non-significance and U.S.-born Hispanic adults have significantly <u>lower</u> vaccine hesitancy than White and Black adults. We do not observe significant differences in vaccine hesitancy between foreign-born Hispanic adults and adults in the other three racial/ethnic groups in the study. When we further adjust Model 3 for Covid-19-related risks and experiences, anti-vaccine beliefs and political attitudes, disparities in vaccine hesitancy between White and Black adults are reduced to almost zero and remain non-significant. Conversely, U.S.-born Hispanic adults remain less vaccine hesitant than White and Black adults and we continue to find no significant differences in vaccine hesitancy when foreign-born Hispanic adults are compared to the other groups.

We also want to point out other estimates from Model 3 that show factors that significantly dampen or increase vaccine hesitancy. Each anti-vaccine belief independently increases the risk of vaccine hesitancy except for beliefs about racial/ethnic-specific vaccine concerns. Identifying as someone who had a friend or family member who was infected or died from Covid-19 or as a person with health conditions that raise the risk of Covid-19 are both associated with less vaccine hesitancy as are being male, a college graduate, and liberal. Age is also negatively associated with vaccine hesitancy.

Before turning to regression decomposition results, we want to summarize results from descriptive and OLS regression analysis. First, the average degree of vaccine hesitancy between foreign-born Hispanic adults is not significantly different than what is observed for U.S.-born Hispanic, White and Black peers even before OLS regression models are adjusted for other covariates. Second, the average degree of vaccine hesitancy between U.S.-born Hispanic adults is not significantly different that White adults at baseline, but it is significantly <u>lower</u> after OLS regression models are adjusted for other variables associated with Covid-19 vaccine hesitancy. Finally, with respect to Black adults, their average vaccine hesitancy is higher than U.S.-born Hispanic and White adults, but once OLS regression models are adjusted for other covariates, differences between Black and White adults are largely attenuated.

Now that we have shown average Covid-19 vaccine hesitancy disparities with and without adjustment for other covariates, we turn to regression decomposition results in Table 3. The decomposition analysis divides bivariate vaccine hesitancy differentials between White adults and the other groups into parts attributable to group compositional differences in anti-vaccine beliefs, Covid-19 risks and experiences, political attitudes, age, sex, and education. The first row of results repeats vaccine hesitancy estimates from Table 1 for Black, U.S.-born Hispanic, and foreign-Born Hispanic individuals, but rounded to the second decimal place. Row 2 shows the same estimate from Table 1 for White individuals. Row 3 reports differences between White adults and adults in other racial/ethnic and nativity groups based on the descriptive estimates in Table 1, and Row 4 shows the degree to which compositional differences in anti-vaccine beliefs, Covid-19 risks and experiences, demographic characteristics, and political attitudes explain group differences in vaccine hesitancy.

Black adults' significantly higher vaccine hesitancy than White adults (Row 3) is almost entirely explained by group-level compositional differences; they account for .32 points of the .34-point difference (Row 4). Greater hesitancy among Black adults is largely due to anti-vaccine beliefs. For example, Black adults are significantly more likely than White adults to believe that the government is not telling the truth about vaccine risks, and this difference explains about .09 points, or one-

Table 2
Results from OLS regression models predicting vaccine hesitancy.

	Model 1		Model 2		Model 3	
Race/ethnicity and nativity						
U.S.-born Black	0.34	***ad	0.13	d	0.03	d
Foreign-born Hispanic	0.14		−0.07		0.00	
U.S.-born Hispanic	−0.03	b	−0.31	**ab	−0.30	***ab
Anti-vaccine beliefs						
Government is not telling truth about risks					0.83	***
Vaccine causes infertility					0.29	*
People of my race/ethnicity need to be careful					0.17	
Vaccine gives people Covid-19					0.27	**
Vaccine developed too quickly					0.98	***
Covid-19 risks and experiences						
Friends/family had Covid-19 or died of Covid-19					−0.27	***
Employed outside home					−0.07	
Health condition puts respondent at risk					−0.31	***
Other demographic characteristics						
Male			−0.35	***	−0.24	**
Age			−0.02	***	−0.02	***
College+			−0.70	***	−0.46	***
Liberal political leanings					−0.43	***
Constant			4.21	***	3.65	***
R-squared			0.09		0.34	

Notes: Estimates are OLS regression coefficients. The data were collected as part of the COVID-19 and its Implications for American Communities (CIAC) survey in February and March 2021. The sample is restricted to unvaccinated adults ages 18–65 who identify as U.S.-born White, U.S.-born Black, U.S.-born Hispanic, or foreign-born Hispanic (N = 1936). Significant pairwise group differences (p < .10) are indicated with superscripts: (a) different from U.S.-born White adults, (b) different from U.S.-born Black adults, (c) different from foreign-born Hispanic adults, and (d) different from U.S.-born Hispanic adults. Asterisks indicate significant differences from zero (*p < .10, **p < .05, ***p < .01).

Table 3
Factors contributing to differences in vaccine hesitancy between U.S.-born White adults and other groups.

| | U.S.-born Whites versus: | | | | | |
	U.S.-born Blacks		Foreign-born Hispanics		U.S.-born Hispanics	
Vaccine hesitancy						
Group mean	3.21		3.01		2.84	
U.S.-born White mean	2.87		2.87		2.87	
Difference	**0.34**	***	**0.14**		**−0.03**	
Explained by compositional differences	**0.32**	***	**0.16**		**0.24**	***
Anti-vaccine beliefs (subtotal)	0.24	***	0.11		0.14	**
Government is not telling truth about risks	0.09	***	0.15	*	0.05	
Vaccine causes infertility	0.00		0.00		0.02	
People of my race/ethnicity need to be careful	0.04	*	0.01		0.01	
Vaccine gives people Covid-19	0.02	*	−0.01		0.01	
Vaccine developed too quickly	0.09	***	−0.04		0.05	
Covid-19 risks and experiences (subtotal)	−0.02		−0.09		−0.07	**
Friends/family had Covid-19 or died of Covid-19	−0.01		−0.06		−0.09	***
Employed outside home	0.00		−0.02		0.00	
Health condition puts respondent at risk	−0.01		−0.02		0.02	
Other demographics and political affiliation (subtotal)	0.10	***	0.14	*	0.17	***
Male	0.02		0.00		0.01	
Age	0.11	***	0.08		0.15	***
College+	0.04	***	0.06	*	0.06	***
Liberal political leanings	−0.06	***	0.00		−0.06	***
Unexplained	**0.01**		**−0.02**		**−0.26**	**

Notes: Estimates are components of a multivariate decomposition analysis (see text for details). The data were collected as part of the COVID-19 and its Implications for American Communities (CIAC) survey in February and March 2021. The sample is restricted to unvaccinated adults ages 18–65 who identify as U.S.-born White, U.S.-born Black, U.S.-born Hispanic, or foreign-born Hispanic (N = 1936). Asterisks indicate significant differences from zero (*p < .10, **p < .05, ***p < .01).

quarter of the racial difference in vaccine hesitancy. Altogether, Black-White differences in five anti-vaccine beliefs account for .24 points of the .34 difference in hesitancy. Other factors contributing to greater vaccine hesitancy among Black adults is their younger age structure, which accounts for .11 points of the difference in hesitancy, and being less likely to have a college degree, which accounts for .04 points of the difference. However, these factors are offset somewhat by a greater tendency for Black adults to have liberal political leanings, which is associated with lower vaccine hesitancy. Differences in Covid-19 risks and experiences play no discernible role in Black-White disparities in vaccine hesitancy.

Foreign-born Hispanic adults do not have significantly higher vaccine hesitancy than White adults. This is because foreign-born Hispanic adults have a mixture of offsetting characteristics that both increase and lower vaccine hesitancy relative to White adults. The former group is more likely than the latter to believe that the government is being

untruthful about vaccine risks, which accounts for .15 points in group differences in hesitancy. Foreign-born Hispanic adults are also less likely to have a college degree, which is associated with .06 more points in hesitancy. However, these group differences are small and are offset by factors that lower foreign-born Hispanics' hesitancy, including being less likely to believe that the vaccine was developed too quickly and more likely to have friends or family who had or died of Covid-19. While none of these other factors are statistically significant on their own, together they reduce the overall difference in hesitancy between foreign-born Hispanic and White adults to non-significance.

Like the foreign-born, U.S.-born Hispanic adults did not differ from White adults in vaccine hesitancy. Unlike foreign-born Hispanic individuals, however, this is not because U.S.-born Hispanic peers have a mixture of offsetting characteristics that both raise and lower vaccine hesitancy. Rather, U.S.-born Hispanic adults have a younger age structure, less education and more anti-vaccine beliefs than White adults, and these characteristics should lead U.S.-born Hispanic adults to have significantly greater vaccine hesitancy than Whites by .24 points (Row 4). U.S.-born Hispanic adults were also more likely to have friends or family who had or died of Covid-19 and were more liberal, which slightly reduced their vaccine hesitancy but not by enough to compensate for their other characteristics that increase hesitancy. Even though they have characteristics that are associated with greater hesitancy, U.S.-born Hispanic adults were no different from White adults because of "unexplained" factors (last row). This means that an unmeasured factor or group of factors is responsible for their unexpectedly low vaccine hesitancy. Further inspection of the detailed decomposition results shows that the unexplained component is likely related to greater sensitivity among U.S.-born Hispanic adults to having friends or family members who had or died of Covid-19. In OLS regression models estimated separately by group, this factor was associated with a reduction in vaccine hesitancy of .70 points (p < .001) among the U.S.-born Hispanic sample, but only 0.17 points (n.s.) among the White sample.

5. Discussion

We estimate that, on average, U.S. adults ages 65 and younger were likely to report that they would get Covid-19 vaccinations in February and March 2021, a time early in vaccination roll-out efforts prior to universal adult eligibility on April 19, 2021. Nonetheless, 39.3% of this population reported that they were less likely or did not plan on Covid-19 vaccination, which is similar to national estimates from summer 2020 (Callaghan et al., 2021).

Nearly half (47%) of Black adults reported this level of vaccine hesitancy, making them the study subgroup that is most hesitant. This is consistent with previous research (Callaghan et al., 2021; Latkin et al., 2021a; Liu and Li, 2021; Nguyen et al., 2021; Savoia et al., 2021) and the long legacy of racism that Black Americans have faced in American medicine and medical research (e.g., Feagin and Bennefield, 2014; Washington, 2016). Our results regarding Black-White disparities also underscore Black adults' greater baseline Covid-19 vaccine hesitancy, in line with our research expectations. Yet, our study and its findings go beyond previous research and make the contribution of showing why this disparity is evident on a national scale. OLS regression models indicate that group differences in earning a college degree and anti-vaccine beliefs help to explain this association. Regression decomposition methods go one step further and show the degree to which group differences are due to anti-vaccine beliefs and other factors. Anti-vaccine beliefs account for 70.6% of the Black-White disparity in vaccine hesitancy (0.24 of the 0.34 difference). This is in line with our research expectations. Group differences in education and age also contribute to this disparity, which would be larger if not for the dampening effect of Black adults' more liberal political leanings.

When taken as a whole, results regarding Black-White disparities in Covid-19 vaccination suggest that education—especially in the form of combatting anti-vaccine beliefs—is a critical public health approach for alleviating Black-White inequity in vaccine hesitancy. Results also suggest that the long history of medical distrust and structural racism in the U.S. has lasting implications for Black-White disparities in Covid-19 vaccine hesitancy, meaning that ongoing efforts to change medical education and institutions to alleviate both problems are critical. Moreover, while our findings are specific to a time frame that was relatively early in vaccination roll-out, results have important implications for current Covid-19 vaccine booster efforts and future booster efforts that are almost certain to emerge as we learn more about vaccine durability and new Covid-19 variants.

Like Black adults, we also expected to find that foreign-born Hispanic adults would be more vaccine hesitant than White adults. Undergirding this expectation were localized studies suggesting that foreign-born Hispanic individuals are vaccine hesitant (Garcia et al., 2021; Gehlbach et al., 2021; Gonzalez et al., 2021) and evidence that a political climate that led undocumented immigrants to fear deportation and foreign-born adults to fear being labeled as public charges likely lead foreign-born Hispanic adults to be vaccine hesitant (Clark et al., 2021). Our research expectation was not supported. Average vaccine hesitancy was substantively and statistically similar between foreign-born Hispanic adults and all other racial/ethnic groups in analyses, including White adults. In fact, in fully adjusted OLS regression models, the difference between foreign-born Hispanic and White adults was estimated to be zero.

Decomposition results indicate that foreign-born Hispanic adults would have had somewhat greater vaccine hesitancy than White adults due to their greater skepticism about governmental disclosure of vaccine risks and lower education, but these factors were offset by a combination of other factors, such as being less likely to believe that the vaccine was developed too quickly and more likely to have friends or family who had or died of Covid-19, which we did expect to have import for the vaccine hesitancy of Hispanic individuals. From a public health standpoint, our results for foreign-born Hispanic adults are encouraging. Higher levels of vaccine skepticism relative to White adults is not a national problem, and instead, appears to be a localized issue best suited for community outreach efforts.

We were unsure whether to expect disparities in Covid-19 vaccine hesitancy between U.S.-born White and Hispanic adults, but our results are encouraging from a public health stand-point. On a national level, there are not statistically significant baseline differences in vaccine hesitancy and substantively this difference is nearly zero (0.03). Moreover, results from adjusted OLS regression models suggest that U.S-born Hispanic adults are less vaccine hesitant than White adults once estimates are adjusted for age and education. Decomposition analyses further indicate that U.S.-born Hispanic adults would have greater hesitancy than White adults because of their younger age structure, lower education, and having more anti-vaccine beliefs if it weren't for offsetting factors. These offsetting factors include being more likely to have friends or family members who had or died of Covid-19 and a greater sensitivity to having friends of family who had or died of Covid-19. Not only were U.S.-born Hispanics more likely to know people who suffered from Covid-19, they appeared more likely to translate this experience into greater willingness to be vaccinated, again consistent with our research expectations for Hispanic individuals. As such, while results are good news from a public health standpoint, structural racism and disadvantages that elevate their risk of contracting COVID-19 are still cornerstones of the decisions made by Hispanic adults considering Covid-19 vaccination.

This study has several strengths including the fact that weights allow us to produce nationally representative estimates of racial/ethnic and nativity disparities in Covid-19 vaccine hesitancy relatively early in vaccine roll-out efforts. To our knowledge, the study is also the first nationally representative study to include a large enough subsample of foreign-born Hispanic adults to analyze as a group and to begin to not only document racial/ethnic and nativity disparities in vaccine hesitancy, but to also explain why differences are observed. This is critically

important for discerning the best approaches to reduce disparities in vaccine hesitancy. Results may also have relevance for messaging when new public health interventions are needed to tackle future public health crises.

Yet this study does have some limitations. Although we confirmed that our weighted subsample of foreign-born Hispanic adults represents those in the U.S. Census, it is still possible that undocumented immigrants, who represent about 40% of the Hispanic foreign-born population (Capps et al., 2020) are not well-represented. Our study also excludes Asian American adults because their sample size is too small to meaningfully analyze as a group and compare to the other groups. Finally, our results are not applicable to adults over the age of 65, who are the most vulnerable to Covid-19 hospitalization and death, and results are unlikely to represent adults eligible for early vaccination given that we exclude vaccinated individuals from the study.

Despite limitations, documenting national-level estimates of racial/ethnic and nativity disparities in hesitancy about new Covid-19 vaccines and the underlying reasons for disparities are essential for guiding equitable public health responses to mitigate disparities in Covid-19 hospitalizations and deaths. Study results also likely have broader implications for ongoing disparities that are likely to emerge in Covid-19 booster vaccines and new public health mitigation efforts to combat the Covid-19 pandemic and future public health emergencies.

Author contribution statement

Michelle L. Frisco: Conceptualization, Writing – original draft preparation; **Jennifer Van Hook**: Conceptualization, Writing – review & editing, Formal analysis; **Kevin J.A. Thomas**: Conceptualization, Writing – review & editing, Data curation

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References

Arias, E., Tejada-Vera, B., Ahmad, F., Kochanek, K.D., 2021. Provisional Life Expectancy Estimates for 2020. Vital Statistics Rapid Release; No 15. National Center for Health Statistics, Hyattsville, MD. https://doi.org/10.15620/cdc:107201.
Broniatowski, D.A., Jamison, A.M., Johnson, N.F., Velasquez, N., Leahy, R., Restrepo, N. J., Dredze, M., Quinn, S.C., 2020. Facebook pages, the "disneyland" measles outbreak, and promotion of vaccine refusal as a civil right, 2009–2019. Am. J. Publ. Health 110 (S3), S312–S318. https://doi.org/10.2105/AJPH.2020.305869.
Callaghan, T., Moghtaderi, A., Lueck, J.A., Hotez, P., Strych, U., Dor, A., Fowler, E.F., Motta, M., 2021. Correlates and disparities of intention to vaccinate against COVID-19. Soc. Sci. Med. 272, 113642 https://doi.org/10.1016/j.socscimed.2020.113638.
Capps, R., Gelatt, J., Soto, A.G.R., Van Hook, J., 2020. Unauthorized Immigrants in the United States: Stable Numbers, Changing Origins. Migration Policy Institute, Washington, D.C.
Caserotti, M., Girardi, P., Rubaltelli, E., Tasso, A., Lotto, L., Gavaruzzi, T., 2021. Associations of COVID-19 risk perception with vaccine hesitancy over time for Italian residents. Soc. Sci. Med. 272, 113688 https://doi.org/10.1016/j.socscimed.2021.113688.
Clark, E.H., Fredricks, K., Woc-Colburn, L., Bottazzi, M.E., Weatherhead, J., 2021. Preparing for SARS-CoV-2 vaccines in US immigrant communities: strategies for allocation, distribution, and communication. Am. J. Publ. Health 111, 577–581. https://doi.org/10.2105/AJPH.2020.306047.
Corbie-Smith, G., 2021. Vaccine hesitancy is a scapegoat for structural racism. JAMA Health Forum 2 (3), e210434. https://doi.org/10.1001/jamahealthforum.2021.0434.
Coughlin, S.S., Moore, J.X., George, V., Johnson, J.A., Hobbs, J., 2020. COVID-19 among african americans: from preliminary epidemiological surveillance data to public health action. Am. J. Publ. Health 110 (8), 1157–1159. https://doi.org/10.2105/AJPH.2020.305764.
Diament, S.M., Kaya, A., Magenheim, E.B., 2022. Frames that matter: increasing the willingness to get the covid-19 vaccines. Soc. Sci. Med. 292, 114562 https://doi.org/10.1016/j.socscimed.2021.114562.

Dubé, È., Ward, J.K., Verger, P., MacDonald, N.E., 2021. Vaccine hesitancy, acceptance, and anti-vaccination: trends and future prospects for public health. Annu. Rev. Publ. Health 42, 175–191.
Feagin, J., Bennefield, Z., 2014. Systemic racism and U.S. Health care. Soc. Sci. Med. 103, 7–14. https://doi.org/10.1016/j.socscimed.2013.09.006.
Ferguson, J.M., Justice, A.C., Osborne, T.F., Magid, H.S.A., Purnell, A.L., Rentsch, C.T., 2022. Geographic and temporal variation in racial and ethnic disparities in SARS-CoV-2 positivity between february 2020 and august 2021 in the United States. Sci. Rep. 12 (1), 273. https://doi.org/10.1038/s41598-021-03967-5.
Fisher, K.A., Bloomstone, S.J., Walder, J., Crawford, S., Fouayzi, H., Mazor, K.M., 2020. Attitudes toward a potential SARS-CoV-2 vaccine: a survey of us adults. Ann. Intern. Med. 173 (12), 964–973. https://doi.org/10.7326/M20-3569.
Garcia, J., Vargas, N., de la Torre, C., Magana Alvarez, M., Clark, J.L., 2021. Engaging latino families about COVID-19 vaccines: a qualitative study conducted in Oregon, USA. Health Educ. Behav. 48 (6), 747–757. https://doi.org/10.1177/10901981211045937.
Gehlbach, D., Vázquez, E., Ortiz, G., Li, E., Sánchez, C.B., Rodríguez, S., Pozar, M., Cheney, A.M., 2021. COVID-19 Testing and Vaccine Hesitancy in Latinx Farm-Working Communities in the Eastern Coachella Valley. preprint. https://doi.org/10.21203/rs.3.rs-587686/v1.
Geronimus, A.T., 2021. Weathering the pandemic: dying old at young age from pre-existing racist conditions. Washington and Lee Journal of Civil Rights and Social Justice 27 (2), 409–440.
Goldman, N., Pebley, A.R., Lee, Keunbok, L., Andrasfay, T., Pratt, B., 2021. Racial and ethnic differentials in covid-19 related job exposures by occupational standing in the U.S. PLoS One E 16 (9), e0256085. https://doi.org/10.1371/journal.pone.0256085.
Gonzalez, D., Karpman, M., Bernstein, H., 2021. Covid-19 Vaccine Attitudes Among Adults in Immigrant Families in California. The Urban Institute, Washington, D.C.
Hill, L., Artiga, S., 2022. Covid-19 Cases and Deaths by Race/Ethnicity: Current Data and Changes over Time. The Kaiser Family Foundation, San Francisco, CA.
Jann, B., 2008. The blinder–oaxaca decomposition for linear regression models. STATA J. 8 (4), 453–479. https://doi.org/10.1177/1536867X0800800401.
Kennedy, J., 2020. Vaccine hesitancy: a growing concern. Pediatr. Drugs 22 (2), 105–111. https://doi.org/10.1007/s40272-020-00385-4.
Kricorian, K., Civen, R., Equils, O., 2022. COVID-19 vaccine hesitancy: misinformation and perceptions of vaccine safety. Hum. Vaccines Immunother. 18 (1), 1950504 https://doi.org/10.1080/21645515.2021.1950504.
Krieger, N., Waterman, P.D., Chen, J.T., 2020. COVID-19 and overall mortality inequities in the surge in death rates by zip code characteristics: Massachusetts, january 1 to may 19, 2020. Am. J. Publ. Health 110 (12), 1850–1852. https://doi.org/10.2105/AJPH.2020.305913.
Latkin, C.A., Dayton, L., Yi, G., Colon, B., Kong, X., 2021a. Mask usage, social distancing, racial, and gender correlates of COVID-19 vaccine intentions among adults in the U. S. PLoS One 16 (2). https://doi.org/10.1371/journal.pone.0246970.
Latkin, C.A., Dayton, L., Yi, G., Konstantopoulos, A., Boodram, B., 2021b. Trust in a COVID-19 vaccine in the U.S.: a social-ecological perspective. Soc. Sci. Med. 270, 113684 https://doi.org/10.1016/j.socscimed.2021.113684.
Liu, R., Li, G.M., 2021. Hesitancy in the time of coronavirus: temporal, spatial, and sociodemographic variations in COVID-19 vaccine hesitancy. SSM - Population Health 15, 100896. https://doi.org/10.1016/j.ssmph.2021.100896.
Mackey, K., Ayers, C.K., Kondo, K.K., Saha, S., Advani, S.M., Young, S., Spencer, H., Rusek, M., Anderson, J., Veazie, S., Smith, M., Kanagara, D., 2021. Racial and ethnic disparities in COVID-19–related infections, hospitalizations, and deaths. Ann. Intern. Med. 174 (3), 362–373. https://doi.org/10.7326/m20-6306%m 33253040.
McLemore, M.R., Altman, M.R., Cooper, N., Williams, S., Rand, L., Franck, L., 2018. Health care experiences of pregnant, birthing and postnatal women of color at risk for preterm birth. Soc. Sci. Med. 201, 127–135. https://doi.org/10.1016/j.socscimed.2018.02.013.
Moran, M.B., Chatterjee, J.S., Frank, L.B., Murphy, S.T., Zhao, N., Chen, N., Ball-Rokeach, S., 2017. Individual, cultural and structural predictors of vaccine safety confidence and influenza vaccination among hispanic female subgroups. J. Immigr. Minority Health 19 (4), 790–800. https://doi.org/10.1007/s10903-016-0428-9.
Murray, C.J.L., Piot, P., 2021. The potential future of the COVID-19 pandemic: will SARS-CoV-2 become a recurrent seasonal infection? JAMA 325 (13), 1249–1250. https://doi.org/10.1001/jama.2021.2828.
Ndugga, N., Hill, L., Artiga, S., Haldar, S., 2022. Latest Data on Covid-19 Vaccinations by Race/Ethnicity. Kaiser Family Foundation, San Francisco, CA.
Nguyen, L.H., Joshi, A.D., Drew, D.A., Merino, J., Ma, W., Lo, C.-H., Kwon, S., Wang, K., Graham, M.S., Polidori, L., Menni, C., Sudre, C.H., Anyane-Yeboa, A., Astley, C.M., Warner, E.T., Hu, C.Y., Selvachandran, S., Davies, R., Nash, D., Franks, P.W., Wolf, J., Ourselin, S., Steves, C.J., Spector, T.D., Chan, A.T., Consortium, o. b. o. t.C., 2021. Racial and Ethnic Differences in COVID-19 Vaccine Hesitancy and Uptake. https://doi.org/10.1101/2021.02.25.21252402 medRxiv, 2021.2002.2025.21252402.
Novak, N.L., Lira, N., O'Connor, K.E., Harlow, S.D., Kardia, S.L.R., Stern, A.M., 2018. Disproportionate sterilization of latinos under California's eugenic sterilization program, 1920-1945. Am. J. Publ. Health 108, 611–613. https://doi.org/10.2105/AJPH.2018.304369.
Pew Research Center, 2021. Beyond Red vs. Blue: the Political Typology. Washington, D. C.
Riley, A.R., Chen, Y., Matthay, E.C., Glymour, M.M., Torres, J.M., Fernandez, A., Bibbins-Domingo, K.B., 2021. Excess mortality among latino people in California during the covid-19 pandemic. Social Science & Medicine-Population Health 15, 100860. https://doi.org/10.1016/j.ssmph.2021.100860.

Romer, D., Jamieson, K.H., 2020. Conspiracy theories as barriers to controlling the spread of COVID-19 in the U.S. Soc. Sci. Med. 263, 113356 https://doi.org/10.1016/j.socscimed.2020.113356.

Savoia, E., Piltch-Loeb, R., Goldberg, B., Miller-Idriss, C., Hughes, B., Montrond, A., Kayyem, J., Testa, M.A., 2021. Predictors of COVID-19 vaccine hesitancy: socio-demographics, Co-morbidity, and past experience of racial discrimination. Vaccines 9 (7), 767. https://www.mdpi.com/2076-393X/9/7/767.

Troiano, G., Nardi, A., 2021. Vaccine hesitancy in the era of COVID-19. Publ. Health 194, 245–251. https://doi.org/10.1016/j.puhe.2021.02.025.

Washington, H.A., 2016. Medical Apartheid: the Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present, *tenth ed.* Doubleday, New York.