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RESEARCH ARTICLE

Racial Discrimination, Social Disadvantage, and Racial–Ethnic Disparities in COVID-19 Vaccine Uptake

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Introduction: Racial–ethnic disparities in COVID-19 vaccination are well documented. The extent to which racism, manifested at the individual and ZIP code levels, explains disparities in early vaccination uptake remains unclear.

Methods: Data from a statewide poll of California registered voters (N=10,256), conducted between April 29 and May 5, 2021, linked to area-level resource data, were analyzed. Weighted multivariable logistic regression models examined racial disparities in COVID-19 vaccination. Decomposition analyses quantified how much of the observed racial disparities in vaccination were explained by racial discrimination and social disadvantage (i.e., educational attainment, 2019 household income, and ZIP code social vulnerability).

Results: Latinx (64.6%) and Black (66.7%) adults were less likely to have at least 1 COVID-19 vaccine dose by April or May 2021 than White adults (74.7%). In adjusted analyses, Latinx (AOR=0.69, 95% CI=0.57, 0.84) and Black (AOR=0.51, 95% CI=0.37, 0.70) adults had a lower likelihood of being vaccinated than Whites. Social disadvantage accounted for 77.4% ($p<0.05$) and 35.8% ($p<0.05$) of the explainable variation in Latinx–White and Black–White disparities, respectively. Self-reported racial discrimination was not associated with COVID-19 vaccination in adjusted analyses.

Conclusions: Social disadvantage but not self-reported racial discrimination explained racial–ethnic disparities in COVID-19 vaccination in California. Removing resource-related barriers may help to increase the relatively low COVID-19 vaccination rates among Black and Latinx populations.

INTRODUCTION

Racism has been deemed a root cause of racial–ethnic health disparities in the U.S.[1,2] During the pandemic, racial–ethnic disparities in coronavirus disease 2019 (COVID-19) infections, hospitalizations, and mortality[3] are stark examples of the consequences of racism on health.[4] Vaccination can reduce COVID-19 hospitalization and mortality rates, as highlighted in the 53.2 times

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greater risk of death among unvaccinated than among fully vaccinated individuals.[5] However, early 2021 reports of COVID-19 vaccination uptake have documented much lower vaccination rates among Black and Latinx adults than among White and Asian adults.[6] Studies examining drivers of racial−ethnic disparities in vaccination have focused primarily on individual-level demographic and economic factors[7] or vaccine hesitancy,[8] excluding critical predictors of preventive healthcare access such as racism. Given the saliency of racial disparities in vaccination, studies have called for more attention to the distinct ways racism shapes COVID-19 vaccine disparities.[9] Understanding the multilevel drivers of racial disparities in early COVID-19 vaccination uptake can help to inform the targeting and tailoring of interventions and policies to address disparities in COVID-19 outcomes. Furthermore, examining the disparities in the early stages of vaccine availability is critical because this is the period where the most pervasive racial−ethnic disparities in COVID-19 vaccination uptake are likely to occur. Early disparities in access to COVID-19 vaccines can lead to racial differences in morbidity, mortality, and life expectancy because of COVID-19, perpetuating existing health inequities.

Fundamental Cause Theory (FCT) provides a valuable framework for understanding early racial disparities in COVID-19 vaccination. FCT focuses on the social causes of health inequities, which shape the flexible resources (i.e., power, prestige, and social connections) that allow advantaged groups to circumvent health risks, implement protective strategies for preventable diseases, and access novel health innovations.[10] Recently, the originators of the FCT proposed that racism is a fundamental cause because it operates through multiple pathways to shape SES and race-related flexible resources, which affect health, health behaviors, and healthcare access.[11] For example, Black and Latinx individuals are more likely to have lower educational attainment and household incomes[12]; work in precarious, low-wage jobs[13,14]; and live in disadvantaged communities burdened by poverty, unemployment, and crowded housing.[15] Social disadvantage places Black and Latinx individuals at risk of multiple disease outcomes, limits access to novel prophylactic measures such as the COVID-19 vaccine, and perpetuates racial health inequities.[11,16]

Beyond the unequal distribution of health-enhancing social resources, significant differences in race-related resources exist. For example, racial differences in prestige, including devaluation and adverse treatment, contribute to differences in health through racial discrimination.[11] Although growing evidence finds that SES is a critical pathway between racism and health,[16] the evidence on self-reported racial discrimination remains mixed.[17−19] Some studies suggest that racial discrimination among individuals who have internalized racism or the acceptance of negative racial stereotypes by a member of a stigmatized racial group[20] is associated with negative health-related behaviors, including poor treatment adherence, risky coping strategies (i.e., substance use), and limited healthcare utilization.[20] In contrast, others find that personally mediated racism is not inherently detrimental and may be protective in some social contexts.[21] For instance, perceived racial discrimination is positively associated with cancer screening and early HIV infection screening among Black individuals once residential segregation is controlled.[19,22] In the COVID-19 context, however, it remains unclear the multiple ways that racism underlies COVID-19 vaccine disparities.

This study quantifies early racial−ethnic disparities in COVID-19 vaccination coverage and examines the extent to which social disadvantage, as a form of structural racism, and interpersonal racial discrimination contribute to these disparities. Using FCT as a framework, we hypothesize that (1) Black and Latinx adults will be less likely to have at least 1 dose of the COVID-19 vaccine than White adults and that (2) social disadvantage will account for a greater share of racial disparities in COVID-19 vaccination than personally mediated racial discrimination because of the greater impact of structural racism on health-enhancing resources.

METHODS

Study Sample

Data from the University of California Berkeley Institute for Governmental Studies (IGS) May 2021 poll of California registered voters were analyzed. The IGS poll is a deidentified survey of California's public opinion on policy and public matters. The web-based survey was administered in English and Spanish from April 29 to May 5, 2021 by distributing e-mail invitations to stratified random samples of the state's registered voters. The overall sample was stratified by age, gender, race−ethnicity, and language to obtain a proper balance of survey respondents across major segments of the registered voter population. Poststratification weights were applied to align the sample of registered voters to the population characteristics of the state's registered voters on the basis of age, race−ethnicity, gender, education, California region of residence, and party affiliation.

Data collection began 2 weeks after the COVID-19 vaccine became available to all California adults.[23] A total of 200,000 registered voters were invited; 16,400 participated (8.2% response rate),[24] and 10,289 submitted the survey (62.7% completion rate). This response

rate is consistent with those of other polls of registered voters.[25] ZIP code social vulnerability data (2018) from the Centers for Disease Control and Prevention Social Vulnerability Index (SVI) were linked to the poll data using each respondent's ZIP code. The analytic sample includes 10,256 adult participants with complete responses on key variables across 1,248 ZIP codes in California (mean adults per ZIP code=8.2, range=1−38). All analyses use sampling weights to generalize to the California registered voter population. All data are public and deidentified and do not constitute human subjects research.

Measures

Our outcome is self-reported receipt of at least 1 dose of the COVID-19 vaccine. Respondents were asked, *Have you received the COVID-19 vaccine or not?* Vaccination was coded 1=*Yes, at least one dose of the vaccine* and 0=*No*.

The primary independent variable of interest is race−ethnicity. We conceptualize race−ethnicity as social categories that shape the distribution of discrimination, risks, and resources.[26] Respondents self-reported their race−ethnicity as Asian/Pacific Islander (PI), Black/African American (Black), Latina/o/x/Hispanic (Latinx), other race, Native American, and White. Given the small sample size, we combined Native Americans in the other-race category. We use White as the reference group, given this group's sample size and historical advantage in access to social resources relative to racially minoritized groups.

We considered 2 sets of explanatory variables: social disadvantage and self-reported racial discrimination in the past 3 years. Social disadvantage includes 2 independent individual-level SES variables (i.e., educational attainment and 2019 annual household income) and ZIP code−level social vulnerability. Educational attainment included high school or lower, some college, college, or postgraduate degree. Annual income categories included $59,999 or less, $60,000−$129,999, over $130,000, and missing. The SVI consists of 4 indices of area-level disadvantage (i.e., SES, household composition and disability, minority status and language, and housing type and transportation) to create a composite measure of community vulnerability in the event of a societal shock, including disease outbreaks.[27,28] The overall SVI is calculated by summing individual indices and converting the total score into a percentile rank ranging from 0 to 1, with higher values indicating greater vulnerability. We multiplied the percentile ranks by 10 (a *1-unit change* refers to 0.1 on the original scale) to help with interpretation. Previous research described each index's composition and data source.[27,28] Racial discrimination was asked as a single, dichotomous item: *In the past three years, have you been treated unfairly because of your race?* Racial discrimination was coded 1=*Yes* and 0=*No*.

We also considered several covariates previously associated with COVID-19 vaccination uptake.[7] These included age (continuous), gender (female/male), nativity (foreign born/U.S. born), and political party affiliation (Democrats, Republicans, Independent, something else). We include California region fixed effects to account for geographic variation in the distribution of vaccines and COVID-19 local-government responses.

Statistical Analysis

Student's *t*-tests and chi-square tests were conducted to assess whether participants reported different results with respect to sociodemographic and other study variables by race−ethnicity. Descriptive analyses used sampling weights to yield representative estimates of California registered voters. We used weighted logistic regression models with cluster robust SEs at the ZIP code level to examine racial−ethnic disparities in COVID-19 vaccination uptake. Clustered SEs account for the grouping of racial−ethnic participants within ZIP codes.[29] Model 1 displayed the unadjusted association between race−ethnicity and COVID-19 vaccination to give us a baseline model. Model 2 examined the relationship between race−ethnicity and COVID-19 vaccination, accounting for demographics, including age, sex, region, nativity, and political party affiliation, which is a key predictor of COVID-19 vaccination uptake. In Models 3 and 4, we adjusted for hypothesized drivers of racial−ethnic inequities (i.e., individual-level and ZIP code−level social disadvantage and interpersonal racial discrimination, respectively) to determine whether racial−ethnic inequities in COVID-19 vaccination remain. In Model 3, we subsequently included educational attainment, household income, and ZIP code SVI. Model 4 then included an indicator for racial discrimination while accounting for all covariates used in Model 3.

On the basis of the final regression models, we implemented the Karlson−Holm−Breen (KHB) decomposition method[30] to assess whether social disadvantage as a form of structural racism or personally mediated racial discrimination better explained early racial−ethnic disparities in COVID-19 vaccination. KHB has been previously used to decompose social factors that explain health disparities by legal status.[31] All $p<0.05$ was considered statistically significant, whereas $p<0.10$ was considered marginally significant. We estimated the variance inflation factor to assess potential collinearity among the covariates in our models and assessed model

fit using the Akaike information criterion. Data were analyzed using Stata 17 (College Station, TX).[32]

RESULTS

Table 1 shows the weighted sample characteristics for the entire sample and by race–ethnicity. Although 72.9% of participants received at least 1 COVID-19 vaccine dose, variation by race–ethnicity exists. Almost 3 in 4 (74.7%) White adults had at least 1 dose of the vaccine compared with 64.6% of Latinx and 66.7% of Black adults. Asian/PI adults had the highest rates (86.5%) of COVID-19 vaccination and had comparable education, income, and SVI levels with those of White respondents. By contrast, Latinx and Black adults had lower educational attainment and annual income levels. SVI scores were higher among Latinx (mean=6.0, SD=1.98) and Black (mean=5.5, SD=2.15) adults than among Whites (mean=3.9, SD=1.94). Black adults (62%) were also more likely to have experienced racial discrimination, followed by Asian/PI (40.3%) and Latinx (32.6%) adults. Overall, most respondents identified as female (52.0%), White (57.5%), born in the U.S. (81.2%), and aged about 50 years on average.

Table 2 shows the results of the weighted logistic regression to examine the association between race–ethnicity and the odds of receiving at least 1 dose of the COVID-19 vaccine. The variance inflation factor of each

Table 1. Weighted Characteristics of the Study Population by Race–Ethnicity, IGS Poll 2021 (N=10,256)

Characteristics	White *n*=6,402, %	Latinx *n*=1,906, %	Asian/PI *n*=986, %	Black *n*= 608, %	Other *n*=387, %	Total *n*=10,256, %	*p*-Value
At least 1 dose of the COVID-19 vaccine	74.7	64.6	86.5	66.7	45.5	72.9	<0.001
Political party affiliation							
Democrat	35.9	47.4	45.1	51.7	18.4	40.0	<0.001
Independent	25.0	19.8	23.7	29.5	26.0	24.0	
Republican	24.7	12.1	14.5	6.1	21.4	19.5	
Something else	14.4	20.8	16.8	12.7	34.2	16.5	
Sex							
Female	51.6	53.6	50.8	52.4	51.5	52.0	0.020
Male	48.4	46.4	49.2	47.6	48.5	48.0	
Annual income							
≤$59,999	29.1	53.0	29.7	41.9	38.3	35.3	<0.001
$60,000–$129,999	32.3	23.8	30.8	34.1	27.6	30.2	
≥$130,000	30.5	10.1	29.8	15.0	10.7	24.6	
Missing	8.1	13.2	9.7	8.9	23.4	9.8	
Racial discrimination	19.0	32.6	40.3	62.0	6.4	26.7	<0.001
California region							
Bay area	21.8	9.5	36.3	21.9	18.5	20.8	<0.001
Central coast	7.8	4.6	2.1	1.7	3.3	5.9	
Inland empire	9.5	15.9	5.8	12.9	9.4	10.6	
Los Angeles	20.0	35.4	30.3	45.3	20.5	26.1	
North Coast/sierras	3.3	0.4	0.1	0.3	6.3	2.1	
Orange	8.4	6.7	11.2	1.8	6.1	8.0	
Sacramento valley	10.3	5.1	4.1	4.4	9.7	8.0	
San Diego	10.0	9.5	6.6	7.7	7.4	9.2	
San Joaquin valley	9.0	12.9	3.5	4.0	18.6	9.1	
Education							
High school or less	10.4	29.6	11.5	12.1	15.3	15.0	<0.001
Some college	39.9	49.7	31.0	57.2	61.6	42.4	
College degree	30.5	15.0	38.3	19.1	12.7	27.0	
Postgraduate	19.3	5.7	19.2	11.6	10.5	15.6	
Immigrant	7.8	34.1	47.2	11.8	4.7	18.8	<0.001
Age, years, mean (SD)	52.7 (18.0)	41.6 (15.9)	43.4 (17.1)	48.0 (17.1)	49.2 (17.1)	48.7 (18.1)	<0.001
SVI, mean (SD)	3.9 (1.9)	6.0 (2.0)	4.2 (2.0)	5.5 (2.2)	4.8 (2.2)	4.5 (2.2)	<0.001

Note: N is unweighted; range=0–10.
IGS, Institute for Governmental Studies; PI, Pacific Islander; SVI, Social Vulnerability Index.

Table 2. ORs for COVID-19 Vaccination Uptake (N=10,256)

Variables	Model 1, OR (95% CI)	Model 2, OR (95% CI)	Model 3, OR (95% CI)	Model 4, OR (95% CI)
Race—ethnicity (ref White)				
Latinx	**0.62*** ** (0.52, 0.73)	**0.69*** ** (0.57, 0.84)	0.91 (0.75, 1.12)	0.92 (0.75, 1.13)
Asian/PI	**2.17*** ** (1.69, 2.79)	**2.28*** ** (1.73, 3.02)	**2.34*** ** (1.76, 3.11)	**2.38*** ** (1.79, 3.17)
Black	**0.68** ** (0.51, 0.90)	**0.51*** ** (0.37, 0.70)	**0.63** ** (0.46, 0.86)	**0.66*** (0.48, 0.91)
Other race	**0.28*** ** (0.19, 0.43)	**0.32*** ** (0.21, 0.50)	**0.38*** ** (0.25, 0.58)	**0.38*** ** (0.25, 0.57)
Education (ref high school or lower)				
Some college			0.97 (0.78, 1.20)	0.98 (0.79, 1.21)
College degree			**1.39** ** (1.10, 1.75)	**1.40** ** (1.11, 1.76)
Postgraduate			**1.86*** ** (1.45, 2.38)	**1.87*** ** (1.46, 2.40)
Annual income (<$59,999)				
$60,000—$129,999			**1.31** ** (1.09, 1.56)	**1.31** ** (1.09, 1.56)
≥$130,000			**1.77*** ** (1.43, 2.20)	**1.77*** ** (1.43, 2.20)
Missing			1.19 (0.89, 1.61)	1.18 (0.87, 1.58)
SVI			**0.96*** (0.92, 1.00)[a]	**0.96*** (0.92, 1.00)[a]
Racial discrimination (ref none reported)				0.89 (0.76, 1.06)
Constant	2.95*** (2.69, 3.24)	2.44*** (1.82, 3.26)	1.95*** (1.33, 2.85)	2.01*** (1.37, 2.95)

Note: Boldface text indicates statistical significance (***$p<0.001$, **$p<0.01$, and *$p<0.05$).
The 95% CIs are in brackets; exponentiated coefficients are shown.
[a]Owing to rounding, the upper bound of the CI is 1.00. Model 1 is the unadjusted baseline model. Model 2 examines the relationship between race—ethnicity and COVID-19 vaccination, accounting for age, sex, region, political party affiliation, and nativity. Model 3 includes educational attainment, annual income, and SVI score. Model 4 adds an indicator for experiences of racial discrimination in the last 3 years.
PI, Pacific Islander; SVI, Social Vulnerability Index.

model, including the fully adjusted model, was <1.5, suggesting that multicollinearity was not an issue. Model 1 shows that Black (AOR=0.68, 95% CI=0.51, 0.90), Latinx (AOR=0.62, 95% CI=0.52, 0.73), and those in the other race category (AOR=0.28, 95% CI=0.19, 0.43) were less likely to have at least 1 dose of the vaccine than Whites. In contrast, Asian/PI (AOR=2.17, 95% CI=1.69, 2.79) participants were twice as likely as White respondents to have had at least 1 dose of the vaccine. In Models 2 and 3, these differences remained robust to the adjustment of covariates and social disadvantage (i.e., household income, education, and area-level SVI) for Black and Asian/PI participants. However, social disadvantage explained disparities in vaccination among Latinxs. Racial discrimination (Model 4) did not attenuate the magnitude of the coefficients for any racial—ethnic category. Respondents who reported racial discrimination were less likely to have a dose of the COVID-19 vaccine (AOR=0.89, 95% CI=0.76, 1.06), albeit it is unclear whether a true difference exists.

Table 3 shows decomposition analyses results of social disadvantage as a form of structural racism (Panel A) and racial discrimination as a form of personally mediated racism (Panel B). Social disadvantage, including individual-level household income, educational attainment, and ZIP code SVI, explained a significant share of Black—White and Latinx—White COVID-19 vaccine disparities, as measured by the confounding percentage $\left(confounding\ \% = \left[\frac{indirect\ effect}{total\ effect} \times 100\right]\right)$. Using Latinxs as an example of how the confounding percentage is calculated, we begin with Panel A of Table 3. First, Latinx participants have a reduced log odds of vaccination by 0.39 compared with White participants (total effect).

Table 3. Vaccination Uptake Decomposition Results: Social Disadvantage and Interpersonal Racial Discrimination, IGS Poll, 2021 (N=10,256)

Decomposition of effects	Panel A: decomposition of social disadvantage on race–ethnicity and COVID-19 vaccination uptake			Panel B: decomposition of racial discrimination on race–ethnicity and COVID-19 vaccination uptake		
	β	SE	*p*-Value	β	SE	*p*-Value
Total Effect of race–ethnicity on COVID-19 vaccination uptake						
White (ref)						
Latinx	**−0.39*****	0.10	<0.001	−0.10	0.11	0.35
Asian/PI	**0.87*****	0.15	<0.001	**0.84*****	0.15	<0.001
Black	**−0.65*****	0.16	<0.001	**−0.47*****	0.16	<0.001
Other	**−1.18*****	0.21	<0.001	**−0.96*****	0.21	<0.001
Direct (unmediated) effect of race-ethnicity on COVID-19 vaccination uptake						
White (ref)						
Latinx	−0.09	0.11	0.42	−0.09	0.11	0.42
Asian/PI	**0.86*****	0.15	<0.001	**0.86*****	0.15	<0.001
Black	**−0.42****	0.17	0.01	**−0.42****	0.17	0.01
Other	**−0.98*****	0.22	<0.001	**−0.98*****	0.22	<0.001
Indirect (mediated) effect of race-ethnicity on COVID-19 vaccination uptake through social disadvantage						
White (ref)						
Latinx	**−0.30*****	0.06	<0.001	−0.01	0.01	0.25
Asian/PI	0.01	0.04	0.89	−0.02	0.02	0.21
Black	**−0.23*****	0.05	<0.001	−0.05	0.04	0.19
Other	**−0.21*****	0.05	<0.001	0.01	0.01	0.25
Summary of confounding	**Confounding %**			**Confounding %**		
White (ref)						
Latinx	77.36			13.1		
Asian/PI	0.69			−2.72		
Black	35.81			10.06		
Other	17.41			−1.49		

Note: Boldface indicates statistical significance (***$p<0.001$ and **$p<0.01$).
Panel A calculated the effects account for demographic variables (gender, age, nativity, political party affiliation); California region fixed effects; and social disadvantage, which includes area-level social vulnerability and individual-level SES. The ZIP code level SVI comprises 4 area-level indices (i.e., SES, household composition and disability, minority status and language, and housing type and transportation). Individual-level SES includes 2 independent indicators: educational attainment and 2019 household income. Panel B calculated effects account for demographic variables (gender, age, nativity, political party affiliation); California region fixed effects; and racial discrimination, which includes having experienced unfair treatment in the last 3 years owing to respondents' race. A negative confounding percentage indicates the mediators related to COVID-19 vaccination in a direction opposite to race–ethnicity.
IGS, Institute for Governmental Studies; PI, Pacific Islander; SVI, Social Vulnerability Index.

Controlling for social disadvantage at the individual and ZIP code levels, the effect of race–ethnicity for Latinx participants reduces to 0.09 (direct effect), yielding an indirect effect of 0.30 (total effect−direct effect). As such, social disadvantage at the individual and ZIP code levels explained 77.36% ($p<0.001$) of Latinx–White vaccine disparities. Furthermore, differences in social disadvantage explained 35.81% ($p<0.001$) of Black–White vaccine disparities. For Black participants, the direct effect results reveal that race–ethnicity also has an independent association with COVID-19 vaccination independent of social disadvantage, suggesting that other factors may explain disparities in COVID-19 vaccination for this group. Notably, personally mediated racial discrimination did not explain racial–ethnic disparities in COVID-19 vaccination for any group ($p>0.10$). None of the main explanatory factors contributed to the explainable variation in vaccine coverage among Asian/PI participants.

DISCUSSION

Our research study assessed the relative association of social disadvantage as a form of structural racism and personally mediated racial discrimination with racial−ethnic disparities in COVID-19 vaccination and the extent to which these factors explained disparities. Guided by FCT, we expected that Black and Latinx participants would be less likely than White participants to receive at least 1 dose of the COVID-19 vaccine because of their relatively limited access to flexible resources, hampering early access to the then-novel COVID-19 vaccine (Hypothesis 1). We posited that social disadvantage would explain a greater share of the disparities in vaccination than self-reported racial discrimination because of the greater impact of structural racism on health-enhancing resources (Hypothesis 2).

Consistent with our Hypothesis 1, Black and Latinx participants were less likely to receive at least 1 dose of the COVID-19 vaccine than White participants, and Asian participants were twice as likely as Whites to have been vaccinated. Our decomposition analyses of racial−ethnic disparities in COVID-19 vaccination provide evidence to support Hypothesis 2. Social disadvantage accounted for a statistically significant share of the explainable variation in racial−ethnic disparities in COVID-19 vaccination. Specifically, social disadvantage accounted for 77.4% of the explainable variation in COVID-19 vaccination disparities between Latinx and White participants, and the coefficient for the group was no longer statistically significant after adjusting for these. Furthermore, social disadvantage explained 35.8% of the disparities in COVID-19 vaccination between Black and White participants. Corroborating with other studies, we found that area-level social vulnerability and SES were key independent predictors of vaccination.[7,8]

Next, the Black−White gap remained despite accounting for important explanations of racial−ethnic disparities in COVID-19 vaccination. Black participants had a 34% lower likelihood of COVID-19 vaccine uptake than White participants, even after accounting for educational attainment, household income, social vulnerability, racial discrimination, and covariates. Other mechanisms may be driving disparities among Black participants. Recent qualitative studies, for instance, have found that Black communities report pervasive mistrust of the healthcare system owing to historical legacies of abuse and structural barriers impeding healthcare access as critical barriers to COVID-19 vaccination.[33] Our findings highlight that COVID-19 vaccination disparities, a vital component to controlling the pandemic and preventing deaths, reflect pre-existing inequities in which disadvantaged groups are the least likely to benefit from novel health developments.

The results suggest that the racial−ethnic disparities in COVID-19 vaccine uptake are much more pronounced for Black and Latinx populations but not for Asian ones. The higher vaccine uptake among Asian individuals is noteworthy. Some studies suggest that attributing COVID-19 to Asian groups may result in some Asian individuals being more likely to receive the vaccine to combat COVID-19−related stereotypes.[34] Moreover, another possibility for the higher vaccination uptake among Asian participants may be related to the presence of this group in essential work and the healthcare sector. For instance, Asian people comprise about 8.5% of all healthcare workers.[35] Certain Asian ethnic groups, such as Filipinos, have been disproportionately represented in COVID-19 infection and mortality cases partly owing to their overrepresentation in the nursing workforce,[36] which may result in a greater willingness to vaccinate.[34]

Notably, self-reported racial discrimination in the last 3 years was not associated with a lower likelihood of having at least 1 dose of the vaccine (the magnitude of the coefficient is in the direction we expect but is not statistically significant) and did not explain any variation of the relationship between race−ethnicity and COVID-19 vaccination in the KHB analyses. A plausible explanation for this finding is that in a racially stratified society such as the U.S., personally mediated racism is highly prevalent, especially within more integrated communities where minoritized racial−ethnic groups have a greater risk of exposure to interracial interactions.[19] Given the pervasiveness of racism, minoritized racial−ethnic groups may have established ways to challenge rather than internalize racism.[22] Previous work has found that individuals who experience personally mediated racism may leverage resources,[22] such as social support, resiliency, or agency, to facilitate self-protective health behaviors. Others have established that having a greater sense of race and the role of racism in one's social context (i.e., race consciousness) is associated with health consciousness and the increased likelihood of protective behaviors.[19]

Our results align with multiple ecologic studies that have analyzed the geographic pattern of COVID-19 vaccination as a function of SVI[8,37] and those that focus on SES to explain racial−ethnic disparities in vaccination.[7] However, these studies do not simultaneously assess individual- and area-level factors influencing COVID-19 vaccination, obscuring key predictors of preventive health behaviors. Our analysis incorporates individual- and area-level explanatory variables to understand the divergent pathways through which social disadvantage

and racial discrimination shape early COVID-19 vaccination, providing a more comprehensive assessment of the relationship between racism, socioeconomic context, and vaccination coverage. Furthermore, consistent with studies of social disparities in the diffusion of medical innovations,[38] we find that Latinx and Black individuals are disproportionately less likely to benefit from the COVID-19 vaccine than their White counterparts. Early racial−ethnic disparities in COVID-19 vaccination uptake were primarily explained by social disadvantage at the individual and ZIP code levels, highlighting that socially advantaged people can more readily deploy their resources to access novel health developments. Our study results suggest that by examining mechanisms of racial−ethnic disparities at distinct levels of analysis, evidence of important health processes can be exposed.

The results have critical implications relevant to COVID-19, other preventable health conditions, and responses to future public health crises: first, making a medical innovation free does not warrant equal use across racial−ethnic groups, and additional efforts to remove access barriers should be a priority for public health practitioners. For example, minoritized racial−ethnic groups may have a greater uptake of future medical innovations if they are accessible and available in their community center/park and during after-work hours and provided alongside financial incentives. These strategies can help to overcome the lack of transportation and the inability to take paid time off from work while providing a small monetary incentive. Second, examining multiple explanatory factors associated with disadvantages at the individual and area levels is essential to address disparities in access to preventive treatments. These lessons learned from COVID-19 vaccination can help to align prevention strategies to better target marginalized and underserved communities for future epidemics.

Limitations

These findings should be considered in light of some limitations. First, COVID-19 vaccination status was self-reported and thus subject to social desirability and recall bias. However, given the politicized nature of COVID-19−protective behaviors, our adjustment of political party affiliation, which is highly correlated with vaccine views, may partially mitigate social desirability bias. Regarding recall bias, the prevalence of self-reported COVID-19 vaccination status may be as accurate as that of the influenza vaccine, which was comparable with registry-based vaccination status.[39] Second, studies have documented geographic variation in COVID-19 vaccination uptake,[37] and our results may not generalize to states with populations with higher vaccine hesitancy. Third, our sample only includes registered voters, limiting generalizability to nonregistered voters, such as permanent residents and undocumented individuals, and disenfranchised or previously incarcerated individuals. Registered voters may be more likely to have the assets needed to overcome personally mediated racism than nonregistered voters of the same race−ethnicity. Thus, our results may be conservative estimates of the relationship of interest given the exclusion of the most socioeconomically disadvantaged populations. Fourth, our single-item measure of racial discrimination lacks information on the frequency and complexity of experiences. Future studies should examine the settings in which racial discrimination occurs, the frequency, and perpetrator characteristics to clarify whether specific discrimination experiences are associated with COVID-19 vaccine access. Fifth, we do not adjust for potential confounders such as employment, health conditions, and insurance status. Despite this limitation, a significant advantage of analyzing the IGS poll data is that racial−ethnic disparities in COVID-19 vaccination uptake can be examined while accounting for political party affiliation, which is a key and strong predictor of COVID-19 vaccination in previous studies[40,41] and is not available in other data sources, including the U.S. Census Bureau Household Pulse Survey, National Health Interview Survey, and the California Health Interview Survey. Furthermore, although we use post-stratification weights to align the sample to California's registered voters, we cannot formally compare respondents and nonrespondents. Finally, the cross-sectional data cannot establish temporal ordering or causal relationships.

CONCLUSIONS

Our findings underscore that structural racism in the form of social disadvantage helps to explain disparities in COVID-19 vaccination uptake among Black and Latinx Californians. This early analysis of the vaccine roll out allows us to better understand whether introducing new prophylactic measures against COVID-19 maintained a health advantage for those with the resources to gain access to the health innovation, despite the vaccine being free for all. Although social disadvantage is negatively associated with COVID-19 vaccination and explains a significant share of racial−ethnic disparities in vaccination, 22.6% of Latinx−White and 64.2% of Black−White disparities remain unexplained. More research on the role of social network factors and other forms of structural racism may elucidate strategies to reduce racial−ethnic disparities in COVID-19 vaccination. Healthcare organizations should be better prepared

to distribute other medical innovations for COVID-19 (i.e., Paxlovid, monoclonal antibodies) and other preventable conditions more equitably. Public health agencies can help to remove resource-related barriers to improve COVID-19 vaccination among racially minoritized populations, including navigation support, financial incentives, and community-based vaccine clinics. Furthermore, special efforts should be made to increase access to vaccination for workers in low-wage industries characterized by a lack of paid time off, including work-based clinics and after-hours appointment availabilities.

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CREDIT AUTHOR STATEMENT

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