Socioeconomic Analysis of California's COVID-19 Vaccination Rollout

Executive Summary

Inequities in the impact of COVID-19 across racial, ethnic, and economic lines in California highlight the importance of pursuing a vaccination rollout that does not reinforce or exacerbate these inequities. Examining data from the CDPH (California Department of Public Health) as well as the US Census Bureau, I find that California's COVID-19 vaccination rollout has been initially plagued by parallel inequities. While vaccination data by race/ethnicity is imperfect, there seems to be a large discrepancy in the share of vaccinations given to Latino Californians in comparison to their share of the population, a trend which mirrors the unequal negative impact of COVID-19 that have been faced by this group. This discrepancy is most heavily concentrated in counties located in the Central and Southern regions of California. Using county-level data, I find a highly statistically significant positive relationship between a county's income per capita and its share of population that has received at least one dose of a COVID-19 vaccination (controlling racial, age, and insured population differentials), indicating that richer counties are being vaccinated at higher rates than poorer ones and that this difference is not easily explained by factors such as senior population or differences in racial demographics. I recommend that the CDPH take immediate action to remedy these inequities.

Introduction

The COVID-19 pandemic has affected Californians unequally. Comparing the percentage of COVID-19 cases and deaths by race and ethnicity with California's demographics reveals severe inequities for both metrics[1] (figure 1).

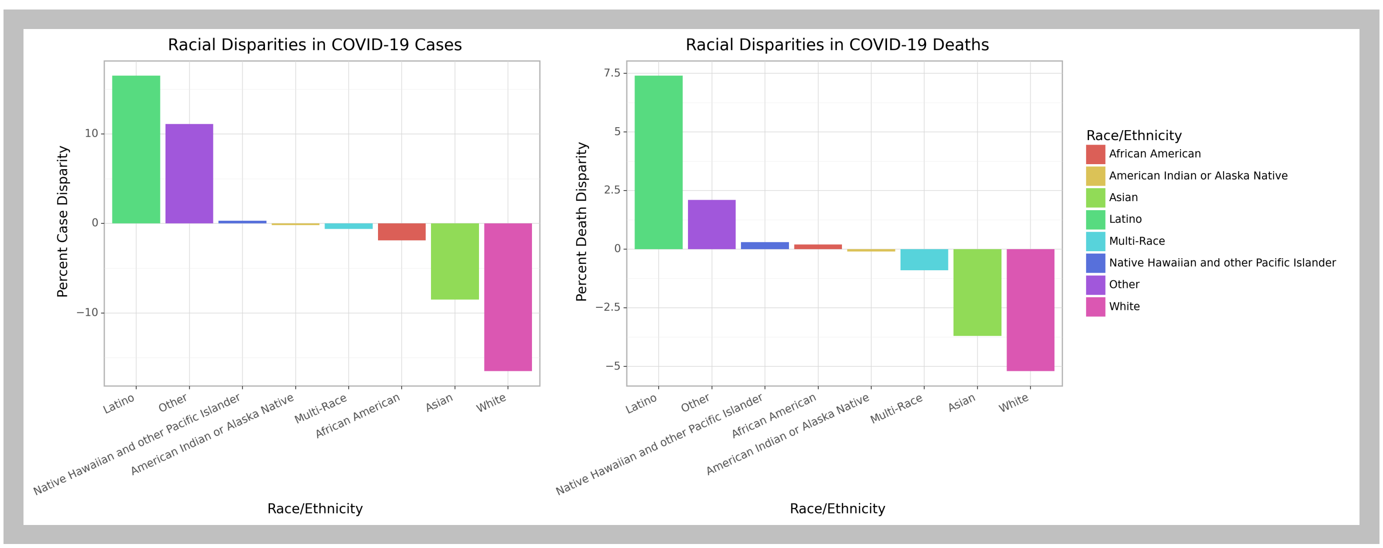

Figure 1: Racial disparities in California's COVID-19 cases and deaths

[1] CA Department of Public Health COVID-19 Race and Ethnicity Data

The most stark example of this is with California's Latino population, which represents 39% of the state's population yet accounts for 55% of cases and 46% of deaths. Furthermore, research has revealed racial inequities in hospitalizations. For example, Azar et. al. show that "compared with non-Hispanic white patients, non-Hispanic African American patients had 2.7 times the odds of hospitalization"[2]. Beyond this, national research has shown the economic impact of COVID-19 has fallen disproportionately on low-income individuals[3]. To avoid compounding these apparent inequities, it is paramount that California's COVID-19 vaccination rollout be as equitable as possible. I will seek to assess the equity of California's vaccination rollout thus far by answering the following questions:

1. Are certain racial/ethic groups being vaccinated at disproportionately high or low rates?
2. For any disparities that exist, how do they differ across the state?
3. To what degree can demographics such as racial makeup and income explain variation in the percentage vaccinated population across counties?

Findings

1. Are certain racial/ethic being vaccinated at disproportionately high or low rates?

In order to assess this, I first aggregated data from CDPH detailing the percentage of vaccinations given to each racial/ethnic group for each county in California[4] (data used for this report is from 3/25/21). I also collected data from the US Census describing the racial makeup of each county in California[5] (using estimates for 2019, generated from 2010 Census data). I began by plotting the proportion of vaccinations administered to each racial/ethnic group for the state overall, in addition to their share of the state's population (figure 2).

At first glance, there appear to be several groups which are receiving a disproportionately low proportion of California's COVID-19 vaccinations. However, there is a critical problem with California's COVID-19 vaccination data: **11.01% of vaccine recipients listed their race/ethnicity as "Other", while 12.07% declined to share this information.** This means that 23.08% of vaccine recipients have a listed race/ethnicity which does not match up with any of the US Census racial/ethnic categories. This poses a massive challenge for my analysis, as I have no way of knowing

[2] Azar et. al., "Disparities in Outcomes Among COVID-19 Patients In A Large Healthcare System in California"

[3] Parker et. al., "Economic Fallout From COVID-19 Continues to Hit Lower-Income Americans the Hardest"

[4] State of California, COVID-19 Vaccines

[5] U.S. Census Bureau, "Quick Facts"

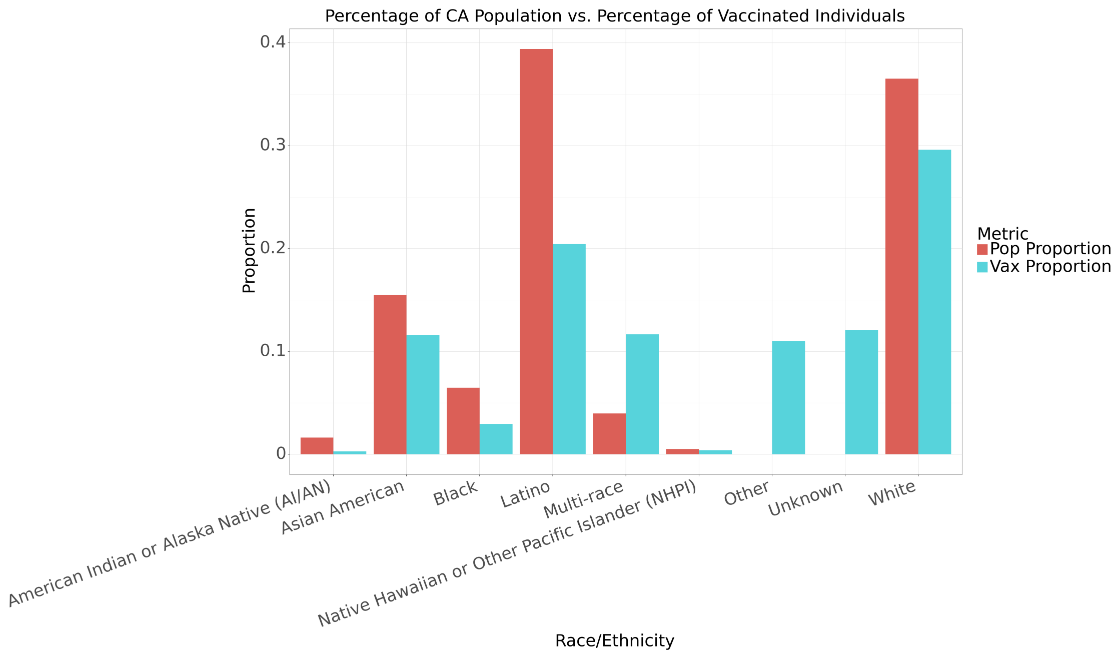

Figure 2: Vaccinations vs. share of population by race/ethnicity

which US Census racial/ethnic group that these individuals would be placed in had they been forced to select one. Visually speaking, consider re-allocating the “Other” and “Unknown” bars in the plot above across the racial/ethnic categories listed. Many of the inequities detailed in figure 2 are small enough that, would these “Other” and “Unknown” individuals have been included in the main categories, there would not appear to be an inequity at all. To demonstrate one version of this, suppose that the breakdown across the 23.08% of individuals who indicated “Other”/ “Unknown” was identical to the breakdown across the 76.92% who listed a race/ethnicity (figure 3).

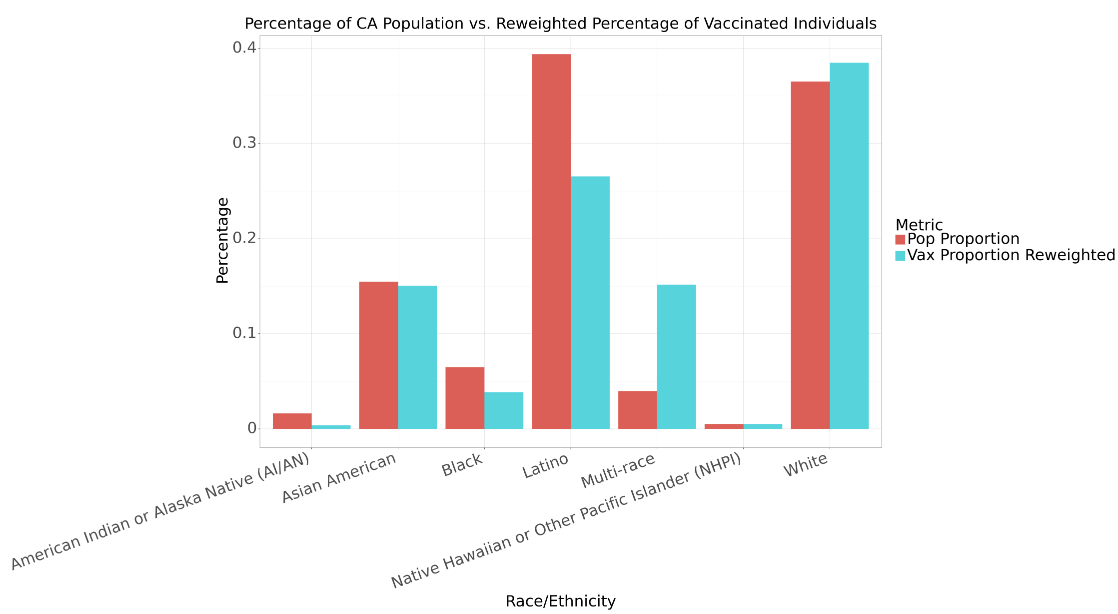

Figure 3: Reweighed vaccinations vs. share of population by race/ethnicity

Comparing this plot to the one in figure 2, we see that the negative gap between the proportion of vaccinations and population has vanished for White Californians and become very small for Asian American Californians, while it has been reduced for the rest of the other racial/ethnic groups. However, the assumption that individuals indicating “Other”/“Unknown” are representative of the vaccinated population who chose to answer this response is likely a poor one, as certain racial/ethnic groups may be more likely than others to refuse to answer questions surrounding their racial background. For example, if African Americans were more likely than other groups to select “Unknown”, then this would likely be enough to negate the negative gap shown in the above plot. **The only group with a large enough gap to be robust to a sizable skew in “Other”/“Unknown” selection is Latino Californians: with an 18.97 percentage point gap between percentage of vaccinations and population, 82.19% of individuals selecting “Other”/ “Unknown” would have to belong to the Latino category in order to account for this discrepancy. Despite these data issues, it is likely that the perceived inequity in vaccinations for Latinos is genuine.**

2. For any disparities that exist, how do they differ across the state?

My above analysis revealed a sizable gap in the proportion of vaccinations administered to Latinos in comparison to their share of California’s overall population. My next goal was to assess the regional variation in this gap. I began by examining the distribution of the “vaccination gap” for Latino Californians across counties (this gap is computed by subtracting the unweighted percentage of vaccinations administered to Latinos from their share of the population in each county) (figure 4). Here, we see that there is a substantial degree of variation in the size of this gap across counties, as indicated by the large spread of the distribution. Given this, I sought to find out in what parts of California this gap is most prominent, and to see if there are any overarching regional trends. In order to accomplish this, I created a map showing the

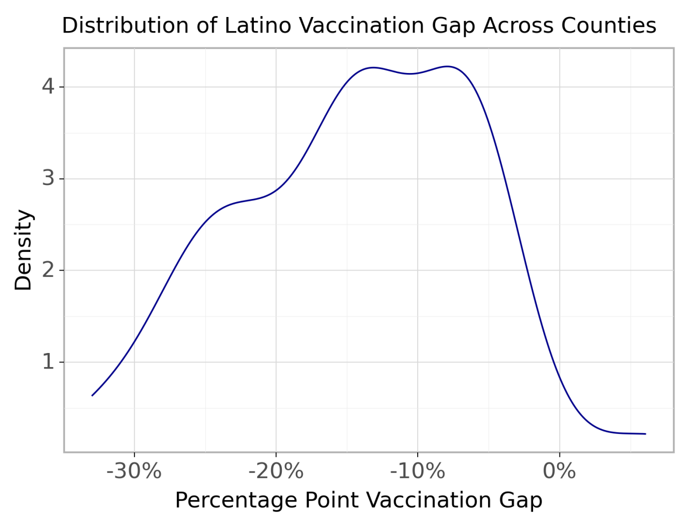

Figure 4: Variation in vaccination gap for Latino Californians

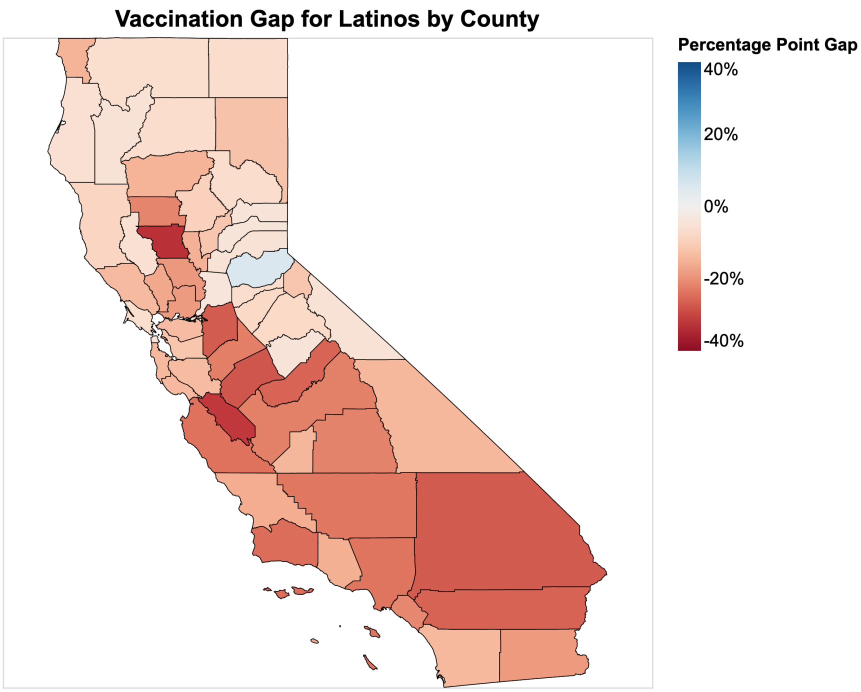

Figure 5: Regional variation in vaccination gap for Latino Californians

above vaccination gap for each county (red counties indicate areas with a negative gap) (figure 5). This geospatial analysis reveals some overarching trends: **the counties with the largest negative vaccination gaps for Latino Californians appear to be concentrated in the central and southern regions of California.** It should again be noted that this map likely overstates these gaps given the data issues previously outlined, however the -20% and larger gaps are likely robust to these issues.

3. To what degree can demographics such as racial makeup and income level explain variation in the percentage vaccinated population across counties?

Comparing the CDPH's county-level vaccination data with population data from the US Census reveals a large degree of variation in the percentage of population that has received at least one dose of a COVID-19 vaccination across counties in California. The best performing county, Alpine, has vaccinated about 26.75% of its population, while the worst performing county, Tehama, has vaccinated only about 8.78%. Continuing with my analysis of

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prop_at_least_one_dose
-----------------------------------------------------
Intercept                                    0.37***
                                             (0.06)
black                                        -0.24
                                             (0.39)
american_indian_or_alaska_native             0.93***
                                             (0.26)
asian_american                               0.35***
                                             (0.12)
native_hawaiian_or_other_pacific_islander 2.45
                                             (4.68)
multi_race                                   -2.63**
                                             (1.30)
latino                                       -0.17**
                                             (0.06)
R-squared                                    0.36
R-squared Adj.                               0.29
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Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01
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Figure 6: Regression analysis of racial/ethnic makeup by county

inequalities by race/ethnicity, I conducted a regression analysis to determine whether a county's racial makeup has a statistically significant impact on the proportion of its population that has received at least one dose of a COVID-19 vaccination (figure 6). The independent variables include the proportion of county population represented by each racial/ethnic group. Examining the output, we find several statistically significant trends: it seems that counties with a higher proportion of multi-race or Latino residents are predicted to have a lower proportion of their population vaccinated, while counties with a higher proportion of American Indian/Alaska Native or Asian American residents are predicted to have a higher proportion of vaccinated population. Compared to my earlier analysis, some of these findings are not surprising (such as the significant negative coefficient on Latino population), while others seem counterintuitive (such as the significant negative coefficient on multi-race individuals). However, there are several confounding variables that could be leading to "omitted variable bias": essentially, this means that there could be factors that are correlated with racial demographics that are truly responsible for the differences in vaccinations by county, rather than the demographic differences themselves. To remedy this, I accounted for several possible confounders by adding Census estimates for the county-level income per capita, percentage of population 65+, and percentage of residents under 65 who lack health insurance (figure 7). In comparison to the model in figure 6, several components stand out. Firstly, this model explains a much greater proportion of the variation in share of population that has been vaccinated across counties: the previous model with only demographic indicators explained about 29%, whereas this model explains about 61%. In other words, this model does a better job at explaining the differences in the share of population that has been vaccinated across different counties. Beyond this, I found that the inclusion of income per capita had a consequential impact on the coefficients of the variables pertaining to race/ethnicity: all except proportion of residents identifying as American Indian/

	prop_at_least_one_dose
Intercept	-0.09
	(0.11)
per_capita_income_thousands	0.01***
	(0.00)
percent_over_65	0.34
	(0.26)
percent_wo_health_insurance_under_65	0.71
	(0.52)
black	0.20
	(0.30)
american_indian_or_alaska_native	1.08***
	(0.20)
asian_american	-0.10
	(0.13)
native_hawaiian_or_other_pacific_islander	2.53
	(3.48)
multi_race	-0.65
	(1.08)
latino	0.05
	(0.09)
R-squared	0.67
R-squared Adj.	0.61

Standard errors in parentheses.
* p<.1, ** p<.05, ***p<.01

Figure 7: Regression analysis including income per capita, percentage senior population, and percent uninsured

Alaska Native are now statistically insignificant, meaning that we now do not have sufficient evidence to assert that they are impacting the proportion of vaccinated population in a meaningful way. The coefficient on income per capita is positive and statistically significant at the 1% level, meaning that there is a positive linear relationship between a county's income per capita and the proportion of its residents who have received at least one vaccination dose. In other words, richer counties seem to be being vaccinated at higher rates than poorer ones, and this is unlikely to be due to chance. There is also a positive and highly significant relationship between the proportion of a county's American Indian/Alaska Native residents and its vaccinated population, indicating that counties with a higher Native American population have vaccinated a higher proportion of their residents on average (this could be due to the highly efficient vaccination rollout implemented by Native American communities early on[6]). The change in the magnitude and significance of most of the race/ethnicity variables suggests that in our previous model, these variables were acting as a stand-in for income per capita, and that it was actually differences in income that were driving the differences in the share of the population that has been vaccinated. **We can conclude from this model that differences in income, rather than racial demographics, seem to be accounting for the bulk of the variation in vaccinated population across counties.** By controlling for each county's senior and uninsured population, we can say that this relationship is not being driven by differences in these factors.

Conclusion: My analysis has revealed serious inequities in California's COVID-19 vaccination rollout thus far, including by race/ethnicity as well as by income.

While issues with CDPH's vaccination data by race/ethnicity render robust analyses of which groups are receiving a disproportionately high or low number of vaccinations difficult, I was able to identify a large gap in the share of vaccinations going to Latino individuals relative to their share of the population that is widespread throughout most of California and large enough to be robust to all but the most extreme assumptions surrounding the "true" identity of individuals selecting "Other"/"Unknown" as their race/ethnicity. Taken in the context of the disproportionately high number of COVID-19 cases and deaths suffered by the Latino community, this discrepancy is especially troubling, and suggests that **efforts should be undertaken to ensure that California's Latino community is given access to the COVID-19 vaccinations and that vaccine acceptance is maximized within this community**. In order to most efficiently

[6] Kaur, "Tribal health providers have figured out the key to Covid-19 vaccine success. Here's their secret"

accomplish this, CDPH should focus their efforts on the counties with the largest vaccination gaps outlined in figure 5 (most of which lie in Central and Southern California), given the high degree of variation in the vaccination gap for Latino individuals across counties in California.

Beyond this, my regression analyses revealed that differences in counties's income per capita, rather than racial demographics, were able to explain much of the variation in the proportion of residents having received at least one vaccination dose (proportion of American Indian/Alaska Native residents was a notable exception). These findings were robust to the inclusion of a county's proportion senior population as well as proportion residents lacking health insurance. This suggests that **efforts should be undertaken to ensure that individuals in California's poorer communities are vaccinated at rates commensurate with the state overall**. Importantly, my analysis does not attempt to determine the underlying reasons for this inequity. Further research should be conducted to determine whether the primary factors driving this are unequal distribution of vaccination resources (e.g., richer communities having the political power to secure a greater number of doses and/or the have resources in place to deliver said doses), or rather/additionally higher rates of vaccination hesitancy in these communities, as this will help to determine the best course of action to remedy this inequality.

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