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# **Computational Analysis of Administered COVID-19 Vaccines in California Based on Racial Demographics**

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## **ABSTRACT**

Our study aims to analyze COVID-19 vaccine administration in California based on various racial demographics using data collected from the California Open Data Portal (“California Grants Portal,” n.d). This analysis will focus on the months following the CDC’s Emergency Use Authorization (EUA) for the COVID-19 vaccines, including Pfizer-BioNTech, Moderna (Spikevax), and Janssen (J&J). Our goal is to examine COVID-19 vaccine equity and accessibility for various racial demographic groups in California, including American Indians or Alaska Natives, Asians, Black people or African Americans, Latinos, Pacific Islanders or other Pacific Islanders, and Whites. In our research study, we found that Whites were administered all COVID-19 vaccines at a much higher rate in the early months of the CDC’s EUA in comparison to other racial demographic groups in California. In addition, another significant finding was how other racial demographic groups, including American Indian or Alaska Natives, Asians, Black or African Americans, and Native Hawaiians or other Pacific Islanders did not reach the same level of administered COVID-19 vaccines between December 2020 to December 2021, whereas Latinos did reach that same level but only after almost a year following the CDC’s EUA, approximately around September 2021 to December 2021. Furthermore, the results of our research suggest larger societal implications regarding vaccine equity and accessibility.

# INTRODUCTION

## Background

COVID-19 is a highly infectious respiratory disease also known as SARS-CoV-2 or severe acute respiratory syndrome-coronavirus-2. It is a single-stranded RNA virus that was given the name “Corona,” the Latin word meaning “Crown,” due to the unique similarity of its spike protein to a crown (Baloch et al., 2020). COVID-19 is mainly transmitted through the respiratory tract, specifically via human-to-human contact or droplet transfer from an infected person such as sneezing or coughing. Infected individuals have common symptoms relative to the common cold like fever, cough, fatigue, and shortness of breath in severe cases; the most common symptoms in severely affected patients include diarrhea, hemoptysis, and headache (Baloch et al., 2020). Thus, the COVID-19 pandemic had countless negative societal impacts, and has affected millions of lives globally with no viable solution, until vaccines were developed, which were eventually shown to help limit the spread and severity of the virus and would also drastically decrease death and hospitalization rates.

## Vaccine Development

The onset of the COVID-19 pandemic brought forth a whirlwind of drastic new changes, including, but not limited to, mask mandates, social distancing recommendations, quarantine restrictions. With the initial widespread panic and the increase in the number of deaths came the urgent need for effective vaccines. According to the Centers for Disease Control and Prevention (CDC), the Pfizer-BioNTech COVID-19 vaccine was approved for EUA in the U.S. on December 11th, 2020 after the final phase 3 clinical trial (“Pfizer Emergency Use Authorization and FDA Approval,” n.d.; “Emergency Use Authorization for Vaccines Explained,” n.d). Other

COVID-19 vaccines including Moderna (Spikevax) and Janssen (J&J), were also approved by the CDC for EUA in the U.S. in the following months (“Moderna COVID-19 Vaccine,” n.d; “Janssen COVID-19 Vaccine,” n.d). The early months following the CDC’s EUA of COVID-19 vaccines represented immense urgency in regard to COVID-19 cases and hospitalizations peaking nationally between December 2020 to January 2021 (“Coronavirus in the U.S.: Latest Map and Case Count.” 2020). This urgency was also attributed to health disparities throughout the COVID-19 Pandemic, in which some populations were more at risk suggesting the immense necessity for equitable vaccine accessibility.

### **The Role of Health Disparities**

Health systems across the United States were challenged with the task of treating the increasing number of COVID-19 cases, in which symptomatic people flocked to hospitals and clinics for testing and treatment, which ultimately illustrated the already prevalent health disparities in the U.S. healthcare system. COVID-19 was predicted to be a pandemic that would affect the population without discrimination; however, California’s death rate among African Americans is higher than the group’s representation in the population with a 10 percent mortality compared to 6 percent population (Azar et al., 2020). The greater odds of mortality and hospitalization indicate societal factors that result in barriers to timely access to care and or create circumstances where patients may deem it better to delay care and seek treatment at a later time. Although support for the Affordable Care Act and expansion of Medicaid have resulted in higher rates of insurance coverage among African Americans, having insurance does not guarantee access to primary care, which can be affected by structural inequities. In addition, biases on the part of providers and patients’ prior negative experiences with the healthcare

system can further perpetuate the growing distrust and decision to seek care only in extreme circumstances. The COVID-19 pandemic has enormously challenged the adequacy of health systems around the world to provide appropriate, high-quality care across various demographics. Race and ethnicity play a pivotal role in the distribution of healthcare and determining how and when care is accessed, as well as what the outcome is. The current data on the impact of COVID-19 on different populations demonstrate the crucial need for solutions to the inequities of our health systems.

## **Research Question**

The goal of our study is to analyze COVID-19 vaccine equity and accessibility for various racial demographics in the state of California. By examining data pertaining to the distribution of vaccines over the course of the pandemic, the issue of healthcare inequality can be better understood and will provide the opportunity to identify and quantify these inequities and to seek solutions.

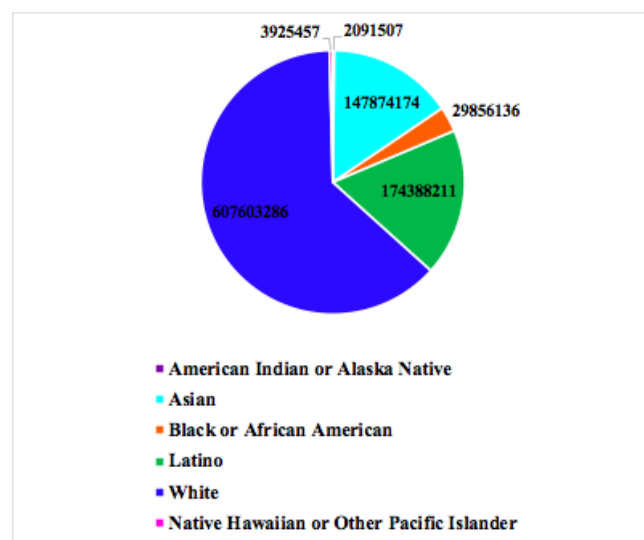
## **METHODS**

To examine how COVID-19 vaccine administration varies for different racial groups in California we will be analyzing data from the California Open Data Portal, which provides statistics regarding COVID-19 vaccine administration by demographics from early clinical trials in December 2020 to the day before in which you are viewing the data set. The data provided includes the administered date, total and cumulative doses of all approved COVID-19 vaccines in the U.S., including Pfizer BioNTech, Moderna (Spikevax) , J&J (Janssen), as well as data

regarding those partially vaccinated, fully vaccinated, who received at least one dose, and booster recipient counts.

The portal also includes data regarding COVID-19 vaccine administration based on age and gender, but for our research purposes, we will be focusing on racial/ethnicity groups because discrimination continues to be a limiting factor in resource accessibility. The racial groups we will be analyzing are Whites, Latinos, Asians, Black people or African Americans, Native Hawaiians or other Pacific Islanders, and American Indians or Alaska Natives. Specifically, we will be extracting data regarding the total and cumulative doses for Pfizer BioNTech, Moderna (Spikevax), J&J (Janssen). We will not be exclusively focusing on booster data, but it may be relevant when examining data in late 2021 (“Coronavirus in the U.S.: Latest Map and Case Count.” 2020). In addition, we will compare the results of our study to California’s overall population racial demographics using the U.S. Census Bureau. To visualize our data, we will be using Microsoft Excel Software.

## RESULTS



Extracted from the California Open Data Portal:  
[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

### **Fig. 1 | Cumulative Total Pfizer BioNTech COVID-19 Vaccine Doses Administered in California Organized by Racial Demographics between December 2020 to April 2021**

Fig. 1 illustrates the cumulative total number of Pfizer BioNTech COVID-19 vaccine doses administered in California between December 2020 to April 2021 based on racial demographics, in which purple represents American Indians or Alaska Natives, cyan represents Asians, orange illustrates Black or African Americans, blue represents Whites, green represents Latinos, and pink represents Native Hawaiians or other Pacific Islanders.

<b>Month</b>	<b>Race:</b> <b>American Indian or Alaska Native</b>	<b>Asian</b>	<b>Black or African Am.</b>	<b>Latino</b>	<b>White</b>	<b>Native Hawaiian or other Pacific Islander</b>
<b>Dec-20</b>	<b>11282</b>	<b>1029905</b>	<b>139056</b>	<b>660839</b>	<b>271873933</b>	<b>35846</b>
<b>Jan-21</b>	<b>101383</b>	<b>7871206</b>	<b>1296849</b>	<b>5818275</b>	<b>13654015</b>	<b>283572</b>
<b>Feb-21</b>	<b>269636</b>	<b>18695719</b>	<b>3687726</b>	<b>16919652</b>	<b>44324831</b>	<b>576562</b>
<b>Mar-21</b>	<b>631321</b>	<b>43324273</b>	<b>9311846</b>	<b>50108166</b>	<b>106786574</b>	<b>1153852</b>
<b>Apr-21</b>	<b>1077885</b>	<b>76953071</b>	<b>15420659</b>	<b>100881279</b>	<b>170963933</b>	<b>1875625</b>
<b>Total</b>	<b>2091507</b>	<b>147874174</b>	<b>29856136</b>	<b>174388211</b>	<b>607603286</b>	<b>3925457</b>
<b>P-Value</b>	<b>0.1289901</b>	<b>0.10001</b>	<b>0.105356</b>	<b>0.13454711</b>	<b>0.0585511</b>	<b>0.0882963</b>

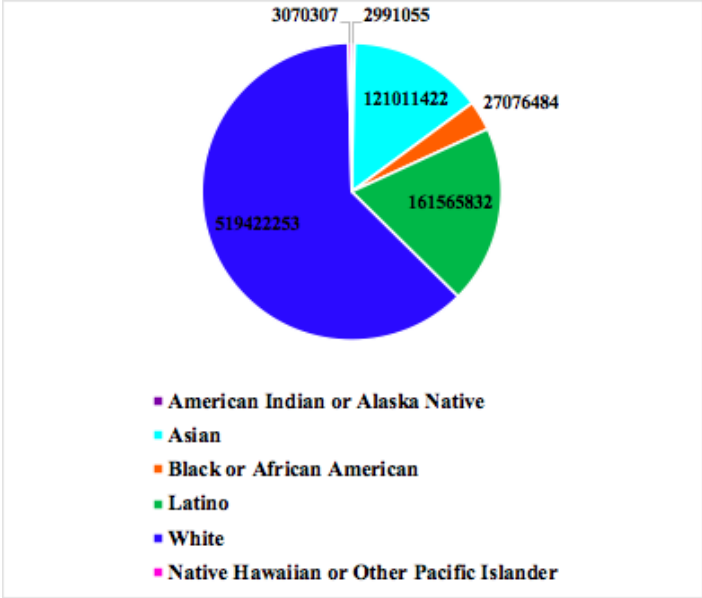
Extracted from the California Open Data Portal:  
[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

### **Fig. 2 | Cumulative Total Pfizer BioNTech COVID-19 Vaccine Doses Administered in California Organized by Racial Demographics between December 2020 to April 2021 to Determine Statistical Significance (Chart Totals)**

Fig. 2 shows the total number of Pfizer BioNTech COVID-19 vaccine doses administered between December 2020 and April 2021. The first column illustrates the Johnson & Johnson doses administered to American Indian or Alaska Native populations, followed by Asians, Black or African Americans, Latinos, White, and Native Hawaiian or other Pacific Islanders. The last



row also illustrates the P-Value for the total administered doses of the Pfizer BioNTech COVID-19 vaccine between December 2020 to April 2021 among the various racial groups to determine statistical significance.



Extracted from the California Open Data Portal:  
[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

**Fig. 3 | Cumulative Total Moderna (Spikevax) COVID-19 Vaccine Doses Administered in California Organized by Racial Demographics between December 2020 to April 2021**

Fig. 3 illustrates the cumulative total number of Moderna (Spikevax) COVID-19 vaccine doses administered in California between December 2020 to April 2021 based on racial demographics, in which purple represents American Indians or Alaska Natives, cyan represents Asians, orange illustrates Black or African Americans, blue represents Whites, green represents Latinos, and pink represents Native Hawaiians or other Pacific Islanders.

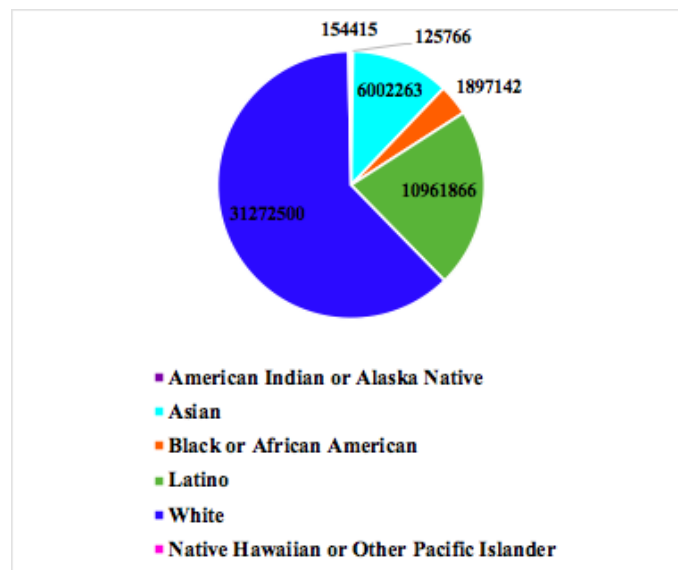
Month	Race:					
	American Indian or Alaska Native	Asian	Black or African Am.	Latino	White	Native Hawaiian or other Pacific Islander

Dec-20	3233	105090	23096	97064	210865288	5134
Jan-21	129470	4975516	912470	4886256	10814583	155732
Feb-21	454456	17412272	3523219	18659776	44465583	445358
Mar-21	988552	38427202	8624787	49270289	102550574	946321
Apr-21	1415344	60091342	13992912	88652447	150726225	1517762
<b>Total</b>	<b>2991055</b>	<b>121011422</b>	<b>27076484</b>	<b>161565832</b>	<b>519422253</b>	<b>3070307</b>
<b>P-Value</b>	<b>0.1056279</b>	<b>0.0961879</b>	<b>0.109238</b>	<b>0.1219847</b>	<b>0.0445952</b>	<b>0.1089327</b>

Extracted from the California Open Data Portal:  
[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

### **Fig. 4 | Cumulative Total Moderna (Spikevax) COVID-19 Vaccine Doses Administered in California Organized by Racial Demographics between December 2020 to April 2021 to Determine Statistical Significance (Chart Totals)**

Fig. 4 shows the total number of Moderna (Spikevax) COVID-19 vaccine doses administered between December 2020 and April 2021. The first column illustrates the Johnson & Johnson doses administered to American Indian or Alaska Native populations, followed by Asians, Black or African Americans, Latinos, White, and Native Hawaiian or other Pacific Islanders. The last row also illustrates the P-Value for the total administered doses of the Moderna (Spikevax) COVID-19 vaccine between December 2020 to April 2021 among the various racial groups in order to determine statistical significance.



Extracted from the California Open Data Portal:

[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

### **Fig. 5 | Cumulative Total J&J (Janssen) COVID-19 Vaccine Doses Administered in California Organized by Racial Demographics between December 2020 to April 2021**

Fig. 5 illustrates the cumulative total number of J&J (Janssen) COVID-19 vaccine doses administered in California between December 2020 to April 2021 based on racial demographics, in which purple represents American Indians or Alaska Natives, cyan represents Asians, orange illustrates Black or African Americans, blue represents Whites, green represents Latinos, and pink represents Native Hawaiians or other Pacific Islanders.

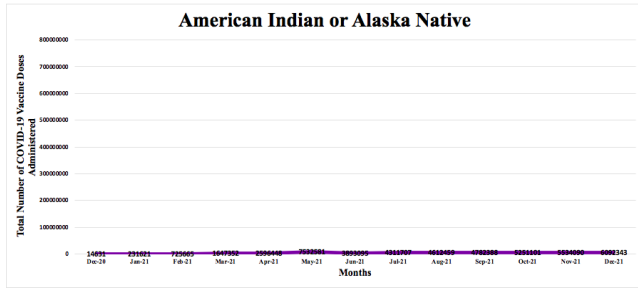
Month:	Race:					
	American Indian or Alaska Native	Asian	Black or African Am.	Latino	White	Native Hawaiian or other Pacific Islander
Dec-20	97	2367	793	2651	17751425	60
Jan-21	258	3387	1436	5346	11097	156
Feb-21	266	4366	2102	8188	15651	218
Mar-21	25086	1049344	354685	2007079	2626432	28478
Apr-21	100059	4942799	1538126	8938602	10867896	125503
<b>Total</b>	<b>125766</b>	<b>6002263</b>	<b>1897142</b>	<b>10961866</b>	<b>31272500</b>	<b>154415</b>
<b>P-Value</b>	<b>0.379385965</b>	<b>0.2936271</b>	<b>0.3230528</b>	<b>0.2823028</b>	<b>0.1503716</b>	<b>0.611647371</b>

Extracted from the California Open Data Portal:

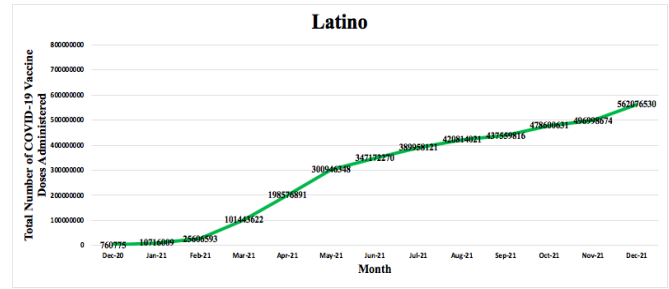
[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

### **Fig. 6 | Cumulative Total J&J (Janssen) COVID-19 Vaccine Doses Administered in California Organized by Racial Demographics between December 2020 to April 2021 to Determine Statistical Significance (Chart Totals)**

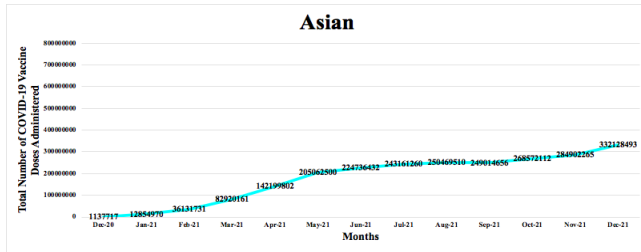
Fig. 6 shows the total number of J&J (Janssen) COVID-19 vaccine doses administered between December 2020 and April 2021. The first column illustrates the Johnson & Johnson doses administered to American Indian or Alaska Native populations, followed by Asians, Black or African Americans, Latinos, White, and Native Hawaiian or other Pacific Islanders. The last row also illustrates the P-Value for the total administered doses of the J&J (Janssen) COVID-19 vaccine between December 2020 to April 2021 among the various racial groups in order to determine statistical significance.



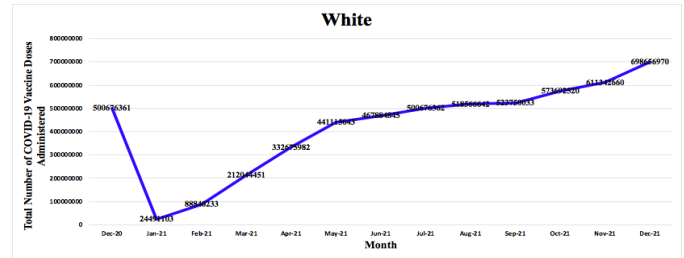
P-Value: 0.0001554



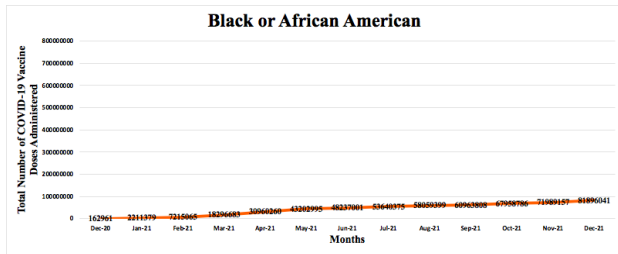
P-Value: 0.0002119



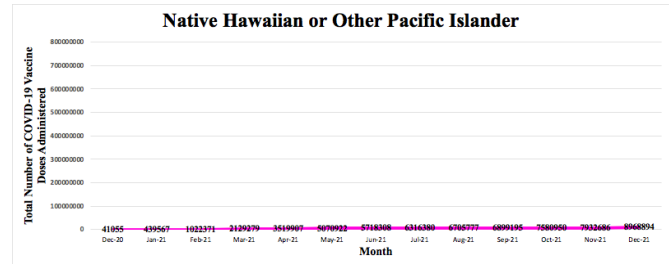
P-Value: 0.00008603



P-Value: 0.00000692



P-Value: 0.00014633



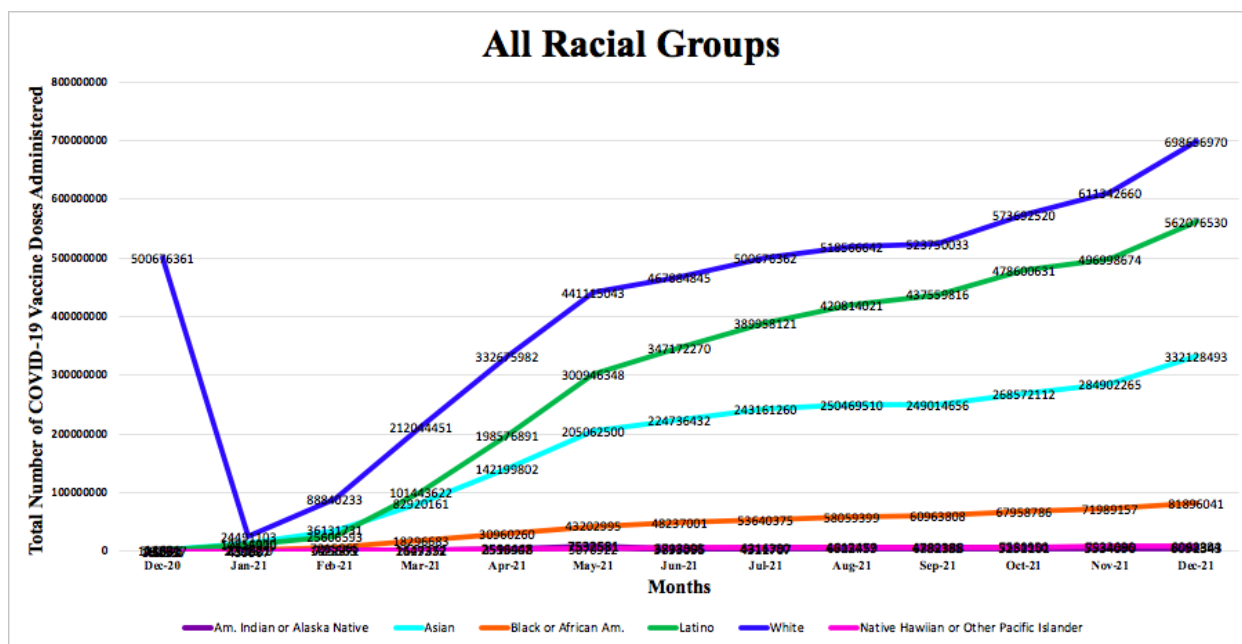
P-Value: 0.0001097

Extracted from the California Open Data Portal:

[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

**Fig. 7| Total Administered COVID-19 Vaccine Doses Administered in California Organized by Racial Demographics between December 2020 to December 2021**

Fig. 5 illustrates the total number of administered COVID-19 vaccine doses in California between December 2020 to December 2021 based on racial demographics, in which the purple line graph represents American Indians or Alaska Natives, followed by Asians represented by the aqua line, Black or African Americans represented by orange, Latinos represented by green, Whites represented as blue, and Native Hawaiians or other Pacific Islanders represented as pink.



Extracted from the California Open Data Portal:  
[https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner\\_span=True](https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data/resource/c341576f-90d2-41ec-bdb1-a4e69f40e6a3?inner_span=True)

**Fig. 8| Total Administered COVID-19 Vaccine Doses Administered in California to All Racial Groups (Combined) between December 2020 to December 2021**

Fig. 8 illustrates the same data from Fig. 7 but combined to illustrate the total number of administered COVID-19 vaccine doses in California between December 2020 to December 2021 for all racial groups, in which the purple line graph represents American Indians or Alaska Natives, followed by Asians represented by the aqua line, Black or African Americans represented by orange, Latinos represented by green, Whites represented as blue, and Native Hawaiians or other Pacific Islanders represented as pink.

**Trends:**

Trends in **Fig. 1** illustrated that Whites received the Pfizer BioNTech vaccines in the early months following CDC’s EUA for COVID-19 vaccines in the U.S. at the highest rate, between December 2020 to April 2021 in California, in comparison to Asians and Latinos, who

were administered the Pfizer BioNTech COVID-19 vaccines at the second highest rate. **Fig. 1** also illustrated that within the early months following the CDC's EUA, between December 2020 to April 2021, American Indians or Alaska Natives, Black or African Americans, and Native Hawaiians or Other Pacific Islanders, were administered the Pfizer BioNTech COVID-19 vaccines at the lowest rate. Despite the key implications suggested by **Fig. 1**, none of these trends were considered statistically significant, as the P-Value between each racial group and the early months following the CDC's EUA for the Pfizer BioNTech COVID-19 vaccine were greater than 0.05 ( $P > 0.05$ ), as illustrated in **Fig. 2**. Moreover, despite some important implications illustrated in **Fig. 1**, mostly revolving around how whites received the Pfizer BioNTech COVID-19 vaccines at the highest rate in the early months following the CDC's EUA in California, these results were still considered statistically insignificant in **Fig. 2** (P-Value  $> 0.05$ ).

Similar trends were suggested regarding whites being administered the Moderna (Spikevax) COVID-19 vaccines at a higher rate in the early months following the CDC's EUA in comparison to other racial demographic groups in California were illustrated in **Fig. 3**. Additionally, this main finding regarding how whites were administered the Moderna (Spikevax) COVID-19 vaccines at the highest rate in the early months of the CDC's EUA illustrates statistical significance in **Fig. 4** because the P-Value for the relationship between administered Moderna (Spikevax) COVID-19 vaccines and the early months following the CDC's EUA was less than 0.05 ( $P < 0.05$ ). Although **Fig. 3** did suggest that all other racial groups were administered the Moderna (Spikevax) COVID-19 vaccines at lower rates in the early months following the CDC's EUA, **Fig. 4** suggests that these results did not present enough statistical

significance, as the P-Values between all racial groups besides whites and the months following the CDC's EUA were above 0.05 (P-Value > 0.05).

In addition, **Fig. 5** demonstrated a similar trend, in which whites were also administered the J & J (Janssen) COVID-19 vaccines at the highest rate following the early months of the CDC's EUA, between December 2020 to April 2021 in California. Although **Fig. 5** does present important implications regarding the inequality of administered J & J (Janssen) COVID-19 vaccines following the CDC's EUA, **Fig. 6** suggests these results were not statistically insignificant due to the P-Value between each racial demographic group and month following the CDC's EUA, between December 2020 to April 2021, were over 0.05 (P-Value > 0.05).

Despite some inconsistencies in the level of statistical significance between the individual approved COVID-19 vaccines in the U.S. in the early months following the CDC's EUA, which was first allocated specifically to Pfizer BioNTech COVID-19 vaccines, followed by Moderna (Spikevax), and J & J (Janssen), there is greater statistical significance when examining the data for all approved COVID-19 vaccines between December 2020 to December 2021, as illustrated in **Fig. 7 and Fig. 8** ("Pfizer Emergency Use Authorization and FDA Approval," n.d.; "Emergency Use Authorization for Vaccines Explained," n.d). **Fig. 7 and Fig. 8** illustrated similar trends previously discussed, such as how whites were administered all approved COVID-19 vaccines in the early months following the CDC's EUA at a higher rate in comparison to all other racial groups in California. Other racial demographic groups, specifically Latinos and Asians did not reach the same rate of administered COVID-19 vaccines until around September 2021 to December 2021. These results also present statistical significance because COVID-19 vaccine administration for each racial group between December 2020 to December 2021 in California, the P-Value was below 0.05 (P-Value < 0.05), as illustrated in **Fig. 7**.

Furthermore, the data presented in **Fig. 7 and Fig. 8** illustrate important social implications regarding the inequality of administered COVID-19 vaccines in California across racial groups that is also statistically significant.

## **DISCUSSION**

The results of our research examination suggest that there is an inequality of administered COVID-19 vaccines across racial groups in California specifically, both following the early months of the CDC's EUA, between December 2020 to April 2021, but also a year after between December 2020 to December 2021. These results could potentially suggest larger societal implications regarding health inequity and inaccessibility. Thus, the two main findings of our research include: how whites were administered all COVID-19 vaccines at a higher rate in comparison to other racial groups in the early months following the CDC's EUA, between December 2020 to April 2021, in California and also how after a year of the CDC's EUA for COVID-19 vaccines, whites were still administered all COVID-19 vaccines at a significantly higher rate than other racial groups, in which Latinos and Asians did not research the same rate of COVID-19 vaccine administration until almost a year after the CDC's EUA.

These results could potentially suggest that the COVID-19 vaccines were more accessible to Whites in California in the early months of the CDC's EUA. This data may also suggest that Asian and Latino populations in California had more access to the COVID-19 vaccines in comparison to other racial groups, including Black people or African Americans, Native Hawaiians or other Pacific Islanders, and American Indians or Alaska Natives. However, it is important to observe California's population racial demographics relative to the data extracted from the California Open Data Portal regarding COVID-19 vaccine administration. To examine



this phenomenon it may be necessary to compare data extracted from the California Open Data Portal to California's population demographics to observe COVID-19 vaccine accessibility across racial groups.

According to the U.S. Census Bureau for 2021, Whites (not Hispanic or Latino) make up 36.5% of California's racial population demographics, in comparison to Latinos who make up 39.4%, followed by Asians making up 15.5%, Black or African American making up 6.5%, American Indian or Alaska Native making up 1.6%, and Native Hawaiian or other Pacific Islanders making up 0.5% ("U.S. Census Bureau - Quick Facts California," 2021). This provides a better understanding of how the COVID-19 vaccines were administered in California following the CDC's EUA for COVID-19 vaccines in the U.S. There is a drastic difference between the rate at which COVID-19 vaccines were administered to Whites in the early months following the CDC's EUA in comparison to Latinos, who also make up a majority of California's population demographics. In examining this data relative to the U.S. Census Bureau, COVID-19 vaccine accessibility is not very equitable because despite how Latinos make up the highest percentage of California's population demographics, they are still far behind in COVID-19 vaccine administrations following the CDC's EUA in comparison to Whites ("U.S. Census Bureau - Quick Facts California," 2021; "California Grants Portal," n.d). Furthermore, comparing data extracted from the California Open Data Portal to the population demographics in California for 2021 via the U.S. Census Bureau suggests a lack of vaccine equitability and accessibility.

Additionally, this data also illustrates significance regarding COVID-19 vaccine accessibility not only at the time of the CDC's EUA but also at a moment in which cases peaked within the U.S. and had a major impact on vulnerable communities ("Coronavirus in the U.S.: Latest Map and Case Count." 2020). Thus, based on data extracted from the California Open

Data Portal, there is a suggested discrepancy between vaccine accessibility on the premise of race (“California Grants Portal,” n.d). Such a discrepancy echoes another health disparity revolving around COVID-19, in which the death rate in California for specific racial groups differs: the death rate for Latinos is 14% higher than whites, and for Black or African Americans it is 18% higher than whites for COVID-19, whereas, the case rate is 18% higher for Native Hawaiians or Pacific Islanders (“California’s Commitment to Health Equity” 2022). This further illustrates the importance of our research study and ultimately the necessity of health equity regarding COVID-19 vaccine accessibility, especially to the most vulnerable populations who have been severely impacted by the pandemic.

Our data illustrated there there is a discrepancy revolving around access to COVID-19 vaccines, especially in the early months following the CDCs EUA when cases, hospitalizations, and deaths peaked, however, it is also important to note the potential influence of vaccine hesitancy when discussing how they were administered over a year-long period between December 2020 to December 2021 (“Coronavirus in the U.S.: Latest Map and Case Count.” 2020). Recent studies have suggested the importance of demographic factors that formulate beliefs regarding vaccine safety (Yasmin et al., 2021). Particularly for African Americans and Latinos, there is a drastic increase in vaccine hesitancy that is potentially the result of medical distrust as a consequence of systemic racism against marginalized communities (Khubchandani and Macias, 2021). Thus, vaccine hesitancy must be addressed in order to officially conclude the COVID-19 Pandemic, in which we must reassure trust in the medical system and attempt to restore systemic racism and its impact on the healthcare field (Yasmin et al., 2021). Thus, the widespread presence of COVID-19 vaccine hesitancy could have potentially affected the data extracted from the California Open Data Portal, but our results still suggest that there is still a

larger issue of vaccine and healthcare accessibility across racial groups due to the strikingly higher rate at which whites were administered all approved COVID-19 vaccines through the CDC's EUA relative to the population demographics of California, which Latinos make up the majority of yet were not administered COVID-19 vaccines to the same degree until almost a following the CDC's EUA, despite also being a vulnerable group to poor health outcomes related to COVID-19, alongside African Americans and Native Hawaiians or Other Pacific Islanders ("California's Commitment to Health Equity" 2022; "California Grants Portal," n.d). Thus, although vaccine hesitancy could have majorly affected our extracted data, there is a suggested larger societal issue and health disparity regarding COVID-19 vaccine accessibility across racial groups in California.

## **CONCLUSION**

Although our research did find there is a present inequality regarding the administration of COVID-19 vaccines across racial groups in California following the CDC's EUA, it is important to further examine the larger social implications of this health disparity. Future directions for this research include further investigating vaccine administration in California based on racial demographics throughout the ongoing pandemic. This is primarily because our research from the California Open Data Portal only focused on the time parameter between December 2020 to December 2021. However, it may be beneficial to examine COVID-19 vaccine administration data throughout the entire duration of the Pandemic.

In addition, since the COVID-19 Pandemic is currently ongoing at the time of this research, we cannot determine the long-term societal implications of how COVID-19 vaccines were administered. Thus, after the COVID-19 Pandemic is officially concluded, it is also

beneficial to reexamine vaccine administration data concerning its long-term implications on access to healthcare and poor health outcomes, especially for marginalized communities.

It may also be valuable to examine COVID-19 vaccine administration on a national level, particularly in the U.S. The COVID-19 pandemic has been managed differently depending on state-level internal political perspectives and management of the pandemic. Thus, only focusing on COVID-19 vaccine administration data in California cannot suggest any nationwide conclusions because access to healthcare, specifically vaccinations, could potentially vary from state to state. Furthermore, it is important to examine COVID-19 vaccine administration on a national level in order to determine how they were distributed based on racial demographics and what that may suggest about the U.S.'s public health response to the pandemic and healthcare equity altogether.

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