# Report: COVID-19 Booster Dose Eligibility in the United States – An Analysis

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***Abstract*— In this paper, we analyze the data collected by the Centers for Disease Control and Prevention (CDC) to determine the vaccination criteria and patterns. Here, we aim to use Tableau academic tool to analyze data extracted for past three months. At last, we provide insights into the future patterns based on the increase and decease of vaccination among different age groups and race/ethnicity.**

***Keywords*— CDC, data, analysis, COVID-19, ethnicity, age, dose.***

## I. INTRODUCTION

Vaccination is essential against deadly viruses—the SARS_CoV-2 and the vaccinations for COVID-19 allow to fight against the virus [1]. Many pharmaceutical companies around the world produced two initial vaccinations. There are three significant companies, Pfizer, Moderna, Johnson, and Johnson, in the United States (US) that provides vaccination to the US population [1] [8]. A booster dose preface to increase the effectiveness of the vaccination. A booster dose follows two initial required doses of vaccination to boost the reduced immunogenicity in a person and was made available to persons with complete primary vaccination [1] [3]. The eligibility criteria set for vaccination allowed the delivery to a more critical and virus-prone population. According to the CDC, adults over the age of 65 we more at risk of catching COVID-19, and from August 13 to November 2021, the US population ≥ the age of 65 (equals 18.7 million) received an additional booster dose [1] [8] [9]. There were a total 42,521,211 number of eligible persons, and the data based on the race/ethnicity recipient was available for 71.3% of the eligible population [8] [9]. CDC has been collecting data to understand the COVID-19 situation in the US better and use this collection to implement masks and vaccine mandates. CDC tried to monitor the status of vaccinated persons with the primary and booster doses through a v-safe surveillance system [2]. The population's immunocompromised vaccination analysis becomes crucial for understanding future predictions of COVID-19 spread [1] [4] [8]. CDC gathered information on the persons' race/ethnicity and age group. However, not all data collected was complete. According to the CDC database, only 71.3% of the race/ethnicity data was recorded [9].

*Data visualization* is an orthodox way researchers use to understand and evaluate big data. Many analytical platforms can be used for analyzing data and generating reports where any data can be called big data, depending on the organizational structure. These platforms provide an orthodox way of visualization to help emphasizes over-analytical techniques and reasonings. This allows researchers to understand trends and patterns in data. It also solves problems relying on or hidden within big data [4]. Tableau is one of those platforms that let us create a comparative view of data visualization. The views are created based on the operational, strategical, and analytics basis .

## II. BACKGROUND

Since the emergence of COVID 19, much research has been carried out to create a vaccine that can help combat the deadly virus. Many vaccines have been developed since 2021 and showed outstanding protection against COVID-19 [1] [3]. However, many people were initially hesitant to take these vaccine doses, and a study assesses this vaccine, and booster hesitancy across the united nations is an associated factor [2]. This study found the need to develop strategies to emphasize vaccine drive, so they are accessible to people [2]. Another study conducted by Koh et al. (2022), also identified factors affecting booster hesitancy in Singapore by examining actual vaccines across time [3] [4].

Another survey conducted in Massachusetts concluded the wide variation in booster and vaccination rates within different zip codes [4]. The study found considerable variation in booster rates for all ages it marked booster inequities by zip code [3]. The research carried out on Massachusetts's Department of Public Health dataset showed significant vaccine and booster coverage disparities [4]. However, a spatiotemporal analysis showed a positive COVID-19 drive around the world. The study showed that globally, with many vaccines being rolled out, the immunization rate is reasonable [3]. People respond positively and get vaccinated, lowering COVID-19's uprise curve [5]. Followed by this is another study conducted in China by Lin et al. (2020) showed the same results that the people had a high intention to receive booster doses once fully vaccinated [6].

However, an analysis of the COVID-19 vaccine's side effects on 19 586 adults reported anaphylaxis or Allergic reaction in 0.3% of participants [10]. Another analysis conducted on the United States vaccine campaign for the first month found local allergic reactions and rare reports of anaphylaxis were found [11]. The same was the study results on US-based dental professionals and students to find that 80% of the participants felt safe working after getting vaccinated. More than 75% were moderate to confident that vaccination can protect them through vaccinations. Common side effects from the doses are arm pain, fatigue/tiredness, body ache, headache, and chills [12].

One more study on COVID-19 vaccination with mRNA vaccines in the USA with 298 million vaccine doses administered found that most side effects were mild and temporary [13]. In this research, we intend to analyze data that is provided by CDC and do not want to change the data. Research is totally for understanding Eligibility criteria and finding any inconsistency.

## III. UNDERSTANDING DATA

Originally, data was extracted in CSV format from CDC's data catalog on 'COVID-19 Booster Dose Eligibility in the United States' collected from the CDC COVID tracking site: Vaccination in the United States (US) and Equity [1] [9]. The data is updated weekly based on the booster dose recipient's eligibility, criteria, and population count [9]. We are working with the data collected in this paper from January 19, 2022 to April 13, 2022. The data contains booster-eligible population in the USA based on age and race/ethnicity, but it does not include primary dose coverage records [9]. There are four eligible age groups 12+, 18+, 50+, and 65+. Here the age groups are classed into two parts; where the first one is for eligible persons who have received booster doses, and the second is for eligible persons who have not been boosted [1] [9] [5]. To better understand eligible booster administration among the race/ethnicity groups, it is categorized based on Total Population, Multiracial, NHOPI (Native Hawaiians and other Pacific Islanders), Black, Asian, Hispanic, American Indians & Alaska Natives (AIAN), White, Other, Unknown, and Known [9].

The data set collected by CDC helped us understand the patterns in vaccinated, unvaccinated populations based on their age and location. Experimenting with the data unwinds the prediction of booster doses among the US population. Even knowing the race/ethnicity of a person can be beneficial regarding a proper and timely approach to vaccination encouragement.

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Date | Category | Location | Booster_Eligible | NotBoosted | Boosted_Pct | NotBoosted_Pct | US_Pct | Eligible_12Plus | NotBoosted_12Plus | Boosted_12Plus_Pct | NotBoosted_12Plus_Pct |
| 2 | 4/13/2022 0:00 | Total_Popu | US | 182,668,608 | 90,681,766 | 50.4 | 49.6 | 100 | 182,668,608 | 90,681,766 | 50.4 | 49.6 |
| 3 | 4/13/2022 0:00 | Race_eth_ | US | 1,394,686 | 641,417 | 54 | 46 | 0.8 | 1,394,686 | 641,417 | 54 | 46 |
| 4 | 4/13/2022 0:00 | Race_eth_ | US | 467,843 | 244,688 | 47.7 | 52.3 | 0.3 | 467,843 | 244,688 | 47.7 | 52.3 |
| 5 | 4/13/2022 0:00 | Race_eth_ | US | 13,889,538 | 7,833,600 | 43.6 | 56.4 | 7.6 | 13,889,538 | 7,833,600 | 43.6 | 56.4 |
| 6 | 4/13/2022 0:00 | Race_eth_ | US | 43,695,202 | 22,809,181 | 47.8 | 52.2 | 23.9 | 43,695,202 | 22,809,181 | 47.8 | 52.2 |
| 7 | 4/13/2022 0:00 | Race_eth_ | US | 138,973,406 | 67,872,585 | 51.2 | 48.8 | 76.1 | 138,973,406 | 67,872,585 | 51.2 | 48.8 |
| 8 | 4/13/2022 0:00 | Race_eth_ | US | 5,290,151 | 2,639,599 | 50.1 | 49.9 | 2.9 | 5,290,151 | 2,639,599 | 50.1 | 49.9 |
| 9 | 4/13/2022 0:00 | Race_eth_ | US | 9,452,282 | 3,750,697 | 60.3 | 39.7 | 5.2 | 9,452,282 | 3,750,697 | 60.3 | 39.7 |
| 10 | 4/13/2022 0:00 | Race_eth_ | US | 24,043,537 | 14,259,617 | 40.7 | 59.3 | 13.2 | 24,043,537 | 14,259,617 | 40.7 | 59.3 |
| 11 | 4/13/2022 0:00 | Race_eth_ | US | 1,245,545 | 674,480 | 45.8 | 54.2 | 0.7 | 1,245,545 | 674,480 | 45.8 | 54.2 |
| 12 | 4/13/2022 0:00 | Race_eth_ | US | 83,189,824 | 37,828,487 | 54.5 | 45.5 | 45.5 | 83,189,824 | 37,828,487 | 54.5 | 45.5 |
| 13 | 4/13/2022 0:00 | Race_eth_ | US | 6,684,837 | 3,281,016 | 50.9 | 49.1 | 3.7 | 6,684,837 | 3,281,016 | 50.9 | 49.1 |
| 14 | 4/6/2022 0:00 | Race_eth_ | US | 82,802,383 | 37,717,042 | 54.4 | 45.6 | 45.6 | 82,802,383 | 37,717,042 | 54.4 | 45.6 |
| 15 | 4/6/2022 0:00 | Race_eth_ | US | 23,842,184 | 14,162,178 | 40.6 | 59.4 | 13.1 | 23,842,184 | 14,162,178 | 40.6 | 59.4 |
| 16 | 4/6/2022 0:00 | Race_eth_ | US | 5,255,407 | 2,627,811 | 50 | 50 | 2.9 | 5,255,407 | 2,627,811 | 50 | 50 |
| 17 | 4/6/2022 0:00 | Total_Popu | US | 181,657,522 | 90,322,084 | 50.3 | 49.7 | 100 | 181,657,522 | 90,322,084 | 50.3 | 49.7 |
| 18 | 4/6/2022 0:00 | Race_eth_ | US | 138,157,375 | 67,570,701 | 51.1 | 48.9 | 76.1 | 138,157,375 | 67,570,701 | 51.1 | 48.9 |
| 19 | 4/6/2022 0:00 | Race_eth_ | US | 6,638,864 | 3,263,850 | 50.8 | 49.2 | 3.7 | 6,638,864 | 3,263,850 | 50.8 | 49.2 |
| 20 | 4/6/2022 0:00 | Race_eth_ | US | 43,500,147 | 22,751,383 | 47.7 | 52.3 | 23.9 | 43,500,147 | 22,751,383 | 47.7 | 52.3 |
| 21 | 4/6/2022 0:00 | Race_eth_ | US | 463,746 | 243,477 | 47.5 | 52.5 | 0.3 | 463,746 | 243,477 | 47.5 | 52.5 |

Figure 1: Source Data from CDC

| | N | O | P | Q | R | S | T |
|---|---|---|---|---|---|---|---|
| 1 | Eligible_18Plus | NotBoosted_18Plus | Boosted_18Plus_Pct | NotBoosted_18Plus_Pct | Booster_Eligible_US_18Plus_Pct | Booster_Eligible_50Plus | Booster_Eligible_NotBoosted_50Plus |
| 2 | 170,963,458 | 82,795,462 | 51.6 | 48.4 | 100 | 90,057,745 | 34,867,209 |
| 3 | 1,174,825 | 499,673 | 57.5 | 42.5 | 0.7 | 527,831 | 161,045 |
| 4 | 423,558 | 215,520 | 49.1 | 50.9 | 0.2 | 168,015 | 64,640 |
| 5 | 12,829,560 | 7,007,297 | 45.4 | 54.6 | 7.5 | 6,701,868 | 2,836,004 |
| 6 | 42,022,825 | 21,627,999 | 48.5 | 51.5 | 24.6 | 22,120,908 | 9,334,080 |
| 7 | 128,940,633 | 61,167,463 | 52.6 | 47.4 | 75.4 | 67,936,837 | 25,533,129 |
| 8 | 4,886,114 | 2,371,971 | 51.5 | 48.5 | 2.9 | 2,440,258 | 947,903 |
| 9 | 8,630,600 | 3,324,022 | 61.5 | 38.5 | 5 | 3,363,567 | 1,044,414 |
| 10 | 21,413,512 | 12,349,113 | 42.3 | 57.7 | 12.5 | 7,943,796 | 3,516,695 |
| 11 | 1,114,741 | 582,310 | 47.8 | 52.2 | 0.7 | 522,456 | 220,380 |
| 12 | 78,467,723 | 34,817,557 | 55.6 | 44.4 | 45.9 | 46,269,046 | 16,742,048 |
| 13 | 6,060,939 | 2,871,644 | 52.6 | 47.4 | 3.5 | 2,968,089 | 1,108,948 |
| 14 | 78,111,302 | 34,721,505 | 55.5 | 44.5 | 45.9 | 46,098,074 | 16,759,900 |
| 15 | 21,241,497 | 12,267,323 | 42.2 | 57.8 | 12.5 | 7,894,706 | 3,506,110 |
| 16 | 4,855,005 | 2,361,773 | 51.4 | 48.6 | 2.9 | 2,428,059 | 947,925 |
| 17 | 170,049,570 | 82,484,600 | 51.5 | 48.5 | 100 | 89,696,522 | 34,884,385 |
| 18 | 128,208,900 | 60,907,559 | 52.5 | 47.5 | 75.4 | 67,643,127 | 25,533,110 |
| 19 | 6,020,474 | 2,857,024 | 52.5 | 47.5 | 3.5 | 2,952,335 | 1,108,223 |
| 20 | 41,840,670 | 21,577,041 | 48.4 | 51.6 | 24.6 | 22,053,395 | 9,351,275 |
| 21 | 420,229 | 214,692 | 48.9 | 51.1 | 0.2 | 167,131 | 64,731 |

Figure 2: Source data from CDC (cont.)

## IV. DATA LIMITATIONS

1. Primary vaccination recipient data is excluded in the data set accessed through the CDC catalog. They are assuming that the person has already received the primary dose.
2. According to CDC, the eligibility counts and the percent from the state of Texas are omitted as the Primary doses data is inconclusive [9].
3. There is a missing/lack of data from Multiracial and Other categories of race/ethnicity in the data set from January 19 to April 13, 2022. Same goes for Not Boosted population.

Category based weekly Eligible Boosted population

| Category | Week of Date: January 16, 2022 | January 23, 2022 | January 30, 2022 | February 6, 2022 | February 13, 2022 | February 20, 2022 | February 27, 2022 | March 6, 2022 | March 13, 2022 | March 20, 2022 | March 27, 2022 | April 3, 2022 | April 10, 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASIAN | 52.30 | 54.60 | 56.80 | 57.70 | 58.40 | 58.90 | 59.30 | 59.60 | 59.80 | 60.00 | 60.10 | 60.20 | 60.30 |
| WHITE | 52.10 | 53.30 | 54.10 | 54.40 | 54.50 | 54.50 | 54.40 | 54.40 | 54.40 | 54.40 | 54.30 | 54.40 | 54.50 |
| Known | 47.70 | 49.10 | 50.20 | 50.60 | 50.90 | 50.90 | 50.90 | 51.00 | 51.00 | 51.00 | 51.00 | 51.10 | 51.20 |
| MULTIRACIAL_O.. | 47.00 | 48.70 | 50.00 | 50.50 | 50.70 | 50.80 | 50.70 | 50.80 | 50.70 | 50.70 | 50.70 | 50.80 | 50.90 |
| UNKNOWN | 44.00 | 45.20 | 46.80 | 47.20 | 47.40 | 47.40 | 47.40 | 47.50 | 47.50 | 47.60 | 47.60 | 47.70 | 47.80 |
| NHOPI | 40.20 | 42.00 | 43.90 | 44.80 | 45.30 | 45.40 | 45.60 | 46.10 | 46.70 | 46.90 | 47.30 | 47.50 | 47.70 |
| AIAN | 41.40 | 42.70 | 43.90 | 44.60 | 44.90 | 45.10 | 45.10 | 45.20 | 45.40 | 45.50 | 45.60 | 45.70 | 45.80 |
| BLACK | 41.10 | 42.30 | 43.00 | 43.40 | 43.70 | 43.80 | 43.70 | 43.70 | 43.60 | 43.60 | 43.50 | 43.60 | 43.60 |
| Hispanic | 33.60 | 35.50 | 37.50 | 38.50 | 39.10 | 39.50 | 39.70 | 40.00 | 40.20 | 40.30 | 40.40 | 40.60 | 40.70 |
| MULTIRACIAL | | | | | | | | | | | 54.00 | 54.00 | 54.00 |
| OTHER | | | | | | | | | | | 49.90 | 50.00 | 50.10 |
| TOTAL POPULATI.. | 46.80 | 48.20 | 49.40 | 49.80 | 50.00 | 50.10 | 50.10 | 50.10 | 50.10 | 50.20 | 50.20 | 50.30 | 50.40 |

Figure 3: Category Based Weekly Percentages

## V. DATA ANALYSIS AND VISUALTIONATION

The Total population eligible for booster dose on January 19, 2022 was 161,801,164 and as of April 13, 2022 it is 182,668,608 [9]. The figure below shows the average

analysis of all age groups from 12+ to 65+, eligible for a booster dose [9]. During the analysis, it can be noticed that the data for age 12+ is missing for the 3rd and 4th week of January. The missing data is due to CDC's guidelines where vaccination mandates for this age group. With the increase in the total population every day, the average booster eligibility is higher for all age groups.

### *A. Booster Eligibility Boosted and Not Boosted*

In figure 4, the visualization shows the average percentage of the total population eligible for boosters following the average percentage of boosted and not boosted. In the third week of January 2022, the average eligible boosted percentage was 44.42% and the not boosted was 55.38% since January to April, there has been a decline in the average not-boosted population and an increase in Boosted population [9]. As the population starts getting booster doses, the decline is inevitable, causing to increase in the number of people with booster doses.

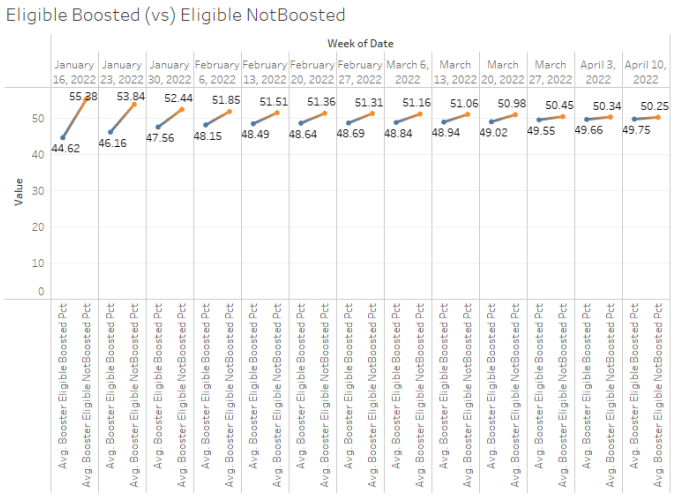


Figure 4: Average Eligible Boosted (Vs) Not Boosted

The decline in data can be visualized using a line for the not boosted population populations (see figure 5). This clearly shows that people are getting their booster doses over time [3]. There is a not to consider that these people have already received their primary vaccination dose for COVID-19 and have waited at least five months before taking a booster dose [3]. The goal of booster dose is to take one of the primary doses to increase the immunization of a person to fight the COVID-19 [1] [3] [8]. The gradual increase in boosted population is a wonderful thing that allows governments to work on the mask mandate rules [3]. However, it is also necessary to consider data for primary vaccination.

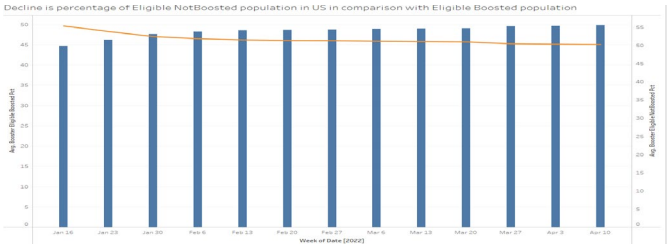


Figure 5: Decline is percentage of Eligible Not Boosted population in US in comparison with Eligible Boosted total population

### *B. Booster Eligibility Based on Age group*

The CDC has outlined the age group to help provide vaccination promptly to persons more prone to catching COVID-19 [3]. The eligibility for any person over the age of 65 is considered a priority to avoid serious illness due to COVID-19 [9]. Then comes the persons over the age of 50, 18, and 12 [9]. Our analysis below in figure 6 shows the eligible percentage of the total population based on age. In the second week of April, an average of 49.75% population in the US was eligible for booster doses than in the third week of January, which was 44.62% (refer figure 4) [9]. This also implies that eligibility has increased as the recipients for primary doses have increased.

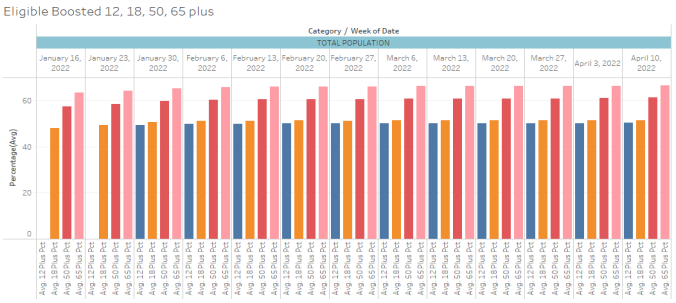


Figure 6: Booster Eligibility for age group

### *C. Category Based Analysis of Booster Eligible – Not Boosted*

Reaching out to different communities of different races/ethnicity is important during a pandemic becomes crucial. Every community has faith that binds them from getting certain medications, or they lack the awareness of it [2] [3]. The data collected by CDC allows us to understand the statistics and probability of required approaches. When analyzing the data for the Not Boosted total population, we notice that Hispanic people are more likely not to get the booster dose compared to persons belonging to another races/ethnicity. The data also shows that persons belonging to the Asian community are more likely to get booster doses. 65.45% Hispanic population is eligible for booster dose but

are not boosted, whereas out of total Asian population, 39.75% in the United States is eligible but are not boosted [9].

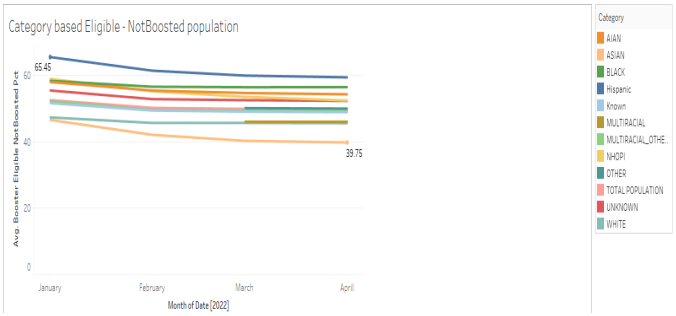


Figure 7: Category Based Eligible – Not Boosted Population

There is an increase where people are not getting booster doses with time in the same categories. Figure 8 shows the weekly forecast of eligibility - Not Boosted data in a horizontal histogram. As seen from the figure below, the forecast trend will be the same as the actual data collected. This could imply that after getting primary vaccination, getting a booster dose is highly unlikely for the eligible population. The missing data for multiracial and other race/ethnicity categories are noticeable. Multiple factors come into count, such as a person does not know how to define a multiracial race/ethnicity or a person refusing to share race/ethnicity details [3]. Identifying one's race/ethnicity is an optional part while getting vaccination doses, which allows data privacy. However, it becomes essential for community outreach efforts when trying to approach a community [3].

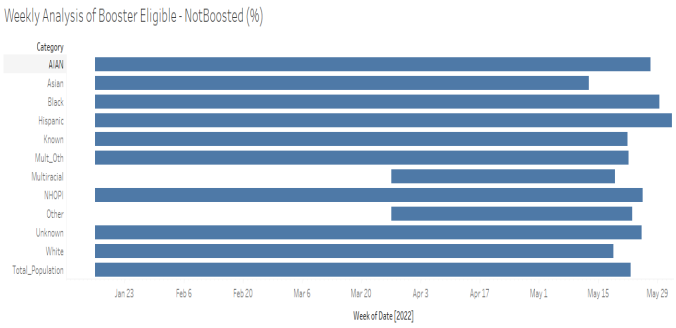


Figure 8: Weekly Analysis of Booster Eligible – Not Booster

*D. Forecast comparison*

As the data is unpredictable, we can only generate a forecast to understand the average trend the data has followed. Here, we generate a forecast showing six weeks from April third week to mid of May. Currently, it is using source data from January 16, 2022, to April 3, 2022 to create this forecast. It is automatically generated using Tableau aggregated by weeks and shows a prediction interval of 90%. Figure 9 shows the average of actual and estimated indicators.

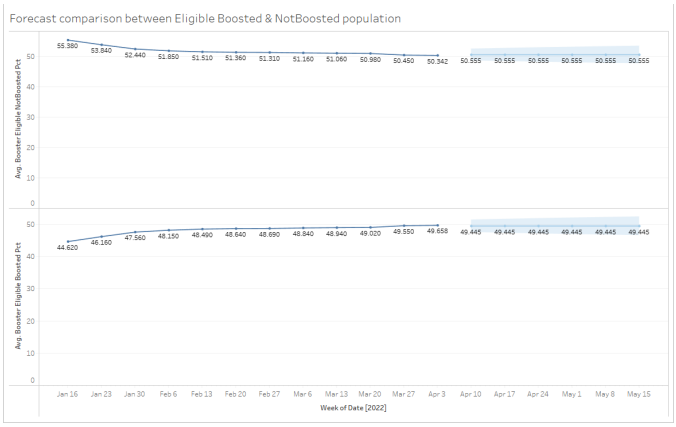


Figure 9: Forecast comparison (Boosted and Not Boosted)

Here we assume that the data provided for the booster doses are up to date, and the person has already received primary vaccination doses. With the decrease in COVID-19 cases around the country, the population is likely either taking booster doses, delaying their booster dose, or not taking at all. Now, this assumption could be accurate depending on the state a person lives or the number of active COVID-19 cases in the region.

The total 50.25 population has not taken their booster dose as of the second week of April. This number will increase with time unless the government mandates a booster dose.

## CONCLUSION

We tried to provide an analysis in this study regarding COVID-19 Booster Eligibility data in the United States. The data CDC collected is for the year 2022 and consists of the count and percentage of the eligible population who are boosted and not boosted. While performing the analysis, we came across multiple factors that helped us understand the booster doses administration among various age groups and different races/ethnicity. We did conclude that booster eligibility data will be more effective along with primary vaccination data.

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