Class17: Vaccination Rate Mini Project

Wenxi Tang

##Background

In today's class, we will explore a dataset on state wide vaccination rate from CA.gov.

The goal of this hands-on mini-project is to examine and compare the Covid-19 vaccination rates around San Diego.

We will start by downloading the most recently dated "Statewide COVID-19 Vaccines Administered by ZIP Code" CSV file from: https://data.ca.gov/dataset/covid-19-vaccine-progress-dashboard-data-by-zip-code

Data input

```
# Import vaccination data
vax <- read.csv("covid19vaccinesbyzipcode_test.csv")
head(vax)
```

```
  as_of_date zip_code_tabulation_area local_health_jurisdiction          county
1 2021-01-05                    93609                    Fresno          Fresno
2 2021-01-05                    94086               Santa Clara     Santa Clara
3 2021-01-05                    94304               Santa Clara     Santa Clara
4 2021-01-05                    94110             San Francisco   San Francisco
5 2021-01-05                    93420           San Luis Obispo San Luis Obispo
6 2021-01-05                    93454             Santa Barbara   Santa Barbara
  vaccine_equity_metric_quartile                 vem_source
1                              1 Healthy Places Index Score
2                              4 Healthy Places Index Score
3                              4 Healthy Places Index Score
4                              4 Healthy Places Index Score
5                              3 Healthy Places Index Score
6                              2 Healthy Places Index Score
```

```
  age12_plus_population age5_plus_population tot_population
1                4396.3                 4839           5177
2               42696.0                46412          50477
3                3263.5                 3576           3852
4               64350.7                68320          72380
5               26694.9                29253          30740
6               32043.4                36446          40432
  persons_fully_vaccinated persons_partially_vaccinated
1                       NA                           NA
2                       11                          640
3                       NA                           NA
4                       18                         1262
5                       NA                           NA
6                       NA                           NA
  percent_of_population_fully_vaccinated
1                                     NA
2                               0.000218
3                                     NA
4                               0.000249
5                                     NA
6                                     NA
  percent_of_population_partially_vaccinated
1                                         NA
2                                   0.012679
3                                         NA
4                                   0.017436
5                                         NA
6                                         NA
  percent_of_population_with_1_plus_dose booster_recip_count
1                                     NA                  NA
2                               0.012897                  NA
3                                     NA                  NA
4                               0.017685                  NA
5                                     NA                  NA
6                                     NA                  NA
  bivalent_dose_recip_count eligible_recipient_count
1                        NA                        1
2                        NA                       11
3                        NA                        6
4                        NA                       18
5                        NA                        4
6                        NA                        5
                                                               redacted
```

```
1 Information redacted in accordance with CA state privacy requirements
2 Information redacted in accordance with CA state privacy requirements
3 Information redacted in accordance with CA state privacy requirements
4 Information redacted in accordance with CA state privacy requirements
5 Information redacted in accordance with CA state privacy requirements
6 Information redacted in accordance with CA state privacy requirements
```

```
library(skimr)
```

A useful function for exploring new datasets is **skimr** package.

```
skimr::skim(vax)
```

Table 1: Data summary

Name	vax
Number of rows	201096
Number of columns	18
Column type frequency:	
character	5
numeric	13
Group variables	None

Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
as_of_date	0	1	10	10	0	114	0
local_health_jurisdiction	0	1	0	15	570	62	0
county	0	1	0	15	570	59	0
vem_source	0	1	15	26	0	3	0
redacted	0	1	2	69	0	2	0

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
zip_code_tabulation_area	0	1.00	93665.11	1817.38	90001	92257.75	93658.50	95380.50	97635.0	
vaccine_equity_metric_quartile	9918	0.95	2.44	1.11	1	1.00	2.00	3.00	4.0	

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
age12_plus_population	0	1.00	18895.04	18993.87	0	1346.95	13685.10	31756.12	88556.7	
age5_plus_population	0	1.00	20875.24	21105.97	0	1460.50	15364.00	34877.00	101902.0	
tot_population	9804	0.95	23372.77	22628.50	12	2126.00	18714.00	38168.00	111165.0	
persons_fully_vaccinated	16621	0.92	13990.39	15073.66	11	932.00	8589.00	23346.00	87575.0	
persons_partially_vaccinated	16621	0.92	1702.31	2033.32	11	165.00	1197.00	2536.00	39973.0	
percent_of_population_fully_vaccinated	20965	0.90	0.57	0.25	0	0.42	0.61	0.74	1.0	
percent_of_population_partially_vaccinated	20965	0.90	0.08	0.09	0	0.05	0.06	0.08	1.0	
percent_of_population_with_1_plus_dose	22009	0.89	0.63	0.24	0	0.49	0.67	0.81	1.0	
booster_recip_count	72997	0.64	5882.76	7219.00	11	300.00	2773.00	9510.00	59593.0	
bivalent_dose_recip_count	158776	0.21	2978.23	3633.03	11	193.00	1467.50	4730.25	27694.0	
eligible_recipient_count	0	1.00	12830.83	14928.64	0	507.00	6369.00	22014.00	87248.0	

```
#sort(vax$as_of_date, decreasing = F)
#sort(vax$as_of_date)
```

> Q1. What column details the total number of people fully vaccinated?

The column "persons_fully_vaccinated"

> Q2. What column details the Zip code tabulation area?

The column "zip_code_tabulation_area"

> Q3. What is the earliest date in this dataset?

```
vax$as_of_date[1]
```

```
[1] "2021-01-05"
```

2021-01-05

> Q4. What is the latest date in this dataset?

```
vax$as_of_date[nrow(vax)]
```

```
[1] "2023-03-07"
```

2023-03-07

> Q5. How many numeric columns are in this dataset?

13

> Q6. Note that there are "missing values" in the dataset. How many NA values there in the persons_fully_vaccinated column?

```r
sum(is.na(vax$persons_fully_vaccinated))
```

```
[1] 16621
```

16621

> Q7. What percent of persons_fully_vaccinated values are missing (to 2 significant figures)?

```r
round(16621/nrow(vax) * 100, 2)
```

```
[1] 8.27
```

> Q8. [Optional]: Why might this data be missing?

It might be some confidential federal areas, or at very early stages, data was not collected.

##Working with dates

We will use the *lubridate* package to help ease the pain of working with times and dates.

```r
library(lubridate)
```

```

Attaching package: 'lubridate'

The following objects are masked from 'package:base':

    date, intersect, setdiff, union
```

```r
today()
```

```
[1] "2023-03-08"
```

> Q9. How many days have passed since the last update of the dataset?

```r
today() - ymd(vax$as_of_date[nrow(vax)])
```

```
Time difference of 1 days
```

I will convert the entire “as_of_date” column to be in lubridate format.

```r
vax$as_of_date <- ymd(vax$as_of_date)
```

```r
today() - vax$as_of_date[(nrow(vax))]
```

```
Time difference of 1 days
```

```r
today() - ymd("1997-4-20")
```

```
Time difference of 9453 days
```

> Q10. How many unique dates are in the dataset (i.e. how many different dates are detailed)?

```r
length(unique(vax$as_of_date))
```

```
[1] 114
```

```r
library(dplyr)
```

```

Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
n_distinct(vax$as_of_date)
```

```
[1] 114
```

Working with zipcode

There are quite a few R packages that can help ease the pain of working with ZIP codes, we will try just one of the smaller ones **zipcodeR**.

```
library(zipcodeR)
```

```
geocode_zip('92037')
```

```
# A tibble: 1 x 3
  zipcode   lat   lng
  <chr>   <dbl> <dbl>
1 92037    32.8 -117.
```

```
zip_distance('92037','92109')
```

```
  zipcode_a zipcode_b distance
1     92037     92109     2.33
```

```
#Calculate the distance between the centroids of any two ZIP codes in miles, e.g.
reverse_zipcode(c('92037', "92109", "92122", "94061") )
```

```
# A tibble: 4 x 24
  zipcode zipcode_~1 major~2 post_~3 common_c~4 county state   lat   lng timez~5
  <chr>   <chr>      <chr>   <chr>       <blob> <chr>  <chr> <dbl> <dbl> <chr>
1 92037   Standard   La Jol~ La Jol~ <raw 20 B> San D~ CA     32.8 -117. Pacific
2 92109   Standard   San Di~ San Di~ <raw 21 B> San D~ CA     32.8 -117. Pacific
3 92122   Standard   San Di~ San Di~ <raw 21 B> San D~ CA     32.9 -117. Pacific
4 94061   Standard   Redwoo~ Redwoo~ <raw 34 B> San M~ CA     37.5 -122. Pacific
# ... with 14 more variables: radius_in_miles <dbl>, area_code_list <blob>,
#   population <int>, population_density <dbl>, land_area_in_sqmi <dbl>,
#   water_area_in_sqmi <dbl>, housing_units <int>,
#   occupied_housing_units <int>, median_home_value <int>,
#   median_household_income <int>, bounds_west <dbl>, bounds_east <dbl>,
#   bounds_north <dbl>, bounds_south <dbl>, and abbreviated variable names
#   1: zipcode_type, 2: major_city, 3: post_office_city, ...
```

> Q. Find the best and worst ratio of "median household income" to "median_home_value" in San Diego county
>
> Q11. How many distinct zip codes are listed for San Diego County?

```
sd_zip <- unique(vax$zip_code_tabulation_area[vax$county == "San Diego"])
length(sd_zip)
```

```
[1] 107
```

```
sd.eco <- reverse_zipcode(sd_zip)
```

Now extract the best and worst "median household income" and "median_home_value"

```
sort(sd.eco$median_household_income/sd.eco$median_home_value, decreasing = T)
```

```
 [1] 0.49313299 0.35517505 0.34548798 0.28576236 0.25878896 0.25671904
 [7] 0.25053447 0.22687477 0.22497633 0.22413397 0.22139649 0.21978362
[13] 0.21812314 0.21737751 0.21539376 0.21355819 0.21243233 0.21139772
[19] 0.20679398 0.20651554 0.20551950 0.20209350 0.20191970 0.19888657
[25] 0.19792504 0.19422057 0.18908834 0.18908362 0.18833910 0.18786741
[31] 0.18769501 0.18727151 0.18673482 0.18672321 0.18607322 0.18288752
[37] 0.18134523 0.18028781 0.17915189 0.17828642 0.17770952 0.17550646
[43] 0.17179217 0.17147450 0.16887196 0.16562207 0.16401408 0.16314344
[49] 0.15958461 0.15884808 0.15613789 0.15532406 0.15500482 0.15364149
[55] 0.15001161 0.14930357 0.14815293 0.14725724 0.14711029 0.14562657
[61] 0.14452578 0.14452332 0.14416319 0.14416195 0.14400708 0.14313883
[67] 0.14243254 0.14100882 0.14073491 0.14019337 0.13936012 0.13388495
[73] 0.13376211 0.13327181 0.13265276 0.12806991 0.12505087 0.12381000
[79] 0.12324040 0.12138591 0.11951699 0.11711611 0.11622243 0.11618388
[85] 0.11487989 0.11445052 0.11431968 0.11381931 0.11355523 0.11223549
[91] 0.10313557 0.09936690 0.09831696 0.09363608 0.09228770 0.09110291
[97] 0.08988986
```

```
arrange(sd.eco, sd.eco$median_household_income, sd.eco$median_home_value)
```

```
# A tibble: 107 x 24
   zipcode zipcode~1 major~2 post_~3 common_c~4 county state   lat   lng timez~5
   <chr>   <chr>     <chr>   <chr>       <blob> <chr>  <chr> <dbl> <dbl> <chr>
 1 91931   PO Box    Guatay  Guatay~ <raw 18 B> San D~ CA     32.8 -117. Pacific
 2 92113   Standard  San Di~ San Di~ <raw 21 B> San D~ CA     32.7 -117. Pacific
 3 92173   Standard  San Ys~ San Ys~ <raw 31 B> San D~ CA     32.6 -117. Pacific
 4 92066   Standard  Ranchi~ Ranchi~ <raw 40 B> San D~ CA     33.3 -116. Pacific
 5 92105   Standard  San Di~ San Di~ <raw 21 B> San D~ CA     32.7 -117. Pacific
 6 91950   Standard  Nation~ Nation~ <raw 25 B> San D~ CA     32.7 -117. Pacific
 7 92086   Standard  Warner~ Warner~ <raw 31 B> San D~ CA     33.3 -117. Pacific
 8 91963   Standard  Potrero Potrer~ <raw 19 B> San D~ CA     32.6 -117. Pacific
 9 92004   Standard  Borreg~ Borreg~ <raw 32 B> San D~ CA     33.1 -116. Pacific
10 92102   Standard  San Di~ San Di~ <raw 21 B> San D~ CA     32.7 -117. Pacific
# ... with 97 more rows, 14 more variables: radius_in_miles <dbl>,
#   area_code_list <blob>, population <int>, population_density <dbl>,
#   land_area_in_sqmi <dbl>, water_area_in_sqmi <dbl>, housing_units <int>,
#   occupied_housing_units <int>, median_home_value <int>,
#   median_household_income <int>, bounds_west <dbl>, bounds_east <dbl>,
#   bounds_north <dbl>, bounds_south <dbl>, and abbreviated variable names
#   1: zipcode_type, 2: major_city, 3: post_office_city, ...
```

```
# Pull data for all ZIP codes in the dataset
#zipdata <- reverse_zipcode( vax$zip_code_tabulation_area )
```

Focus on the San Diego area

> Q12. What San Diego County Zip code area has the largest 12 + Population in this dataset?

```
sd <- filter(vax, county == "San Diego")
```

```
ind <- which.max(sd$age12_plus_population)
sd[ind,]
```

```
   as_of_date zip_code_tabulation_area local_health_jurisdiction    county
67 2021-01-05                    92154                 San Diego San Diego
   vaccine_equity_metric_quartile                 vem_source
67                              2 Healthy Places Index Score
   age12_plus_population age5_plus_population tot_population
67               76365.2                82971          88979
```

```
   persons_fully_vaccinated persons_partially_vaccinated
67                       16                         1400
   percent_of_population_fully_vaccinated
67                                0.00018
   percent_of_population_partially_vaccinated
67                                   0.015734
   percent_of_population_with_1_plus_dose booster_recip_count
67                               0.015914                  NA
   bivalent_dose_recip_count eligible_recipient_count
67                        NA                       16
                                                                redacted
67 Information redacted in accordance with CA state privacy requirements
```

> Q13. What is the overall average “Percent of Population Fully Vaccinated” value for all San Diego “County” as of “2023-03-07”?

```
vax$as_of_date[nrow(vax)]
```

```
[1] "2023-03-07"
```

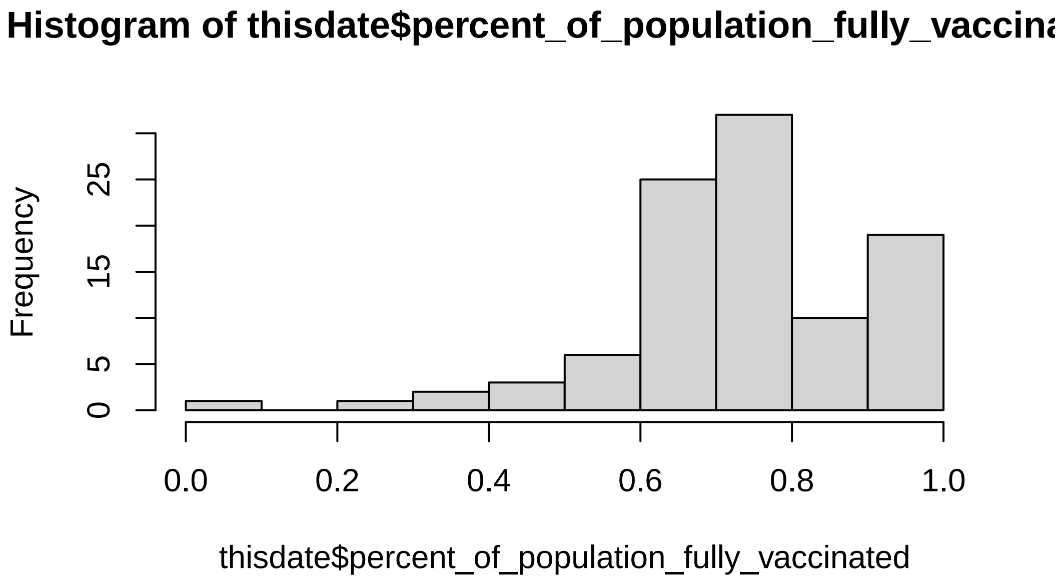
```
thisdate <- filter(sd, as_of_date == "2023-03-07")
```

```
mean(thisdate$percent_of_population_fully_vaccinated, na.rm = T)
```

```
[1] 0.7402567
```

> Q14. Using either ggplot or base R graphics make a summary figure that shows the distribution of Percent of Population Fully Vaccinated values as of “2023-02-28”?

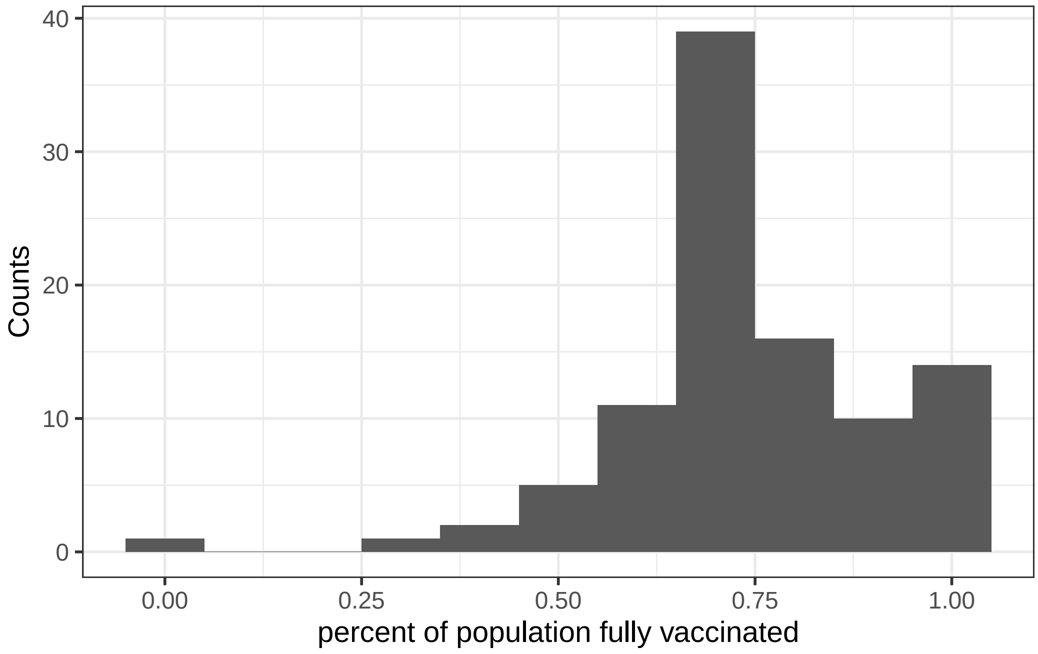
```
hist(thisdate$percent_of_population_fully_vaccinated)
```



```
library(ggplot2)
```

```
ggplot(thisdate) +
  aes(percent_of_population_fully_vaccinated) +
  geom_histogram(binwidth = 0.1) +
  theme_bw() +
  xlab("percent of population fully vaccinated") +
  ylab("Counts")
```

```
Warning: Removed 8 rows containing non-finite values (`stat_bin()`).
```



Focus on UCSD/La Jolla

UCSD resides in the 92037 zip code area.

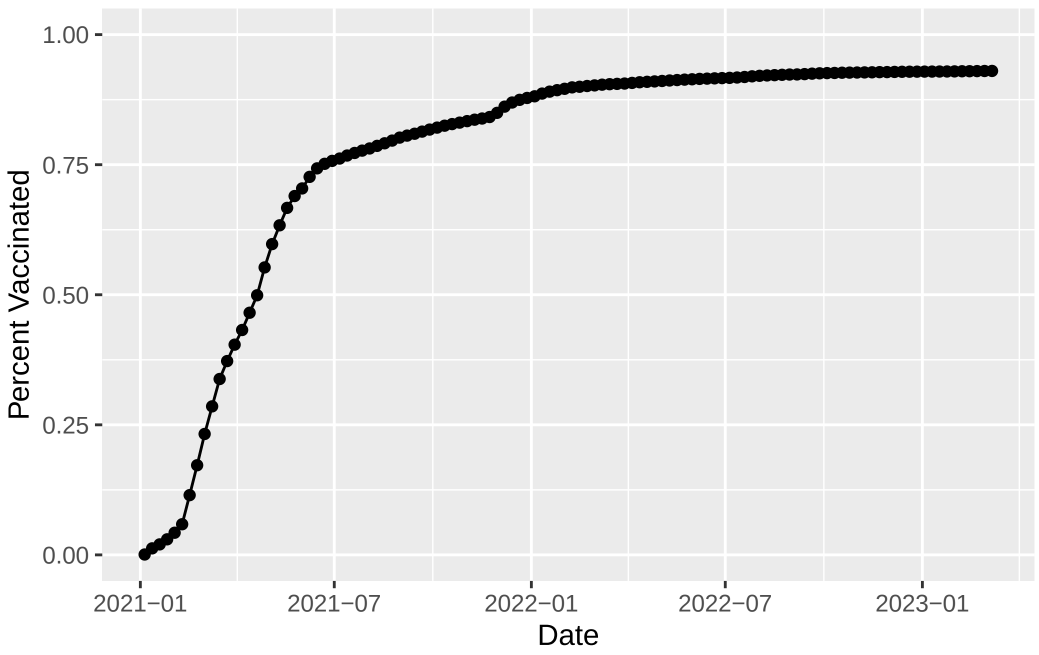
```
ucsd <- filter(sd, zip_code_tabulation_area=="92037")
ucsd[1,]$age5_plus_population
```

```
[1] 36144
```

> Q15. Using ggplot make a graph of the vaccination rate time course for the 92037 ZIP code area:

```
ljplot <- ggplot(ucsd) +
  aes(as_of_date,
      percent_of_population_fully_vaccinated) +
  geom_point() +
  geom_line(group=1) +
  ylim(c(0,1)) +
  labs(x = "Date", y="Percent Vaccinated")

ljplot
```



Comparing to similar sized areas

Let's return to the full dataset and look across every zip code area with a population at least as large as that of 92037 on as_of_date "2023-03-07".

```r
# Subset to all CA areas with a population as large as 92037
vax.36 <- filter(vax, age5_plus_population > 36144 &
                as_of_date == "2023-03-07")

head(vax.36)
```

```
  as_of_date zip_code_tabulation_area local_health_jurisdiction         county
1 2023-03-07                    94116             San Francisco  San Francisco
2 2023-03-07                    92703                    Orange         Orange
3 2023-03-07                    94118             San Francisco  San Francisco
4 2023-03-07                    92376            San Bernardino San Bernardino
5 2023-03-07                    92692                    Orange         Orange
6 2023-03-07                    95148               Santa Clara    Santa Clara
  vaccine_equity_metric_quartile                 vem_source
1                              4 Healthy Places Index Score
2                              1 Healthy Places Index Score
3                              4 Healthy Places Index Score
```

```
4                              1 Healthy Places Index Score
5                              4 Healthy Places Index Score
6                              4 Healthy Places Index Score
  age12_plus_population age5_plus_population tot_population
1               42334.3                45160          47346
2               57182.7                64387          69112
3               37628.5                40012          42095
4               70232.1                79686          86085
5               41008.9                44243          46800
6               42163.3                46202          48273
  persons_fully_vaccinated persons_partially_vaccinated
1                    41255                         2450
2                    57887                         7399
3                    33284                         3040
4                    51367                         5674
5                    35117                         2603
6                    42298                         2684
  percent_of_population_fully_vaccinated
1                               0.871351
2                               0.837582
3                               0.790688
4                               0.596701
5                               0.750363
6                               0.876225
  percent_of_population_partially_vaccinated
1                                   0.051747
2                                   0.107058
3                                   0.072218
4                                   0.065912
5                                   0.055620
6                                   0.055600
  percent_of_population_with_1_plus_dose booster_recip_count
1                               0.923098               34108
2                               0.944640               28297
3                               0.862906               27401
4                               0.662613               23832
5                               0.805983               23695
6                               0.931825               31583
  bivalent_dose_recip_count eligible_recipient_count redacted
1                     19158                    41000       No
2                      7627                    57775       No
3                     15251                    33146       No
4                      6393                    51276       No
```

```
5                       10169                       35031        No
6                       12604                       42120        No
```

Q16. Calculate the mean "Percent of Population Fully Vaccinated" for ZIP code areas with a population as large as 92037 (La Jolla) as_of_date "2023-02-28". Add this as a straight horizontal line to your plot from above with the geom_hline() function?

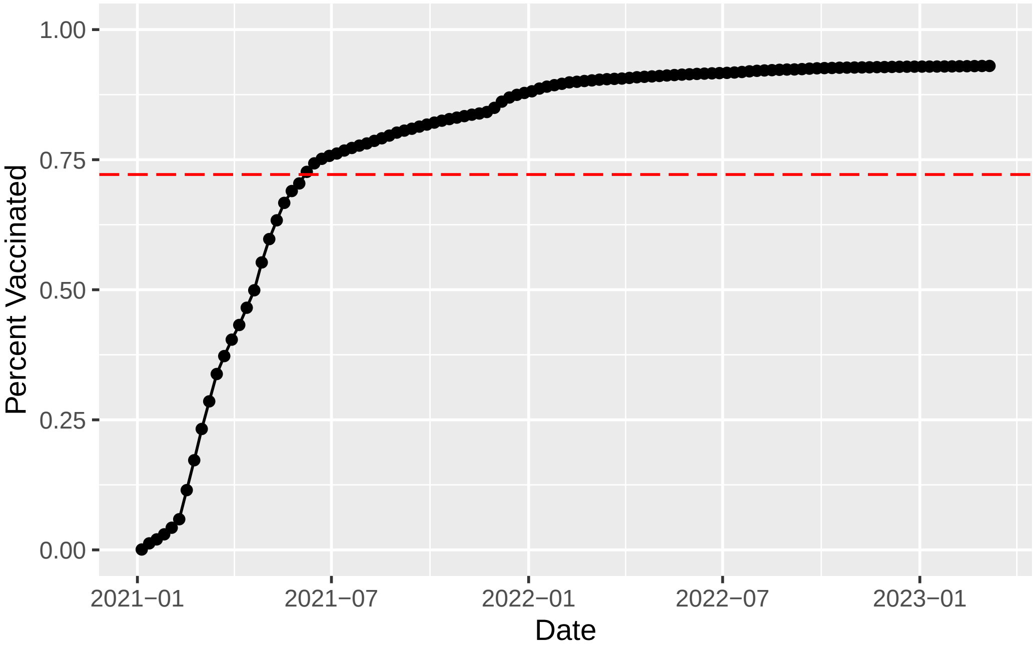
```
n_distinct(vax.36$zip_code_tabulation_area)
```

```
[1] 411
```

```
mean(vax.36$percent_of_population_fully_vaccinated, na.rm = T)
```

```
[1] 0.7214936
```

```
ljplot +
  geom_hline(yintercept = 0.7214936, col = "red", linetype = 5)
```



Q17. What is the 6 number summary (Min, 1st Qu., Median, Mean, 3rd Qu., and Max) of the "Percent of Population Fully Vaccinated" values for ZIP code areas with a population as large as 92037 (La Jolla) as_of_date "2023-03-07"?

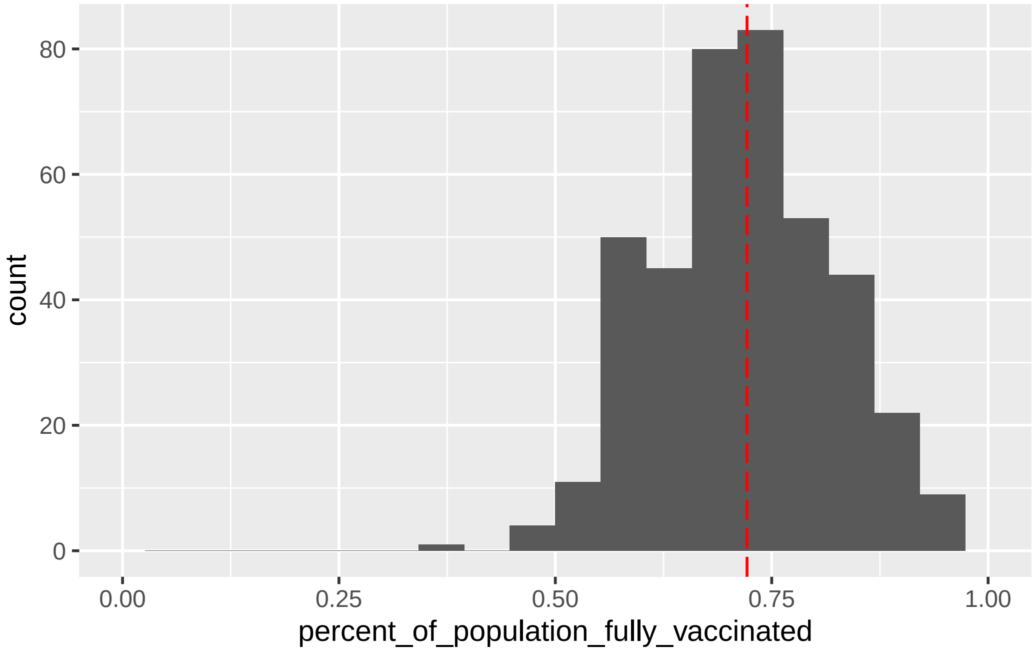
```
summary(vax.36$percent_of_population_fully_vaccinated)
```

```
  Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
0.3805  0.6459  0.7183  0.7215  0.7908  1.0000 
```

Q18. Using ggplot generate a histogram of this data.

```
ggplot(vax.36) +
  aes(percent_of_population_fully_vaccinated) +
  geom_histogram(bins = 20) +
  xlim(0,1) +
  geom_vline(xintercept = 0.7215, col = "red", linetype = 5)
```

```
Warning: Removed 2 rows containing missing values (`geom_bar()`).
```



Q19. Is the 92109 and 92040 ZIP code areas above or below the average value you calculated for all these above?

```
vax %>% filter(as_of_date == "2023-03-07") %>%
  filter(zip_code_tabulation_area== "92040") %>%
  select(percent_of_population_fully_vaccinated)
```

```
  percent_of_population_fully_vaccinated
1                               0.550533
```

```
filter(vax.36, zip_code_tabulation_area %in% c("92109", "92040"))
```

```
  as_of_date zip_code_tabulation_area local_health_jurisdiction    county
1 2023-03-07                    92109                 San Diego San Diego
2 2023-03-07                    92040                 San Diego San Diego
  vaccine_equity_metric_quartile                 vem_source
1                              3 Healthy Places Index Score
2                              3 Healthy Places Index Score
  age12_plus_population age5_plus_population tot_population
1               43222.5                44953          47111
2               39405.0                42833          46306
  persons_fully_vaccinated persons_partially_vaccinated
1                    32725                         4234
2                    25493                         2156
  percent_of_population_fully_vaccinated
1                               0.694636
2                               0.550533
  percent_of_population_partially_vaccinated
1                                   0.089873
2                                   0.046560
  percent_of_population_with_1_plus_dose booster_recip_count
1                               0.784509               19677
2                               0.597093               14175
  bivalent_dose_recip_count eligible_recipient_count redacted
1                      8109                    32622       No
2                      4649                    25433       No
```

They are both below 0.7215.

> Q20. Finally make a time course plot of vaccination progress for all areas in the full dataset with a age5_plus_population > 36144.

```r
last <- vax[vax$age5_plus_population > 36144,]
head(last)
```

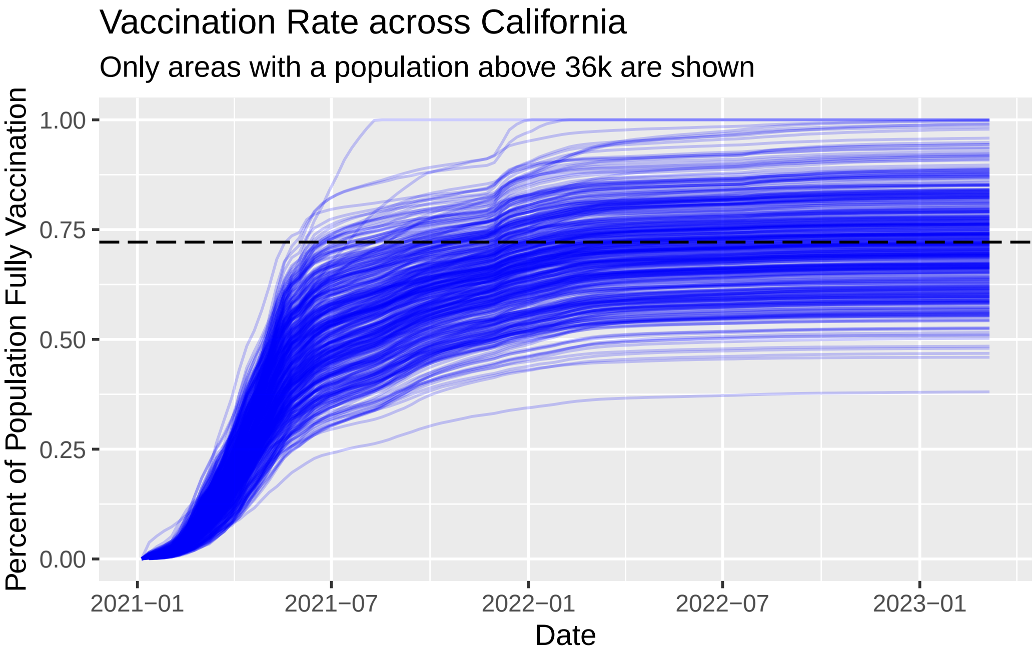
```
   as_of_date zip_code_tabulation_area local_health_jurisdiction        county
2  2021-01-05                    94086               Santa Clara   Santa Clara
4  2021-01-05                    94110             San Francisco San Francisco
6  2021-01-05                    93454             Santa Barbara Santa Barbara
7  2021-01-05                    93458             Santa Barbara Santa Barbara
9  2021-01-05                    93536               Los Angeles   Los Angeles
12 2021-01-05                    94066                 San Mateo     San Mateo
   vaccine_equity_metric_quartile                 vem_source
2                               4 Healthy Places Index Score
4                               4 Healthy Places Index Score
6                               2 Healthy Places Index Score
7                               1 Healthy Places Index Score
9                               2 Healthy Places Index Score
12                              4 Healthy Places Index Score
   age12_plus_population age5_plus_population tot_population
2                42696.0                46412          50477
4                64350.7                68320          72380
6                32043.4                36446          40432
7                43262.5                51006          57256
9                59659.1                65612          70237
12               37730.3                40903          43101
   persons_fully_vaccinated persons_partially_vaccinated
2                        11                          640
4                        18                         1262
6                        NA                           NA
7                        NA                           NA
9                        53                         1066
12                       NA                           NA
   percent_of_population_fully_vaccinated
2                                0.000218
4                                0.000249
6                                      NA
7                                      NA
9                                0.000755
12                                     NA
   percent_of_population_partially_vaccinated
2                                    0.012679
4                                    0.017436
6                                          NA
```

```
7                                           NA
9                                     0.015177
12                                          NA
   percent_of_population_with_1_plus_dose booster_recip_count
2                                 0.012897                  NA
4                                 0.017685                  NA
6                                       NA                  NA
7                                       NA                  NA
9                                 0.015932                  NA
12                                      NA                  NA
   bivalent_dose_recip_count eligible_recipient_count
2                         NA                       11
4                         NA                       18
6                         NA                        5
7                         NA                        2
9                         NA                       53
12                        NA                        3
                                                                redacted
2  Information redacted in accordance with CA state privacy requirements
4  Information redacted in accordance with CA state privacy requirements
6  Information redacted in accordance with CA state privacy requirements
7  Information redacted in accordance with CA state privacy requirements
9  Information redacted in accordance with CA state privacy requirements
12 Information redacted in accordance with CA state privacy requirements
```

```r
vax.36.all <- filter(vax, age5_plus_population > 36144)


ggplot(vax.36.all) +
  aes(as_of_date,
      percent_of_population_fully_vaccinated,
      group=zip_code_tabulation_area) +
  geom_line(alpha=0.2, color="blue") +
  ylim(0,1) +
  labs(x="Date", y="Percent of Population Fully Vaccination",
       title="Vaccination Rate across California",
       subtitle="Only areas with a population above 36k are shown") +
  geom_hline(yintercept = 0.7215, linetype=5)
```

```
Warning: Removed 183 rows containing missing values (`geom_line()`).
```



Q21. How do you feel about traveling for Spring Break and meeting for in-person class afterwards?

I feel pretty safe because the vaccination rate is pretty high.