

# Does Vaccination Rate Impact Coronavirus Cases?

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## Introduction

This report is dedicated to investigating the relationship between the number of coronavirus cases and the vaccination rate (fully vaccinated) in Canada, Mexico, and the United States. We picked these three countries because they are the top 3 most populated countries in North America, providing sufficient statistics for this investigation. We hypothesize that as the vaccination rate increases, the number of coronavirus cases decreases. Data pulled from the Johns Hopkins University Center for Systems Science and Engineering (JHU CCSE) Coronavirus repository are used in this analysis.

## Results

In Figure 1, it can be observed that in order of most to least vaccinated, it goes Canada, United States, then Mexico. As seen in Table 1, the actual percentage of people fully vaccinated in Canada was 79%, in the United States it was 64%, and in Mexico it was 60%. Figure 2 shows that Mexico actually had the fewest number of total coronavirus cases per 100k, then Canada had the second fewest number of total cases, and the United States had the most number of coronavirus cases per 100k.

Figure 1. COVID-19 Vaccination Rates in Canada, Mexico, and USA

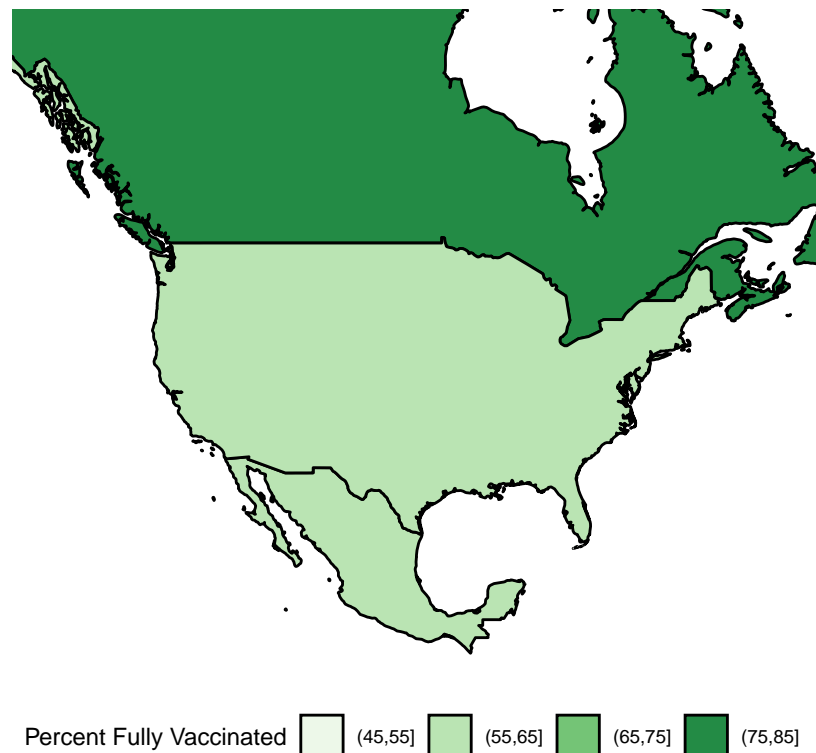


Figure 2. Total COVID-19 Cases in Canada, Mexico, and USA

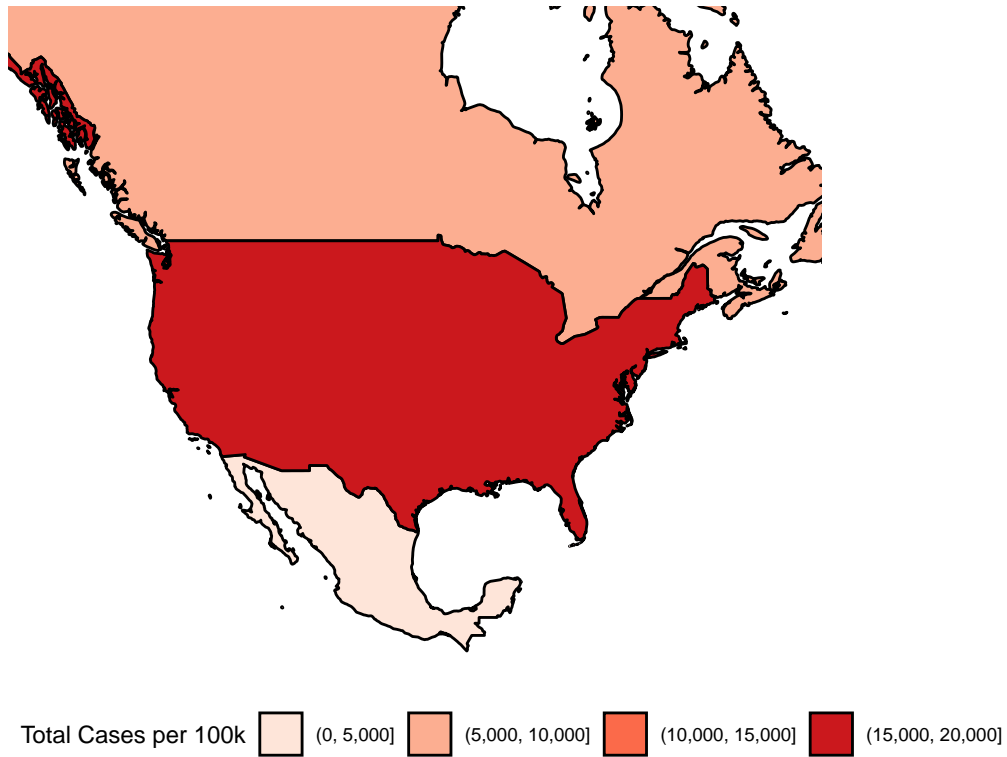


Table 1: Coronavirus Statistics

Country	Total Cases per 100k	Percent Vaccinated
Canada	9814	80
Mexico	4098	61
USA	18110	65

According to Figure 3, 4, and 5, as the vaccination rate gradually increased between January and July in 2021, the number of coronavirus cases appeared to be decreasing in the US, Canada, and Mexico. All three countries experienced a moderate spike in coronavirus cases from August to September in 2021 as the vaccination rates continued to climb. Although the vaccination rates in all three countries were still rising, we saw another huge spike in coronavirus cases between December 2020 and January 2021.

Figure 3. COVID-19 Cases and Vaccination Rate in the US

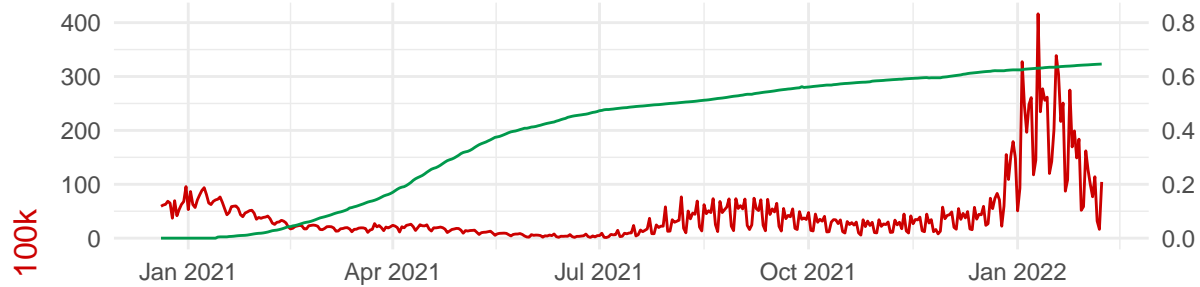


Figure 4. COVID-19 Cases and Vaccination Rate in Canada

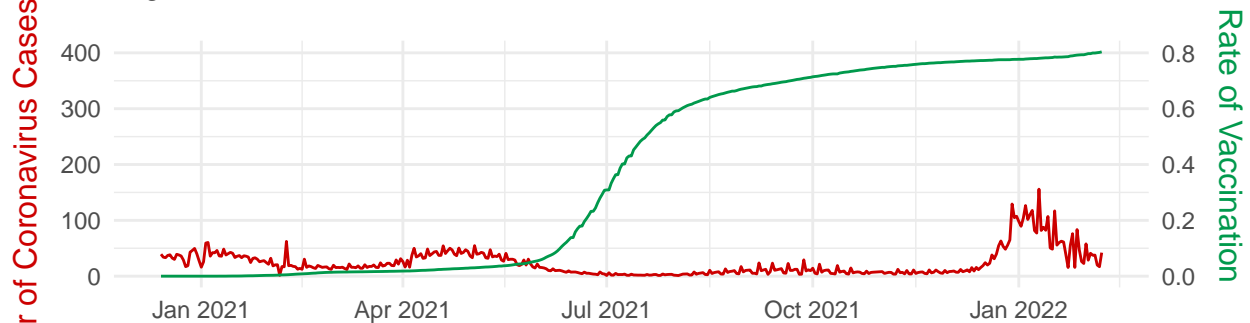
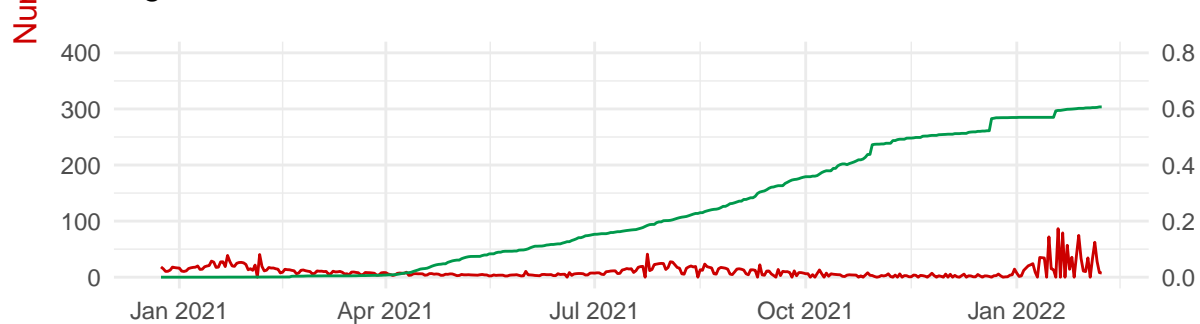


Figure 5. COVID-19 Cases and Vaccination Rate in Mexico



## Discussion

As seen in the two maps, Mexico has much fewer total coronavirus cases per 100k in comparison to the United States, even though their current vaccination rates are relatively close. However, there is a possibility that Mexico has underreported their coronavirus cases, causing this statistic to be lower than the actual value. On the other hand, the population of Canada is 15% more vaccinated than the population of the United States, and the total number of deaths per 100k is half as much in Canada. This comparison of the US and Canada overall supports the hypothesis that a more vaccinated population will have fewer coronavirus cases.

Looking at the graphs, there does not seem to be an obvious relationship between the vaccination rate and the number of coronavirus cases. Although they appear to be negatively correlated between January and July in 2021, this is likely due to the seasonality of the coronavirus instead of merely 0.1 to 0.2 vaccination rates. As the weather became colder and the new Omicron variant swept through the world, the number of coronavirus cases skyrocketed despite relatively higher vaccination rates.

It is noteworthy that Canada, with an almost 0.8 vaccination rate, experienced less than half of the peak in coronavirus cases in January 2022 compared to the US, which had a vaccination rate around 0.6 at that time. However, we acknowledge that this discrepancy may be due to the difference in the two nations' population densities or other confounding variables. In contrast, Mexico, with a similar vaccination rate as the US, saw

only one third of the increase in coronavirus cases in January 2022 compared to the US. We suspect that this may be due to the fact that coronavirus cases in Mexico are widely underreported.

It could have been insightful to do a trend analysis of vaccination rate with number of deaths over time. Since the vaccine also helps to prevent symptoms in addition to preventing catching the coronavirus, there may be a more noticeable correlation between vaccination rate and new coronavirus deaths. There is also a chance that deaths from coronavirus would be more accurately reported in places such as Mexico. However, the dataset from JHU CCSE does not include this as a metric.

## Appendix

Visualization and data wrangling steps for maps and time series graphs:

- filter countries of interest in covid19\_vaccine
- filter countries of interest in coronavirus
- calculate the total number of coronavirus cases in each country on each day
- join coronavirus and covid19\_vaccine data sets
- remove unnecessary columns
- calculate the number of coronavirus cases per 100k and the vaccination rate
- filter the results
  - The number of coronavirus cases has to be larger than or equal to 0
  - The vaccination rate has to be between 0 and 1
- calculate total number of cases gotten in each country
- join coronavirus data with map\_data for the map plots
- generate maps of vaccination rates and coronavirus cases
- generate a table of vaccination and coronavirus statistics
- generate a time series graph of vaccination rate and coronavirus cases for each country