Revisiting COVID-19 Data in Europe: Incidence, Mortality and Vaccination

Ololade Gbadebo[1]

[1]Department of Biomedical and Pharmaceutical Sciences, University of Rhode Island, Kingston, USA

Abstract

The Coronavirus (COVID-19) disease caused by SARS-CoV-2 virus was declared an emergency of international public health concern by the World Health Organization (WHO) in January 2020. This study was aimed at using real world data to explore the incidence, mortality, and vaccination rates in European countries. Generally, these epidemiological factors varied across the regions of the continents as well as the different countries. As more people were being vaccinated, vaccination rates decreased over the years. Moreover, the season of the year had no significant influence on incidence while it significantly influenced mortality due to COVID-19. This report will be useful for the governments of European countries governments in their policy making on COVID-19 containment.

Introduction

The Coronavirus (COVID-19) disease caused by SARS-CoV-2 virus was declared an emergency of international public health concern by the World Health Organization (WHO) in January 2020 [1,2]. As of 7 May 2024, 6.8 million confirmed deaths and 676 million confirmed cases of the infection have been recorded [3]. Asides the precautionary methods, governments have resorted to vaccination as a means of containing the infection [4]. As of 7 May 2024, 13 billion vaccine doses have been administered worldwide [3]. Vaccination inclination however varies across regions and international economic classes, and this may influence the incidence and mortality rates. In this report, I examined the incidence, mortality and vaccination rates of European countries while hoping that it aids the governments in their policy making on COVID-19 containment.

Methods

In this report, I analyzed COVID-19 data "covid_data.csv" while focusing on European countries. Data was downloaded from Our World in Data using the link "https://github.com/owid/covid-19-data/tree/master/public/data". Our World in Data is a daily updated and open-source data source for everyone. The data used in this project was updated till 19th April, 2023. The data was further filtered to desired forms to answer some research questions. This project was focused on Europe. With a shell script, the global dataset was filtered by continent to output only European countries. The European COVID-19 data was further filtered and analyzed to present the weekly incidence of COVID-19. Further analysis and visualization were done in R. The key indicators used in this study were total cases per hundred, total deaths per hundred, total vaccinations per hundred, total cases per capita and vaccination rates. Statistical analysis was conducted using linear regression.

Results and Discussion

To determine the regional difference in the epidemiology and vaccination rates, I compared the incidence, mortality and vaccination rates between the regions in Europe. Necessary columns (location, new case, new vaccinations, and population) were filtered from the full data. The raw data has the data for the United Kingdom and the constituent countries. To avoid replicating data, the constituent countries were removed. A table of European regions and countries was made and joined to the data table using location/country as the unique identifier. Cases, deaths and vaccinations were summed up per region and the values per 100 people were calculated. The regional COVID-19 epidemiology and vaccination rates between January 1, 2020 and April 19, 2024 are provided (Table 1). Incidence was highest in Western Europe with 51.26 cases per hundred people, while British Isles had the highest mortality (0.33 deaths per hundred) and vaccination (218.23 vaccinations per hundred people) rates.

Table 1: COVID-19 epidemiology and vaccination rates in European regions until April 19, 2024.

Region	Total cases per hundred	Total deaths per hundred	Total vaccinations per hundred
British Isles	36.81	0.33	218.23
Eastern Europe	17.84	0.30	95.23
Northern Europe	36.71	0.22	69.29
Southern Europe	39.19	0.31	161.09
Western Europe	51.26	0.22	199.31

Aside from the region, a difference in incidence across countries may also be expected. To confirm this, the data was then analyzed to determine the number of cases per capita between January 1, 2020 and December 31, 2023. The data was capped at that time because upon manual observation of the data, some countries were without data after December 2023. The cumulative number of cases per country was determined and divided by their respective populations. Cyprus had the highest incidence, followed closely by San Marino (Figure 1). Belarus and Vatican have a least incidence which may be due to different factors including low reporting rate and limited surveillance.

Moreover, the vaccination rates of the European countries were looked at. It is important to understand the trend of vaccination over the past years, perhaps there were moments of high vaccination rates and time there were plateaus in the curves. To avoid congestion in the plot, 12 countries were selected based on their high data availability. Also, the analysis was stopped at December 2023 for uniformity. This was because some countries stopped reporting in December 2023. The location, date, population, and total_vaccinations columns were extracted from the main table. Total vaccination here is the cumulative number of vaccinations administered from the start of the vaccination exercise up to a day. These values were calculated as a percentage of the population of the selected countries. A linear regression analysis was conducted to establish the differences in the vaccination rates across the different countries. Generally, a sharp increase in cumulative vaccinations per 100 people was noticed from the second quarter of 2021 up till the first quarter of 2022 (Figure 2). This was expected since that was the period COVID-19 vaccines were approved and rolled out globally. Statistical analysis shows a significant difference (ANOVA p-value: 0.0000, R-squared:0.8467) in the vaccination trend in the selected country between January 2020 and December 2023. This suggests that different factors peculiar to each selected country as well as time of the year influences COVID-19 vaccination rates.

Furthermore, I analyzed the data to see the trend of monthly vaccination in selected countries. Portugal, Belgium, United Kingdom, Malta, Sweden, Italy, Finland, Netherlands, Greece, Czechia, Croatia, and Bulgaria were selected because they reported adequate vaccination data necessary for this analysis. The end period for this analysis was December 2023. The daily vaccination data for each selected country was summed up per month and taken as a percentage of the population of the countries. The plot shows that vaccination began in Belgium, Czechia and Italy in January 2021 followed briefly later by other countries. A linear

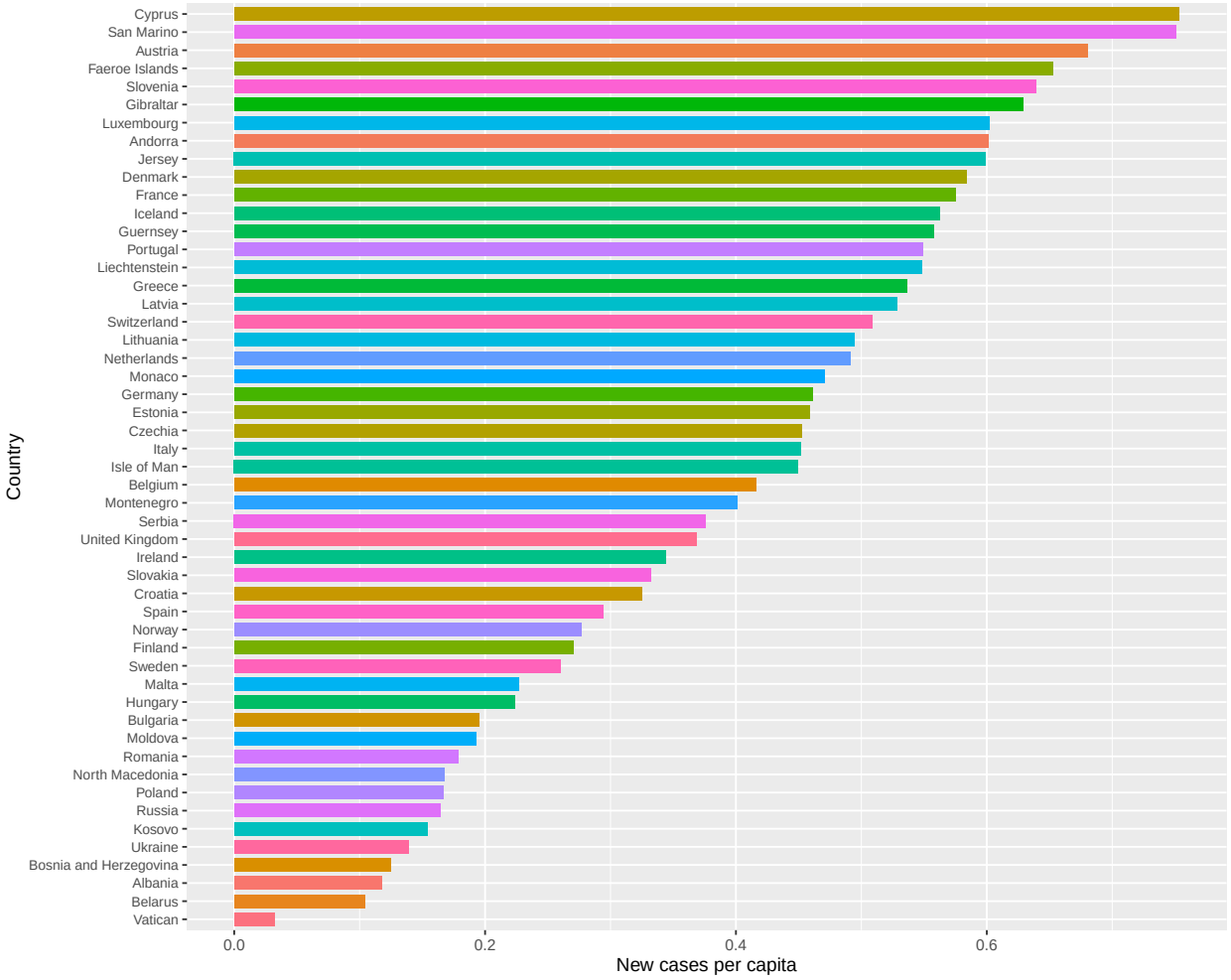

Figure 1: COVID-19 cases per capita in European countries. Data was sourced from Our World In Data and the coverage in this plot was January 2020 - December 2023. Cyprus had the highest prevalence, followed closely by San Marino while it was least in Vatican.

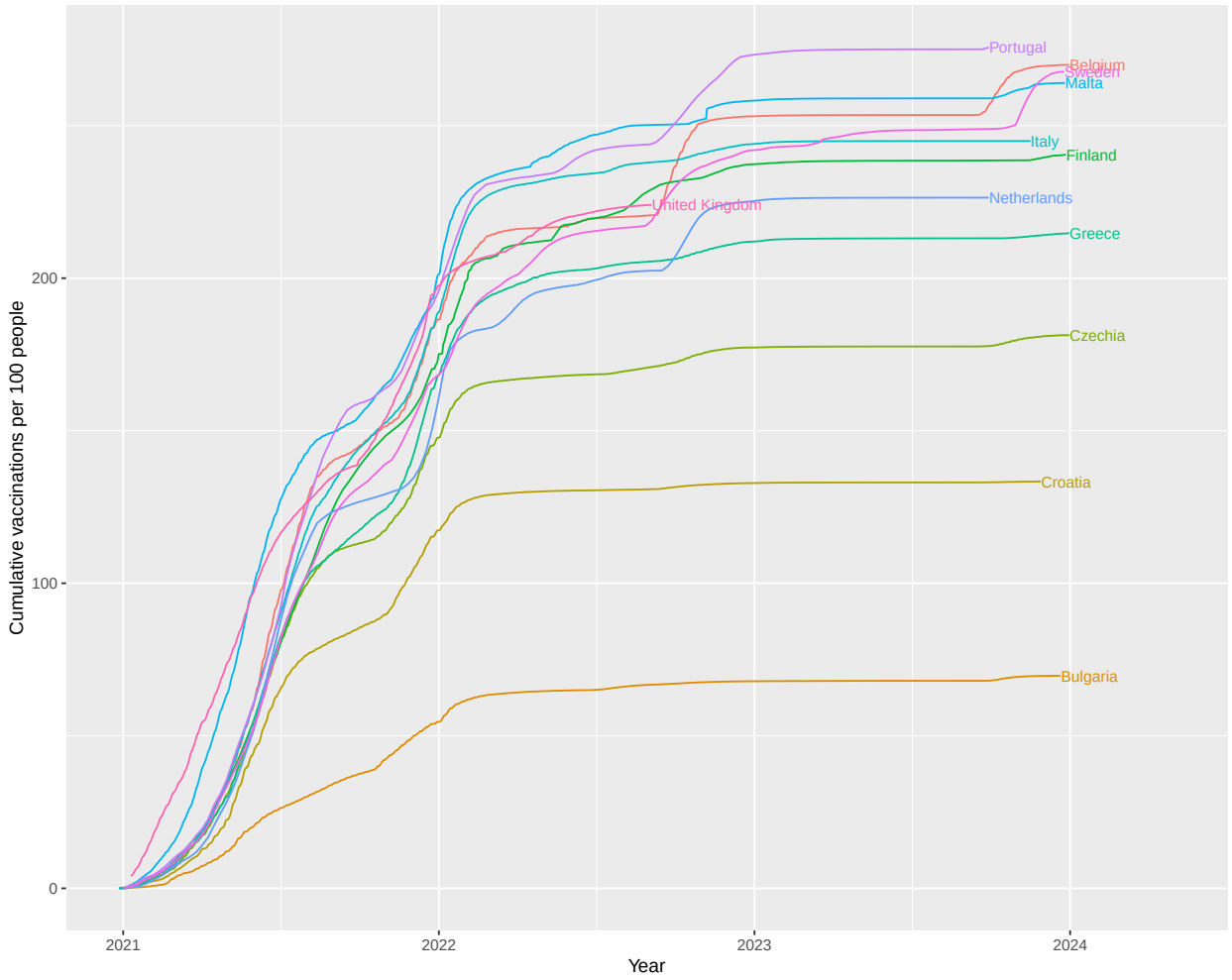

Figure 2: COVID-19 cases per capita in European countries. Data was sourced from Our World In Data and the coverage in this plot was January 2020 - December 2023. Cyprus had the highest incidence rate, followed closely by San Marino while it was least in Vatican. Statistical analysis shows a significant difference (ANOVA p-value: 0.00000 R-squared: 0.8466979) in the vaccination trend in the selected country between January 2020 and December 2023.

regression analysis was also done to check for interactions between the month of the year, location, and vaccination rate. There was a sharp increase in the vaccination rate through the first half of 2021 followed by a decline that lasted about 4 months. This decline was again followed by an increased vaccination rates and an eventual decline and flattening in the first quarter of 2022. However, Belgium recorded a spike in vaccination between August and November 2022 (Figure 3). Statistical analysis shows a significant difference in the monthly vaccinations per 100 people trend across the different selected countries (ANOVA p-value: 4.284272e-10).

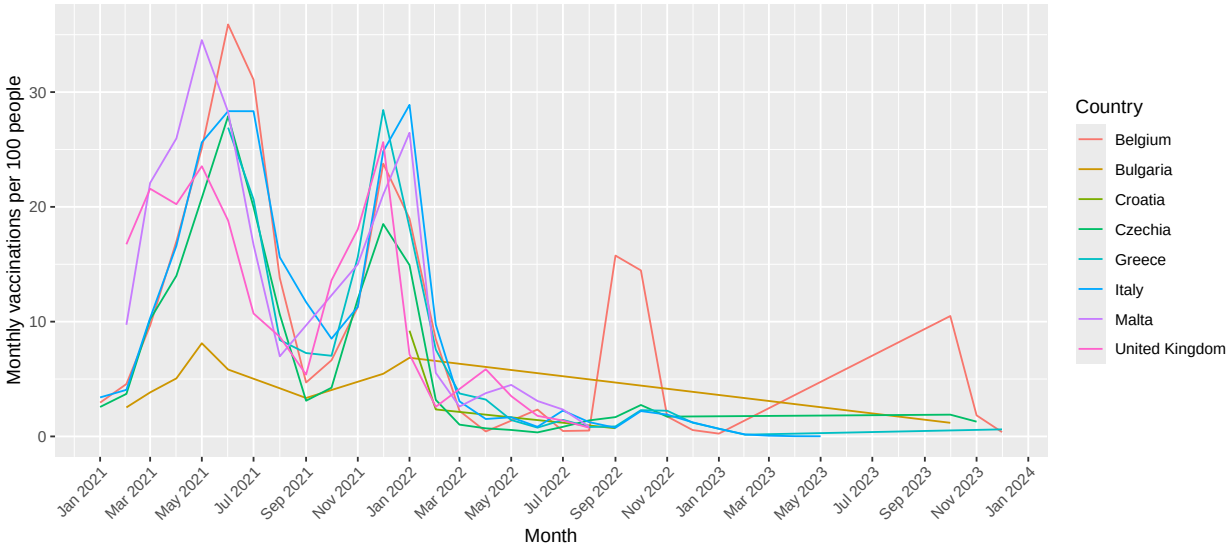

Figure 3: Monthly vaccination trend in selected European countries. Data was sourced from Our World In Data and the coverage in this plot was January 2020 - December 2023. Vaccination began in Belgium, Czechia and Italy in January 2021 followed briefly later by other countries. Generally, there was an initial increase in vaccination rates, followed by a decline that lasted 4 months, then an increase and subsequent decline and flattening. Statistical analysis shows a significant difference in the monthly vaccinations per 100 people trend across the different selected countries (ANOVA p-value: 4.284272e-10 R-squared: 0.3519848).

Although vaccines have been widely distributed and have gained wide acceptance globally, it would be helpful to know the percentage of residents of countries who were vaccinated at least once or fully vaccinated. Fully vaccinated people have taken the first and second doses of the COVID-19 vaccine. In this analysis, the dataset up till April 2024 was used. Necessary columns for selected countries were extracted. The number of people vaccinated only once and fully vaccinated were taken as a percentage of population. The plot compares the two cases under consideration while including the last day data was reported for each of the selected countries (Figure 4). As expected, there were lower percentage of people who had been vaccinated at least once compared to those that had received full vaccination. This shows that some people didn't complete their full vaccination.

One of the major risk factors for respiratory infection is season. During cold season, susceptible people are likely to come down with allergy, cold and flu. Then I attempted to answer the question of the impact of season on the incidence and mortality rates of COVID-19. Since the winter season cuts across two years, the season year was given the year it is starting. e.g. December 2021, January 2022 and February 2022 were classified as Winter 2022. Data was visualized with box plots containing multiple samples (years) per season (Figure 5). I conducted a linear regression analysis to explore the influence of seasonality on the number of COVID-19 cases and deaths. The analysis showed that the influence of season on the number of COVID-19 cases is not statistically significant (ANOVA p-value:0.8870). Conversely, there is a statistically relevant influence of season on the number of COVID-19 deaths (ANOVA p-value: 0.0042). This suggests that seasonal variations do not significantly impact the case count while they appear to play a role in mortality rates.

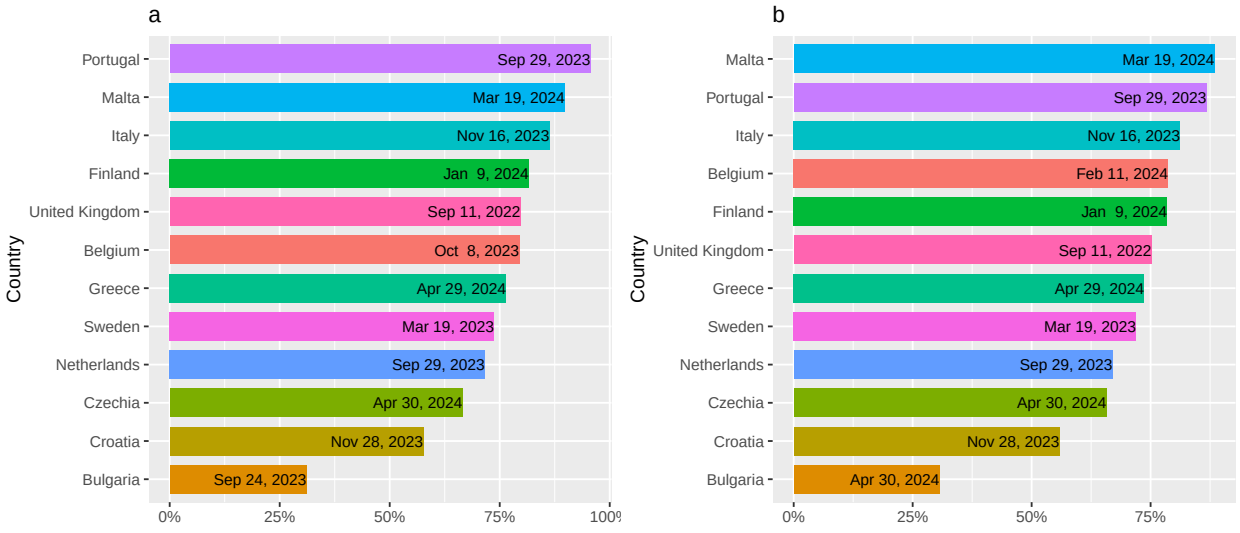

Figure 4: Percentages of the populations of selected countries that have received at least one dose of the COVID-19 vaccine (a) or have been fully vaccinated against COVID-19 (b). Data was sourced from Our World In Data and the coverage in this plot was January 2020 - April 2024. Date on each shows the end date for the vaccination reportage for each country.

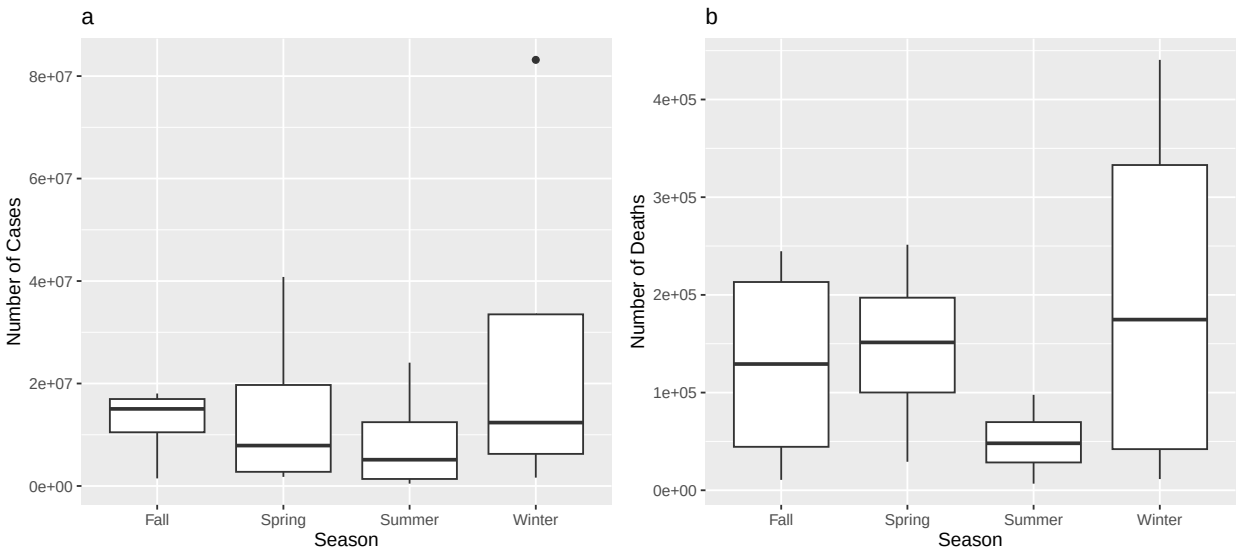

Figure 5: Seasonal changes in the number of cases (a) and deaths (b) caused by COVID-19 between March 2020 and February 2024. Data was downloaded from Our World in Data website and analyzed. Influence of season on the number of cases is not statistically significant (ANOVA p-value: 0.8870719 R-squared: -0.4026093). However, a statistically relevant influence of season on number of deaths was observed (ANOVA p-value: 0.004184515 R-squared: 0.7688419).

In this report, I have considered the incidence, mortality and vaccination rates of COVID-19. Data was analyzed using shell scrip and R, and visualized using the ggplot2 package in R. Incidence, mortality and vaccination rates varies across the regions of the continent. Moreover, there were significant influence of date and country factors on vaccination rates. Seasonal changes had no significant influence on the number of new cases while they significantly impact mortality rates.

Limitations

This research largely relies on the data from the data source, Our World in Data. The dataset depends on data from national government and some other sources. The incompleteness of data of some variables as well as the abrupt reportage of data by some countries also raises limitations.

Conclusion

While drugs that cure COVID-19 still has not been approved, vaccination remains a means of protecting human health against the infection. However, the vaccination coverage in some European countries is still low. Moreover, possible co-morbidities that may raise the mortality rates of COVID-19 in the winter should be looked into.

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