An Overview of the Latest Outbreak Data from World-Wide Regions and the Reasons for the Increase of Infections in the UK Since Omicron

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ABSTRACT
Since the beginning of COVID-19, 10 vaccines have been introduced, but the virus is mutating at the same time. Although more new cases are being confirmed, which may be caused by a higher transmission rate of the virus, some countries are planning to or have already lifted their precautionary measures. In this paper, we use global and European data from the WHO for statistical data analysis and explore the UK data in more detail. This is followed by building a multiple linear regression of the number of new confirmed cases for potential reasons, including policy measures. Based on the statistical model results, the statistical insignificance of the stringency index could only provide a better reference to the countries that have similar levels of restriction enforcement. Apart from this factor, the positive rate and the daily new cases also significantly affect the number of new cases per day. Although the vaccines could still protect humans from the currently prevalent variants, the effectiveness against future variants of the virus is uncertain.

Keywords: *COVID-19, Explanatory Data Analysis, Multivariate Analysis, Multiple Linear Regression Model, Statistics*

1. INTRODUCTION

The COVID-19 pandemic is one of the greatest challenges facing humanity in recent years. It has been more than 2 years since a cluster of cases of pneumonia was reported by the Wuhan Municipal Health Commission, China. A novel coronavirus was eventually identified [1]. As of April 1st, there have been 10 vaccines granted emergency use by the World Health Organisation (WHO), including Protein Subunit, RNA, Non-replicating Viral Vector, and Inactivated [2]. However, humans cannot ignore the fact that viruses have also mutated several times in order to adapt to their surroundings [3]. From 2022 onwards, the policies and regulations of some countries to combat the epidemic have also changed. Denmark is the first country in the European Union to lift all COVID restrictions [4]. As of April 3, 2022, more European countries have removed their international travel restrictions, which are usually the certificates of full vaccination or recovery from COVID-19, including France, Hungary, Iceland, and so on [5] [6]. Despite a resurgence in cases, the United Kingdom lifted the COVID-19 international travel restrictions for all passengers on March 18, 2022 [7], and nearly all coronavirus control measures were lifted on February 24, 2022 [8].

In order to monitor and aggregate the data on COVID-19, some official organisations, including WHO [9] and the UK government [10], have been exploring the data for the world or specific countries on confirmed cases, deaths, and vaccinations. The department of health in Northern Ireland even does a descriptive analysis of these data based on demographic variables such as the local government districts, age groups, and gender groups [11]. This paper aims to find the reasons behind the increasing number of cases recently, though vaccine coverage is already widespread in some areas after completing the multivariate analysis on the recent data (cases, deaths, vaccination, reproduction rate, fatality rate, etc.) from the globe and Europe. Then, we build a multiple linear regression model of the number of newly-reported cases per day for the potential reasons. According to the model results, apart from the vaccinations, the number of daily COVID tests and the share of positive results in the total tests are the important factors that influence the reported new cases every day. The coefficient of stringency index is not statistically significant in the model, but it could still contribute to the change in the number of cases.

2. ANALYSIS

2.1. Global Overview

Figure 1 Flow Map of the main parts of the paper

This part of the paper uses the datasets on coronavirus from the WHO website up to April 4, 2022. Figure 1 is a simple flow map that states the order of analysis for the main parts of the paper. First and foremost, we analyze the global data about the number of reported cases and deaths and the number of people vaccinated based on the WHO regions (Europe, Americas, South-East Asian, Western Pacific, Eastern Mediterranean, Africa, and other regions). Then, we focus on the European data, especially those in the last 7 days and the percentage of confirmed cases of Omicron in these countries. After that, by analysing the overall UK data, especially after the identification of the Omicron variant, we built a regression model to find the key factors influencing the number of new cases.

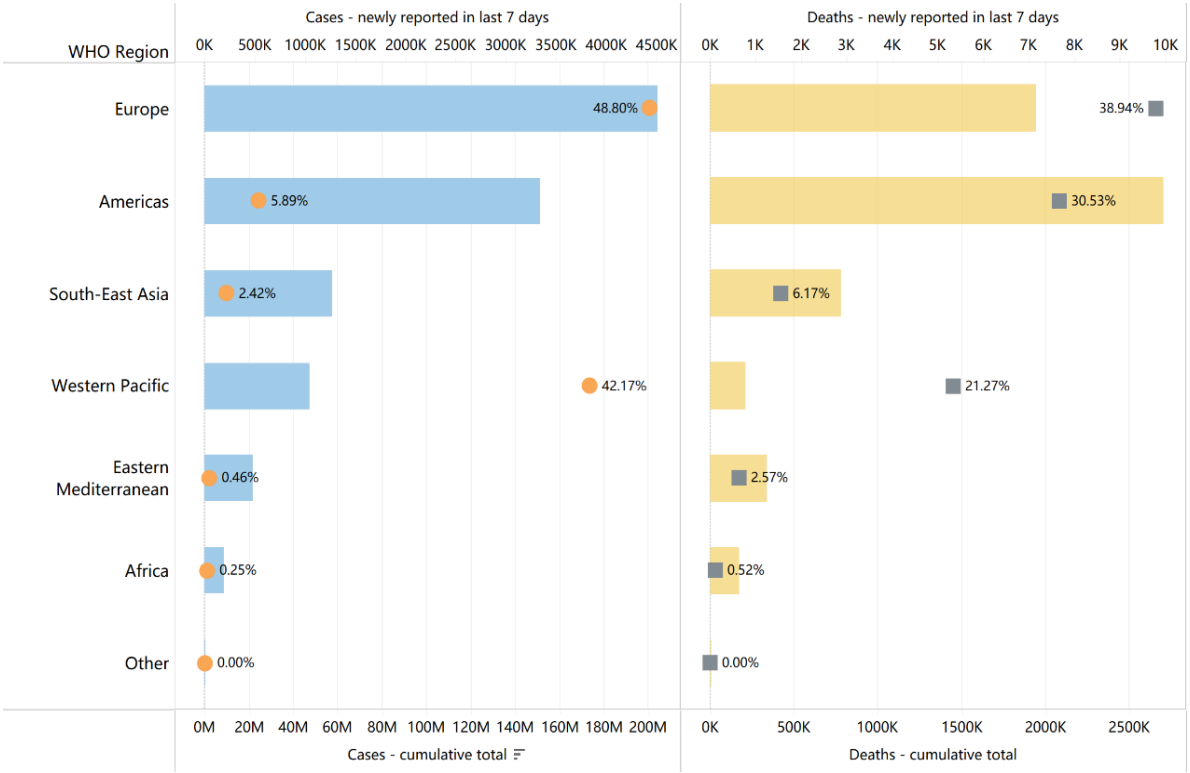

Figure 2 Region-Cummulative cases and death (with corresponding newly reported data in last 7days)

As of 8:11 p.m. CEST on April 4, 2022, WHO had received reports of 489,779,062 confirmed COVID-19 cases worldwide, with 6,152,095 deaths [9]. Figure 2 shows the cumulative cases and deaths in each WHO region, which are associated with the corresponding newly reported cases and deaths in the last seven days, respectively. This newly reported data for the past seven days is presented as a percentage of the total for each region. From the following bar chart, Europe and the Americas are the top two countries with the highest cumulative totals of cases and deaths since the outbreak started. However, in the last seven days, 42.17% of the cases were found in the Western Pacific region, which is only followed by the new cases of 48.80% reported in Europe. Despite the low number of confirmed cases in the Americas, the death toll is still second only to Europe, with 30.53% of the deaths in the last seven days.

As of April 4, 2022 [9], WHO has administered a total of 11,183,087,530 vaccine doses. Note that not all countries have reported their latest data to WHO, Table 1 below demonstrates the information about the cumulative total vaccine doses and the number of people vaccinated by different levels of doses based on WHO regions. For a more intuitive comparison, all values are shown by percentage rather than the number of people. Meanwhile, to compare the prevalence of vaccines in different areas, data of vaccine doses per 100 population are used here rather than cumulative data, with the exception of the first column, Total Vaccinations, which is the cumulative number of vaccine doses administered.

Table 1 The information of Vaccination as of 4 April, 2022 for each region

Region	Total Vaccinations	At least one dose	Fully Vaccinated	Booster
Europe	33.34%	29.78%	31.49%	40.89%
Americas	25.96%	26.25%	26.04%	22.74%
Western Pacific	19.52%	20.11%	19.76%	21.94%
Eastern Mediterranean	7.74%	8.09%	7.98%	5.95%
Africa	7.48%	9.65%	8.80%	3.19%
South-East Asia	5.33%	5.59%	5.34%	4.25%
Other	0.63%	0.53%	0.59%	1.04%
Overall	100.00%	100.00%	100.00%	100.00%

(All variables are the number of people per 100 population.)

Obviously, European countries not only have the highest total vaccine doses delivered, but they also have the highest number of people who have received at least one dose, full doses or boosters or additional doses. The Americas and Western Pacific follow closely behind. Despite having the highest vaccination rate per 100 people, Europe still has the highest number of new cases and the second highest number of deaths in the last seven days. Some may wonder whether the vaccine does not provide protection against the virus. Further analysis of COVID data from European countries will be presented in the next two sessions.

2.2. Europe Data

From this part onwards, the dataset from the Our World Data website will be used for further analysis. Figure 3 shows the ten countries with the highest number of confirmed cases in the last seven days, associated with the number of deaths for each country listed below.

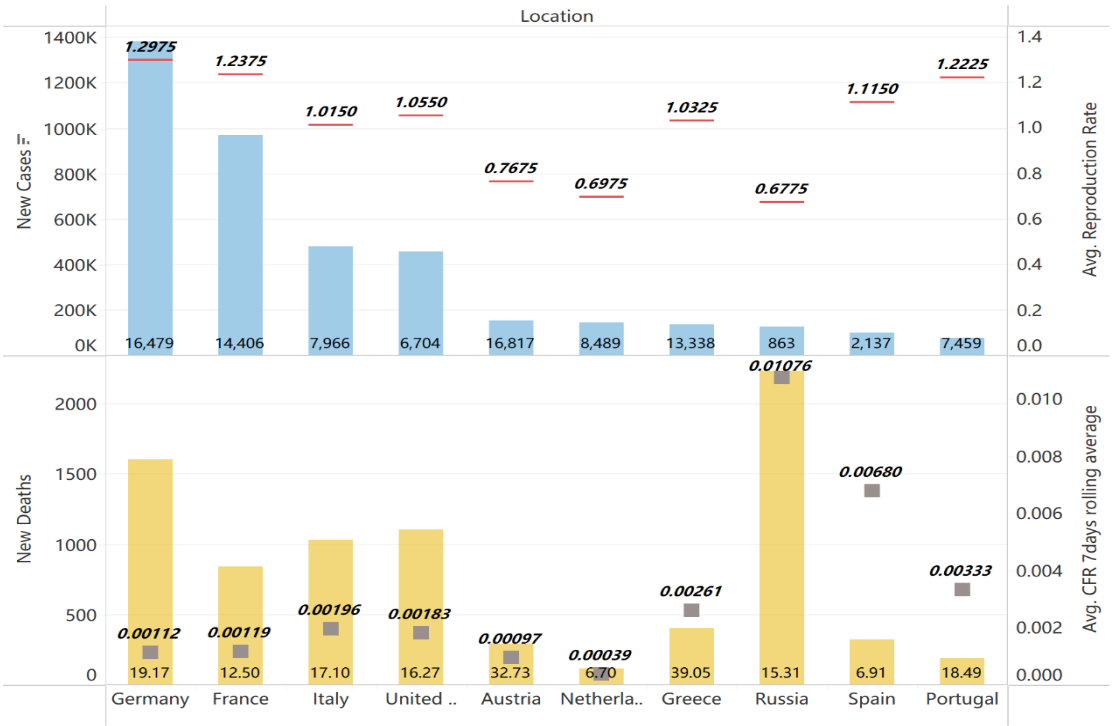

Figure 3 Top 10 Countries with the highest newly-reported cases (with death) in last 7days

Here, there are two important indices in epidemiology to better understand the pandemic – Reproduction rate and Case Fatality Rate. In some publications, the reproduction rate, also known as the basic reproduction number or R value, refers to the average number of new infections caused by a single infected individual in a completely susceptible population [12].It is a widely used parameter to present the transmission of infectious

diseases. If the rate exceeds one, the virus has the potential to spread throughout the population. [12] If it falls below 1, the number of instances in the population will gradually decline until it reaches zero. [12]. Additionally, the Case Fatality Rate (CFR) is a measure of severity among detected cases, which represents the proportion of deceased patients in the confirmed cases of disease [13]. The lag time might be caused by the incubation period (time from exposure to having symptoms) and the extra time needed to test PCR or report [14]. Due to the time lag of the ongoing pandemic, CFR here is calculated by:

$$CFR\ in\ \% = \frac{The\ number\ of\ deaths\ in\ a\ given\ day}{The\ number\ of\ cases\ confirmed\ 10\ days\ earlier} * 100$$

This way to estimate case fatality is also discussed by Abdullatif Khafaie, M. and Rahim, F. (2021) [15].

From the above graph, Germany has the highest newly reported cases with the highest average reproduction rate of 1.2975 in the last seven days, whereas the CFR is not as high as one might think. Russia has the highest value of CFR at 1.076%, and the number of deaths from the pandemic is indeed much higher than in other countries. In terms of epidemic data during the last seven days, the figures for the UK are not very promising either – the fourth highest number of confirmed cases and the third highest number of deaths. This could be caused by the impact of the removal of all COVID restrictions in the UK since mid-March [7]. To continue, further data from the UK must be analysed with the combination of the epidemic control measures or other factors.

2.3. The UK Data

2.3.1. Graph

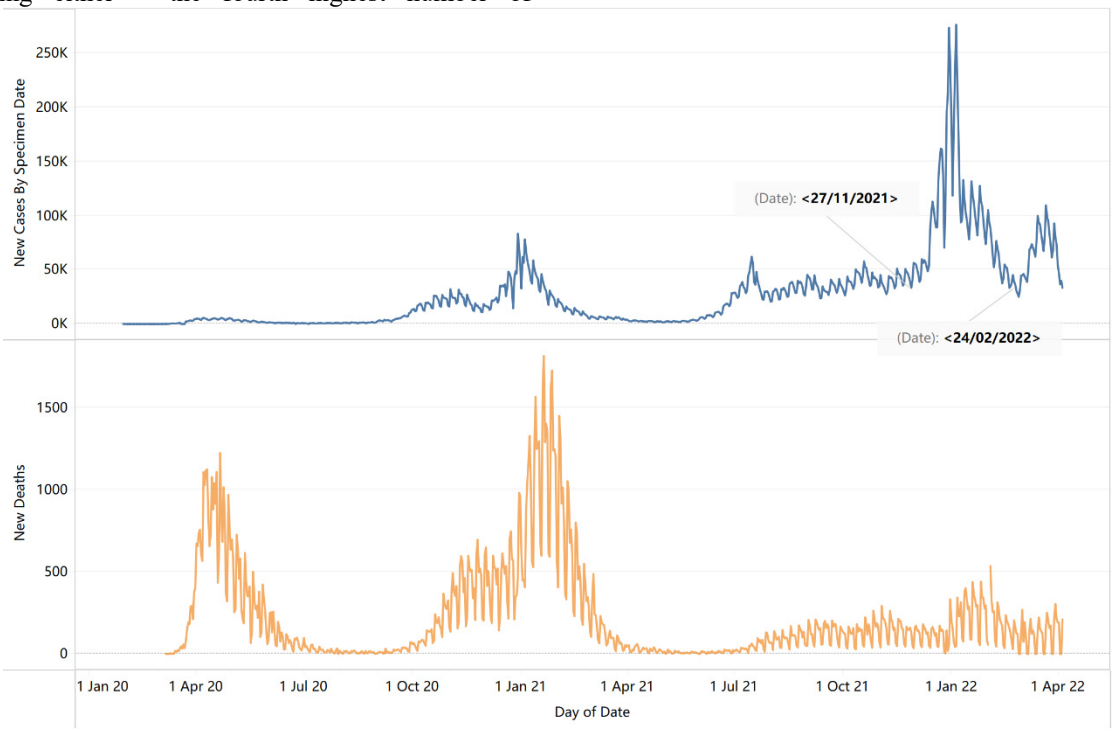

Figure 4 Overall trends for new cases and death in the UK

By now, by looking at the overall trends of UK COVID data, we could intuitively conclude that the virus has mutated to become more transmissible, but the death rate of the pandemic seems to have been reduced. The UK government reported the first case of the Omicron variant identified on November 27, 2021 [16]. In the following month, Omicron took over the top share for SARS-CoV-2 variants in the UK, and it was rapidly leading to a surge in the number of daily confirmed cases, but the number of deceased people did not increase dramatically at the same time. The share of all sequences analysed in the last three months was 96% or more for the Omicron variant with its sub-lineage BA.2 [17]. On the one hand, the UK announced the lifting of all COVID measures on February 24th and the lifting of international travel restrictions on March 18th. This might contribute to another small peak in the number of new cases during March.

2.3.2. Multiple Linear Regression

At the beginning of the pandemic, Smita Rath built a multiple linear regression (MLR) model to predict the new active cases of COVID-19 [18]. LiLin Liang also

investigated that the mortality rate of infectious diseases is negatively associated with test numbers and government measures by MLR [19]. We will also use a multiple linear regression model to comprehensively consider the impact of each factor on the number of new cases by ordinary least square (OLS) estimators since the first Omicron case was reported in the UK. The independent variables used are the stringency index, reproduction rate, positive rate, and new vaccinations. It is impossible to get the mean value of number of new cases when all of these regressors are equal to zero. In other words, there is no way to determine the number of people who have positive results without any testing. That's why the intercept (also called constant term) is not included in the model. The causal relationship between the number of new cases and R value might be abstract, but a high increase in daily new cases is always accompanied by a relatively high value of the reproduction rate. The government stringency index is a composite metric based on nine response indicators, such as school and workplace closures, face-covering policies, public gathering rules, travel bans, etc. [20]. Moreover, the log transformation of the number of new vaccinations is imposed because of the asymmetry of distribution caused by positive skewness.

The regression results are displayed below:

Linear regression

Number of obs	= 111
F(5, 106)	= 502.70
Prob > F	= 0.0000
R-squared	= 0.9194
Root MSE	= 28072

new_cases	Coefficient	Robust std. err.	t	P>|t|	[95% conf.	interval]
reproduction_rate	21992.84	12149.12	1.81	0.073	-2093.962	46079.65
positive_rate	837893.1	139372.3	6.01	0.000	561574	1114212
new_tests	.0973462	.0109083	8.92	0.000	.0757195	.1189729
lnnew_vaccinations	-9413.014	1582.442	-5.95	0.000	-12550.36	-6275.668
stringency_index	-31.27003	454.7878	-0.07	0.945	-932.9311	870.391

Figure 5 MLR Output

In order to produce unbiased OLS estimators, the use of Robust standard errors, which adjust the model-based standard errors using the empirical variability of the model residuals, the difference between the observed outcome and the outcome predicted by the statistical model, is essential. [21]

All coefficients of covariates except the one of the stringency index are statistically significant with p values lower than 0.1, which is the critical value at 10% levels of significance. Even the coefficients of positive rate, new tests, and new vaccinations are significant at 1% levels of significance. Therefore, these four factors could provide useful information when modelling the number of daily new cases. But the UK government's policies or regulations for controlling COVID might have little impact on the number of new confirmed cases. We are going to interpret the estimated coefficients of the four significant covariates. An increase in the reproduction rate by 0.01 could lead to the number of positive cases increasing by 220 people. Once there is a 0.01 increase in the percentage of positive cases in daily tests, the daily confirmed cases will increase by 8379 people. The daily new tests for detecting COVID-19 also affect the number of reported cases, where the corresponding coefficient indicates that performing 10 more tests on COVID-19 could lead to an approximate 1 person increase in the response variable. In terms of the vaccination situation, a 1% increase in daily new vaccinations would result in a reduction of 94 people in newly-reported cases.

3. DISCUSSION

Generally speaking, the direction of the impact of all the factors we are considering on the number of new diagnoses was consistent with our perception. The R-squared obtained in this regression model is 0.9194, which means that there is around 92% variance for the number of new cases that is explained by these five regressors. The effectiveness of the stringency index is less likely to influence the UK's daily new cases. But in reality, it could support more practical reference if we interpret the coefficient of the government control measures in relation to the strength of their implementation. For example, China has very strict restrictions against the spread of the disease, which means the results we obtained in this paper could not provide a good reference for China's COVID policies.

On the other hand, several countries around the world are currently facing new variants of coronavirus or 3 recombinant lineages being monitored as part of horizon scanning: XD, XE, and XF [22]. Although our model in 2.3.2 shows that the vaccines currently in use are still effective in reducing the number of infections, there is no certainty that they will remain effective as the SARS-CoV-2 is mutating at a faster rate with more and more variants. Because of a change in testing policy, most people will be unable to obtain free lateral flow tests after April 1, 2022 [8], the time between experiencing symptoms and receiving testing results may be longer.This could cause a greater extent of lag on the

daily new tests. Therefore, the MLR to model the number of new cases might only work well in the short term. The uncertainty caused by the effectiveness of vaccines and the implementation of the new policies may cause the simulation results to depart from the true scenario.

4. CONCLUSION

This paper analyses the global distribution of new confirmed cases in each region over the past seven days and finds that Europe accounts for almost half of the total number of cases, although Europe has the highest vaccination rates in the world. This is followed by the analysis of the numbers of newly infected and deceased people for ten European countries in the last seven days. To further explore the factors influencing the number of new cases, we used the COVID data from the United Kingdom since the first Omicron variant was identified. The reproduction rate, new tests per day, and the share of positive results in total tests per day have positive effects on the number of new cases. Unsurprisingly, there is a negative association between daily new vaccinations and new confirmed cases. The model result shows the UK government's rules for controlling COVID, mainly the Omicron variant, might have little negative impact.

At this particular time when the new variants BA.2 and others are more likely to spread and the effectiveness of the vaccine against them is still uncertain, the analysis of recent data from the UK, which is one of the countries that have lifted the COVID restrictions, could provide a statistical reference for countries that have not. More importantly, because different countries have varying levels of government control enforcement, the impact of the stringency index could only be used as a benchmark for countries with similar levels of enforcement as the UK. It is more realistic for other countries to impose the epidemic measures according to their national conditions.

This paper does not discuss the effectiveness produced by different vaccines that are used in different countries or regions, nor does it go further in the model to explore the correlation with the number of new cases per day. Meanwhile, as the antibody responses produced by the COVID-19 vaccines decay over time [23], and the ability of the vaccine to fight the virus gradually diminishes, the correlation between the antibody levels in the human body and new cases could exist. Therefore, if we want to explain the new confirmed in a country, it may be of more practical value to consider the type of vaccine used in that country and the decline in antibody levels corresponding to that vaccine.

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