DEPARTMENT OF STATISTICAL SCIENCES, UNIVERSITY OF TORONTO

Why Variant Omicron of COVID-19 is a Sign of the End of Pandemic? A Statistical Analysis Based on the SIR Model

Jiaqi Bi
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ABSTRACT There some new report and articles indicate that the Omicron variant may be the start of the ending of the COVID-19 global pandemic. We are using deterministic SIR Model to compare the Delta wave and Omicron wave to see the difference. The results show that Omicron has higher transmission rate but much higher removal rate, and the density of the Omicron variant is much less than the Delta. This implies that the Omicron wave lasts less time periods than the Delta. Thus, we will understand why people tend to conclude that the Omicron is the ending of the pandemic.

1 INTRODUCTION

The world is now fighting against a severe public health issue of COVID-19, which has caused more than 5 millions of deaths. However, there is an optimistic sign that some healthcare workers have mentioned that the variant of Omicron may be the ending theme of this global pandemic starting from 2019. There are facts in the research of epidemiology that all pandemics end eventually, and we will use some statistical findings to interpret the analysis based on different variants of COVID-19 daily new cases in Maharashtra State of India, Belgium, New York state of USA and London of England. The study is solely based on the SIR model that widely used in the area of mathematical modelling in epidemiology.

2 METHODS

2.1 SIR MODEL

Definition 2.1. *We have a given time point t where every individual can only be one of three states of Susceptible (S_t), Infectious (I_t), or Removed (R_t). That is,*

$$S_t + I_t + R_t = 1 \text{ for all } t$$

The analysis within this study is considered as the SIR Compartmental Model where $\frac{dS_t}{dt} = -\beta S_t I_t$, $\frac{dI_t}{dt} = \beta S_t I_t - \gamma I_t$, and $\frac{dR_t}{dt} = \gamma I_t$ where β is the transmission rate, and γ is the removal rate.

2.2 COVID-19 Daily New Cases Visualization

The study will analyze two waves of variants of Delta and Omicron to see the difference of parameters produced to the SIR model, and will compare these two waves.

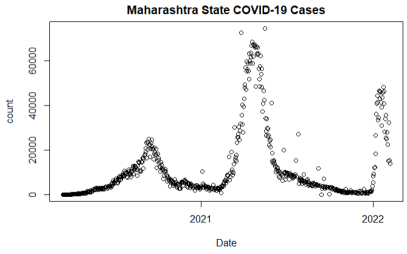

Figure 2.1: Maharashtra COVID-19 Cases

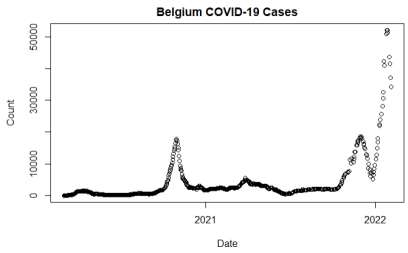

Figure 2.2: Belgium COVID-19 Cases

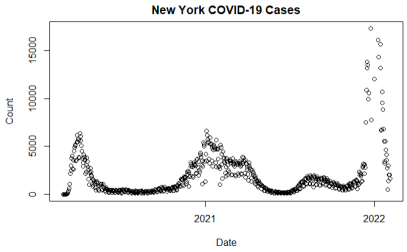

Figure 2.3: New York COVID-19 Cases

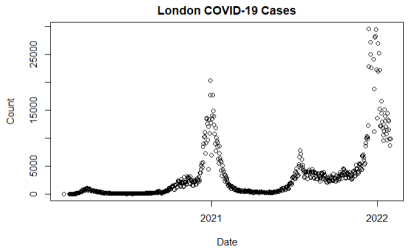

Figure 2.4: London COVID-19 Cases

Note some of countries have higher cases for Omicron while the Delta wave was not comparably significant, but the data is still manageable for analysis since we have the assumption that all waves of epidemiology follow SIR behavior.

3 Results

3.1 Maharashtra State of India

By fitting the SIR model, we have the following ODE results of Delta wave for Maharashtra State:

$$\frac{dS_t}{dt} = -0.3412 S_t I_t$$

This indicates that the transmission rate of Delta variant in Maharashtra is 0.3412 per time period, and the susceptible proportion decreases as infectious proportion increases.

$$\frac{dI_t}{dt} = 0.3412 S_t I_t - 0.0967 I_t$$

This applies to the infectious proportion increases with the rate of 0.3412, and the removal rate is 0.0967 where infectious proportion changes with some people become infected from susceptible population and some people become recovered or deceased from the infectious population.

$$\frac{dR_t}{dt} = 0.0967 I_t$$

The removal rate indicates how much the proportion of infectious population becoming recovered or deceased.
Then we have the following results of Omicron wave in Maharashtra State:

$$\frac{dS_t}{dt} = -1.7223 S_t I_t$$

$$\frac{dI_t}{dt} = 1.7223 S_t I_t - 0.0338 I_t$$

$$\frac{dR_t}{dt} = 0.0338 I_t$$

Figure 3.1 shows that our proposed SIR parameters do fit the real data well, so we will continue to use these parameters for the SIR visualization and analysis.

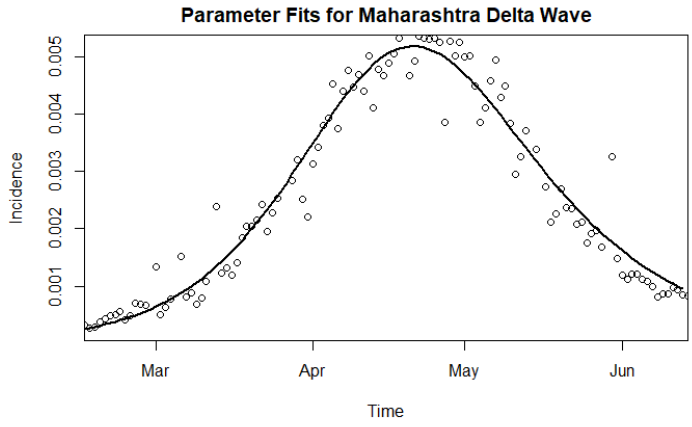

Figure 3.1: Proposed SIR Parameters Fits the Real Data

Based the the parameters we have for two SIR models, as well as the initial Susceptible and Infectious proportion as shown in Table 3.1, we can visualize the SIR model to compare the simulated infections of two variants.

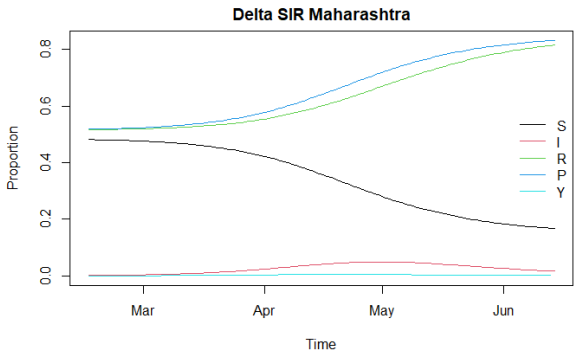

Figure 3.2: Maharashtra Delta SIR Model

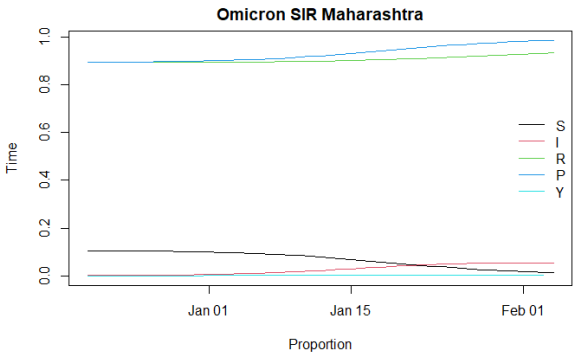

Figure 3.3: Maharashtra Omicron SIR Model

Figure 3.2 and Figure 3.3 have shown the difference between two variants, where Delta variant caused the most COVID-19 cases around May and it lasts for 4 months. However, Omicron variant in Maharashtra has higher transmission rate that susceptible population proportion decreases rapidly within one month. But the removal proportion increases within one month as well.

3.2 Belgium

According to the Belgium COVID-19 data, and the simulation of SIR model, we can generate the following results for Delta wave in Belgium:

$$\frac{dS_t}{dt} = -0.1975 S_t I_t$$

$$\frac{dI_t}{dt} = 0.1975 S_t I_t - 0.1394 I_t$$

$$\frac{dR_t}{dt} = 0.1394 I_t$$

and the SIR model for Omicron wave in Belgium:

$$\frac{dS_t}{dt} = -0.1575 S_t I_t$$

$$\frac{dI_t}{dt} = 0.1575_t I_t - 0.05 I_t$$

$$\frac{dR_t}{dt} = 0.05 I_t$$

With the parameters we proposed, the visualization of two variants comparison can be formed as shown in Figure 3.4 and Figure 3.5.

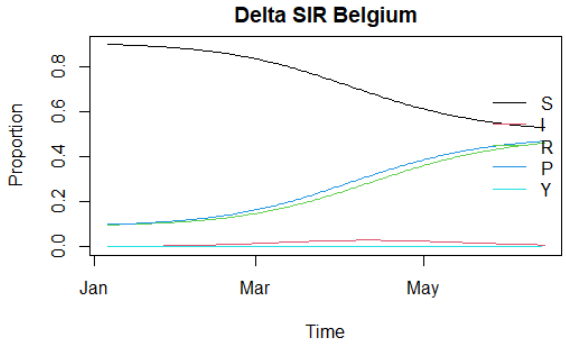

Figure 3.4: Belgium Delta SIR Model

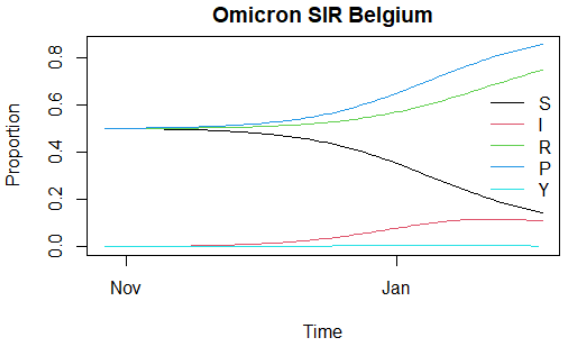

Figure 3.5: Belgium Omicron SIR Model

The graph indicates that the Omicron variant in Belgium is highly infectious, but the removal rate is comparably much higher than the Delta variant. Most of incidents happened within a month for Omicron variant while Delta variant lasts as long as three to four months.

3.3 New York City of the US

Based on the data of COVID cases in New York, we can produce the output of the SIR model as following for Delta wave:

$$\frac{dS_t}{dt} = -0.1234 S_t I_t$$

$$\frac{dI_t}{dt} = 0.1234 S_t I_t - 0.0684 I_t$$

$$\frac{dR_t}{dt} = 0.0684 I_t$$

and the SIR model for Omicron wave in Belgium:

$$\frac{dS_t}{dt} = -0.1145 S_t I_t$$

$$\frac{dI_t}{dt} = 0.1145_t I_t - 0.0236 I_t$$

$$\frac{dR_t}{dt} = 0.0236 I_t$$

The proposed parameters are informative if we take a close look to the visualization as shown in Figure 3.6 and Figure 3.7.

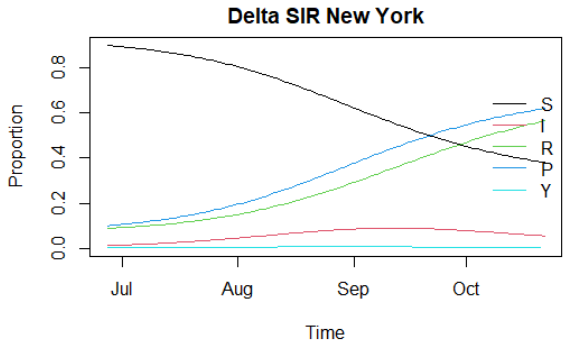

Figure 3.6: Belgium Delta SIR Model

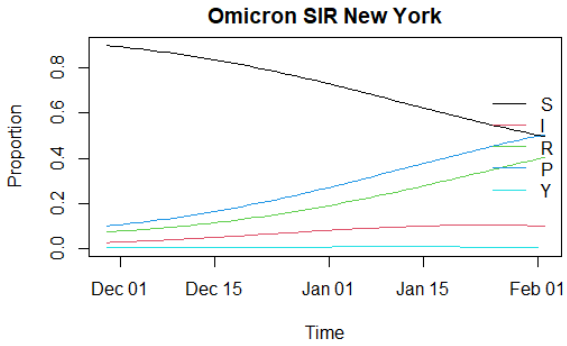

Figure 3.7: Belgium Omicron SIR Model

The two SIR models for Delta and Omicron waves indicate that Delta variant lasts longer than Omicron variant, but the transmission rates are very similar. However, Omicron has a rapid increasing in the infectious population proportion and the removal population has increased expeditiously.

3.4 London of the UK

London has the SIR model for Delta variant and Omicron variant as following:

$$\frac{dS_t}{dt} = -0.0486 S_t I_t$$

$$\frac{dI_t}{dt} = 0.0486_t I_t - 0.0255 I_t$$

$$\frac{dR_t}{dt} = 0.0255 I_t$$

and the Omicron SIR model follows the following:

$$\frac{dS_t}{dt} = -0.0958 S_t I_t$$

$$\frac{dI_t}{dt} = 0.0958_t I_t - 0.0143 I_t$$

$$\frac{dR_t}{dt} = 0.0143 I_t$$

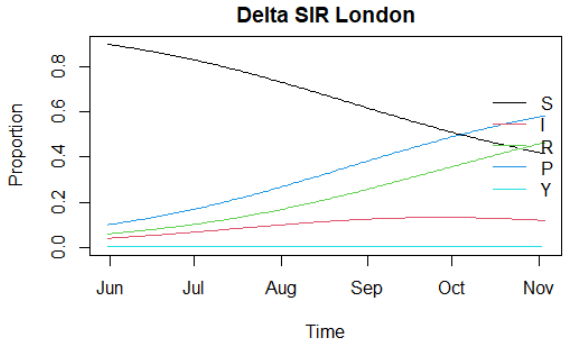

Figure 3.8: London Delta SIR Model

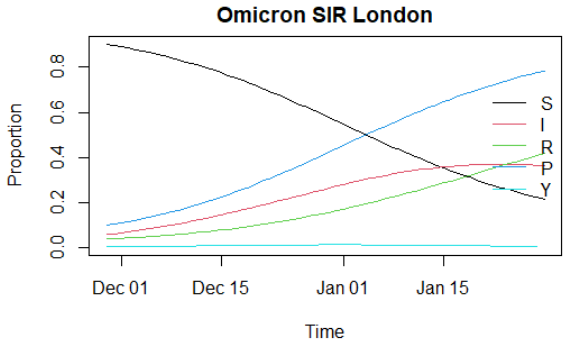

Figure 3.9: London Omicron SIR Model

Moreover, the SIR model shows a quick decreasing of susceptible population while the infectious and removal population have increasing trend with a sharp ratio for Omicron variant. The Delta SIR model

shows a 6 months of suffering for the variant, while the Omicron only shows a one to two months of pandemic in London as shown in Figure 3.8 and Figure 3.9. The Omicron has a feature that it transmits rapidly but the infectious rate drops in one month in London. Unlike Delta variant, it consistently increases until November from June.

3.5 Overview

All areas we are analyzing show a big difference for Delta wave and Omicron wave, while Omicron indeed shows a higher transmission rate in the beginning but it drops rapidly as well.

Table 3.1: Initial Susceptible and Infectious Proportion and Parameters

	Susceptible	Infectious	Transmission Rate	Removal Rate
Maharashtra				
Delta	0.4818	0.0015	0.3412	0.0967
Omicron	0.1056	0.0010	1.7223	0.0338
Belgium				
Delta	0.9000	0.0020	0.1975	0.1394
Omicron	0.9000	0.0000	0.1575	0.0500
New York				
Delta	0.9000	0.0120	0.1234	0.0684
Omicron	0.9000	0.0266	0.1145	0.0236
London				
Delta	0.9000	0.0402	0.0486	0.0255
Omicron	0.9000	0.0603	0.0958	0.0143

As shown in Table 3.1, the initial parameters show a higher transmission rate for variant Omicron in Maharashtra State and London. Based on the initial parameters, we are able to construct the comparisons with a full timeline of Delta wave and Omicron wave to see the difference between two waves.

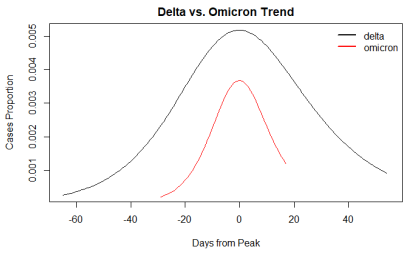

Figure 3.10: Delta vs. Omicron in Maharashtra

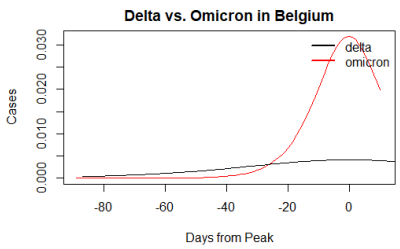

Figure 3.11: Delta vs. Omicron in Belgium

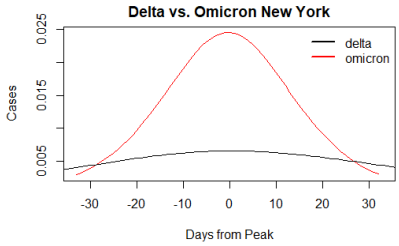

Figure 3.12: Delta vs. Omicron in New York

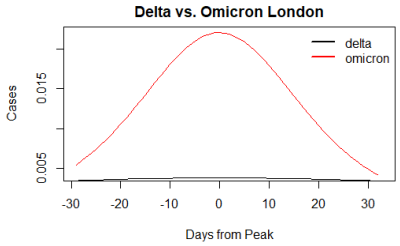

Figure 3.13: Delta vs. Omicron in London

Figures above illustrate that how Omicron may have higher incident rates and lower time periods. While some of areas do not have a significant Delta wave, so the graph may contain a bad Delta incident graph.

4 Conclusion

While some people may say "Omicron wave has narrower behavior than Delta wave" according to data reports in the news or on certain websites. However, it is not a coincidence. The Omicron variant has higher transmission rate while the Delta has longer lasting periods. As shown in Figure 3.10 to Figure 3.13 where the Omicron mostly has a higher incident proportion than the Delta variant, but it shows a quick increasing and rapid decreasing as well while the Delta wave is mostly consistent. Thus, based on the statistical analysis in these three areas, we can optimistically conclude that the Omicron may be the ending theme of the pandemic. However, this does not apply to that everyone can now stop practicing public health suggested prevention or measurements. The analysis of these two variants is based on the same public health interventions and prevention for the response of the pandemic.

5 Limitation and Discussion

Usually, the wave of Delta and Omicron have similar curve of pandemic. But some of regions do not have significant Delta wave such as Belgium. This makes the model fitting a bit harder where parameters are difficult to identify in this case. There may be a better solution to compare the previous waves to the Omicron wave to prove that the epidemiology will finally end.