Reduction in the infection fatality rate of Omicron (B.1.1.529) variant compared to previous variants in South Africa

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Abstract: Omicron variant has caused global concern. In this work, we estimate the transmissibility and infection fatality rate of Omicron (B.1.1.529) variant based on data in South Africa. We found that the peak transmissibility of the Omicron (B.1.1.529) variant is more than 3-fold of that of the previous variant while the infection fatality rate is substantially decreased. The reduction in the infection fatality rate is 87.8% with an 95% confidence interval (79.3% , 92.8%).

Keyword: COVID-19; Omicron; Infection fatality rate.

Introduction

The coronavirus pandemic has been going on for nearly two years since 2019, according to the WHO, there were over 260 million cases have been reported and including more than 5 million deaths [1]. The virus, first identified in late 2019, has mutated multiple times and has been classified by the WHO into three categories: variants of concern(VOC), variants of interest (VOI) and variants under monitoring (VUM). As four of the variants of concern which includes Alpha (B.1.1.7) variant, Beta (B.1.351) variant, Gamma (P.1) variant and Delta (B.1.617.2) variant have been responsible for a large number of infections and deaths worldwide, Omicron (B.1.1.529) variant was designated as the fifth VOC on 26 November 2021. [2]

Before the Omicron (B.1.1.529) variant emerged, South Africa had seen three waves of concentrated infections affected by the variant virus, with nearly 3 million confirmed cases. The first infections occurred in March 2020, peaked in July and ended in September. [3] The second wave of the epidemic, with Beta (B.1.351) variant, began in October 2020 with progressively higher levels of infection in Nelson Mandela Bay, followed by Eastern Cape, Western Cape, and Kwazulu-Natal experiencing a second wave of transmission by early December. [4] In May 2021, the emergence of the Delta (B.1.617.2) variant led to a third outbreak in South Africa. According to [5], the Delta (B.1.617.2) variant in South Africa quickly replaced the Beta (B.1.351) variant and began to spread rapidly, peaking in July, when the Delta (B.1.617.2) variant accounted for 86% of the viruses sequenced in the first week.

The Omicron (B.1.1.529) variant, which quickly became the main variety in Gauteng, was first detected in South Africa on 23 November 2021, followed by a dramatic increase in the number of infections, with more than 2,000 cases of omicron (B.1.1.529) in South Africa as of early December 2021. [6] As the most mutable variant, the omicron (B.1.1.529) variant has at least 30 amino acid substitutions, three deletions and one small insertion. It is noteworthy that 15 of the

30 amino acid substitutions are located in the receptor binding portion (RBD), includes: S371L, S373P, S375F, K417N, N440K, G446S, S447N, T478K, E484A, Q493R, G496S, Q498R, N501Y, Y505H, T547K, D614G. [7] Additionally, the Omicron (B.1.1.529) variant carries the mutation found in other variants of concern, has a deletion at the peak position 60-79, and has three key mutations similar to the Beta (B.1.351) variant, gamma (P.1) variant, which may increase its ability to escape immunity. [8] According to [9], the neutralization ability of serum and Omicron (B.1.1.529) variants in convalescent patients infected with early and Delta (B.1.617.2) strains was very low. In particular, neutralizing antibody titers of the Omicron (B.1.1.529) variant decreased 36 times during recovery from early infection. This also contributes to the omicron (B.1.1.529) variant immune escape ability.

Fortunately, the severity of the Omicron (B.1.1.529) variant seems to differ from that of its predecessors. According to [10], In Tshwane, South Africa, the bed occupancy rate during peak infection of the Omicron (B.1.1.529) variant was about half that of the Delta (B.1.617.2) variant, suggesting that the relative number of cases of hospitalization for Omicron (B.1.1.529) infection was lower than for the Delta (B.1.617.2) strain. At the same time, fewer ICU admissions and shorter hospital stays may indicate reduced disease severity caused by Omicron (B.1.1.529) variant.

Method

In this work, we study the infection fatality rate in South Africa. We found that the COVID-19 case and death reporting in South Africa was consistent overtime. For instance the reported COVID-19 death was consistently 1/3 of the excess deaths. The raw infection fatality rate (IFR) was consistent over time before the emergence of the Omicron (B.1.1.529) variant. After the emergence of Omicron (B.1.1.529) variant, the raw IFR seemingly decreased significantly. This motivated us to fit our previous proposed SEIHDR [11-13] (susceptible-exposed-infectious-hospitalized-death-recovered) model to the observed case and death data. We assume a proportion of the infectious was reported and we fit the reported COVID-19 deaths, but we note that the reported COVID-19 deaths were likely only 1/3 of the true COVID-19 deaths based on the excess deaths. We also obtain the proportion of dominant variants sampled over time from [14]. Finally we incorporate the vaccination coverage (fully vaccinated population per hundred). We denote the proportion of Omicron (B.1.1.529) variant is ω_t. We assume the IFR of the previous variant is IFR_1, the IFR of the Omicron (B.1.1.529) variant is IFR_2. Thus the overall IFR of an one-strain model is (1-ω_t) IFR_1+ ω_t IFR_2, i.e, a weighted average of the two IFRs. Then we fit our SEIRHDRV model (with vaccination) [15,16] to the observed case and death data. We assume a vaccine efficacy of 85% against both infection and deaths. The reporting ratio of cases is not higher than 7%. This can be seen from total reported cases in the country and high value of seroprevalence from serological studies[17]. We assume the eventually 80-85% of the whole population were infected, and we considered imperfect vaccine efficacy and we ignore the re-infection. We note that the re-infection of the Omicron (B.1.1.529) is high. However, by ignoring the re-infection route, we synthesize the immunity escaping (either through vaccination or prior infection) ability of Omicron (B.1.1.529) into its transmissibility. The immunity escaping ability concerns the size of the susceptible pool S, while the transmissibility concerns β. Unfortunately, these two terms appear in product in our model. We argue that these two cannot be disentangled through this kind of modelling. However if we synthesize both changes into β. We quantify the overall risk of Omicron (B.1.1.529). We note that the changes in β, or $\mathcal{R}_t$ are coming from two sources: namely the enlarge of susceptible pool due to immunity escaping and the intrinsic transmissibility.

Result

In Figure 1, we show our fitting result of four waves in South Africa. Our model simulations (green curve) match the reported case and death (red circle) reasonably well, cases in panel (a) and deaths in panel (b) . The black curve shows the counterfactual scenario when vaccination was absent. The estimated IFR1 is about 0.277%, as we discussed we knew the reported death is only 1.3 of excess deaths. It was generally believed that the excess death is a good proxy of the true COVID-19, thus the true IFR could be 0.831% which was well in line with current knowledge of COVID-19 before Omicron (B.1.1.529) variant. The inset panel in panel (b) show the log likelihood profile versus the reduction in IFR. We find that the reduction in IFR is 87.8% with an 95% confidence interval (79.3%, 92.8%).

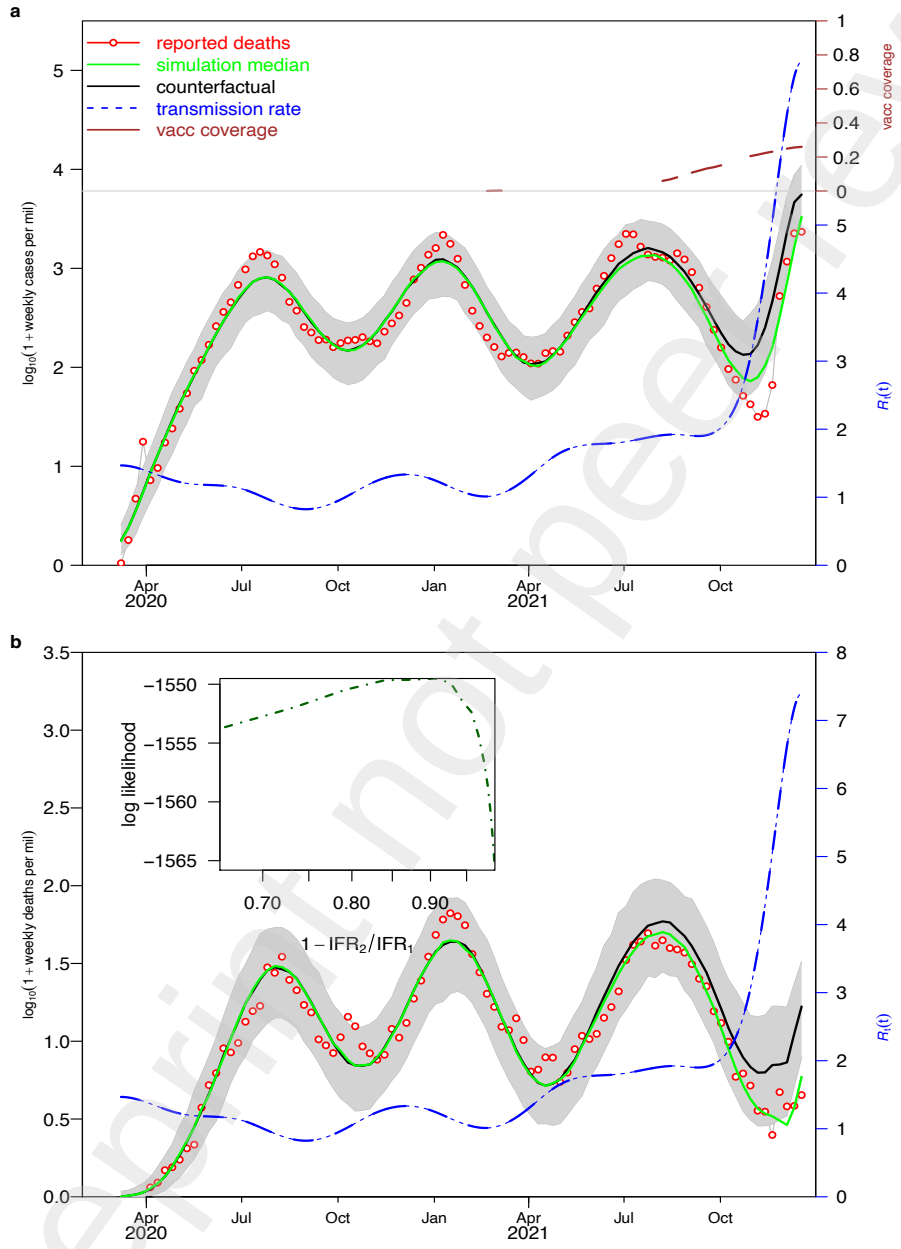

Figure 1. Fitting an SEIHDRV model to reported cases and deaths in South Africa. We denote the proportion of Omicron variant is ω_t. We assume the IFR of the previous variant is IFR_1, the IFR of the Omicron variant is IFR_2. Thus the overall IFR of an one-strain model is $(1-\omega_t)\ IFR_1 + \omega_t\ IFR_2$, i.e, a weighted average of the two IFRs.

Limitation

We assume that the case testing/reporting effort was consistent. While this might not be always true. When a new variant emerged, the testing effort of cases could be enhanced. Thus the IFR we estimated could be underestimated for Omicron (B.1.1.529) variant due to this transient effect.

Conclusion

In summary, we found that the transmissibility of Omicron (B.1.1.529) variant (including due to immunity escaping) Is more than 3-fold higher than previous variant, which is in line with our previous estimate[18]. The IFR of Omicron (B.1.1.529) variant is about 1/10 of previous variant.

Declarations

-Ethics approval and consent to participate

This study only reanalyzed publicly available data which were carried out in accordance with relevant guidelines and regulations.

-Consent for publication

Not applicable.

-Availability of data and materials

All data are publicly available. https://ourworldindata.org/grapher/covid-variants-area. The Our world in data obtained their variant data from GISAID.

Competing interests

The authors declare that they have no competing interests.

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-Authors' contributions

All authors conceived the study, carried out the analysis, wrote the draft, revised the manuscript critically, and approved it for publishing.

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