Mathematical model shows high viral transmissions reduce progression rates for severe COVID-19

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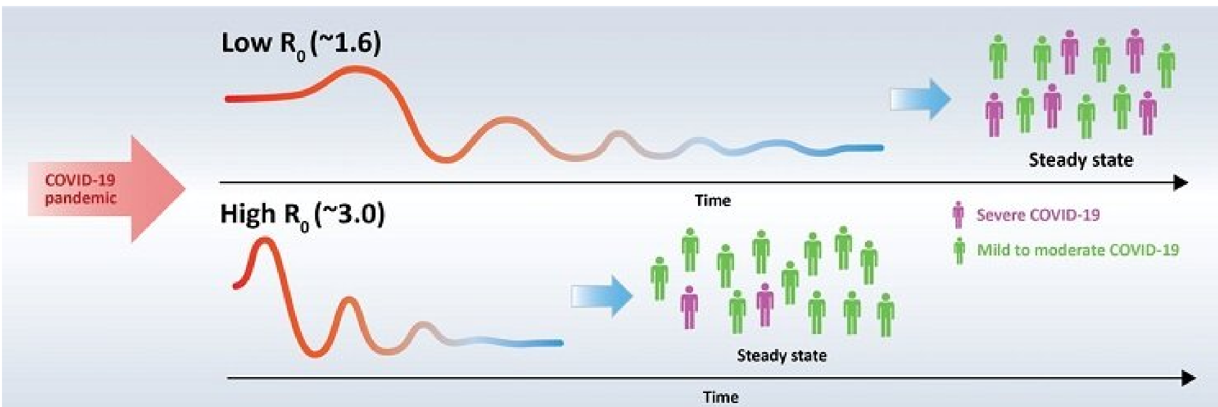

In the study, courses of endemic transition of COVID-19 were estimated by mathematical modelling. The analysis shows an unexpected advantage of increased viral spread (high R0): a faster transition to the endemic phase with lower rates of severe COVID-19 and lower numbers of patients with severe COVID-19. Conditions in which viral spread (R0) increases include relaxing social distancing measures or the rise of variants with higher transmission rates like the omicron variant. Credit: KAIST

A mathematical model demonstrated that high transmission rates among highly vaccinated populations of COVID-19 ultimately reduce the numbers of severe cases. This model suggests a clue as to when this pandemic will turn into an endemic.

With the future of the pandemic remaining uncertain, a research team of mathematicians and medical scientists analyzed a mathematical model that may predict how the changing transmission rate of COVID-19 would affect the settlement process of the virus as a mild respiratory virus.

The team led by Professor Jae Kyoung Kim from the Department of Mathematical Science and Professor Eui-Cheol Shin from the Graduate School of Medical Science and Engineering used a new approach by dividing the human immune responses to SARS-CoV-2 into a shorter-term neutralizing antibody response and a longer-term T-cell immune response, and applying them each to a mathematical model. Additionally, the analysis was based on the fact that although breakthrough infection may occur frequently, the immune response of the patient will be boosted after recovery from each breakthrough infection.

The results showed that in an environment with a high vaccination rate, although COVID-19 cases may rise temporarily when the transmission rate increases, the ratio of critical cases would ultimately decline, thereby decreasing the total number of critical cases and in fact settling COVID-19 as a mild respiratory disease more quickly.

Conditions in which the number of cases may spike include relaxing social distancing measures or the rise of variants with higher transmission rates like the omicron variant. This research did not take the less virulent characteristic of the omicron variant into account but focused on the results of its high transmission rate, thereby predicting what may happen in the process of the endemic transition of COVID-19.

The research team pointed out the limitations of their mathematical model, such as the lack of consideration for age or patients with underlying diseases, and explained that the results of this study must be applied with care when compared against high-risk groups. Additionally, as medical systems may collapse when the number of cases rises sharply, this study must be interpreted with prudence and applied accordingly. The research team therefore emphasized that for policies that encourage a step-wise return to normality to succeed, the sustainable maintenance of public health systems is indispensable.

Professor Kim said, "We have drawn a counter-intuitive conclusion amid the unpredictable pandemic through an adequate mathematical model," asserting the importance of applying mathematical models to medical research.

Professor Shin said, "Although the omicron variant has become the dominant strain and the number of cases is rising rapidly in South Korea, it is important to use scientific approaches to predict the future and apply them to policies rather than fearing the current situation."

The results of the research were published on medRxiv.org on February 11, under the title "Increasing viral transmission paradoxically reduces progression rates to severe COVID-19 during endemic transition."

More information: Hyukpyo Hong et al, Increasing viral transmission paradoxically reduces progression rates to severe COVID-19 during endemic transition (2022). DOI: 10.1101/2022.02.09.22270633

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