

# **A unified nonlinear mathematical model for Beta-CoV**

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## **Abstract**

COVID-19 is a new deadly virus caused by the SARS-CoV-2 coronavirus, first identified in China at the end of 2019. Mathematical modeling is one of the most operative ways to comprehend and manage the growth of such viruses. However, existing models have limitations, including challenges in mathematical analysis and a tendency to represent each virus individually. In this paper, a unified mathematical model is proposed to describe the dynamics of Beta-CoV viruses in the human body, providing insights into their spread and control. This model is adaptable to multiple coronaviruses, including MERS, SARS-CoV-2, COVID-19, and Omicron. The model parameters are carefully adjusted to ensure suitability for each Beta-CoV variant. The stability of the proposed model is analyzed using the Describing Function nonlinear technique. Additionally, the incubation periods of different Beta-CoV viruses are investigated to determine which has the shortest duration in the human body. The model is further extended to study the impact of antiviral drugs on viral dynamics. Finally, a sensitivity analysis is conducted to identify the most influential parameters affecting viral behavior, which can help in developing targeted interventions.

**Keywords:** Coronavirus Describing Function Nonlinear SARS-CoV-2 Virus Clearance Virus Production Sensitivity Analysis