

Effect of under-reporting, vaccine efficiency and social behavior on epidemic progression

Samiran Ghosh^{1,*}, Alonso Ogueda-Oliva², Aditi Ghosh³, Malay Banerjee¹, Padmanabhan Seshaiyer²

¹*Indian Institute of Technology Kanpur, Kanpur - 208016, India*

²*George Mason University, Fairfax, VA, USA*

³*Texas A&M University-Commerce, Commerce, 75429, TX, US*

samiran@iitk.ac.in

In late 2019, the emergence of COVID-19 in Wuhan, China, led to the implementation of stringent measures forming the zero-COVID policy aimed at eliminating transmission. Zero-COVID policy basically aimed at completely eliminating the transmission of COVID-19. However, the relaxation of this policy in late 2022 reportedly resulted in a rapid surge of COVID-19 cases. We investigate the factors contributing to this outbreak using a new SEIR-type epidemic model with time-dependent level of immunity. Our model incorporates a time-dependent level of immunity considering vaccine doses administered and time-post-vaccination dependent vaccine efficacy. We find that vaccine efficacy plays a significant role in determining the outbreak size and maximum number of daily infected. Additionally, with the help of imitation dynamics of under-reporting in daily cases and deaths, we understand the effect of social behavior on the outbreak magnitude. Moreover, we discuss a Physics Informed Neural Networks (PINNs) approach which is extremely useful in estimating critical parameters and helps in evaluating the predictive capability of our model.