Chapter 8
Controlling the Transmission of COVID-19 Infection in Indian Districts: A Compartmental Modelling Approach

Ankit Sikarwar, Ritu Rani, Nita H. Shah, and Ankush H. Suthar

Abstract The widespread of the novel coronavirus (2019-nCoV) has adversely affected the world and is treated as a Public Health Emergency of International Concern by the World Health Organization. Assessment of the basic reproduction number with the help of mathematical modeling can evaluate the dynamics of virus spread and facilitate critical information for effective medical interventions. In India, the disease control strategies and interventions have been applied at the district level by categorizing the districts as per the infected cases. In this study, an attempt has been made to estimate the basic reproduction number R_0 based on publically available data at the district level in India. The susceptible-exposed-infected-critically infected-hospitalization-recovered (SEICHR) compartmental model is constructed to understand the COVID-19 transmission among different districts. The model relies on the twelve kinematic parameters fitted on the data for the outbreak in India up to May 15, 2020. The expression of basic reproduction number R_0 using the next-generating matrix is derived and estimated. The study also employs three time-dependent control strategies to control and minimize the infection transmission from one district to another. The results suggest an unstable situation of the pandemic that can be minimized with the suggested control strategies.

Keywords COVID-19 · India · Districts · Compartmental model · Basic reproduction number · Optimal control theory

A. Sikarwar (✉) · R. Rani
Department of Development Studies, International Institute for Population Sciences, Mumbai 400088, Maharashtra, India
e-mail: anks.sik@gmail.com

R. Rani
e-mail: rituroy4@yahoo.com

N. H. Shah · A. H. Suthar
Department of Mathematics, Gujarat University, Ahmedabad 380009, Gujarat, India
e-mail: nitahshah@gmail.com

A. H. Suthar
e-mail: ankush.suthar1070@gmail.com