



# Dynamical Analysis of COVID-19 Model Incorporating Environmental Factors

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## Abstract

The continuing coronavirus pandemic has come up with considerable questions in front of the world. Presently, India is among concerned countries in Asia. Even though the recovery rate is more than the death rate, it is affecting human lives and experiencing losses to the market. Several methods were employed to study the spread of novel coronavirus. Mathematical modeling is one of the prominent techniques to evaluate the dynamics of novel coronavirus. In this work, we extend the mathematical model SEIAQRDT by incorporating environmental transmission to analyze the transmission of coronavirus in India. The notable aspect of the model incorporates asymptomatic population, quarantine individuals, and environmental transmission factors. These factors have enormous significance in the ongoing COVID-19 outbreak. The basic reproduction number  $R_0$  is calculated theoretically. Bifurcation analysis of  $R_0$  is also done analytically. The existence and stability analysis of disease-free equilibrium (DFE) and endemic equilibrium (EE) points are established. The impact of environmental factors in spreading COVID-19 pandemic is deliberated. The case study for India and Italy is presented and compared with real data, and the results are in accordance with the real situation.

**Keywords** Coronavirus · Environment factors · Asymptomatic · Quarantined · Global stability · Bifurcation

## 1 Introduction

COVID-19 originated in Wuhan, China, in late December 2019 (Wu et al. 2020). In a small-time, the novel coronavirus was transmitted all around the globe. Novel coronavirus disturbs upper respiratory system and causes severe respiratory disease (Oud et al. 2021). COVID-19 was

announced as epidemic by WHO (WHO 2020). It is still an ongoing pandemic. Even though the recovery rate is more comparative to death rate, it affects human lives badly. Around 214,766,860 confirmed cases and 4,477,155 deaths were reported by August 26, 2021, in the world (Worldometer 2020a), whereas in India 32,558,530 confirmed and 4,36,396 death cases have been reported (Worldometer 2020b). COVID-19 outbreak surpassed the previous records of diseases like SARS-Cov syndrome (WHO 2020).

The infectious disease has symptoms for instance fever, throat infection, breath shortening, kidney failure, etc. (World Health Organization (WHO) (2021)). The epidemic is continuously transmitting in lack of proper treatment and vaccine doses. The government implemented many preventive measures like social distancing, self-isolation, quarantining, and wearing masks. This disease has presented many challenges in front of scientists and the medical community (Oud et al. 2021). The coronavirus is an extremely communicable disease spread by micro-droplets in the company of symptomatic and asymptomatic infectious individuals or indirect contact with contaminated

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