

# Chapter 2

# Advancements in Epidemiological Modelling and Control Strategies for Infectious Diseases: Implications for Population Health Management, Pharmacogenomics, and Patient–Centered Care

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## **ABSTRACT**

*The chapter argues that communicable diseases are typically spread from one person to another through contact with blood and body fluids, breathing in an airborne virus, or being bitten by a carrier of the virus. An epidemiological mathematical model is a model that describes epidemics. When a pandemic occurs, mathematical models play an important role in comparing, planning, implementing, evaluating, and optimizing various methods of detection, prevention, treatment, and control programs, contributing significantly to the fight against the spread and control of infectious diseases. Therefore, in order to create an epidemiological model, mechanisms of the spread of each virus as well as characteristics governing the population need to be included. In this chapter, the most common epidemiological models include Susceptible Infectious (SI) (Susceptible-Infected), Susceptible Exposed Infectious Susceptible (SEIS), and Susceptible Exposed Infectious Recovered (SEIR).*

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## INTRODUCTION

In recent years, especially the last two, the spread of the new respiratory infection COVID-19 has rekindled interest in studying and modelling such problems. Consequently, much work is already devoted to developing and analysing epidemic models, but fewer projects provide proper knowledge and mechanisms to control these procedures effectively. Therefore, some details are described in this work, with classic and recent results in the literature.

At the same time, several open problems are described that can benefit from the collective knowledge of optimisation and control theory. In general, modelling an epidemic consists of three components (Abbey, 1952; Ackerman et al., 1984; Allen and Allen, 2003; Thieme, 2003):

- Understanding the propagation mechanisms and how different parameters can potentially influence its development epidemic.
- The ability to predict the evolution of the epidemic.
- The definition of the mechanisms that deal with the outbreak, prevent its possible spread and avoid the risk of conversion into a pandemic.

Therefore, it is vital to create an epidemiological model, including the mechanisms of each virus's spread and the nature/characteristics governing the population. The mechanisms of spread are responsible for how the virus is transmitted, and depending on the species, it can spread differently (Clancy and Green, 2007; Diekmann and Heesterbeek, 2000).

By considering the spread of disease as an effect on the population, scientists can make important decisions about strategic health management planning.

Epidemiological disease modelling of a population is law-based on mass action, which states that the contact rate is proportional to the product of infection and susceptibility in a mixed population. That is, the rhythm of contacts, which plays a role in the infection rate, is directly related to the product of infected persons with those susceptible to the virus (Bailey, 1990).

## EPIDEMIOLOGICAL MODELING

Epidemic models aim to predict the evolution of epidemics. Mathematical models of this kind are fundamental, as epidemics are the leading cause of death worldwide. The transmission mechanism of an infectious disease from one infected person to another susceptible person is understood for almost all communicable diseases, and it is also known how diseases spread through a chain of transmission of infections.

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