

ABSTRACT

The aim of this study is to represent a mathematical model of the Influenza virus that includes many compartments, including susceptible individuals, diagnosed influenza infections with or without virus symptoms. Influenza is the leading cause of morbidity and mortality among respiratory infections, resulting in seasonal epidemics that kill around 500,000 people worldwide each year. The influenza pandemic has had a significant impact on society, the economy, and public health due to its widespread. This research proposes a modified SVEIAIST R model for influenza transmission dynamics. Mathematical models are an effective tool for forecasting the dynamics, outbreaks and control of infectious diseases, but defining the underlying epidemic structure can be difficult, particularly for new and understudied diseases. In this study, the conventional Susceptible- Exposed- Infectious Recovered (SEIR) model is improved by integrating asymptomatic, symptomatic, vaccination and a treatment compartment, and their impact on the transmission of influenza across the population is investigated. Despite international efforts, influenza continues to be a persistent global threat. This entails a comprehensive investigation of our understanding of the disease, paying particular emphasis to its routes of transmission, significant risk factors, and potentially life-long consequences. We first study its basic analytical properties and then go on to numerical simulations. Our analytical research validates the model's validity and practically by establishing the boundedness and positivity of its solutions by using the Laplace Transform. To ensure the model is trustworthy and useful for predicting, we demonstrate its poseness. The threshold parameter is calculated by using the Next Generation approach, which is used to determine the criteria for the existence of equilibria and their stability. To

validate our analytical conclusions, we use the RK-4 numerical technique. A complete quantitative evaluation of the model is carried out, involving the adjustment of vaccination and treatment rates using constant control techniques. Numerical experiments suggest that implementing coordinated control methods and awareness campaigns can accelerate disease eradication efforts. Furthermore, the study highlights critical characteristics that have a substantial impact on the disease's evolution, improving our understanding of the underlying mechanisms. To successfully manage and alleviate disease in the population, we used a sophisticated approach called optimal control strategy, which takes into account time-dependent controls. To analyze the optimal control problem, we use Pontryagin's Maximum Principle (PMP). This initiative aims to identify the most effective time-dependent controls for both susceptible and infected populations. The effectiveness and efficiency of these meticulously designed controls are graphically depicted before and after the optimization process. Our findings provide solid evidence supporting the efficacy of the recommended control techniques, achieving the desired result of reducing financial burdens and limiting illness spread. The influence of this method grows as vaccine distribution rates improve. When immunizations are postponed during an epidemic, the adaptive technique surpasses the continual vaccination strategy, but it requires significantly more vaccine coverage. The study implies that vaccine efficacy plays a critical role in regulating vaccination dynamics during outbreaks. This poses the challenge of how to strike a compromise between vaccination policies' effectiveness and cost-efficiency in the face of restricted vaccine availability.