



MATHEMATICAL MODELING OF VACCINATION STRATEGIES IN INFLUENZA DYNAMICS: A SATURATED INCIDENCE PERSPECTIVE

A. VENKATESH*

Department of Mathematics, AVVM Sri Pushpam College,
(Affiliated to Bharathidasan University, Tiruchirappalli),
Poondi, Thanjavur(Dt.), Tamilnadu, India.
(E-mail: avenkateshmaths@gmail.com)

K. ARUN KUMAR

Department of Mathematics, AVVM Sri Pushpam College,
(Affiliated to Bharathidasan University, Tiruchirappalli),
Poondi, Thanjavur(Dt.), Tamilnadu, India.
(E-mail: arunkaruppusamyvinnai@gmail.com)

and

M. MANIVEL

Department of Mathematics, AVVM Sri Pushpam College,
(Affiliated to Bharathidasan University, Tiruchirappalli),
Poondi, Thanjavur(Dt.), Tamilnadu, India.
(E-mail: manivelmani718@gmail.com)

Abstract. This study explores an $SQVEIR$ epidemic model that integrates saturated incidence and vaccination dynamics to assess disease transmission and control strategies. By accounting for vaccination effects, immunity waning, and the half-saturation constant, the model captures the intricate relationship between disease spread and intervention measures. The stability analysis of both disease-free and endemic equilibria is conducted, with their behavior governed by the control reproduction number R_v . Specifically, the research

*Corresponding author

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investigates how variations in key parameters such as vaccination rates and transmission rates affect disease dynamics and the success of intervention measures. Sensitivity analysis and Partial Rank Correlation Coefficient (PRCC) analysis are utilized to identify the key parameters driving infection spread. The results provide important insights for prioritizing intervention strategies to enhance disease control effectiveness. Furthermore, the study employs 3D surface plots and heatmaps to analyze the effects of biological parameters on the epidemic's behavior, with a particular emphasis on vaccination strategies and immunity dynamics. This work offers a comprehensive framework for understanding the role of vaccination in controlling infectious disease outbreaks and provides insights that can guide the design of more effective public health interventions.