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Global Dynamics and Ergodic Stationary Distribution of a Stochastic Two-Strain Influenza Model with Markovian Switching

Communication Info

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Abstract

This paper proposes an extension of the epidemiological model describing resistant and non-resistant influenza strains [1,2] by incorporating Markovian regime switching. Unlike traditional Gaussian white noise perturbations, this model utilizes a continuous-time Markov chain to capture abrupt structural changes, such as seasonal variations or public health interventions. We formulate a system of stochastic differential equations where transmission and treatment rates switch between multiple discrete states. First, we prove the existence and uniqueness of a global positive solution by employing stochastic Lyapunov functional methods adapted for jump systems [3]. Subsequently, we establish sufficient conditions for the extinction of the disease as well as the existence of an ergodic stationary distribution, ensuring the persistence of the epidemic under specific noise intensities [4]. Finally, numerical simulations using the Milstein method illustrate the impact of regime shifts on the dynamics of both strains. The results demonstrate that regime switching provides a more realistic framework for modeling environmental uncertainty and the management of influenza outbreaks compared to purely deterministic or simple diffusion models.

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