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Full Length Article

Vaccination dilemmas in mitigating monkeypox outbreaks: An imitation dynamics game model approach

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A B S T R A C T

The monkeypox epidemic poses a serious global health threat, making effective control strategies essential. Using a mechanistic SEIR (Susceptible-Exposed-Infectious-Recovered) model, this study incorporates both pro- and anti-vaccination attitudes among susceptibles to examine their impact on transmission. Sensitivity analysis via partial rank correlation coefficients (PRCC) identifies key parameters affecting the basic reproduction number (R_0). The model reveals both forward and backward bifurcations, indicating potential for stable infection states and persistent epidemics. To address vaccination behavior, a coupled vaccination game based on imitation dynamics is introduced. Results show that higher imitation rates increase pro-vaccine adoption and reduce infections. The study highlights the role of social dilemmas, where low pro-vaccine uptake and frequent strategy switching worsen outbreaks. High vaccination costs further reduce social payoff, but strong social learning still promotes uptake, even with low susceptibility or high costs. Overall, social learning strategies can enhance vaccination rates and curb monkeypox spread.

1. Introduction

Monkeypox was first recognized in 1970 in the Democratic Republic of the Congo and is a zoonotic viral disease caused by the Orthopoxvirus [1–3]. A significant outbreak in May 2022 resulted in more than 52,000 PCR-confirmed cases reported in 100 countries, primarily impacting unvaccinated people under the age of 50 [4]. The symptoms are similar to those of smallpox and encompass fever, rash, and swollen lymph nodes, with potential complications including secondary infections, encephalitis, and vision-threatening corneal problems, generally lasting 2 to 4 weeks [5,6]. It spreads through close contact with infected individuals, animals, or contaminated surfaces, such as respiratory droplets and vertical transmission [7–9]. Vaccination continues to be a crucial approach to preventing monkeypox and other infectious diseases [10–14].

In contemporary research, mathematical models are utilized to analyze, predict, or improve intricate systems and processes [15–18]. The authors of [19] investigate the management of Nipah virus outbreaks in pig farms using biosecurity measures and culling strategies. Mansouri et al. [20] introduced a discrete-time model for monkeypox to evaluate optimal control tactics. Allehiany et

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