Global dynamics and bifurcation analysis of a fractional-order SEIR epidemic model with saturation incidence rate

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Abstract

The present paper studies a fractional-order SEIR epidemic model for the transmission dynamics of infectious diseases such as HIV and HBV that spreads in the host population. The total host population is considered bounded, and Holling type-II saturation incidence rate is involved as the infection term. Using the proposed SEIR epidemic model, the threshold quantity, namely basic reproduction number R0, is obtained that determines the status of the disease, whether it dies out or persists in the whole population. The model's analysis shows that two equilibria exist, namely, disease-free equilibrium (DFE) and endemic equilibrium (EE). The global stability of the equilibria is determined using a Lyapunov functional approach. The disease status can be verified based on obtained threshold quantity R0. If $R0 < 1$, then DFE is globally stable, leading to eradicating the population's disease. If $R0 > 1$, a unique EE exists, and that is globally stable under certain conditions in the feasible region. The Caputo type fractional derivative is taken as the fractional operator. The bifurcation and sensitivity analyses are also performed for the proposed model that determines the relative importance of the parameters into disease transmission. The numerical solution of the model is obtained by the generalized Adams- Bashforth-Moulton method. Finally, numerical simulations are performed to illustrate and verify the analytical results.

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