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Dynamics of stochastic delay differential models for COVID-19: case study in the UAE

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Motivation and Aim: Public health science is increasingly focusing on understanding how COVID-19 spreads among humans. For the dynamics of COVID-19, we propose stochastic epidemic models, with time delays; in the first model we consider Susceptible-Infected-Asymptomatic-Quarantined- Recovered (SIAQR) [1, 3]. While in the second model we extend SEIR epidemic model with vaccination. For both models the stationary ergodic distribution of positive solution is examined, in which the solution fluctuates around the equilibrium of the deterministic case, causing the disease to persist stochastically. Theoretically, it is possible to attain infection free status (extinction) in some situations, in which diseases die out and with a probability of one [2, 4]. The numerical simulations and fit to real observations prove the effectiveness of the theoretical results. Combining stochastic perturbations with time delays enhances the dynamics of the model, and white noise intensity is an important part of the treatment of infectious diseases [5].
Results: COVID-19 can be reduced in severity, by prior vaccination (immunization) or the timely use of specific antiviral agents. Vaccination is then operated by reducing the pool of susceptible individuals, and when this is reduced sufficiently, an infectious disease cannot spread within the population. It is not, of course, necessary to vaccinate everyone to prevent an epidemic: immunizing someone not only protects that person but confers some protection to the population in general.
Conclusion: The effect of environmental factors on the spread of COVID-19 is of experimental and theoretical importance in understanding the disease dynamics. Stochastic epidemic model, with time-delays, gives an extra degree of authenticity in comparison with its comparing deterministic show. It is consistent with the physical sensitivity and fluctuation of the real observations.
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