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Global dynamics of two heterogeneous SIR models with nonlinear incidence rate and delays

To investigate the effect of heterogeneity on the global dynamics of two SIR epidemic models with general nonlinear incidence rate and infection delays, we formulate a multi-group model corresponding to the heterogeneity in the host population and a multi-stage model corresponding to heterogeneous stages of infection. Under biologically motivated considerations, we establish that the global dynamics for each of the two models are determined completely by the corresponding basic reproduction number: if the basic reproduction number is less than or equal to one, then the disease-free equilibrium is globally asymptotically stable and the disease dies out in all groups or stages; if the basic reproduction number is larger than one, then the disease will persist in all groups or stages, and there is a unique endemic equilibrium which is globally asymptotically stable. Then we conclude that the heterogeneity does not change the global dynamics of the SIR model when the incidence rate is a general nonlinear function. Our results extend a class of previous results and can be applied to the other epidemiological models. The proofs of the main results use Lyapunov functional and graph-theoretic approach. This is a joint work with Weihua Jiang(HIT) and Shengqiang Liu(HIT).