JUNLING MA, University of Victoria

Comparative Analysis of Simplifications in Behavior-Structured SIRS Dynamics

Human behavior can substantially impact disease dynamics, but fully behavior-structured compartmental models are often high-dimensional and analytically challenging. We compare methods for simplifying a baseline behavior-stratified SIRS model and assess their reliability. We first aggregate the behavioral subclasses within the susceptible and recovered compartments while retaining infectious stratification. Then we use two different approximations, a quasi-steady-state approximation (QSSA) and a population-coverage closure, to combine the stratified infectious classes. The population-coverage closure may increase the threshold transmission rate, while the other two simplifications always retain the disease threshold. Our analytical and numerical analyses show that both the simplification retaining infectious stratification and the QSSA closure reproduce the overall epidemic trends of the baseline model, particularly under fast behavior change. The population-coverage closure can also capture these trends, especially under weaker attenuation, but may substantially underestimate peak prevalence and exhibit large time-averaged absolute prevalence errors under higher transmission, strong attenuation, and slow behavior change. Overall, our results show that it is possible to use a QSSA closure to find a nonlinear force of infection to simplify a behavior-stratified multigroup model to an unstructured model while retaining good qualitative and quantitative fidelity.