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Effects of asymptomatic infectious on the spatial spread of infectious diseases

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ABSTRACT

we propose a susceptible-infective-asymptomatic-recovered patch model to address the influence of asymptomatic infections on the spatial spread of infectious diseases. The multipatch basic reproduction number $\mathcal{R}_0$ of the model is defined and shown to be a threshold quantity for disease eradication and persistence. Namely, the disease disappears if $\mathcal{R}_0 \leq 1$ whereas it spreads otherwise. The monotonicity of $\mathcal{R}_0$ with respect to the dispersal rates of the symptomatic and asymptomatic populations is investigated. In particular, for the two-patch case, $\mathcal{R}_0$ is either strictly decreasing or strictly increasing or constant in terms of dispersal rates. However, nonmonotonic dependence can occur with movement between three or more patches. The asymptotic profiles of the endemic equilibrium (when it exists) as one or all dispersal rates approach zero or infinity are studied. Interestingly, an increase in infectious dispersal may decrease $\mathcal{R}_0$ but increase the number of nonsusceptible individuals. Analytical and numerical results confirm that ignoring asymptomatic carriers not only significantly underestimates the infection risk but also impairs the efficacy of travel restrictions.