



Household epidemic models with varying infection response

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Abstract

This paper is concerned with SIR (susceptible \rightarrow infected \rightarrow removed) household epidemic models in which the infection response may be either mild or severe, with the type of response also affecting the infectiousness of an individual. Two different models are analysed. In the first model, the infection status of an individual is predetermined, perhaps due to partial immunity, and in the second, the infection status of an individual depends on the infection status of its infector and on whether the individual was infected by a within- or between-household contact. The first scenario may be modelled using a multitype household epidemic model, and the second scenario by a model we denote by the infector-dependent-severity household epidemic model. Large population results of the two models are derived, with the focus being on the distribution of the total numbers of mild and severe cases in a typical household, of any given size, in the event that the epidemic becomes established. The aim of the paper is to investigate whether it is possible to determine which of the two underlying explanations is causing the varying response when given final size household outbreak data containing mild and severe cases. We conduct numerical studies which show that, given data on sufficiently many households, it is generally possible to discriminate between the two models by comparing the Kullback-Leibler divergence for the two fitted models to these data.

Key words: Household epidemic model, infector dependent severity, Kullback-Leibler divergence, multitype epidemic, varying response, final outcome data.