

A model for the co-evolution of dynamic social networks and infectious disease dynamics

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Research

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Abstract

Recent research shows an increasing interest in the interplay of social networks and infectious diseases. Many studies either neglect explicit changes in health behavior or consider networks to be static, despite empirical evidence that people seek to distance themselves from diseases in social networks. We propose an adaptable steppingstone model that integrates theories of social network formation from sociology, risk perception from health psychology, and infectious diseases from epidemiology. We argue that networking behavior in the context of infectious diseases can be described as a trade-off between the benefits, efforts, and potential harm a connection creates. Agent-based simulations using a generic model implementation show that: (i) high (perceived) health risks create strong social distancing, thus resulting in low epidemic sizes, (ii) small changes in health behavior can be decisive for whether the outbreak of a disease turns into an epidemic or not, (iii) high benefits for social connections create more ties per agent, providing large numbers of potential transmission routes and opportunities for the disease to travel faster, and (iv) higher costs of maintaining ties with infected others reduce final size of epidemics only when benefits of indirect ties are relatively low. These findings suggest a complex interplay between social network, health behavior, and infectious disease dynamics. Furthermore, they contribute to solving the issue that neglect of explicit health behavior in models of disease spread may create mismatches between observed transmissibility and epidemic sizes of model predictions.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

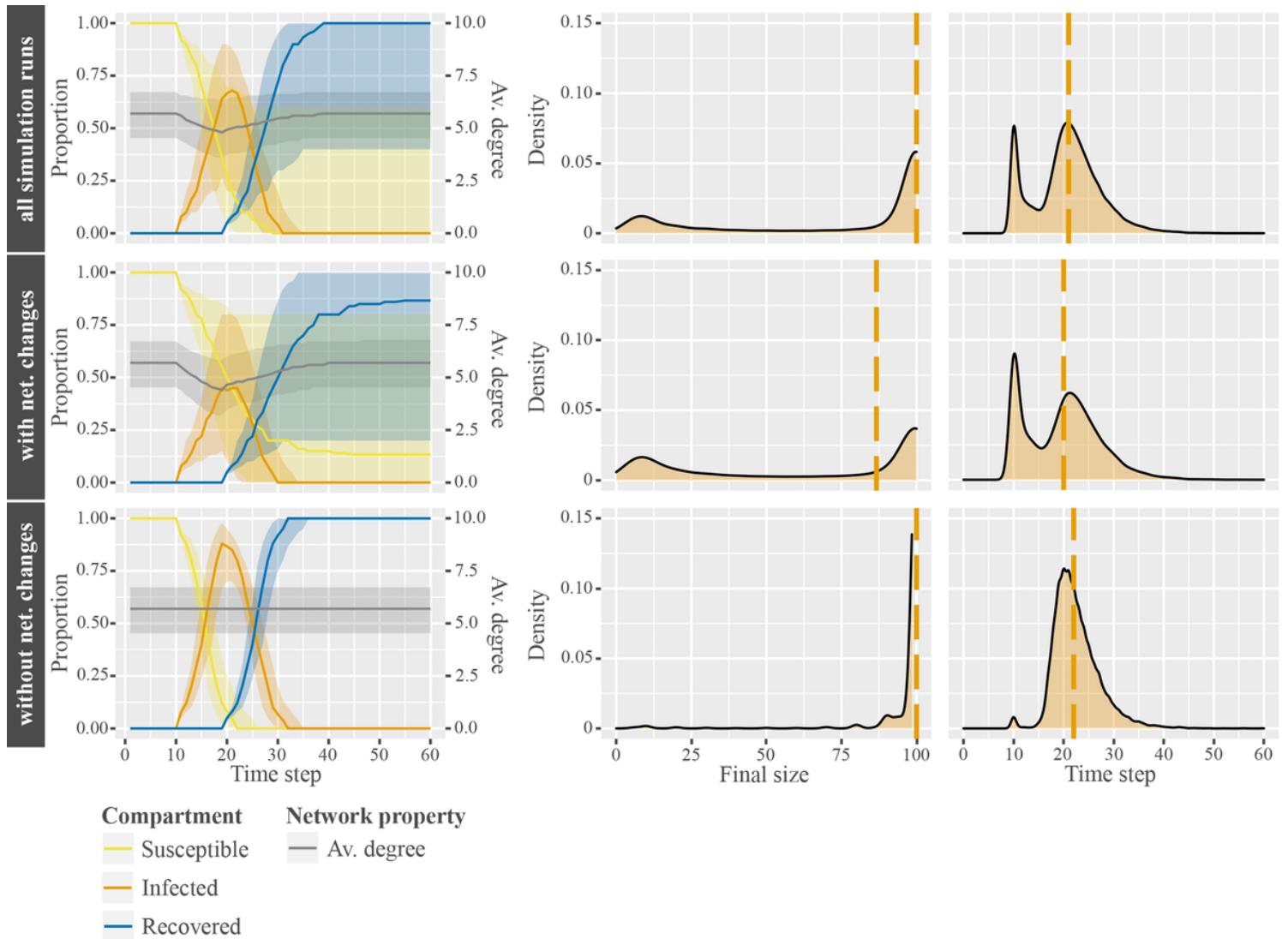


Figure 1

Disease dynamics in networks with and without network changes. Interplay of network and epidemic dynamics by comparison of median proportions of disease states and average degree over time (column 1), distribution of final size of epidemics (column 2), and distribution of duration (column 3); over the whole data (row 1), simulation runs with network changes during epidemics (row 2), and simulation runs without network changes during epidemics (row 3).

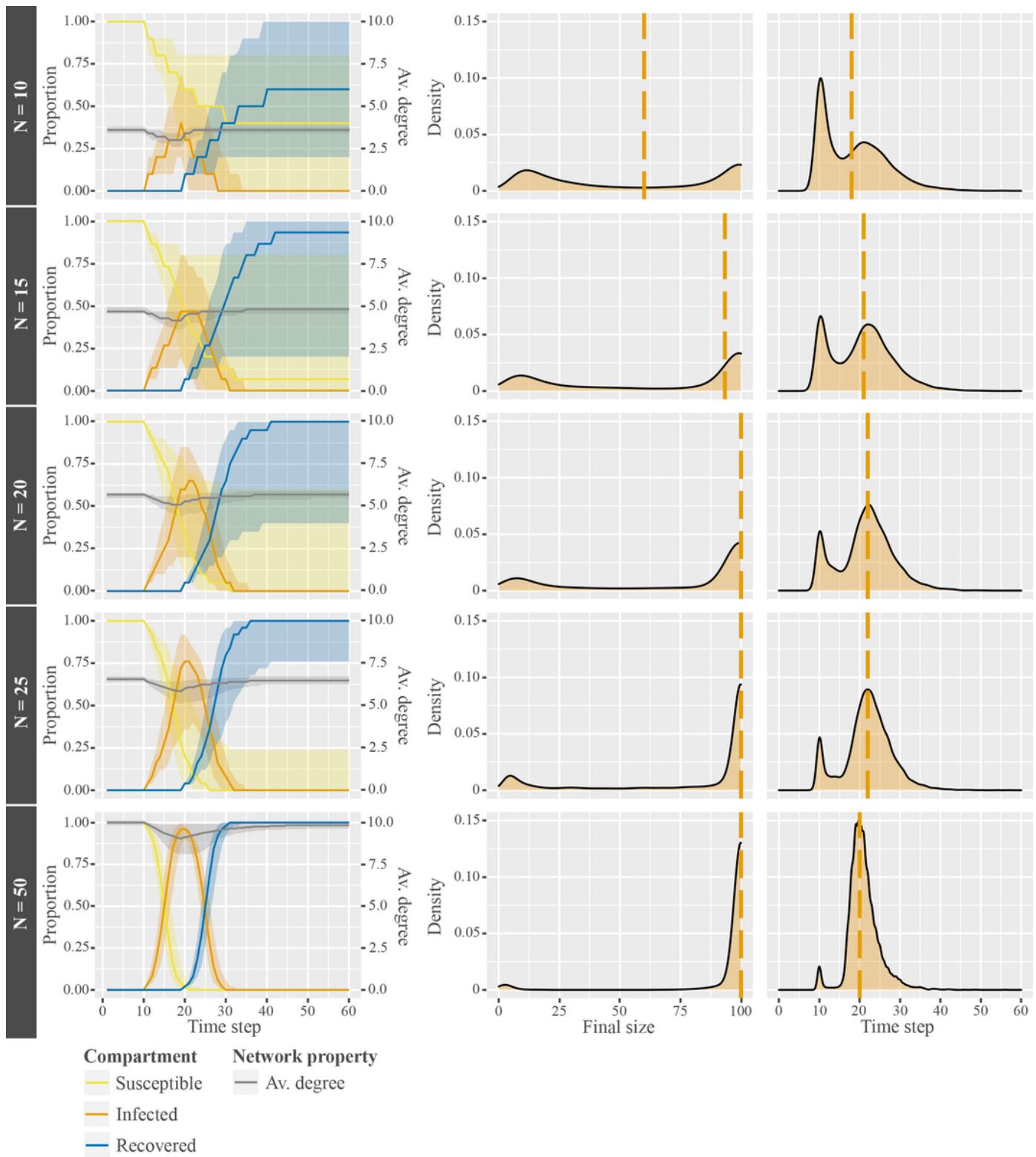


Figure 2

Disease and network dynamics by network size. Interplay of network and epidemic dynamics by comparison of median proportions of disease states and average degree over time (column 1), distribution of final size of epidemics (column 2), and distribution of duration (column 3), divided by networks size (row 1: $N = 10$, row 2: $N = 15$, row 3: $N = 20$, row 4: $N = 25$, row 5: $N = 50$).

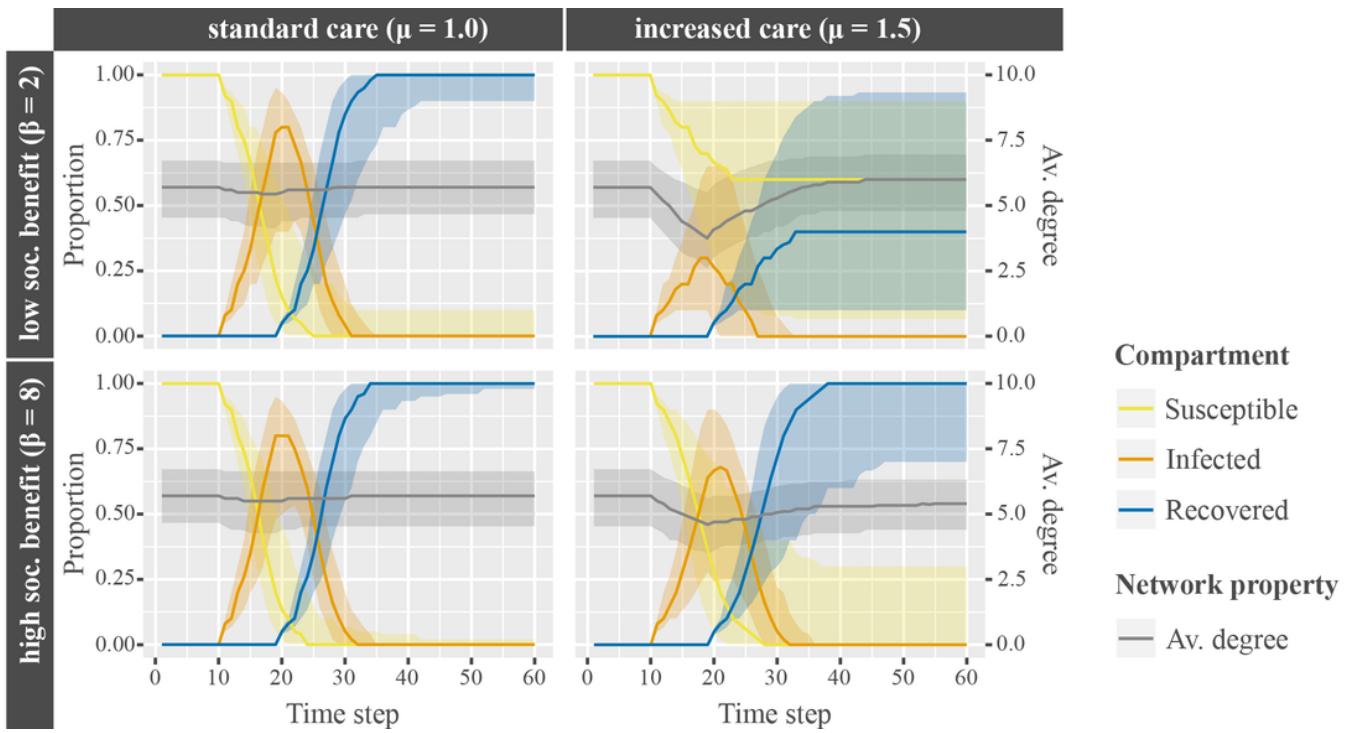


Figure 3

Interaction of costs for infected ties and value of indirect connections. Interaction of increased costs for infected ties and value of indirect connections on the median proportions of susceptible (yellow), infected (orange), recovered (blue), and average network degree (gray) over time. Shaded areas describe interquartile ranges.

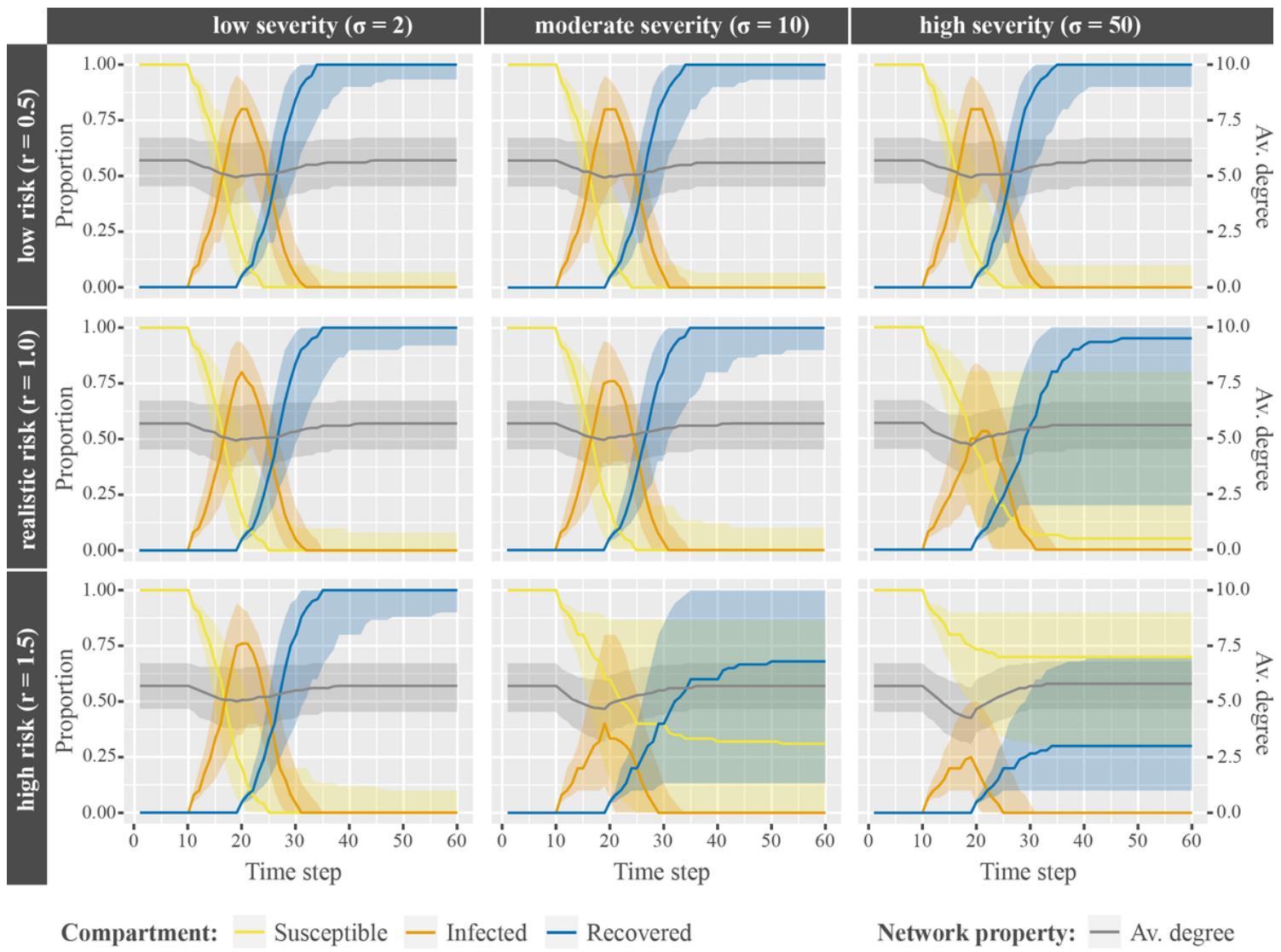


Figure 4

Interaction of disease severity and risk perception. Interaction of disease severity and risk perception on the median proportions of susceptible (yellow), infected (orange), recovered (blue), and average network degree (gray) over time. Shaded areas describe interquartile ranges.

Supplementary Files

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- [OnlinefigA1.png](#)
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