Modeling effects of individual-level social distancing on the spread of seasonal influenza using a small-world network

Cornell University

Emma K France[1], Steven M Albert [2], Supriya Kumar[2] , Vivian Zayas [1]

[1]Department of Psychology, Cornell University, Ithaca, NY

[2]Graduate School of Public Health, University of Pittsburgh, Pittsburgh, PA

Background

How does the flu spread? How can we as individuals prevent it? Both questions can be answered in part by computational modeling. Here, we model person-to-person contacts in the workplace as a small world network. This type of network has gained popularity in the past decade for its accurate portrayal of human interactions. Using this model, we asses whether avoidance behaviors such as verbal warnings of illness can significantly impact a workplace epidemic.

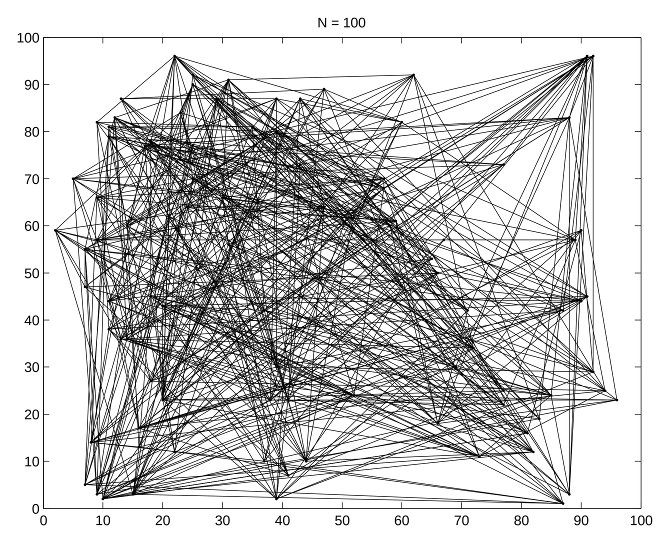

Fig. 1. A small world network with 100 connected agents

Research Objectives

- Model dynamics of seasonal influenza transmission on a small world network
- Determine common avoidance behaviors
- Examine the effects of the most common avoidance behaviors on the extent of a workplace epidemic

Methods and Results

The online survey revealed the two most common avoidance behaviors, which were used as parameters. For avoidance of the susceptible by the ill, the most common behavior was being willing to stay home when sick (83%). For avoidance of the ill by the susceptible, 37% of respondents said they would avoid a person with flu symptoms. Other parameters such as transmission and death rate were taken from the literature. The model was created in Matlab, with code for generation of the network contributed by Solomon Hsiang. The model was designed to give the timeline and magnitude of infections for a workplace of 1000 employees given the particular transmission dynamics of seasonal influenza.

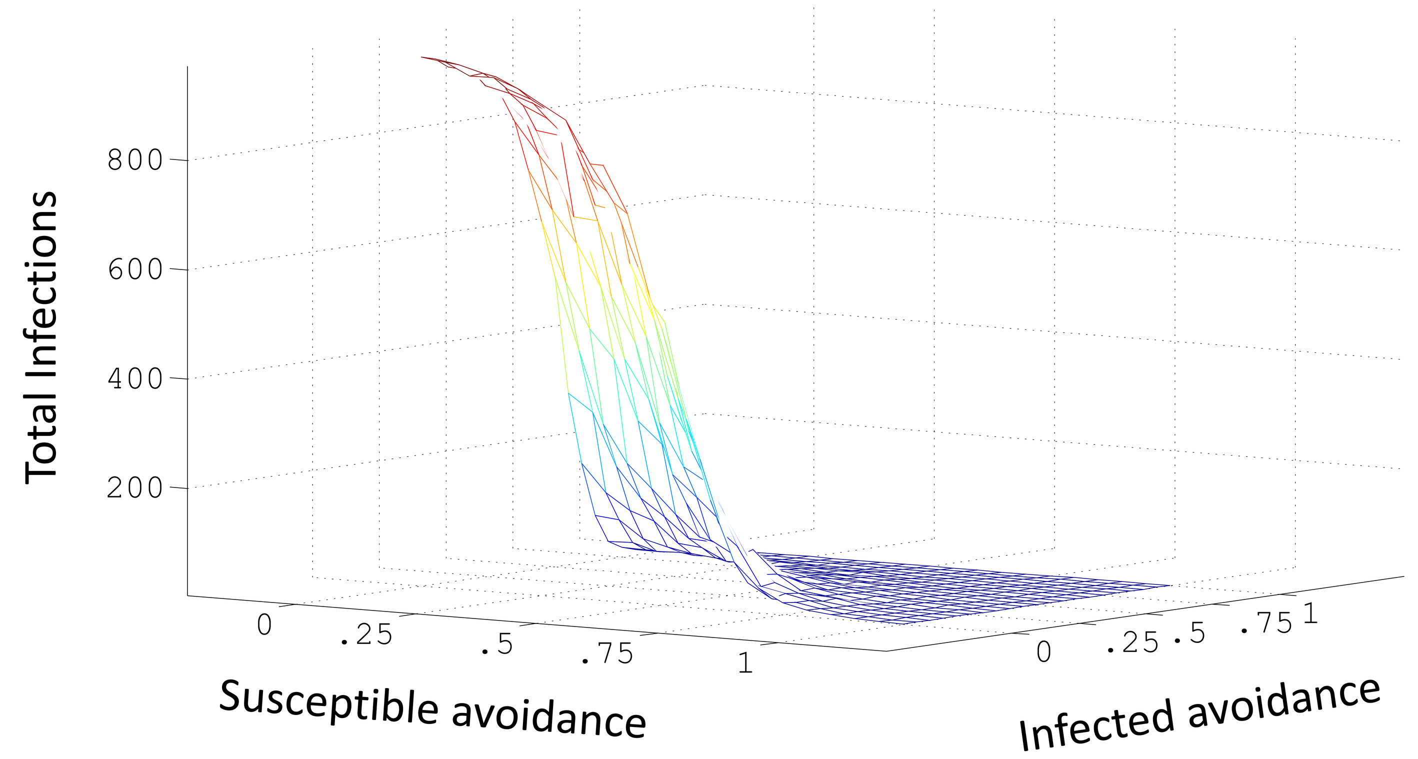

Figure 2. Total infections for varying values of A_i and A_s when employees are given 2 paid sick days

When employees are given the standard two sick days, the model shows that standard rates of avoidance behavior bring the total infections down from 97% to 2%. A distinct threshold of avoidance rates is shown in Figure 2. When avoidance by both the sick and the susceptible parties falls below a sum of about 60%, infection rates rise drastically.

Conclusions

The modeled timeline of the epidemic depended on the parameters used to set up the network. Using a more connected (friendly) network, infection dynamics agreed with previous work. Our main results were attained using a less connected network which exhibited unique timeline changes when avoidance rates were altered. This shows that contacts between employees affect the length of the epidemic, and more work is needed to provide a realistic connectivity value and to examine the differences in connectivities in different work environments.

The results of modeling different rates of behavior show how drastically something as simple as taking a sick day can change the course of an outbreak. To this end, policy makers must consider the benefits of offering more paid sick days to employees as a method of ensuring reduced outbreaks and more overall productivity.

References

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Acknowledgements

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