SOCIUS

Data Visualization

Socius: Sociological Research for a Dynamic World
Volume 7: 1–3

DOI: 10.1177/23780231211058026
srd.sagepub.com
SAGE

Community Effectiveness of Masks and Vaccines

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Abstract

Recent controversies about wearing masks and getting vaccinated to slow the spread of coronavirus disease 2019 highlight the potential for individual rights and decision making to create widespread community-level outcomes. There is little work demonstrating the collective spillover effects of pandemic mitigation efforts. The authors contribute by visualizing the proportion of unvaccinated people who would become infected at different combinations of mask wearing and vaccination in a hypothetical community. A common pattern emerges across all assumptions: below some joint threshold of mask and vaccination rates, almost all unvaccinated people will eventually become infected, and beyond that threshold there is a steep drop leading to widespread community-level protection. What differs across settings is the timing and shape of the drop-off after crossing the threshold. The authors conclude that masking and vaccination are sensible and in the best interest of the population.

Keywords

COVID-19, disease spread, masking, vaccination

Recent controversies about wearing masks and getting vaccinated to slow the spread of COVID-19 highlight the potential for individual rights and decision making to create widespread—and potentially detrimental—community-level outcomes. Many Americans now refuse to wear masks (Lang, Erickson, and Jing-Schmidt 2021; Pro et al. 2021) or receive a vaccine (Beleche et al. 2021; Sgaier 2021) despite evidence of their effectiveness at slowing disease spread. The disproportionate effect of the delta variant on the unvaccinated underscores the individual-level effects of noncompliance, but the rapid increase in illness and death have contributed to a wider public health crisis in the United States. Although there is widespread discussion of individual effectiveness, there is much less work demonstrating the collective spillover effects of pandemic mitigation efforts.

We contribute to this conversation and the literature on epidemic threshold patterns (Moody, adams, and Morris 2017) by visualizing the proportion of unvaccinated people who would become infected at different combinations of mask wearing and vaccination in a hypothetical community (Figure 1). Each panel in the figure represents a different type of social network for the community: either a large number of social connections (i.e., high degree) or a small number of social connections (i.e., low degree) and either a highly clustered community or a community with little clustering (i.e., characterized by random network ties).

We find a common pattern across all assumptions: below some joint threshold of mask and vaccination rates, almost all unvaccinated people will eventually become infected, and beyond that threshold there is a steep drop leading to widespread community-level protection. What differs across settings is the timing and shape of the drop-off after crossing the threshold: in both the high-degree, clustered (top left) and low-degree, random (bottom right) scenarios, the rapid decline in infections happens at relatively moderate rates of masking and vaccination. By contrast, in the high-degree, random scenario (top right), the threshold emerges much later. And finally, in the low-degree, clustered scenario (bottom left), the threshold appears at the lowest levels and tapers more slowly.

These patterns underscore the importance of both masking and vaccination, but perhaps most important, the results show that community safety is attainable at mitigation levels that are highly dependent on the structure of the underlying network, which is usually unknown. Once a community

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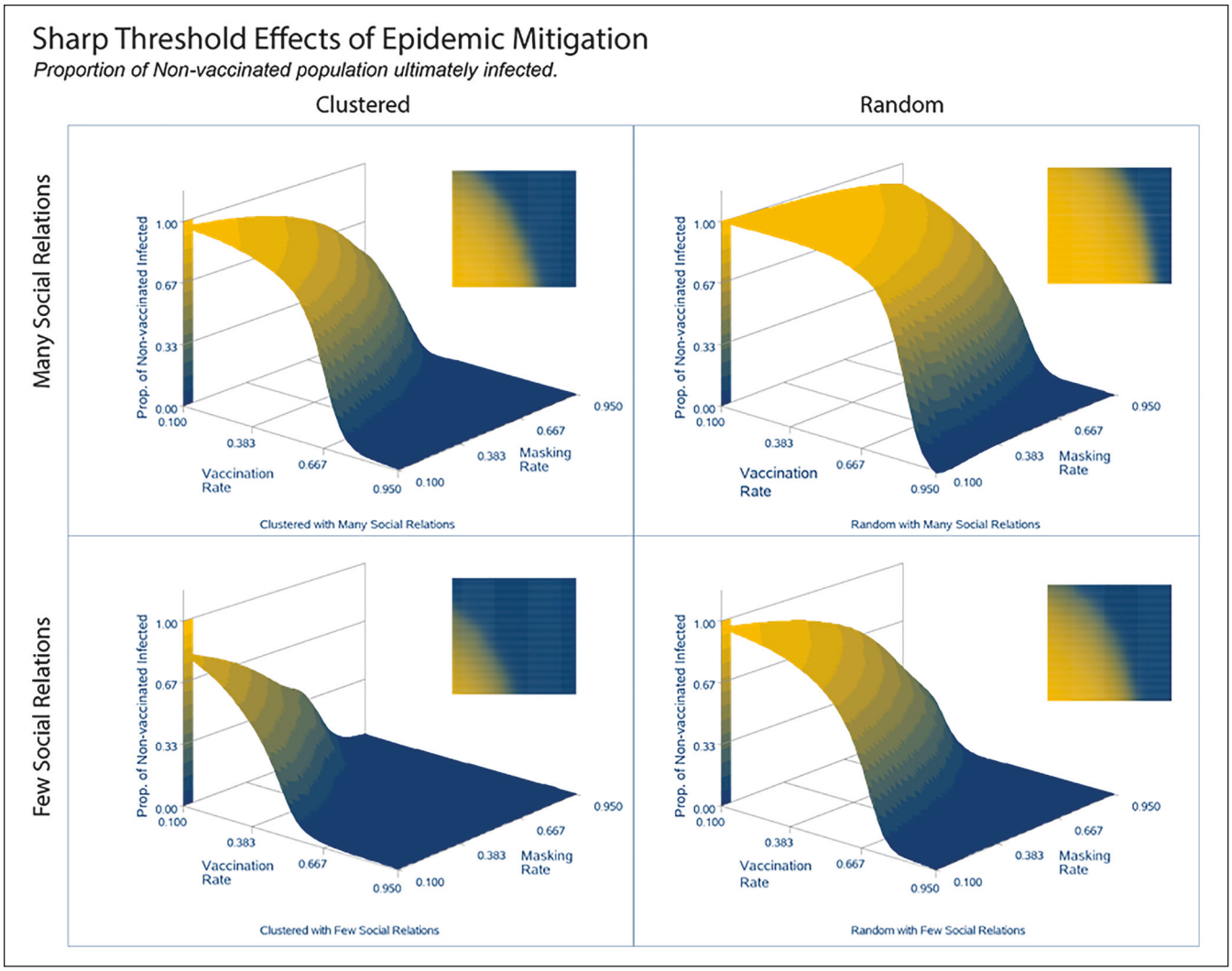

Figure 1. Sharp threshold effects of epidemic mitigation.
Note: The figure depicts the ultimate reach of COVID-19 as a proportion of unvaccinated who would become infected across varying levels of masking and vaccination, under four community types: high and low social connections (degree) and high and random clustering. Each figure shows a plateau (gold), cliff (green), and floor (blue) that represent nearly universal reach, intermediate protection, and ultimate disease die-out, respectively. The presence of a clear threshold in each scenario suggests that, in the absence of local data on network structure that would allow more nuanced strategies, universal mandates to wear masks and receive a vaccine have the most beneficial outcomes for both individuals and the community.

crosses the threshold, even the unvaccinated will be safe as the infection effectively dies out. But, given that we cannot know where that threshold lies in any given community, we must keep promoting mitigation until transmission wanes.

Although a one-size-fits-all approach to masking and vaccination might seem a blunt instrument, given the unknowability of potential transmission network structure, it is the safest approach. That is, mandates will be most important in dense but clustered communities, and we typically do not know which communities those are. It follows that the approach of the Centers for Disease Control and Prevention and other federal agencies for universal masking (which has virtually no negative externalities) and vaccination (whose potential side effects are rare and minimal) are both sensible and in the best interest of the population.

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Supplemental Material

Supplemental material for this article is available online.

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Author Biographies

James W. Moody is Professor of sociology at Duke University. He has published extensively in the field of social networks, methods, and social theory. His work has focused theoretically on the network foundations of social cohesion and diffusion, with a particular emphasis on building tools and methods for understanding dynamic social networks. He has used network models to help understand organizational performance, school racial segregation, adolescent health, disease spread, economic development, and the development of scientific disciplines, and much more.

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