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CO-CIRCULATION OF INFECTIOUS DISEASES AND HEALTH OPINIONS

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Risk-taking and health-protective behaviour in the context of infectious diseases depend on social norms and beliefs, but are also influenced by epidemic spread. On the other hand, social norms/health opinion distribution may affect course of an outbreak. We investigate the impact of changing health protective behaviour due to social influence and risk of acquiring infection on epidemic dynamics.

We propose an ODE model that captures concurrent dynamics of two health-related opinions and infection spread. The model accounts for effects of various social behavior features, such as varying contact intensities and assortative mixing. We model an opinion switching rate with Holling type III functional response that depends on the density of individuals holding an opinion. The switching rate can be modified by disease prevalence. Infection was modeled using a Susceptible-Infected-Susceptible (SIS) or a Susceptible-Infected-Removed (SIR) model. Local and global stability analysis yielded possible stable opinion distributions in a disease-free population. We computed the basic reproduction number for different opinion distributions and used bifurcation analysis to investigate how mixing patterns that simultaneously shape both opinion distribution and disease spread, impact the opinion and epidemic dynamics.

In a disease-free population, multi-stability between an equilibrium of coexisting opinions and equilibria where one of the two opinions is dominant may occur. The course of an epidemic depends on the distribution of opinions at the onset of the epidemic. During an epidemic outbreak, behaviors can be modified further. Subsequently, the outbreak can cause a shift of the whole population to the health protective opinion, which will dominate even after the outbreak has ended. Reduction of contact rates will affect both opinion and infection propagation and as such may cause elimination of health-protective opinion and subsequently cause increase in prevalence, rather than decrease. For certain behavior combinations, sustained oscillations may arise causing epidemic waves. These cycles can be interpreted as a process where, as individuals adopt a health-protective opinion, prevalence declines and subsequently, with pressure to switch to the health-protective opinion reduced, some individuals revert to their risk-taking behaviour. This outcome aligns with results by He et al. [**?**] which indicated that behavior adaptation is one of key factors in explanation of appearance of several waves of incidence during 1918 influenza pandemic in England and Wales.

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Our findings indicate that, depending on different socialization paradigms, various types of interventions may yield different qualitative and quantitative outcomes, not all of which would be beneficial for population health.

References

[1] D., Dushoff J., Day T., Ma J., & Earn, D.J.D. (2013). *Inferring the causes of the three waves of the 1918 influenza pandemic in England and Wales*. Proceedings of the Royal Society B: Biological Sciences, 280(1766) https://doi.org/10.1098/rspb.2013.1345

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