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Multi-scale modeling of schistosomiasis transmission dynamics

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In this study, we develop a multi-scale model that integrates the within-host and between-host transmission dynamics of schistosomiasis. The resulting linked models are sometimes called immuno-epidemiological models. However, there is still no generalized framework for linking the within-host and between-host dynamics of infectious diseases. Moreover, for environmentally transmitted infections, there is a gap in knowledge on how environmental factors alter many aspects of such infections including susceptibility to infective dose, persistence of infection, pathogen shedding and severity of the disease. In this work, we integrate the within-host and between-host sub-models by identifying the within-host and between-host variables and parameters associated with the environmental dynamics of the pathogen and then design a feedback of the variables and parameters across the within-host and between-host models using human schistosomiasis as a case study. We study the mathematical properties of the linked model and show that the model is epidemiologically well-posed. Using results from the analysis of the endemic equilibrium expression, the disease reproductive number and numerical simulations of the full model, we adequately account for the reciprocal influence of the linked within-host and between-host sub-models. We expect the conceptual modeling framework developed here to be applicable to many environmentally transmitted infectious diseases other than the specific disease system of human schistosomiasis considered here.

Biography

Dephney Mathebula has her expertise in multi-scale modeling of infectious diseases such as schistosomiasis, malaria and influenza. Her passion is in improving the implementation of infectious diseases control measures by developing multi-scale models that account for both between-host and within-host disease dynamics. Her multi-scale model adequately accounts for the reciprocal influence of the linked within-host and between-host models.

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