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Disease Modeling: how to control and prevent epidemic outbreaks

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Disease Modeling: how to control and prevent epidemic outbreaks

In recent years vaccination studies have led to greater understanding and improvements on the development and distribution of vaccines, especially with respect to certain childhood diseases. However, while current vaccination campaigns strive to achieve herd immunity (a critical threshold of 'immune' individuals needed to protect an entire population from infection), eradication has not been achieved and populations continue to be affected by childhood diseases globally. These outbreaks are usually attributed to the movement of one or more asymptomatic cases from a country affected by the pathogen in question. Nevertheless, individuals coming from regions with infection-induced immunization can provide protection to the receiving region. Mathematical models are able to describe the dynamics of an infectious diseases in populations, and they can provide important measurements for public health such as the basic reproductive ratio, the vaccination threshold needed to achieve herd immunity, and project the number of cases that could be observed during an outbreak. In particular, metapopulation models can be used to track the movement of individuals through travel or immigration to better understand the movement and persistence of infectious diseases, and border restriction policies. We propose infectious disease models to study the distribution of immunity in a population and how this changes with immigration and travel, by using a Susceptible-Exposed-Infectious-Recovered framework. Our work is in collaboration with Public Health Ontario and has been used to better understand the effects of measles immunity in a population. Our results show that the biggest loss in the susceptible population happens when the infected individual introduced in the population belongs to the group of children between 5 and 9 years, even when vaccination thresholds recommended by the WHO are achieved.