

Interpreting phenotypic variances and modelling super-spreaders

This section aims to interpret the values used for phenotypic variances. When variances are small, the square root in their value (*i.e.*, the phenotypic standard deviation) gives the expected fractional change in the trait. So $\Theta_{gg}=0.1$ corresponds to a fractional variation in susceptibility of $\sqrt{0.1}=0.32$. In other words, individuals will be roughly 32% more or less susceptible, randomly distributed around a population average. As variances become larger and larger, however, this simple interpretation breaks down. Figure A looks at the case of infectivity. Here we plot the fraction of infections caused by the top 20% most infectious individuals at any given point in time against phenotypic variance in infectivity Θ_{ff} . This curve assumes a large number of individuals and is generated by numerically evaluating

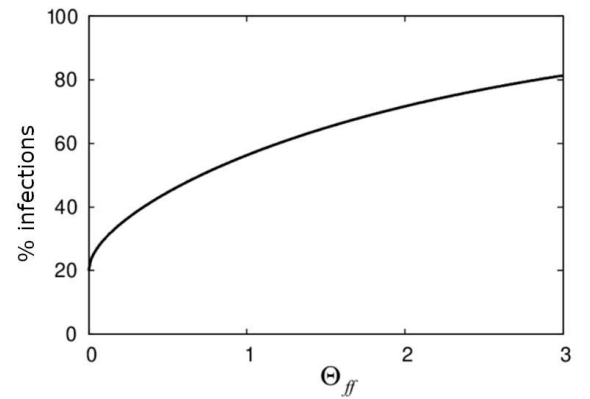


Figure A: Percentage of infections caused by the 20% most infectious individuals as a function of the phenotypic variance in infectivity Θ_{ff} .

$$\int_{x_{80}}^{\infty} N(x|0, \Theta_{ff}) e^x dx / \int_{-\infty}^{\infty} N(x|0, \Theta_{ff}) e^x dx \quad (1)$$

where $N(x|0, \Theta_{ff})$ is a normal distribution with zero mean and variance Θ_{ff} . The value x_{80} is the 80th percentile of this distribution.

When the phenotypic variance is small, individuals have almost identical infectivity, hence the curve in Fig. A goes through 20% on the left-hand edge. On the other extreme, the right-hand edge corresponds to some individuals being vastly more infectious than others (by several orders of magnitude). Uncommonly infectious individual, otherwise known as “super-spreaders”, are an established feature in many epidemiological settings. Some cases of super-spreading conform to the 80/20 rule [75], where approximately 20% of the infected individuals are responsible for 80% of transmissions. By inspecting Fig. A we find that this corresponds to a phenotypic variance of $\Theta_{ff} \approx 2.8$. This value is used in the exemplar model (Table 2).