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Effect of population density on epidemics

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Abstract

Investigations of possible links between population density and the propagation and magnitude of epidemics have so far proved inconclusive. There are three possible reasons (i) A lack of focus on appropriate density intervals. (ii) For the density to be a meaningful variable the population must be distributed as uniformly as possible. If an area has towns and cities where a majority of the population is concentrated its average density is meaningless. (iii) In propagation of an epidemic the initial proportion of susceptibles (persons who have not developed an immunity) is an essential, yet usually unknown, factor. The assumption that most of the population is susceptible holds only for new strains of diseases.

Here we show that when these requirements are properly accounted for, the size of epidemics is indeed closely connected with the population density. This empirical observation comes as a welcome confirmation of the classical KMK (Kermack-McKendrick 1927) model. Indeed, one of its key predictions is that the size of the epidemic increases strongly (and in a non linear way) with the initial density of susceptibles.

An interesting consequence is that, contrary to common beliefs, in sparsely populated territories, like Alaska, Australia or the west coast of the United states the size of epidemics among native populations must have been limited by the low density even for diseases for which natives had no immunity (i.e., were susceptibles).

Key-words: epidemic, propagation, population density, Kermack and McKendrick model.

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