Mobility patterns influence the spread and containment of an epidemic

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Daily mobility between districts reduces the spread of an epidemic. Credit: ©CC0

Contrary to expectations, recurring mobility between different cities or districts of a large city (for example, work-home commutes) can

minimise the spread of an epidemic. This is the finding of research carried out by researchers from the Universitat Rovira i Virgili (Àlex Arenas) and the University of Zaragoza (Jesús Gómez and David Soriano) and which has just been published in the journal *Nature Physics*.

The researchers designed a mathematical model that predicts how mobility can encourage or reduce the spread of an epidemic. Using data from a large city (Cali, Colombia), they demonstrated that daily mobility between districts reduces the spread of an epidemic, contrary to expectations. During an epidemic, common sense suggests that people should isolate themselves from the rest of the population or reduce their movements to diminish the likelihood of contagion. However, isolation may actually increase our chances of contracting a disease and worsen the existing local situation.

People regularly travel to other cities or neighbourhoods and then return home. The researchers therefore asked whether this mobility affects the spread of an epidemic.

"The answer is yes," explained Àlex Arenas from the URV's Department of Computer Engineering and Mathematics. But it occurs in a way that is counter-intuitive: Recurring mobility results in fewer epidemics. The mathematical model designed by the researchers corroborates this phenomenon and suggests an explanation. "We found, to our surprise, that an increase in mobility does not always increase the spread of an epidemic," explained Jesús Gómez Gardeñes, researcher at the University of Zaragoza.

The cities and districts they analysed differed in terms of the population size and population density. So what was happening? When people move around during the course of their daily activities, these populations end up balancing themselves out; that is, the populations of business and

office districts increase when people arrive from residential areas to work. The homogenisation of the population in metacities (cities that have connections between people who move around in a recurring manner) indicates that the spread of an epidemic could be reduced, in contrast to what was previously believed.

The spread of a disease and population density

In a small settlement, it is more difficult for diseases to spread, because although they remain infectious, fewer people come into contact with them. In a larger settlement, therefore, the spread of infection is theoretically much more likely. However, the risk of widespread infection in these large populations is actually lower because of the increased mobility of people between them. The researchers' mathematical model can predict when this is likely to be the case. That is, it provides a more detailed understanding of why, in certain cities, the spread of an epidemic may be lower than in others, even though the level and means of infection in theory remain the same. Widespread mobility helps to even out the population and thus to reduce the occurrence of epidemics.

The researchers believe that similar studies could be carried out on other cities or territories provided that there was sufficient accurate data regarding mobility between them. According to the researchers, analysing such data with this model could play a crucial role in developing policies for preventing the spread of an epidemic or predicting when one is likely to occur: "If we fail to understand how the spread of an epidemic is related to mobility, we will not be able to apply the right measures when the need arises," said Arenas.

More information: J. Gómez-Gardeñes et al, Critical regimes driven by recurrent mobility patterns of reaction–diffusion processes in networks, *Nature Physics* (2017). DOI: 10.1038/s41567-017-0022-7

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