

Social stress key to population's rate of COVID-19 infection, study finds

November 23 2021



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Mathematicians have analyzed global COVID-19 data to identify two constants which can drastically change a country's rate of infection.

An international team of researchers led by Professor Alexander Gorban from the University of Leicester used available data from 13 countries to determine the rate of stress response, or 'mobilization' and the rate of spontaneous exhaustion, or 'demobilisation'.

Their findings, published in *Scientific Reports*, show that [social stress](#)—which varied broadly across the countries studied—drives the multi-wave dynamics of COVID-19 outbreaks.

The study analyzed data from China, the USA, UK, Germany, Colombia, Italy, Spain, Israel, Russia, France, Brazil, India, and Iran—and contributed to the research team's proposed new system of models, which combine the dynamics of the established concept of social stress with classical epidemic models.

Alexander Gorban is a Professor of Applied Mathematics at the University of Leicester, and Director of the Centre for Artificial Intelligence, Data Analysis and Modelling. Professor Gorban said:

"We tried to use the pandemic for research and quantify the social and cultural differences between countries. We measured how variable countries are in two processes: mobilization of people for rational protective behavior and exhaustion of this mobilization with destroying of rational behavior.

"This is a serious lesson for the development of education, for planning of real politics and similar things. Why was mobilization in Germany and Israel significantly quicker than in the UK? Why, according to the published epidemic data, did some countries quickly mobilize, but also demobilized very quickly (Iran)?

"How can we convince people to mobilize and maintain their rational behavior? When and how should we teach our children these skills? And

what are we willing to pay for these abilities? Our study shows we must answer these and many other questions."

For each country analyzed in the study, researchers examined 200 days of data, from the point of 100 confirmed cases of COVID-19 in each country. They expanded on the SIR model for the spread of disease, which takes into account the number of infected individuals compared to the number of 'recovered' and 'susceptible' members of the population, by accounting for various modes of human behavior.

Each country demonstrated some form of first wave and second wave pattern, though the model does not take into account factors that become important later including ongoing improvement of biological protection methods (like vaccination), economic trends, and viral mutations. During the first 200 days, the dynamics of the outbreak is determined mostly by the contagiousness of the virus and the behavior of people.

Therefore, researchers determined that the large difference between COVID-19 spread between countries is caused by social differences, through response to the established sociological concept of social stress.

This states that 'susceptible' individuals will pass through a cycle of three modes; ignorance (living without restrictions); resistance (individuals consciously and actively practicing social distancing measures; and exhaustion (the depletion of the person's capacity to follow social distancing measures).

The rate at which this cycle repeats is largely driven by a population's stress response rate, and the rate at which a population becomes exhausted by social distancing measures. Colombia, Iran and the USA showed the highest 'exhaustion rates' of the countries in the study, with the UK at the median rate.

China's stress response rate was the highest of the 13 countries analyzed, reflecting a rapid and dramatic spread of the virus among the human population—after a large initial spike, cases and morbidity rates dropped sharply due to a highly unified society response.

Professor Victor Kazantsev, leader of the Lobachevsky University team which contributed to the study, and head of Neurotechnology Department, Nizhny Novgorod, Russia, said:

"COVID-19 pandemics made people better understand our behavior in global stressful situations. This knowledge will help humanity to survive further. Our work is a step in the extraction of this new knowledge from COVID-19 data."

Dr. Innokentiy Kastalskiy from Lobachevsky University and the Institute of Applied Physics, Russian Academy of Sciences, added:

"This work is a first step in the combination of modeling social stress with epidemics dynamics. We should also take into account the dynamics of immunity, viral evolution, and economics. Such models will provide us with tools to quantify different situations, evaluate solutions, and play out different 'in silico' scenarios to develop anti-epidemic strategies specific to a particular society: country, region, or social group."

The researchers state that classifying countries according to their ability to mobilize people for protective anti-epidemic behavior and to maintain this mobilization for a considerable time can help in predicting the dynamics of future epidemic outbreaks and in managing their impact on the population.

Leicester students from the Data Analysis for Business Intelligence MSc program will also use the models presented in the paper to further

analyze epidemics in all UN countries.

'Social stress drives the multi-wave dynamics of COVID-19 outbreaks' is published in *Scientific Reports*.

More information: Innokentiy A. Kastalskiy et al, Social stress drives the multi-wave dynamics of COVID-19 outbreaks, *Scientific Reports* (2021). [DOI: 10.1038/s41598-021-01317-z](https://doi.org/10.1038/s41598-021-01317-z)

Provided by University of Leicester

Citation: Social stress key to population's rate of COVID-19 infection, study finds (2021, November 23) retrieved 27 April 2024 from <https://medicalxpress.com/news/2021-11-social-stress-key-population-covid-.html>

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