COVID-19 phone apps can provide real-time information on the spread of infectious diseases

July 12 2024

Researchers analyzing data from mobile phone apps used during the COVID-19 pandemic found that digital contact tracing provides rich
insights into epidemic dynamics with unprecedented resolution and speed, revealing how transmission varied by day of the week, gatherings during the 2021 Christmas period, and the UEFA Euro football tournament in July 2021.

Digital contact tracing uses a proximity-detecting phone app to alert people at risk of being infected. It was implemented for COVID-19 in the U.K. by the NHS, and also in many other countries.

In a new study published in *Science*, researchers from the University of Oxford's Pandemic Sciences Institute, the University of Warwick and the UK Health Security Agency (UKHSA) analyzed data from these apps. They found that digital contact tracing can provide unprecedented insights into epidemic dynamics, allowing public health bodies to better monitor and analyze evolving epidemics.

The authors analyzed anonymized data that was collected by the NHS COVID-19 app for England and Wales to ensure its correct function. During the COVID-19 pandemic the authors provided updates of many of the results presented here to the UK Government and public health authorities with weekly frequency, and at peak times daily, for situational awareness.

These results are now for the first time being presented for scientific publication, showing how the analyses performed over the whole pandemic period, along with detailed analyses focused on robustness and generating methods of wider applicability for use in pandemic preparedness.

Researchers used data from the app to calculate the dynamics of the reproduction number $R$—the average number of times each person with the virus passed it on to someone else—seeing changes five days earlier than other methods, providing an early warning system when the
epidemic suddenly changed.

A unique feature of this data allowed the authors to determine when R changed because of changing contact patterns between people, and when it changed because of a higher or lower probability of transmission to each person.

The researchers observed regular variability in transmission events detected by the app by day of the week and by context—for example, they noticed that there were twice as many transmissions associated with brief encounters (less than half an hour) on Saturdays as on Mondays.

During the Christmas season in 2021, researchers observed:

- Peaks in transmissions from short exposures on the two Saturdays before Christmas Day, three to five times higher than the baseline, which were likely from shopping and social events.
- On Christmas Day itself, a shift towards contacting fewer people, with transmissions coming from longer exposures, likely from socializing in the household. There were twice as many transmissions from long exposures on Christmas Day than on the previous Saturday.
- Transmissions were again weighted towards short exposures on New Year's Eve and New Year's Day, when there were nearly six times the expected numbers of transmissions from brief contacts.
- While these patterns of mixing are of course well known, this is the first study to quantify the direct impact of these seasonal festivals on respiratory epidemic dynamics. Quantification of risk is central to developing policy recommendations.

During the Euro football tournament in July 2021:

- Days with England matches showed sharp spikes in both numbers
of exposures and the transmission probability. The extra transmissions on match days accounted for 29% of all transmissions in the period.

- On 11 July 2021—when England played Italy in the final—transmissions were between six and nine times higher than what would otherwise have been expected.
- Since Euro matches in 2021 were played in football stadiums all across Europe, peaks in transmission on match days can be attributed mostly to social gatherings in homes and pubs, rather than to supporters at the stadium.

Professor Christophe Fraser from the Pandemic Sciences Institute, University of Oxford and Principal Investigator of the study, said, "Our work has shown that digital contact tracing frameworks, as well as reducing the spread of respiratory infections like COVID-19, can be of great use in providing real-time information on the state of the epidemic and the nature of transmission.

"Ensuring that digital systems are in place before new pathogens begin rapidly spreading is critical to preparing for future epidemics.

"The current worrying spread of highly-pathogenic avian influenza among multiple mammal species in the Americas should serve as a warning. We must build systems such as contact tracing in advance to prepare the world for future pandemics, making sure lessons from COVID-19 are implemented rather than forgotten."

Dr. Michelle Kendall of the University of Warwick, who co-led the analysis, said, "Public health interventions which restrict population movement inevitably have socio-economic costs. Measuring which types of human contact are—and are not—driving transmission is important for balancing these costs against the harms caused by the disease."
"We have shown that privacy-preserving data from digital contact tracing can reveal valuable information about transmission very quickly and in remarkable detail.

"We are grateful to everyone in England and Wales who engaged with the NHS COVID-19 app. Not only did they help limit the spread, reduce pressure on the NHS and save lives, but their anonymized data also provided important real-time updates on the evolving epidemic and unprecedented insights into how a respiratory virus was transmitted."

The study builds on previous work by this team on digital contact tracing: proposing its use to accelerate contact tracing for COVID-19 (Science 2020), evaluating how many infections it prevented and lives it saved in England and Wales (Nature 2021 and Nature Communications 2023), and understanding how each individual's risk of infection depended on the duration and proximity of their exposure (Nature2023).


Provided by University of Oxford


This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.