

Epidemiological insights from the NHS COVID-19 contact tracing app **Oberwolfach**

Michelle Kendall, University of Warwick 23 February 2023









Plan

Quantifying epidemiological impact of the NHS COVID-19 app throughout its first year, and beyond

Epidemiological insights from the NHS COVID-19 app

Epidemiological toolkit: Public Health and Social Measures (PHSMs) "against" infectious diseases

Social distancing

Therapeutics

Hygiene

Vaccines

Testing

Masks

Lockdowns

Contact tracing



Ventilation



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PHSMs

Effectiveness in reducing harms from pathogen



Quantifying effects of t PHSM toolkit

- PHSMs toolkit varies over time: availability,
- Relative impacts vary over time
- Impacts also vary across geographies and c e.g. under 16s
- Inter-dependence, e.g.
 - Contact tracing triggered by testing
 - Success/failure of one can lead to less/m dependence on another
- They all chip away at reducing harms from t some much more than others, in a time-vary

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Package of Test and Trace interventions on Isle of Wight May 2020

THE LANCET Digital Health

ARTICLES | VOLUME 2, ISSUE 12, E658-E666, DECEMBER 01, 2020

Epidemiological changes on the Isle of Wight after the launch of the NHS Test and Trace programme: a preliminary analysis

Michelle Kendall, PhD $\[Locale Delta Meridian M$

Open Access Published: October 14, 2020 DOI: https://doi.org/10.1016/S2589-7500(20)30241-7

... from having the third highest R rate before the launch to the twelfth lowest soon afterwards, out of 150 UTLAs.



Quantifying epidemiological impacts of the NHS COVID-19 app

- Direct effect:
 - People who are infected are notified and take precautions before "realising" another way
- Indirect effects include:
 - Ease of ordering tests (more cases identified, more self-isolation, more contact tracing of all types triggered)
 - Speed of ordering tests and receiving results (act earlier in the infectious period)
 - Access to information on policy etc.
 - Behaviour and incentives to avoid pings... quantify?
 - Quarantining people who are not infected but would have become infected had they not isolated: a triangular network effect because the virus is circulating in their close contact network
- "Broader" effects:
 - For each case averted, a transmission chain is broken
 - The higher the app's specific impact, the less reliance needed on "less desirable" tools in the toolkit



Launched across England and Wales 24 September 2020





The NHS COVID-19 app lets you know quickly if you've come into contact











Easily check into venues with the QR code scanner



Needle & **Thread Bistro** 1.Jan 2020 11:00

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Wymant & Ferretti, Nature, 2021



Fig. 2 | The link between app use and cases averted in each LTLA. a, b, Estimated number (a) and percentage (b) of cases averted in phases 1 and 2 combined versus number of app users. c, Unadjusted relationship between difference in app uptake and difference in number of cases per capita in phases

- 284,000 (108,000-450,000) cases averted, estimated by modelling
- 594,000 (317,000-914,000) cases averted, estimated by spatial comparison (incorporates more of the indirect effects)
- The app helped to reduce cases in Sep-Dec 2020 by 14-24%
- Every 1% increase in users led to a 1-2% reduction in cases

1 and 2 combined. In b, c, the blue line shows the least-squares fit of the y-axis variable to the x-axis variable, and the shaded grey area shows the associated 95% confidence interval.

Beyond Autumn/Winter 2020

- Increasingly challenging to quantify
- Privacy-preserving by design
- Spatial assumptions break down
- Confounding with vaccination uptake •
- We rely on modelling approaches
 - assumptions (with wide ranges)
 - sensitivity analyses



The first year

nature > nature communications > articles > article

(yesterday!) Article Open Access Published: 22 February 2023 **Epidemiological impacts of the NHS COVID-19 app in England and Wales throughout its first year**

Michelle Kendall 2, Daphne Tsallis, Chris Wymant, Andrea Di Francia, Yakubu Balogun, Xavier Didelot,

Luca Ferretti & Christophe Fraser

Nature Communications 14, Article number: 858 (2023) Cite this article Metrics

https://www.nature.com/articles/s41467-023-36495-z



Uptake and engagement

а



Uptake and engagement

a



Notifications per positive test: digital and manual contact tracing

a









Accuracy







С

e



Quantifying cases averted

- Recall, the number of cases averted uses:
 - The number of exposure notifications (affected by engagement, prevalence, the sensitivity of the app's risk calculation, and by national contact rates)
 - The proportion of those notified who are infected
 - The average reduction in infectiousness upon being app-notified
 - The fraction of the infectious period that occurs after notification and before the individual might have 'realised' another way
 - The counterfactual onward transmission chain

Infectiousness reduction attributable to app notification





Cumulative cases averted in the app's first year



$\Omega_{\text{Delta}} = 0.2$

Sensitivity analysis





$\Omega_{\text{Delta}} = 0.6$ $\Omega_{\text{Delta}} = 0.8$

$\Omega_{\text{Delta}} = 1$











Sep 21 Aug 21 Jul 21 Jul 21 May 21 May 21 Feb 21 Jan 21 Dec 20 Nov 20 Oct 20













Cumulative cases, hospitalisations and deaths averted





9.51 k

Cases averted





Beyond the first year

Increasingly challenging to quantify:

- Changing meaning of a notification (isolation -> testing -> guidance)
- Increasing interaction with other interventions, e.g. lateral flow devices (quicker to 'realise' but also ~2 days quicker to notify from January 2022)
- End of free testing April 2022: extra leaky pipeline to testing?
- Harder to apply method to "endemic" and overlapping-variant waves
- Self-declaration of positive test results, December 2022

Some national statistics publicly available

https://bdi-pathogens.shinyapps.io/NHS-COVID-19-app-statistics/ using data from https://www.gov.uk/government/publications/nhs-covid-19-app-statistics/

Weekly totals of positive tests reported through the app and contact tracing alerts received



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Primary purposes

To help the user:

- Access information
- Check symptoms
- Book tests
- Receive test results
- Reduce chances of becoming infected
- Reduce chances of infecting others



Know if you have been exposed to coronavirus



Receive updates on the risk level in your area



LD8 area risk level is LOW

Normal coronavirus (COVID-19) control measures are in place and you should continue to stay alert.

It is important you continue to follow the latest official government guidance, helping control The virus. To protect yourself and others, when you leave home you must:



Secondary impact: epidemic insights

- Minimal, anonymised, aggregated but almost real-time data (usually available within 4 hours)
- Contact rate C(t) = #notifications / (#positives x #users x #keys) is the estimated number of contacts a test-positive app user had shortly before they tested positive (c.f. CoMix, Google mobility etc.)
- Proportion testing positive after exposure notification (TPAEN) is a proxy for 'infectiousness' of the contact (changes with vaccinations, variants, policies e.g. outdoor vs indoor, etc.). Available with a 6-day lag.
- R_app(t) := C(t) x TPAEN(t) the average number of infections per app user before they test positive



Measuring R(t)

- Usually we measure R(t) via its 'consequences': cases / infections / hospitalisations / deaths. Then calculation from data using e.g. EpiEstim, or calibration to models, etc.
- App data enables us to 'measure' R(t) directly, with the limitations:
 - subset of the population
 - before the index tests positive only
 - TPAEN is (under) estimated
- rate and infectiousness

App data is informative about the components of R(t): decomposition into contact

Measuring R(t)



For more details see https://www.coronavirus-fraser-group.org/blog#2august2021

Measuring R(t)



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[Slides redacted for privacy reasons]

Summary

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Thank you

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