MDDAC

SNAPSHOT REPORT 2
TECH-DRIVEN APPROACHES TO PUBLIC HEALTH

Sneha Dawda (Lead Author)
Rachel Allsopp, Claire Bessant, Charlotte Emmett, Matthew Higgs, Ardi Janjeva, Marion Oswald, Guangquan Li, Selina Sutton and Mark Warner.

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EXECUTIVE SUMMARY

- This Snapshot Report incorporates OMDDAC's findings from interviews with key stakeholders,[1] together with published research, to capture the experiences and lessons learned throughout the pandemic in relation to technology-driven approaches to public health. This Report examines three case studies: digital proximity and exposure notification; risk scoring algorithms; and Covid-status certification.

- Our research has found that a small number of stakeholders believe a centralised NHS Covid-19 app would have had a positive impact on public health and that the decentralised app has failed to produce significant benefits. However, it is unclear what checks and balances would have been in place to protect privacy and avoid adverse consequences with a centralised version of the app.

- There remain major concerns regarding the deployment of a Covid-status certification scheme. These include the potential use of certification as a discriminatory tool and associated cyber security risks. More fundamentally, the long-term value of the certificate is uncertain given the speed of the vaccine rollout.

- Risk scoring algorithms, whilst useful for helping to protect the most vulnerable in society, require careful examination with regard to the role they should play in clinical decision making.

HEADLINE RECOMMENDATIONS

- The Department of Health and Social Care (DHSC) should develop an **oversight mechanism** to ensure the Covid-status certification is not being applied in a **discriminatory** way.

- DHSC should **review the potential discrimination in the development and deployment of tech-based tools** to manage the pandemic. Lessons learned from this review should feed into any future development of such tools.

- Algorithmic risk scoring has been used during the pandemic to **enable triaging and prioritisation decisions to occur at speed.** Questions remain however over the **consequences of errors** and the extent to which algorithmic-informed decision-making is **transparent to individual patients.**

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[1] Interviews have been conducted with key stakeholders across a range of backgrounds and disciplines, including: data organisations, government, regulators, law enforcement, the medical profession, the legal profession, charities and the third sector, the private sector and an inter-disciplinary range of academics.

CASE STUDY 1
DIGITAL PROXIMITY AND EXPOSURE NOTIFICATION

HEADLINE FINDINGS

- According to a small number of stakeholders, the decentralised model of the NHS Covid-19 app has had **little effect on public health due to a lack of data collection** which could have been used to inform public health decision making.

- Attention should be paid to a longer-term evaluation of the consequences of a decentralised approach on public health aims, and the **safeguards and governance frameworks that would be needed to generate trust in a centralised model.**

- The **rates of download of the NHS Covid-19 app differ between communities and ethnic groups.** This prompts significant questions with regard to the **efficacy** of the app, particularly in relation to communities at greater risk of contracting Covid-19.

CASE STUDY OVERVIEW

This case study examines the use of smartphone applications to facilitate exposure or proximity notifications. Specifically, this case study focuses on the NHS Covid-19 app released in England and Wales. *Figure 1* sets out the timeline of the development and release of the contact tracing app and also highlights when the corresponding apps in Scotland and Northern Ireland were launched.
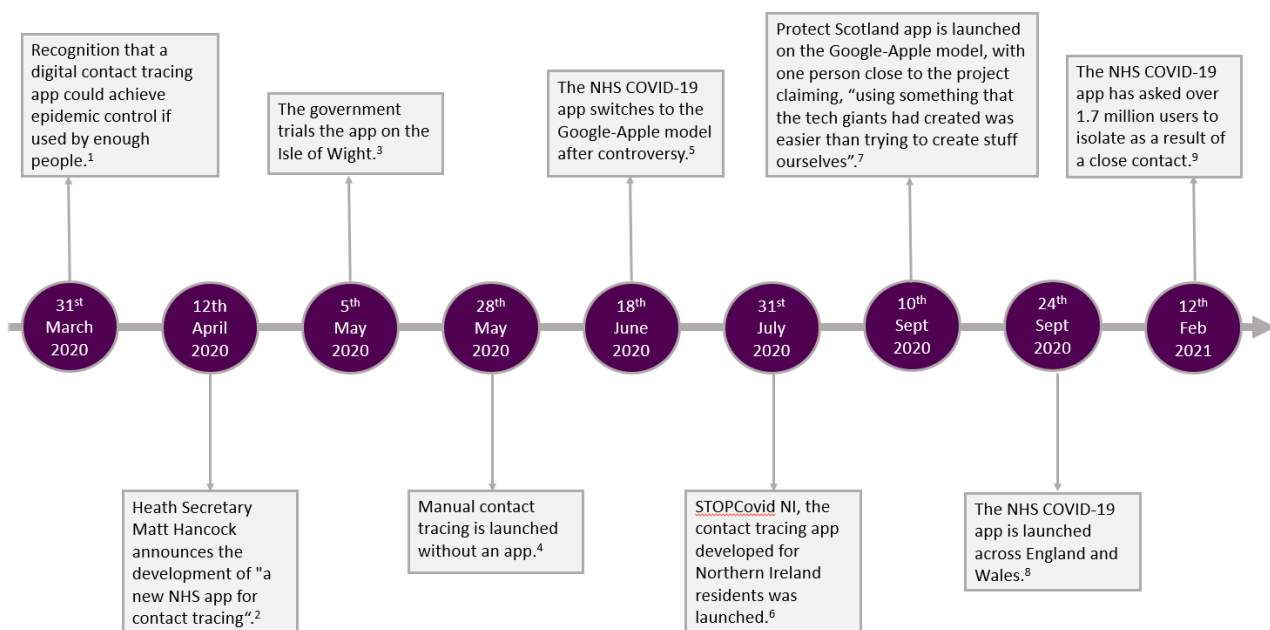
References to Figure 1

1 L. Ferretti et.al, 'Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing.' Available at: https://www.medrxiv.org/content/10.1101/2020.03.08.20032946v2

2 Department of Health and Social Care, 'Health and Social Care Secretary's statement on coronavirus (COVID-19): 12 April 2020', 30 April 2020. Available at: https://www.gov.uk/government/speeches/health-and-social-care-secretarys-statement-on-coronavirus-covid-19-12-april-2020

3 Andrea Downey, 'Covid-19: NHS contact-tracing app launched in Isle of Wight', Digital Health, 4 May 2020. Available at: https://www.digitalhealth.net/2020/05/covid-19-nhs-contact-tracing-app-launched-in-isle-of-wight

4 James Gallagher, 'Coronavirus: Test and trace system will start on Thursday', BBC News, 27 May 2020. Available at: https://www.bbc.co.uk/news/health-52820592

5 Andrea Downey, 'Government abandons contact-tracing app for Apple and Google's tech', Digital Health, 18 June 2020. Available at: https://www.digitalhealth.net/2020/06/government-abandons-contact-tracing-app-for-apple-and-googles-tech/

6 HSC Covid-19 NI. See: https://covid-19.hscni.net/stopcovid-ni-faqs/

7 BBC News, 'Scotland's Covid contact tracing app downloaded more than 600,000 times', 11 September 2020. Available at: https://www.bbc.co.uk/news/uk-scotland-54098960

8 NHS Oxford University Hospitals, 'NHS Covid-19 App Is Launched', 24 September 2020. Available at: https://www.ouh.nhs.uk/covid-19/news/article.aspx?id=1379

9 Department of Health and Social Care, 'NHS COVID-19 app alerts 1.7 million contacts to stop spread of COVID-19', 9 February 2021. Available at: https://www.gov.uk/government/news/nhs-covid-19-app-alerts-17-million-contacts-to-stop-spread-of-covid-19

AIMS, OBJECTIVES & BENEFITS

The purpose of the digital proximity app is to identify and notify people who have been in close contact with someone who has contracted Covid-19, to reduce further transmission by requesting them to self-isolate. Through targeted communications with people who may have been exposed to the virus, epidemics could theoretically be contained without the need for mass quarantines or nationwide lockdowns.

Contact tracing applications, by design, present potential risks to privacy and medical confidentiality (as explored below). Design choices to mitigate these risks are therefore vital to ensure that a sufficient propoertion of the population trust, install, and use the app effectively. For the purposes of this report, the app will be referred to as a 'digital exposure' app. This is because the app does not trace individual contacts, rather it notifies individuals through push notifications without revealing their personal data to a central body. The app has reportedly prevented thousands of deaths in a significant endorsement for digital proximity and exposure notification apps.[2]

Centralised Model

Early in the development of the NHS Covid-19 app, the UK pursued a model in which all data would be stored in a centralised NHS database.[3] The data included de-anonymised identifiers of people infected with Covid-19 and the identifiers of all those with whom an infected person had been in contact. This information could allow an actor to reconstruct the "social graph" of who an individual

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[2] BBC News, 'NHS tracing app 'prevented thousands of deaths'', 13 May 2021. Available at: https://www.bbc.co.uk/news/technology-57102664

[3] Digital Health, 'NHSX differs with Apple and Google over contact-tracing app', 30 April 2020. Available at: https://www.digitalhealth.net/2020/04/nhsx-differs-with-apple-and-google-over-contact-tracing-app/

had been in physical contact with over time, and risked leading to a disproportionate level of surveillance. Concerns about the centralised model were voiced in a joint statement signed by over 150 academics at UK universities.[4]

Decentralised Model

Following backlash against this approach, it was abandoned by the Government in favour of a decentralised model which stores proximity data and checks for exposure events on users' devices.[5] This decentralised approach was developed by Apple and Google. They explain how it works in the following terms: 'users' devices will regularly send out a beacon via Bluetooth that includes a random Bluetooth identifier - a string of random numbers that aren't tied to a user's identity and change every 10-20 minutes for additional protection. Other phones will be listening for these beacons and broadcasting their own as well. At least once per day, the system will download a list of the keys for the beacons that have been verified as belonging to people confirmed as positive for COVID-19. Each device will check the list of beacons it has recorded against the list downloaded from the server. If there is a match between the beacons stored on the device and the positive diagnosis list, the user may be notified and advised on steps to take next.'[6]

The NHS Covid-19 app also offers additional features, including venue check-in functionality via QR codes; a symptom reporting tool; the means to order a test and receive the results; a countdown timer for self-isolation; and a means to communicate local authority advice and support information.[7]

Digital proximity apps assist in the delivery of two types of intervention: (1) notifying symptomatic individuals to isolate; and (2) tracing the contacts of symptomatic cases and requiring these individuals to quarantine.[8] These interventions aim to curtail the spread of the virus, by encouraging people to self-isolate when they exhibit symptoms or have been in contact with a person who tests positive for Covid-19. By aiming to contain the virus effectively, this approach should theoretically have a resultant positive effect on the wider population by avoiding the need for nationwide lockdowns.

In addition, research has identified that the app has two 'key value propositions',[9] the first being 'a non-pharmaceutical intervention' to the pandemic as discussed.[10] The second is 'as a data source' to gather information in near-real time.[11] As a result, the app was consciously designed to comply with Google and Apple's 'privacy preserving federated approach' to digital proximity and exposure notification.

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[4] See: https://github.com/CCTPS/UK/blob/master/Joint%20Statement.pdf
[5] Leo Kelion, BBC News, 'UK virus-tracing app switches to Apple-Google model', 18 June 2020. Available at: https://www.bbc.co.uk/news/technology-53095336.
[6] Apple and Google, 'Exposure Notifications Frequently Asked Questions', September 2020. Available at: https://covid19-static.cdn-apple.com/applications/covid19/current/static/contact-tracing/pdf/ExposureNotification-FAQv1.2.pdf.
[7] NHS Covid-19 App Support, 'What the app does'. Available at: https://www.covid19.nhs.uk/what-the-app-does.html.
[8] Requirement to self-isolate is a legal requirement. See: https://faq.covid19.nhs.uk/article/KA-01146
[9] Interview with Data expert ('D') 11.
[10] Ibid.
[11] Interview with D13.

RISKS & CHALLENGES

Stakeholders highlighted several risks and challenges in the development and deployment of the digital proximity app. The first challenge was proving the decentralised app has had a positive impact on public health. In this regard, our research found that the evaluation of the app 'used causal inference mechanisms to establish a causal link between the app, impact, and its role as a non-pharmaceutical intervention.'[12] Stakeholders observed that the app began as an experiment, 'a hypothesis that it could deliver impact.' One year on, one interviewee claimed that the Government has 'proved that now'.[13] However, it has been argued that the application of the de-centralised model has limited the impact of the app, as officials cannot 'observe the contact graph' but must instead 'infer properties' of said graph.[14] Nonetheless, officials can still calculate how much 'risky interaction is occurring' denoted by an estimated 'R' number.[15] In producing this estimate of the R number, the app can provide data 8-10 days ahead of the published R number because the data is produced in real-time.[16] A paper examining the utility of digital proximity apps poses two questions that are in fact highly relevant to proving impact: (a) what data should be collected to fulfil the digital contact tracing functionality and (b) what data should be collected to gain epidemiological understanding of the spread of Covid-19?[17]

> 'The first [centralised] version of the app is ethically more defensible than the current version because… unless you collect data around it you can't actually know whether it's an appropriate intervention or not.'
> **Stakeholder interview A10**

In building the digital proximity app, one interviewee felt that the UK government was more interested in building a customer interface app than a tool which provides data to help our understanding of the spread of Covid-19.[18] Notwithstanding the data that could have been gathered had a centralised version of the app been deployed, one interviewee stated that 'the number one thing is you need public adoption'.[19] Self-evidently, without public adoption, the app would be bound to fail. 'Buy-in' from the public is essential to have true impact.

> '[The app] is not necessarily strictly about data but it is about the seductive nature of technology'.
> **Stakeholder interview A10**

However, one stakeholder pointed out that 'nobody [can] really know whether the apps have the intended outcome... unless you collect data around it you can't actually know whether it's appropriate intervention or not'.[20] Indeed, simply having an app in operation could arguably lead to the unintentional creation of a 'false sense of security' within the population (i.e. the country has an

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[12] Interview with D11.

[13] Ibid.

[14] Ibid. The contact graph refers to a graph that demonstrates where Covid-19 is being most spread, for example, the graph may indicate that supermarket X is where a large number of infections are taking place. Without this graph, officials must try to estimate where hotspots for spreading the virus take place. For example, there is a 40% chance that the virus is being spread at restaurants, and a 30% chance at gyms.

[15] The reproduction number, also known as the R number, quantifies how many people, on average, an infected person will pass the virus on to. An R value greater than 1 indicates an infected person will, on average, infect more than one other person while an R value below 1 suggests a slowdown of the spread of the virus.

[16] Interview with D11.

[17] Marcel Salathe and Ciro Cattuto, 'COVID-19 Response: What Data is Necessary for Digital Proximity Tracing', 10 April 2020.

[18] Interview with Academic ('A') 10.

[19] Interview with D13. There are approximately 20 million downloads of the NHS Covid-19 App. See: https://www.digitalhealth.net/2021/03/nhs-covid-19-app-important-pillar-in-easing-lockdown-restrictions/

[20] Interview with A10.

app so it must work).[21] A false sense of security could lead to an over-reliance on technology to be infallible. Moreover, there is recent evidence to suggest that the public may in fact have been more accepting of privacy intrusive measures than anticipated (such as location tracking) in the interests of public health.[22] An opportunity may therefore have been lost to implement a more effective public health intervention. However, additional safeguards may be required if a centralised approach were adopted, to ensure adequate checks and balances to prevent the unintended use of the data.

An important challenge relates to the risks of excluding certain sections of society owing to a reliance on a technology solution. The UK Government's evaluation of the 'early adopter' roll-out of the app in August 2020 found a 'significant difference between the rates of download of white (51%) and BAME (33%) respondents.[23] Furthermore, the Ada Lovelace Institute found that contact tracing apps and other data-driven tools have not benefited the whole of society owing to a digital divide.[24] This encompasses issues such as lack of access to smartphones and broadband, poor digital skills and more general concerns over the app's effectiveness.

Cyber Risk

A significant risk to the NHS Covid-19 app is from poor cyber security and cyber hygiene, an issue which in the initial stages of deployment was a central focus. For example, the centralised iteration of the app was tested on the Isle of Wight to assess this risk. Criminals sent fake SMS messages to people to steal personal data through a method called smishing (phishing through SMS).[25] The texts informed recipients that they had come into contact with an individual who tested positive for Covid-19 and asked them to go to a fake website to input personal details. Furthermore, security researchers found weaknesses in the app including in the sign-up process where attackers could steal encryption keys and prevent users from being notified when a contact had registered positive for Covid-19.[26] Whilst issues with the technology itself can always be patched, reliance on the digital literacy of users, particularly cyber hygiene, is a persistent risk with any technology, not only for public health driven solutions.

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[21] Ibid.
[22] Stephan Lewandowsky et.al, 'Public acceptance of privacy-encroaching policies to address the COVID-19 pandemic in the United Kingdom', 22 January 2021, PLoS ONE, Vol. 16.
[23] Department of Health and Social Care, 'NHS COVID-19 app: early adopter evaluation report: NHS Test and Trace programme', 8 April 2021, p.15. The data collected as part of the early adopter evaluation report uses the term BAME to measure downloads. A more nuanced approach from the Government would have broken down BAME into separate ethnic groupings to provide more granular data. The data collection as it stands does not account for cultural differences between these communities which may impact download and use of the Covid-19 app.
[24] Ada Lovelace Institute, 'The Data Divide: Public attitudes to tackling social and health inequalities in the COVID-19 pandemic and beyond', March 2021.
[25] Alex Scroxton, ComputerWeekly, 'UK's contact-tracing app targeted by scammers', 14 May 2020. Available at: https://www.computerweekly.com/news/252483125/UKs-contact-tracing-app-targeted-by-scammers
[26] BBC News, 'Coronavirus: Security flaws found in NHS contact-tracing app', 19 May 2020. Available at: https://www.bbc.co.uk/news/technology-52725810

LAW, REGULATION & GOVERNANCE

The NHS Covid-19 app is subject to domestic data protection and privacy laws of the GDPR and Data Protection Act 2018, together with human rights protections afforded by the Human Rights Act 1998 and applicable international human rights instruments. The Health Secretary has issued legal notices under the National Health Service Act 2006 requiring NHS Digital, NHS England, and others to share and process confidential health information under the Health Services (Control of Patient Information) Regulations 2002.[27]

Privacy and Data Protection

The NHS Covid-19 app has been designed to preserve the user's privacy. No personal data is recorded on the app itself when the app is downloaded or when a user informs the app that they have tested positive for Covid-19. No personal data can be accessed by the app from the smartphone. Since the app works by exchanging randomly generated codes, no personal or private information is shared with other users. In order for the app to notify the user as to whether their local area becomes high risk the first characters of the postcode are required. It is not possible, however, to identify the individual user from these characters.

> **Data Protection**
> The Data Protection Act 2018 and UK GDPR apply where an organisation processes (collects, stores, shares etc) personal data (information that relates to an identified or identifiable living person – Art. 4). The legislation will apply where data may be used to identify an individual directly or in combination with other information, using all reasonable means possible. Examples of identifiers include: name, location data, online identifiers such as IP address. The use of 'special category data' (including data concerning health, race or ethnic origin) imposes additional, more stringent requirements (Art. 9).

Medical Law and Ethics

Section 2A of the NHS Act 2006 forms the legal basis for the provision of the NHS test and trace service and subsequent NHS Covid-19 app.[28] This section imposes a statutory duty on the Secretary of State for Health and Social Care to take such steps as are appropriate to protect the public from disease or dangers to health, which would include mobile digital proximity applications for monitoring and tracing the spread of Covid-19.

Ethical debates concerning the use of the NHS Covid-19 app have centred on:

- the app's efficacy (given its effectiveness depends on a high degree of uptake by the public);
- digital poverty and the risk that the use of technology might exacerbate existing health inequalities amongst already disadvantaged groups;
- the extent to which the app provides anonymity and security of personal data;
- issues regarding misinformation and understanding;
- the public's willingness to trust that their potentially sensitive data will not fall into the hands of public and private bodies, governmental agencies (police, immigration services, local authorities etc), third sector organisations.

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[27] NHS Digital, 'Control of patient information (COPI) notice', https://digital.nhs.uk/coronavirus/coronavirus-covid-19-response-information-governance-hub/control-of-patient-information-copi-notice
[28] National Health Service Act 2006. See: https://www.legislation.gov.uk/ukpga/2006/41/contents

An ethics advisory board (EAB) chaired by Sir Jonathan Montgomery was established to provide 'constructive challenge to, and independent scrutiny of' initial proposals to develop an NHS Covid-19 app in May 2020.[29] The EAB published its proposed ethical framework for a digital proximity app and published a draft report on 25 August 2020 setting out 6 guiding principles (value, impact, security and privacy, accountability, transparency, and control).[30] The ethical framework devised by the EAB remains pertinent to the subsequent development of the NHS Covid-19 app in September 2020.[31]

Software used for medical purposes must be either CE, CE United Kingdom Northern Ireland (UKNI) or UK Conformity Assessed (UKCA) marked to conform to regulatory standards, and is fit for intended purposes, and meets safety legislation.[32] These directives are given effect in UK law through the Medical Devices Regulations 2002 (SI 2002 No 618, as amended) (UK MDR 2002). The MHRA (Medicines and Healthcare products Regulatory Agency) is responsible for market surveillance of medical devices in the UK market and takes decisions on marketing and supply of devices within this jurisdiction. The trial of the app during August 2020 in the Isle of Wight was approved by the MHRA[33] and the app itself is a registered Class-1 medical device and has received a UKCA mark following registration by the MHRA.[34]

LESSONS LEARNED

- Managing the public's attitude to privacy and gathering useful data to inform policy decisions is a difficult balance to strike. **The consequences of a decentralised approach to digital contact tracing should be further evaluated.**

- **Cyber security risks are a concern** and therefore any technological solution requires **trust** in the technology provider and an awareness of **cyber literacy** in the user, which is typically low.

- The number of downloads across different groups of people varied significantly. **Individuals from ethnic minority backgrounds are less likely to download and use the app.**

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[29] Andrea Downey, DigitalHealth, 'NHSX sets up ethics advisory board to oversee contact-tracing app', 27 April 2020. Available at: https://www.digitalhealth.net/2020/04/nhsx-sets-up-ethics-advisory-board-to-oversea-contact-tracing-app/
[30] Report on the work of the Ethics Advisory Group to NHSx on the COVID-19 Contact Tracing App. Available at: https://covid19.nhs.uk/pdf/ethic-advisory-group-report.pdf
[31] See also international projects on the ethics and governance of digital contact tracing such as Kahn, Jeffrey and Johns Hopkins Project on Ethics and Governance of Digital Contact Tracing Technologies, 'Digital Contact Tracing for Pandemic Response: Ethics and Governance Guidance', Johns Hopkins University Press, 2020.
[32] Directive 93/42/EEC on medical devices (EU MDD).
[33] See: https://faq.covid19.nhs.uk/article/KA-01111/en-us
[34] Apple Store, 'NHS COVID-19', https://apps.apple.com/kh/app/nhs-covid-19/id1520427663

HEADLINE FINDINGS

- Our research uncovered concerns that using risk scoring algorithms to inform public health policymaking is **not always a reliable method of quantifying risk in individuals.**

- The **QCovid algorithm**, used in the UK to identify people at high risk of being hospitalised or dying of Covid-19, has **helped to provide a data-driven approach to public health policy.** However, questions remain about the extent to which the patient should be involved in this process, to provide **consent.**

CASE STUDY OVERVIEW

This case study examines the QCovid risk scoring algorithm, used to identify vulnerable people at high risk of being hospitalised and dying from Covid-19. The QCovid algorithm was used in England to inform public policy decisions by identifying those who needed to shield (i.e. reduce all contact with others and self-isolate throughout the pandemic) and those most in need of the vaccine.

AIMS, OBJECTIVES & BENEFITS

The QCovid algorithm aims to minimise death and severe illness from Covid-19 by protecting the vulnerable, or those most in need of vaccination. It achieves this by identifying the most at-risk groups within the population. The QCovid algorithm is an 'evidence-based risk prediction model that estimates' the risk of admission to hospital or death from Covid-19.[35] The algorithm is used to support the risk prioritisation of people who should shield and those most clinically in need of the vaccine.

The primary use of QCovid to inform public health policy is 'the prevention of COVID-19 mortality and the protection of health and social care staff and systems'.[36] Advice on vaccine prioritisation has been developed based on evidence drawn from various UK epidemiological data.[37] QCovid is an important contributor to these data sources. The QCovid algorithm is also used by local authorities to cross check adult social care records.[38] This helps local authorities to identify those who need to shield and ensure they are supported.[39] The principal benefit of using the QCovid algorithm is to apply a more data driven approach to safeguarding the most vulnerable in society, potentially identifying individuals who may go unnoticed by manual, non-algorithmic risk assessment methods. The QCovid algorithm informs the COVID-19 Clinical Risk Assessment Tool.[40]

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[35] See: https://qcovid.org/Home/Algorithm
[36] Joint Committee on Vaccination and Immunisation, 'Advice on priority groups for COVID-19 vaccination', 30 December 2020. Available at: https://www.gov.uk/government/publications/priority-groups-for-coronavirus-covid-19-vaccination-advice-from-the-jcvi-30-december-2020/joint-committee-on-vaccination-and-immunisation-advice-on-priority-groups-for-covid-19-vaccination-30-december-2020#references
[37] Ibid.
[38] Interview with Government representative ('G') 7.
[39] See Snapshot Report 1, Data-Driven Approaches to Public Policy.
[40] See: https://digital.nhs.uk/coronavirus/risk-assessment/clinical-tool#data-protection-impact-assessment-dpia-template

Parameters and Statistical Validity

Through the combination of various characteristics (age, ethnicity, BMI as well as a number of comorbidities), QCovid estimates the risks of hospitalisation and mortality from Covid-19 in adults.[41] Models were constructed to establish mathematical relationships between the outcomes of interest (the two considered in QCovid are the primary outcome of death from Covid-19 and the secondary outcome of time to hospital admission with confirmed Covid-19 infection) and the risk factors. Models were developed separately for men and women.

The dataset consisted of 'national linked datasets from general practice and national SARS-CoV-2 testing, death registry, and hospital episode data for a sample of more than 8 million adults representative of the population of England.'[42] In developing and validating the algorithm, the entire dataset was split into two, the training set and the test set. Model development (involving parameter estimation and variable selection to identify the important risk factors) was carried out using the training data. To examine the predictive performance, risk predictions were made using the resulting models and the model predictions were then compared against the outcomes in the test set. The performance of the QCovid algorithm was externally validated by the Office of National Statistics.[43]

RISKS & CHALLENGES

One of the key challenges presented by the QCovid algorithm, or indeed any algorithmically informed decision-making tool, is the use of outdated or unreliable health data to inform risk stratification. This may, for example, result in an individual being classified as high risk and thus directed to shield on the basis of a past health issue. Similarly, this issue could enable individuals who are not 'high-risk' to receive a vaccine earlier than those who are clinically vulnerable. In the case of missing data, one interviewee observed that a precautionary approach had been applied, resolving any omissions with data that indicates a high risk in the interests of safety.[44]

> *'To train a good machine learning algorithm you need lots of data and so we have places within the health system that will naturally have large quantities of data, but that doesn't necessarily mean it is clean data or well labelled data. And then when you use that data to train, you inherit both all of its clinical utility and the faults.*
> **Stakeholder interview D12**

A further risk highlighted by interviewees focused largely on uncertainties around using algorithmic tools to inform wider policymaking, as opposed to the QCovid algorithm specifically. Generally, stakeholders were concerned about the 'black box' effect of algorithmic tools: 'the fact that you don't know how it is making [the decision], what is driving the decision between the inputs and outputs'.[45] This lack of transparency can also have an impact upon accountability for those decisions. Another interviewee stated that 'this is not weather forecasting, it's modelling for illustration, modelling for

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[41] Clift A K, Coupland C A C, Keogh R H, Diaz-Ordaz K, Williamson E, Harrison E M et al. 'Living risk prediction algorithm (QCOVID) for risk of hospital admission and mortality from coronavirus 19 in adults: national derivation and validation cohort study', BMJ 2020, doi:10.1136/bmj.m3731

[42] Ibid.

[43] Vahe Nafilyan, et.al, 'An external validation of the QCovid risk prediction algorithm for risk of mortality from COVID-19 in adults; national validation cohort study in England', 22 January 2021.

[44] Interview with A10.

[45] Interview with D12. This comment was made in the context of wider risk scoring algorithms that use machine learning, not the QCovid model which was publicly validated by the Office of National Statistics.

building understanding, modelling for storytelling and that is it.'[46] In other words, mathematical modelling is not used for the purpose of finding the answer, it is for providing the path to an answer.

On the other hand, one stakeholder highlighted the 'risk of being forced to use modelling beyond its power because politicians are under pressure and need something to help'.[47] Exacerbating this issue, according to one interviewee, is 'misinformation'[48] – the risk of 'people just grabbing numbers out there' and misinterpreting the data, leading to tenuous conclusions.[49] Furthermore, algorithms can develop 'spurious correlations'.[50] For instance, one interviewee stated that an algorithm using chest x-rays to detect Covid-19 in patients determined that patients were more likely to be seriously ill or die if they were lying down when the x-ray was taken.[51]

LAW, REGULATION & GOVERNANCE

The key legal frameworks in relation to the QCovid algorithm are the UK GDPR and Data Protection Act 2018. Again, domestic common law principles of consent and confidentiality also apply to the sharing of confidential medical data, together with European and international human rights laws where applicable.

Privacy & Data Protection

To use the QCovid app, the clinician must be connected to the Health and Social Care Network. When the app is used by a clinician, the clinician enters information about an individual's age, sex, ethnicity, height, weight, postcode, and medical history to determine an individual's risk of being hospitalised or dying from Covid-19.

The data protection impact assessment provided in relation to the NHS Digital Covid-19 Clinical Risk Assessment Tool states that no personal data is processed by the Tool. The clinician entering data will, however, process personal data (information relating to and from which an individual may be identified) when they review a patient's health record or seek and record information about a patient in such records. Personal data use is governed by the data protection regime.[52] NHS Digital confirms that organisations/clinicians using QCovid must have a data protection impact assessment in place together with a privacy notice informing patients how their personal data is going to be used in relation to the QCovid algorithm (in order to comply with obligations as to fair and transparent processing of data).[53] Since personal data relating to ethnicity and health data is classified as 'special category' personal data, the clinician's processing of the data in the patient's health record (retrieval and review) must be justified.

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[46] Interview with D9.
[47] Ibid.
[48] Interview with Regulator ('R') 5.
[49] Ibid.
[50] Interview with D9.
[51] Ibid. Machine learning algorithms were developed to analyse chest x-rays to determine disease severity and likelihood of progression in patients. For more details see: https://www.thelancet.com/journals/landig/article/PIIS2589-7500(21)00039-X/fulltext
[52] UK GDPR and Data Protection Act 2018.
[53] NHS Digital, 'COVID-19 Clinical Risk Assessment Tool', For more details see: https://digital.nhs.uk/coronavirus/risk-assessment/clinical-tool#data-protection-impact-assessment-dpia-template

Human Rights

Article 8 ECHR (Z v Finland (1988) 25 EHRR 371) covers information which individuals can legitimately expect not to be gathered, published, stored, or used without their consent, including medical data. Article 8 is a qualified right, however. This means that interferences with the right are permissible where in accordance with the law and necessary in a democratic society to achieve such aims as the protection of health or the protection of the rights and freedoms of others (of relevance here). Given that personal information is not provided, that it is envisaged that data will often be input by a clinician in the presence of the patient, with their knowledge and consent, it could be argued that the tool is a proportionate response to the aim of protecting health.

Medical Law and Ethics

Where individuals have been identified by the Covid-19 Clinical Risk Assessment Tool as clinically extremely vulnerable, they are encouraged to shield. This direction amounts to advice only and individuals have the right to choose whether to follow that advice in line with established legal principles of personal autonomy and self-determination.[54] Should they choose to ignore the advice to shield, they must nevertheless follow any Covid-19 Government restrictions that are currently in place.

It is envisaged that medical decisions relating to the QCovid score must be taken by a patient in consultation with their doctor.[55] The risk assessment tool 'therefore supplements clinical decision making and does not replace it'.[56] The Covid-19 Clinical Risk Assessment Tool obtains information with consent from 1) clinicians entering patient information and 2) existing medical records. For consent to be valid, it must be given voluntarily by a person who has capacity to consent and who understands the nature of the proposed intervention and risks involved. Information relating to medical treatment is subject to a duty of confidence although it is assumed that information is shared with the knowledge and consent of the patient and no personally identifiable information is retained by the tool.

There will be some clinically extremely vulnerable people who have conditions, such as dementia or learning disabilities, which impact upon their ability to make informed decisions about Covid-19 risks and whether to shield. Their capacity to make this decision should be assessed in accordance with the Mental Capacity Act 2005 in England and Wales (with similar laws operating in Scotland and Northern Ireland). 'Best-interests' decisions will be made for people who are assessed to lack capacity based on clinical advice, involving the person as much as possible, ascertaining the views of significant others and attorneys, and with regard to the person's past and present wishes.

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[54] See FAQs letter to GPs on risk tool, 15 February 2021. Available at: https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/C1099_-Letter-to-GPs-on-Risk-Tool-15-February.pdf
[55] See QCovid licence: https://qcovid.org
[56] See QCovid licence: https://qcovid.org

LESSONS LEARNED

- It is important to ensure that **transparency around the use of algorithms** is sufficient with **appropriate validation.**

- Where the reliability of data in an algorithm is low, there is a **risk of 'spurious correlations'** being made.

- Public health emergencies may justify the deployment of an algorithm that makes (false positive) errors owing to a precautionary approach. However, attention must be paid to **monitoring and evaluating the consequences** of such an approach.

CASE STUDY 3
COVID-STATUS CERTIFICATION

HEADLINE FINDINGS

- A digital Covid-status certification scheme faces **significant implementation challenges.** Stakeholders raised concerns around the **timeliness and purpose of certification**, the **right to privacy**, and **security risks** that could arise. The probabilistic and contextual nature of certification is not well known or understood.

- A certification scheme could adversely impact those who demonstrate vaccine hesitancy, particularly from ethnic minority communities. Considerable concerns were raised in our research over **certification becoming a surrogate for discrimination.**

CASE STUDY OVERVIEW

This case study explores the proposed digital 'passport' or 'certificate' to communicate a person's full vaccination status and/or their ability to transmit Covid-19 to others based on the current vaccine roll-out in the UK. The 'passport' or 'certificate' may enable travel across borders and potentially entry to domestic venues such as bars and restaurants. The validity of Covid-status certificates has been called into question given the lack of scientific data regarding the long-term immunity from Covid-19 provided by vaccination or previous infection.

AIMS, OBJECTIVES & BENEFITS

The aim of a digital Covid-status certificate is to aid the return to pre-Covid-19 activities and travel without compromising personal or public health. A Covid-status certificate aims to achieve this objective by certifying that holders are protected from the virus, allowing them to carry out the activities for which the certificate is needed and avoid additional burdens on health services. This assumes that an individual cannot become infectious and transmit Covid-19 to others. At the time of writing, the UK government has indicated an intention to incorporate a certificate into the NHS app specifically for travelling abroad.[57]

A Covid-status certification scheme is a method of identifying which individuals have 1) had the full vaccination; 2) a recent negative Covid-19 test; or 3) antibodies (in some proposals). Each of these types of evidence presents its own strengths and weaknesses:

1) **Full vaccination:** While the benefits of being vaccinated for the individual are clear (i.e. a significantly reduced risk of severe illness or hospitalisation), it is less clear how a vaccination affects an individual's infectiousness, and thus their ability to transmit Covid-19 to others. Additionally, different vaccines may potentially offer different levels of effectiveness to the

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[57] See: https://www.gov.uk/guidance/demonstrating-your-covid-19-vaccination-status-when-travelling-abroad

various genetic variants of the virus, and there is a significant number of individuals who are not yet eligible for vaccination.

2) **Negative Covid-19 test**: A recent negative Covid-19 test result, on the other hand, may be more widely available, but does not protect the tested individual from infection. In addition, test results can vary in accuracy and implications. For example, there are 'red light' tests which indicate a person is potentially infectious and 'green light' tests where a negative result means the person is not infectious. As a result, the type of test will likely need to be considered. Relatedly there is a concern that more expensive tests can lead to more accurate results, with implications for fair access to certification. Furthermore, a negative test result only captures data for one given point in time and does not guarantee that the person will not catch Covid-19 after the test is taken.

3) **Antibodies:** A third type of evidence that is being considered is the presence of antibodies arising from a previous Covid-19 infection. This would mean that people who have already contracted and recovered from Covid-19 may benefit from greater societal privileges. However, there is currently no evidence that indviduals who have recovered from Covid-19 and have antibodies are protected from a second infection, or new variants of the virus.

At the time of writing, the benefits of certification are not fully realised. A certification framework that indicates test results may be beneficial for those who had not yet received the vaccine or who choose not to vaccinate. More broadly, a certification framework could assist in opening up the economy and preventing future restrictions on domestic travel. International travel could resume to countries without the need to quarantine on departure or arrival. Another benefit of the certification identified by stakeholders was the re-opening of large venues to enable gatherings for sport or music.[58] In this regard, one interviewee opined that because these venues are not obligatory to attend, the certificate would not be unreasonable to request.[59]

Parameters and Statistical Validity

The confidence in a digital 'passport' or 'certification' hinges on the efficacy of vaccinations and the accuracy of test results. The Royal Society highlighted 12 challenges for vaccine passports in February 2021, stating that 'A Covid-19 vaccine passport is feasible but not all the pieces are in place to allow one to be effectively delivered yet'.[60] There is currently a need for more information on the efficacy of vaccines in preventing infection and transmission by the currently circulating viruses, including genetic variants and the duration of protective immunity to establish how long a certificate might be valid.

Tests to measure Covid-19 antibodies in the blood can be a valuable tool to assess the prevalence and spread of the virus. But they vary widely in quality and efficacy. This has led the World Health Organisation and former US Food and Drug Administration commissioner Scott Gottlieb to caution against their use in assessing individual health or immunity status.[61] Several available tests are

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[58] Interview with A8.
[59] Ibid.
[60] The Royal Society, '12 Challenges for Vaccine Passports', 19 February 2021. Available at: https://royalsociety.org/news/2021/02/12-challenges-for-vaccine-passports/.
[61] CNBC, 'Dr. Scott Gottlieb sees 'some level' of immunity for most people who had coronavirus', 27 April 2020, https://www.cnbc.com/2020/04/27/gottlieb-sees-some-level-of-immunity-for-most-who-had-coronavirus.html

sufficiently accurate, meaning they are validated to have at least 99% specificity and sensitivity. But preliminary data suggests that the vast majority are not reliable. Low specificity means the test measures antibodies other than those that are specific to Covid-19. This causes false positives, leading people to think they are immune when they are not. Low sensitivity means that the test requires a person to have a high concentration of Covid-19 antibodies for them to be measured effectively. This causes false negatives in people who have few antibodies, leading to potentially immune individuals being incorrectly classified as not immune.

Research found that most recovered patients produce antibodies for Covid-19.[62] However, uncertainties remain around how effective antibodies are for future strains or how long immunity lasts. Currently, estimates are based on prior knowledge of immunity in severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). The best guess is therefore one to two years of protection.[63] However, if Covid-19 mimics the common cold the timeline for immunity could be much lower. This lack of data on immunity could impair the relevance or impact of a Covid-status certificate for domestic or international use.

RISKS & CHALLENGES

Our stakeholders raised several significant risks and challenges to implementing Covid-status certifications. One stakeholder outlined that the certification 'takes information at a point of time, a test result and their origin body result which has… all of these probabilities. You would then interpret those probabilities with lots of other information and give a piece of advice that says no I don't think you should go here because I think that you're a bit higher risk than usual or you might be presenting risks to others.'[64] In essence, the certificate attempts to take a number of variables and reduce the probabilities involved to assign people into one of two categories in order to determine if a person is infectious or not. This can be misleading because, as the stakeholder surmised, 'clinically this is much more probabilistic and much more contextual.'[65]

At the time of writing the UK has announced a Covid-status certificate will be available in electronic format through the NHS app.[66] However, there are significant practical challenges facing the implementation of the certificate. As Chris Green MP raised in a House of Commons debate on vaccination passports, 'If we moved from paper certificates to electronic, however, significant questions of civil liberty would arise. Who in the world would run that database? What data would go into it and who would determine that? Would it be an international body such as the United Nations, the EU or some other organisation? If we could not get an international organisation to take the lead, would a big corporate organisation do so? Would big tech in California have control over the database? In the light of what happened when the Australian national Government confronted a big

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[62] Ania Wajnberg, et.al, 'Humoral immune response and prolonged PCR positivity in a cohort of 1343 SARS-CoV2 patients in the New York City region', medRxiv, May 2020.
[63] Natalie Kofler and Francoise Baylis, Nature, 'Ten reasons why immunity passports are a bad idea', 21 May 2020. Available at: https://www.nature.com/articles/d41586-020-01451-0#ref-CR3
[64] Interview with A8.
[65] Ibid.
[66] Cristina Criddle, BBC News, 'NHS app ready to become vaccine passport next week', https://www.bbc.co.uk/news/technology-57070185

tech company, giving such a company so much power would be a colossal problem. We need to be proportionate and cautious.'[67]

In our stakeholder interviews, experts were most concerned about the prospect of certification becoming a 'surrogate for discrimination'.[68] Stakeholders raised the concern that if workplaces were to request vaccine certification to either get a job or return to the workplace, this could lead to 'indirect discrimination'.[69] Furthermore, according to one interviewee there are remaining questions around how much the process will be outsourced to the private sector, without being guided by human rights obligations.[70] This was mirrored in a report by Ada Lovelace outlining six requirements for governments issuing a vaccine passport system. 'Ethical consideration and clear legal guidance about permitted and restricted uses, and mechanisms to support rights and redress and tackle illegal use' is a requirement that links directly with our stakeholders' concerns.[71]

Our research has also found that 'coercion by the backdoor' is a key concern with regard to certification for people of all ages, regardless of how quickly certain age groups are vaccinated.[72] Concerns were raised about the application of certificates without scrutiny, as well as what can be perceived as an 'unjustified intrusion' on an individual's personal choice with regard to vaccination.[73] By revealing the status of vaccination an individual's 'medical status becomes publicly interrogable'.[74] One interviewee argued that certification will effectively result in a two-tiered society whereby vaccinated people are treated differently from those who have not been vaccinated.[75]

Stakeholders also questioned whether the implementation of the Covid-status certification would logistically deliver its intended outcome in view of the planned timeline for vaccination of the population: 'The window in which [vaccine passports] are useful is really quite narrow because once everybody is vaccinated you don't really need to differentiate. The community is reasonably safe and so why would you exclude some people? … it's only really useful when you have a sufficient number of people vaccinated that enables you to open things up, but you don't have everybody vaccinated, so you can open them up to everybody.'[76] The value of a vaccine certificate scheme is therefore 'transitional'.[77] This stakeholder estimated, based on the current vaccination delivery plan, that it is very unlikely that families with children will have been fully vaccinated by the summer holidays in 2021: 'There's a window of opportunity and it doesn't seem to fit what we need. We need something for this summer now. … what is the practical benefit of this?'[78] Relatedly, it was pointed out that for many businesses it will not be commercially sensible to operate a Covid-status certificate scheme, given that a large proportion of their potential customers will not have been vaccinated. There appears

[67] House of Commons, Hansard, Westminster Hall, Vaccine Passports, Volume 691: debated on Monday 15 March 2021. Available at: https://hansard.parliament.uk/Commons/2021-03-15/debates/8D4B8782-7BA5-475B-A48A-370859B78209/VaccinePassports?highlight=police%20test%20trace%20data#contribution-00CF44C0-0D9F-4CE4-B568-46FAB9B4163D
[68] Interview with A4.
[69] Ibid.
[70] Ibid.
[71] Ada Lovelace Institute, 'Checkpoints for vaccine passports', 10 May 2021, https://www.adalovelaceinstitute.org/report/checkpoints-vaccine-passports/
[72] Interview with D6.
[73] Ibid.
[74] Ibid.
[75] Ibid.
[76] Interview with A10.
[77] Ibid.
[78] Ibid.

to be a 'mismatch between the rhetoric of what [vaccine passports] are about and what they would do for society' and as this stakeholder fundamentally observed 'it is not obvious what problem is solved by this certification'.[79]

Furthermore, there is an inherent cyber risk in using Covid-status certificates. Questions remain about whether they could be duplicated, corrupted, or destroyed without the permission of the certificate owner. In Israel, several flaws were found in the app including the ability to be duplicated and therefore sell fake certificates online.[80] The Economist pointed out that 'security is a good place to start, for if passports are to work, they must be trustworthy.'[81] If trust in the scheme is compromised, it could lead to further distrust of other government backed technologies to tackle the pandemic or relating to healthcare more widely.

LAW, REGULATION & GOVERNANCE

As in the above case studies the UK's GDPR is the primary data protection framework governing the use of individuals' data. In addition to the privacy and data protection implications, this section focuses on the ethical considerations around discriminatory implementation of any certification scheme.

Privacy and Data Protection

Covid-status certificates may contain personal, private, health-related information (Covid-19 vaccination, Covid-19 antibodies, negative test for Covid-19). They will therefore contain 'special category' personal data and be covered by the UK GDPR and Data Protection Act 2018. Processing of such data is possible where justified, as necessary.[82] If an individual is unable to travel freely, enter or access certain premises unless they consent to inclusion of their personal data then such consent is not freely given.

If Covid-status certificates are used for domestic purposes, then organisations must consider carefully how they can justify asking someone to produce a certificate and what the legal basis is for asking to view a certificate. Businesses are likely to have to consider an alternative legal basis, such as processing on the basis of substantial public interest.[83] Businesses must also consider how they will satisfy the stringent security requirements that apply to the collection and storage of such data. Ideally any business seeking to rely upon Covid-status certificates should carry out a data protection impact assessment.

The requirement for someone to disclose their health status in order to travel or to access services engages their rights under the Article 8 ECHR right to private life. Article 8 covers information which individuals can legitimately expect not to be gathered, published, stored, or used without their consent, including medical data.[84] Article 8 is a qualified right, but any interference with the right (i.e. a

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[79] Ibid.

[80] Toi Staff, The Times of Israel, 'Thousands reportedly attempt to obtain easily forged vaccinated certificate', 18 February 2021. Available at: https://www.timesofisrael.com/thousands-reportedly-attempt-to-obtain-easily-forged-vaccinated-certificate/

[81] The Economist, 'Are vaccine passports a good idea?', March 13 2021. Available at: https://www.economist.com/science-and-technology/2021/03/13/are-vaccine-passports-a-good-idea

[82] The justifications in Article 6/Section 8 DPA 2018 apply to personal data, and additional justifications under Article 9 UKGDPR and Part 2 of Schedule 1 DPA 2018 must be demonstrated for special category personal data.

[83] Of the Part 2 Schedule 1 DPA 2018 list of 23 substantial public interest conditions which might be considered only two appear relevant: safeguarding of individuals at risk and safeguarding of economic well-being.

[84] *Z v Finland* (1988) 25 EHRR 371.

requirement to disclose one's Covid status) must be in accordance with the law and necessary in a democratic society to achieve such aims as the protection of health or the protection of the rights and freedoms of others.

Medical Law and Ethics

Ethical concerns surrounding Covid-status certificates include the potential for discrimination (direct and indirect) and the worsening of existing inequalities. Mandating certificates would unfairly exclude those who do not have access to vaccines. The World Health Organisation is currently advising against the introduction of certificates by national authorities and conveyance operators on scientific and equality grounds.[85] 'The disparate timing in vaccine roll-out, compounded by some high-income countries signing advance purchase agreements with vaccine companies, creates a segregated society or world into the 'vaccine-privileged' versus 'vaccine-deprived'.'[86]

Vaccinations are being offered to older people and other vulnerable adults, some of whom may have impaired capacity to consent to vaccinations and for whom best-interests decisions need to be made. Adults with the capacity to decide whether to be vaccinated (as well as those making best interest decisions on behalf of incapacitated adults) may feel coerced into consenting to vaccinations as without a Covid-status certificate they will potentially be denied access to certain services, jobs, and foreign travel, for example. This risk may be especially pertinent amongst people of certain ethnic minority groups exhibiting vaccine hesitancy, people with conscientious objections, people from socioeconomic backgrounds with a historical mistrust of medical health systems, and those with specific health status/conditions.

The need to comply with equality and discrimination laws, which in the UK are now principally found in the Equality Act 2010, means that some people may be exempt from having to receive vaccinations (protected religious/philosophical beliefs or due to underlying health/disability grounds) and holding certificates. A burden is being placed on frontline workers to police the regulation of certificates without appropriate tools. Certain sectors of society who may not have access to digital smartphones to access the certificate would be excluded from services, exacerbating the digital divide for the elderly or those without digital devices.[87]

> **Equality**
> The Equality Act 2010 sets out the public sector equality duty (s.149) which requires, amongst other things, that public authorities have due regard to the need to advance equality of opportunity between people who share a protected characteristic and those who do not. The protected characteristics (s.4) are: age; disability; gender reassignment; pregnancy or maternity; being married or in a civil partnership; race; religion or belief; sex; or sexual orientation. In particular, in relation to people with protected characteristics, public authorities must take steps to remove or minimise disadvantage; meet the specific needs where they differ from the needs of other people; and encourage participation in public life/activities where participation is disproportionately low. The Act also prohibits direct and indirect discrimination by providers of services to the public based on a protected characteristic.

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[85] World Health Organization, 'Interim position paper: considerations regarding proof of COVID-19 vaccination for international travellers', 5 February 2021. Available at: https://www.who.int/news-room/articles-detail/interim-position-paper-considerations-regarding-proof-of-covid-19-vaccination-for-international-travellers

[86] Lawrence O. Gostin et.al, 'Digital Health Passes in the Age of COVID-19: Are "Vaccine Passports" Lawful and Ethical?', JAMA, April 7 2021.

[87] The Royal Society, '12 Challenges for Vaccine Passports', 19 February 2021. Available at: https://royalsociety.org/news/2021/02/12-challenges-for-vaccine-passports/.

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Human rights

Article 8 of the European Convention for the Protection of Human Rights and Fundamental Freedoms (ECHR) affords a right to respect for private life. Art. 8 covers information which individuals can legitimately expect not to be gathered, published, stored or used without their consent, including medical data (*Z v Finland* (1988) 25 EHRR 371); and personal data more generally (*Satakunnan Markinaporssi Oy and Satamedia Oy v Finland App* no 931/13). Art. 8 is a qualified right with which the state may interfere in certain circumstances where necessary in a democratic society and in accordance with the law. This includes in the interests of public safety, the protection of health or morals, and for the protection of the rights and freedoms of others. The requirement that interference is necessary entails a test of proportionality; interference must be no more than necessary to meet the stated aim.

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The Equality Act 2010 also bans indirect discrimination. Indirect discrimination might occur where:

• A business denies entry to their premises or denies a service to someone because they do not have a Covid-status certificate.

• The rule impacts disproportionally on people with a protected characteristic such as age; disability; ethnicity.

Human Rights

One argument for certificates is that they enable individuals to move freely in public (exercising their Article 11 ECHR right to freedom of assembly and association) whilst at the same time protecting health and preventing loss of life (Article 2 ECHR) by limiting unfettered movement without mask or other restrictions to those who can evidence that they are unlikely to pose a risk to others. If Covid-status certificates are used to limit individuals' ability to exercise their Article 11 ECHR right to freedom of assembly and association then consideration needs to be given to ensuring that the practical operation of certificates does not discriminate against particular groups. Article 14 ECHR makes clear that the enjoyment of all ECHR rights must be afforded, without discrimination on any grounds, including grounds of sex, religion, colour, language, religion, national or social origin, association with a national minority, property, birth, or other status. Issues are potentially posed for elderly adults who do not own smartphones or related technology.

None of the current debates about Covid-status certificates consider the child's perspective. Significant reports bring together numerous academics, none of whom are experts on children's rights.[88] The benefits of Covid-status certificates for children are the same as adults. But there are currently no plans to offer vaccinations to children under 16 years old. Certificates linked to a previous positive test will be relevant only to a limited number of children (reports suggest 20-35% of children with Covid-19 are asymptomatic). Governments do not currently appear to be considering how certificates can be applied to children or seeking children's views in this regard despite requirements under the UNCRC for public bodies to treat the child's interests as a primary consideration in all actions undertaken by them (Article 3) and the Article 12 UNCRC requirements to afford capable children the ability to express views on issues affecting them.

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[88] Ada Lovelace Institute, 'What place should COVID-19 vaccine passports have in society?', 17 February 2021.

LESSONS LEARNED

- The risk of coercion by the backdoor and the impact of potential discrimination from certification should be mitigated by **communicating a clear purpose for certification and implementing rules specifying permitted use.** A monitoring and oversight mechanism should be implemented to **prevent misuse** of the certification scheme.

- The **probabilistic, contextual, and time-limited nature** of certification needs to be better understood and communicated to individuals.

- The wider **human rights implications** of certification should be front and centre of the debate without excluding the voice of children.