

Ethics of digital contact tracing wearables

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ABSTRACT

The success of digital COVID-19 contact tracing requires a strategy that successfully addresses the digital divide—inequitable access to technology such as smartphones. Lack of access both undermines the degree of social benefit achieved by the use of tracing apps, and exacerbates existing social and health inequities because those who lack access are likely to already be disadvantaged. Recently, Singapore has introduced portable tracing wearables (with the same functionality as a contact tracing app) to address the equity gap and promote public health. We argue that governments have an ethical obligation to ensure fair access to the protective benefits of contact tracing during the pandemic and that wearables are an effective way of addressing some important equity issues. The most contentious issues about contact tracing apps have been the potential infringements of privacy and individual liberty, especially where the use of apps or other technology (such as wearables or QR codes) is required for access to certain spaces. Here we argue that wearables, as opposed to apps alone, will make a digital contact tracing mandate more practical and explain some conditions under which such a mandate would be justified. We focus on Singapore as a case study that has recently deployed contact tracing wearables nationally, but also reference debate about wearables in Australia and New Zealand. Our analysis will be relevant to counties trialling similar portable tracing wearables.

INTRODUCTION

As COVID-19 continues to beleague the world, there is sustained interest in developing and deploying digital contact tracing tools. One of the most common forms of digital contact tracing is through smartphone applications (apps) that can help public health officials identify individuals with whom patients with COVID-19 have been in contact. More recently, several countries have begun developing wearable contact tracing tokens as a supplement or alternative to the use of such apps.

In this paper, we use Singapore as a specific case study to examine the ethics of newly developed contact tracing wearables intended to supplement existing contact tracing apps. We focus on Singapore for several reasons. One, Singapore is one of the first countries in the world to produce contact tracing wearables, and is currently committed to making the wearables available to every resident.¹ Two, the ethics of contact tracing is highly context sensitive, contingent on a country's specific health conditions, technological capacity, legal protections, vulnerabilities, power structures and other local factors. We illustrate the ways in which these socioeconomic factors contextualise contact tracing tools in Singapore, and indicate how in other

contexts the challenges may differ. For comparative purposes we also refer briefly to the use of contact tracing technology in Australia and New Zealand.

Our starting point is that COVID-19 contact tracing apps are, under the right governance conditions, a defensible public health tool to promote effective identification of COVID-19 contacts and the deployment of appropriate public health measures in response. Some of the risks and challenges of deploying apps, especially to privacy, are discussed below. But in a public health emergency, those privacy risks are substantially less urgent compared with the risks of leaving contacts of COVID-19 cases undetected and at risk of further spreading the virus—especially when the apps are subject to standards of good governance.

Our analysis aims to describe the ethical merits and complications of the use of wearables in the Singapore context, and to capture useful lessons for other countries considering the use of tracing wearables.

We propose that wearables are a 'value add' that should be developed in parallel to contact tracing apps in order to maximise apps' benefits and reduce health inequities. We further argue that wearables may make feasible digital contact tracing mandates for entry into public spaces, and that under the right conditions these mandates can be well justified.

BACKGROUND ON CONTACT TRACING APPS

In order to appreciate the ethics of contact tracing wearables, we first need to understand how they are being developed in light of the limitations of contact tracing apps. Apps are designed to complement and enhance (rather than replace) the current manual contact tracing performed by public health officials or volunteers. Manual contact tracing is expensive, slow and labour intensive. These apps' primary purpose is to record when two app users are in close proximity for an extended duration of time. Then, if one user is later diagnosed with COVID-19, the app data could be used to efficiently identify individuals who may have been exposed to the virus and ensure they are promptly tested themselves. A number of different designs have been proposed and developed, with variations in terms of what data are gathered (eg, Bluetooth vs Global Positioning System), how data are stored and whether public health officials are able to retrieve data from certain users ('centralized' vs 'decentralized' models). Concurrently, several frameworks for the ethical oversight and governance of contact tracing apps have been promulgated.²⁻⁸

Contact tracing apps may be beneficial for the individual user and for the community. First, there is a potential personal benefit to users of the app as they can be quickly informed of any close



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contact with someone who has tested positive for COVID-19, encouraging the user to seek testing that could lead to earlier and more effective treatment. Second, there is a potential public health benefit because the app can improve the effectiveness and efficiency of contact tracing, ensuring timely delivery of stay-at-home notices¹ and other public health measures that help prevent further community transmission.

This second benefit is only possible on a ‘centralized’ model of contact tracing apps, where public health officials receive the app data of patients with COVID-19. We focus in this paper on centralised models of digital contact tracing, because centralised gathering of data accessible to public health officials is essential for the app to effectively assist in contact tracing. Decentralised models might involve less privacy risk to individuals, but they also provide less potential public health benefit because public health officials are unable to access the data. In addition, it is not clear how contact tracing wearables could be integrated into a decentralised system.⁶ Since wearables are not tied to an app, there would not be a ready means to easily and anonymously inform individuals of their exposure to someone who had tested positive. It is not a coincidence that countries such as Singapore and New Zealand that currently employ a centralised model of digital contact tracing are also the very ones considering the deployment of wearables.

Contact tracing is a form of public health surveillance and as such raises valid concerns about privacy, liberty and proportionality. Contact data are sensitive, and theoretically could be misused—for example, by passing the data to law enforcement officials, which goes well beyond the public health justification for gathering the data. Contact tracing apps raise further concerns through the automated collection of sensitive data, the use of digital consent and the degree of data privacy afforded. These costs of contact tracing more widely, and contact tracing apps specifically, must be weighed against the degree of protection afforded to individuals and populations.

Along with many other authors on this topic we think that offering contact tracing apps is ethically justified so long as various limitations are in place. These conditions stipulate that there must be: adequate evidence of benefit; proportionality of benefits to the risks; security and confidentiality of data; subjection to independent monitoring; limitation of data use to contact tracing; transparency on how the app works, who has access to data and how data use is governed; and equitable access to benefits.^{5 7–10} These are not necessarily unreasonable expectations; it has been argued elsewhere that most of these conditions adequately obtain, for example, in South Korea’s use of digital contact tracing.¹¹

We are broadly in agreement with this position on contact tracing apps and in this paper extend the conversation to wearables, particularly the concern about equity. One point of departure regards the claim by some that digital contact tracing should be offered on a voluntary, not compulsory, basis.^{4 5 9 12} A mandate would obviously have a greater impact on the liberty and autonomy of users. In the latter part of the paper we return to the issues of compulsory use of contact tracing apps and wearables in public spaces, and propose that as long as other conditions of good governance are met, compulsory use of digital contact tracing in some public spaces is justifiable.

¹‘Stay-at-home notice’ refers to a legally enforceable order not to leave the place of one’s primary residence for a specified period of time, except for very specific purposes such as seeking medical treatment.

An important difficulty with contact tracing apps identified by several commentators is lack of universal access.^{2 4–8} Some people do not have a smartphone, or a smartphone with Bluetooth capabilities.⁴ Others may be reluctant to download a new app on their phone, whether out of suspicion of misuse or mere inertia. This lack of universal access and acceptability poses two related ethical problems—effectively protecting public health and promoting justice.

First, for the apps to effectively assist in suppressing viral transmission, there needs to be sufficient public uptake.¹³ Countries that have promoted national apps, like Norway and India, have fallen far short of stated targets.¹⁴ Rates of downloads may in fact overstate the number of individuals usefully covered by the app, since the app could be downloaded but then deleted or deactivated. If insufficient people use an app, its utility in protecting public safety is undermined.

Second, those who lack access to a smartphone that can support contact tracing apps are more likely to be disadvantaged due to factors such as socioeconomic status, residency status or age. This presents an equity issue because specific populations at higher risk of COVID-19 have less opportunity to benefit from protective public health initiatives. Equity refers to the absence of avoidable or remediable difference between groups of people. Tracing wearables are a potential solution to these challenges.

To understand the equity considerations relevant to the adoption of tracing wearables, let us consider the example of Singapore. Due to lower rates of smartphone ownership, some specific subpopulations known to be at greater risk of COVID-19 (foreign workers and older individuals) are also less likely to be able to access and thereby benefit from a contact tracing app. Reliance on smartphone contact tracing is likely to make younger, wealthier Singaporeans relatively safer; while leaving older, poorer populations and foreign workers at relatively greater risk.

In Singapore, low-paid foreign workers (domestic services and construction) account for 18% of the total population.¹⁵ Only 53% of those foreign workers have smartphones,¹⁶ compared with 94% of citizens and permanent residents.¹⁷ With over 90% of confirmed cases in Singapore occurring among the foreign worker population, they are particularly at risk of infection as well as very restrictive movement orders.¹⁸ These orders have confined workers to specific dormitories for extended periods of time, sometimes months on end.¹¹ In other countries, low-income level is associated with lower smartphone uptake,¹⁹ and has been identified as a risk factor for COVID-19 susceptibility.²⁰

Older individuals are also less likely to own smartphones. A 2019 survey in Singapore found 100% smartphone usage in citizens and permanent residents aged 15–49, but only 78% usage for those 60 years and above.¹⁷ Similar patterns are evident in other countries.^{19 21 22} This is especially concerning for COVID-19, where there is a strong correlation between adverse outcomes and age.²³

CONTACT TRACING WEARABLES

Contracting wearables are a clear solution to this problem of unequal access to smartphone-based tracing apps. In late 2020, Singapore began to produce and freely distribute a physical

¹¹Prior to the COVID-19 outbreak, many foreign workers lived in dormitories in which 12–16 people would share a single room, contributing to the outbreak in that subpopulation. Since June, the maximum occupancy of workers’ dorms has been reduced to 10 persons per room in an effort to improve the capacity for social distancing.⁴⁰

wearable device that functions the same as, and is interoperable with, the national contact tracing app.²⁴ The New Zealand government is also trialling a similar approach through the CovidCard.²⁵ Just like the app, the wearable operates using Bluetooth technology, internally logging when and with whom it is in physical proximity for a certain duration of another wearable or app user.

Contact tracing wearables have the same, or arguably less, privacy risks as compared with contact tracing apps. They both use the same data (Bluetooth), encryption approach, limitations on use, degree of public health authority access and method of integration into contact tracing. The wearable might arguably be even more secure. Because it is not attached to an internet-connected device, there is less risk of malicious hackers remotely hijacking a device and breaking through the system's data encryption. The consent processes for apps versus wearables might differ (one occurring at the point of download, the other at the point of wearable collection), but if an adequate consent process can be developed for contact tracing apps, a similar process should be deployable for wearables.

Developing and distributing contact tracing wearables has the potential to substantially improve the effectiveness and equity of existing contact tracing apps. With more individuals integrated into an app/wearable digital contact tracing network, more contacts of a patient with COVID-19 will be able to be quickly identified, in turn enhancing COVID-19 containment and mitigation efforts. These devices overcome an unjust barrier to access inherent in the smartphone app system. In line with this, the distribution of the first batch of Singapore's contact tracing wearables was targeted at one of the particularly vulnerable populations identified above—older individuals.²⁶

Wearables, then, have roughly the same form and degree of risks as with a contact tracing app, but substantial further advantages in terms of ability both social benefit and social equity. For these reasons, contact tracing wearables should be developed, distributed and integrated into digital contact tracing systems.

IMPLICATIONS FOR A DIGITAL CONTACT TRACING MANDATE

As with apps and other digital tracing tools, wearables may be offered on a voluntary or mandated basis. In fact, distributing contact tracing wearables may facilitate and enable a digital contact tracing mandate that would otherwise be infeasible or unjustifiable and this is one potential source of concern regarding wearables. Here, we lay out the circumstances in which a digital contact tracing mandate can be justifiable.

A general mandate to use contact tracing apps would be infeasible, due to lack of universal access to smartphones that can run contact tracing apps. It might be possible to nevertheless require the app to be used to enter certain public spaces, but this would be unjust. Those without a compatible smartphone would be doubly disadvantaged by not being able to access public spaces.

Distributing contact tracing wearables would make mandates more feasible. So long as there is distribution of wearables to anyone lacking a smartphone (or, more robustly, to the entire population as in the case of Singapore), a requirement to have either a contact tracing wearable or app could become a requirement to enter certain public spaces such as schools, workplaces, libraries, restaurants and shops.³

To say that a mandate might be feasible does not in itself imply it is overall justifiable. Indeed, some countries like Australia have statutory prohibitions on any requirements to download or use that country's contact tracing app.²⁷ Such legislative prohibitions may be necessary in contexts where there is a lack of popular

support for a mandate, in order to maintain public expectations and be democratically responsive to popular will. However, law and popular opinion can be mistaken. We propose that a mandate could indeed be justified, though its scope would need to be carefully circumscribed.

A general mandate to have a contact tracing app or wearable active at all times would likely be untenable due to enforcement concerns. Unlike with masks, which are readily visible, enforcement could not be done passively by authorities observing people walking on the street.ⁱⁱⁱ Enforcement would necessitate routine stopping and searching or scanning of persons' possessions without reasonable cause. This requires substantial human resources and would amount to unjustified intrusion of liberty. An analogous policy of 'stop-and-frisk' in New York City was widely derided as unnecessarily invasive, and resulted in disproportionate and biased targeting of racialised minorities.²⁸

The more defensible approach, as mooted in Singapore, is a requirement to present a contact tracing app or wearable in order to enter public spaces. This is continuous with previously existing requirements for individuals to log their entry into public spaces, through either an app or presentation of ID.

Still, a mandate on possessing a contact tracing app or wearable for entry into public spaces would involve a substantial degree of privacy intrusion that requires proportionate evidence of public health benefit to justify. Exactly what counts as sufficient evidence is debatable. Is modelling of contact tracing effectiveness sufficient, or are real-world data needed? Most commentators hold that, because there is still too little real-world evidence of effectiveness, contact tracing apps are still 'experimental' and a mandate would not be warranted.^{2 6-8 29}

However, this standard of evidence is unacceptably high, to the point of potentially being unachievable. A digital contact tracing mandate would be intended to bring about conditions that by definition do not yet obtain: high uptake of contact tracing apps and wearables. Digital contact tracing is in this way unlike biomedical interventions such as vaccines—whose effectiveness can be measured in a controlled study. By contrast, digital contact tracing's effectiveness depends crucially on the how members of society are using the apps or wearables. The only way to know, based on real-world data, whether a mandate is effective is to actually institute a mandate.

In addition, the evidence demanded before digital contact tracing can be mandated is inconsistent with the standard of evidence used to justify coercive policies enacted in many countries, such as mask mandates or city-wide lockdowns. While masks and lockdowns have some evidence base for effectiveness, that evidence base for the effectiveness of such interventions versus alternative approaches has generally been of low or uncertain quality.^{30 31} Some of these interventions, such as lockdowns, have impacts on individual liberty far more severe than a requirement to download an app or present a wearable.³² Lockdowns or mask mandates may ultimately have proportionately large benefits to justify coercive enforcement, but most importantly for our purposes is that the decision to institute these measures was based, at least initially, on projections and modelling rather than real-world data. Modelling studies on the

ⁱⁱⁱIn Singapore, enforcement of masks and other social distancing requirements is performed by enforcement officers who are posted at various public spaces, usually in conjunction with one or more volunteer safe distancing ambassadors. While the volunteer ambassadors have no enforcement power themselves, they increase the human resources available for surveillance activities and can alert enforcement officers of potential breaches.

effect of a digital contact tracing mandate^{33 34} should be sufficient evidence to demonstrate potential benefits that can justify the privacy and liberty costs of a mandate.

This is not to say mandates should be insensitive to real-world evidence. As mandates are rolled out, they must be evaluated both in terms of impact on uptake and effectiveness in improving public health officials' ability to engage in effective and efficient contact tracing. Indeed, preliminary data on digital contact tracing are suggestive of benefit. For example, as of November 2020, Singapore reported 25 000 contacts of positive COVID-19 cases had been identified using digital contact tracing, of which 160 ultimately tested positive.³⁵ Even with that evidence base, though, modelling is still needed to project how many additional contacts and cases might have been identified sooner were a mandate in place.

Beyond questions of effectiveness, enacting a public space mandate for digital contact tracing will raise concerns about the surveillance state: governments gathering increasingly sensitive data, in turn using those data to monitor residents and enforce the law. The extent to which a digital contact tracing mandate can avoid contributing towards the surveillance state may depend on the extent to which a 'purpose limitation' can be maintained, where data are used solely for the purpose of contact tracing and mission creep into other secondary purposes is avoided.

Singapore offers something of a cautionary tale in this regard. While initially assurances were given by both government and the app developers that TraceTogether data would indeed be limited solely for the use of contact tracing, it was later revealed that the police can access the data for other criminal investigations, and had already done so in at least one murder investigation.³⁶ After an outcry, a law was quickly passed limiting the use of TraceTogether data for only prescribed crimes such as terrorism, kidnapping, drug offences carrying the death penalty or causing serious hurt.³⁷

Police access to contact tracing data undermines the justifiability of a mandate in at least two ways. First, this would exacerbate the privacy intrusion of a mandate, as a wider range of agencies gain access to sensitive data for a larger number of purposes than originally intended. Second, the expanded scope of data access risks creating a feedback loop to further increase social surveillance: as the apps and wearables are used for purposes other than contact tracing, their functionality may also be altered to more easily facilitate police investigations that over time may increasingly come to rely on them.

In light of these considerations, purpose limitations of digital contact tracing should be adhered to if a mandate is to be considered.

Governments, though, are not the only entities that might preside over a digital contact tracing system. If enforcement of an app or wearable mandate is instead done by employers, this may raise even deeper concerns about privacy intrusions and inadequate governance. Such a system is currently being piloted at certain worksites in Singapore, as a reaction to companies not having access to contact tracing data from the government-run app. One company executive highlighted that 'It is important for companies to have total control over the contact tracing process', including having direct access to personal contact data.³⁸ It is unclear if workers who live in employer-run dormitories would be required to wear the wearables after workhours.

The use of compulsory workplace tracing apps or wearables is ostensibly meant to make it easier for companies to protect workers by more quickly isolating workers exposed to COVID-19 and preventing further spread. But the company has commercial interests in maintaining an operational workforce

and avoiding temporary suspension of business operations due to a slower government contact tracing process or full lockdown if there was a sustained outbreak. These commercial interests may conflict with employees' interests in privacy and freedom of movement. Corporate control of personally identifiable contact tracing data raises serious, perhaps insurmountable privacy concerns. Foreign workers whose immigration status is tied to employment, in particular, would lack bargaining power to push back against excessive privacy intrusions. The lack of oversight, transparency and accountability, in addition to a substantial conflict of interest on the part of employers between the welfare of their employees and the financial interest of the company, runs afoul of recently promulgated best practices for digital contact tracing,^{2 7 8} and poses substantial personal risks to the vulnerable individuals subject to monitoring requirements by employers.

Governments and corporations may vary in terms of their ability and willingness to effectively and responsibly govern mandatory digital contact tracing. By nature, however, governments are better placed, as they are (at least ideally) primarily constituted for the benefit of the people, rather than the benefit of the owners or investors of a company. In addition, robust democratic systems have been developed in many governments to promote the same sort of values that have been espoused as paradigms of digital contact tracing governance. Even if these systems often fall short of the democratic ideal, they generally come closer to that ideal than corporate governance.³⁹ As such, a digital contact tracing system will be much more defensible if managed and enforced by a government rather than an employer.

CONCLUSION

Contact tracing wearables should be part of any digital contact tracing system. Contact tracing wearables would not replace an app, but rather supplement it; in turn, both contribute to the efforts of public health officials to identify contacts of patients with COVID-19. The additional risks and downsides of such a wearable are, as discussed above, relatively containable and addressable. At the same time, wearables could play an important role in countering one of the biggest problems with contact tracing apps, inequitable access. As such, countries that are already committed to developing and promulgating a contact tracing app should seriously consider adapting Singapore's approach to a physical wearable.

Improving the effectiveness of contact tracing among populations lacking smartphone access would provide a variety of social benefits. At the broadest level, it would lead to more effective track-and-trace methods to lower disease spread among the general population, both preventing morbidity and mortality from the disease as well as providing indirect economic and social benefit by reducing the need for severe lockdowns. This, however, is contingent on the existence of adequate protections and social support for the vulnerable populations who may disproportionately receive tracing wearables, and so be subject to resultant public health interventions.

In fact, with adequate governance protections and purpose limitations, mandates on contact tracing apps or wearables may be justified. It would be inconsistent and unjustifiable to preclude the possibility of a mandate because of limitations on the current evidence base. In a global health emergency, public health interventions can reasonably be based on good modelling, continually updated as real-world evidence comes in after policies are implemented.

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