EVALUATING THE OPTIMAL CONTACT TRACING STRATEGY FOR COVID-19: BALANCING COLLECTIVE GOOD AND INDIVIDUAL RIGHTS IN THE CANADIAN CONTEXT

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I: INTRODUCTION

In the midst of a global health, social, and economic crisis, urgency often takes precedence and shapes the public understanding of who should act and what should reasonably be done in response. In March 2020, COVID-19 was declared a pandemic by the World Health Organization (WHO), three months after cases were first identified in Wuhan, China.[1] In response to the emergence of COVID-19 cases worldwide, public health officials scrambled to implement broad public health measures to contain the transmission of SARS-CoV-2, including personal hygiene, protective clothing, and social distancing. Many governments issued emergency mandates restricting transportation, closing public venues and workplaces, and restricting movement across national borders.[2] Consistent with previous responses to global disease outbreaks, controlling the transmission of COVID-19 requires the rapid detection and containment of individual cases by health officials, and the interruption of community transmission; this process requires a robust health system supported by routine health surveillance, case management, and public communication.[3]

In response to the urgency of COVID-19, many governments have signaled their interest in leveraging ubiquitous digital technologies, such as personal smartphones, to strengthen traditional public health practices.[4] Amongst the first of these digital health interventions developed in response to COVID-19 were mobile applications for personal smartphones that support contact tracing; contact tracing is a fundamental public health strategy, in which individual cases are detected and infected individuals are contacted to determine their recent locations and contacts.[5] Capable of tracking individual movement and proximity, digital contact tracing (hereby: DCT) applications offer a potentially effective strategy for enhancing the capacity of traditional contact tracing practices, which can be expensive, labor-intensive, and susceptible to fallible human memory.[6] Digital health technologies, such as DCT applications, have been successfully implemented to support public health emergencies, including the 2003 severe acute respiratory

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[1] WHO. "WHO Director-General's opening remarks at the media briefing on COVID-19". 2020.
[2] Kitchin, R. "Civil liberties or public health, or civil liberties and public health?" 2020.
[3] Budd, J. "Digital technologies in the public-health response to COVID-19." 2020
[4] Kitchin, R. "Civil liberties or public health, or civil liberties and public health?" 2020.
[5] Li, Jand Guo, X "Global Deployment Mappings and Challenges of Contact-tracing Apps for COVID-19." 2020
[6] Stokel-Walker, C. "Can mobile contact-tracing apps help lift lockdown?" 2020

syndrome (SARS) outbreak in Hong Kong and the 2014 Ebola outbreak in West Africa.[7] Despite their success, some have - justifiably - questioned their implications for civil liberties, particularly personal privacy. DCT applications are capable of recording personal data (health and non-health), tracking individual movement, and surveilling communication; and while some developers may deactivate these functions, technological vulnerabilities still persist. Others have suggested that DCT applications introduce new tools of state surveillance into the public and further entrench private technology firms within societal spheres historically held by governments.[8]

While much of the debate on DCT applications has centred upon the ethical and legal tension between individual rights (namely, personal privacy) and collective good (or public health)[9], this paper cautions against the false dichotomy of privacy v. health.[10] Instead, DCT applications are recognized as a supplemental tool, which are capable of effectively strengthening traditional contact tracing practices with limited risk to civil liberties, when implemented appropriately. This mixed contact tracing approach – using both digital technologies as well as manual methods for contact tracing – advises against an over-reliance on technological solutions for public health emergencies and stresses the importance of a robust health system for the effective utilization of DCT applications.

To better understand the practical considerations of implementing DCT applications in the Canadian context, this paper first reviews the current body of evidence in relation to DCT applications and examines their legal, ethical, and technological implications. A comparative methodological approach is then used to analyze DCT applications introduced in two additional countries with fairly homogenous political systems and similar measurements of civil liberties. This paper concludes with a series of comprehensive recommendations for government officials and health authorities in Canada for the effective implementation of national DCT applications for

[7] Leung et al ."The epidemiology of severe acute respiratory syndrome in the 2003 Hong Kong epidemic: an analysis of all 1755 patients." 2004; Stokel-Walker, C. "Can mobile contact-tracing apps help lift lockdown?" 2020; Wesolowski, A. et al. "Commentary: containing the ebola outbreak."2014.
[8] Kitchin, R. "Civil liberties or public health, or civil liberties and public health?" 2020
[9]Chia, T., & Oyeniran, O. " Human health versus human rights: An emerging ethical dilemma arising from coronavirus disease pandemic."2020; Kitchin, R. "Civil liberties or public health, or civil liberties and public health?" 2020; Sun, N. *Applying Siracusa: A Call for a General Comment on Public Health Emergencies* 2020
[10] Kitchin, R. "Civil liberties or public health, or civil liberties and public health?" 2020

COVID-19 using a mixed approach. Recommendations reinforce a balanced approach that reconciles privacy rights and collective beneficence.

II: POLICY OPTIONS

Governments have three options to consider for contact tracing as they attempt to identify all individuals at risk of COVID-19 exposure: manual contact tracing, DCT, and a mixed model of the two.

1. Manual Contact Tracing

For manual contact tracing, individuals who test positive for COVID-19 are interviewed to identify contacts who may have been infected during the days prior to symptom onset. These individuals are then notified and asked to self-isolate and get tested. Manual contact tracing is resource-intensive, takes up significant time, and is limited by the individual's memory. Individuals are less likely to remember those they came into brief contact with and will likely have come in contact with people unknown to them.[11]

2. Digital Contact Tracing

The second option is DCT which involves the downloading of an application that, through various methods discussed below, records two devices being in close proximity to determine with whom a person testing positive for COVD-19 has come in contact. DCT provides more timely results than manual contact tracing as the process is largely automated, thus notifying contacts of potential exposure faster. However, there are security concerns as smart devices and the central server can be vulnerable to malicious actors.

3. Mixed Model for Contact Tracing

The last option to consider for contact tracing is a mixed model that involves both manual and DCT methods. The use of both in tandem ensures that contact tracing is available to identify the contacts of patients that may be uncomfortable with the use of DCT due to privacy and security concerns as well as those without smartphones, which include elderly and racialized populations that are the most at-risk from COVID-19 but the most likely to not have smartphones.[33] Automated

[11] Anglemyer, A. "Digital contact tracing technologies in epidemics: a rapid review." 2020

DCT will allow for resources to be focused on manual contact tracing for those unwilling or unable to participate in DCT. For those using DCT applications, it will be possible to identify individuals that a user comes into contact with who are unknown to the user and would be unidentifiable through manual contact tracing.

While each of these approaches present their own ethical and legal implications in consideration of public benefit and privacy rights, this report is advocating for a mixed-method approach.

III: ETHICAL AND LEGAL CONSIDERATIONS FOR DIGITAL CONTACT TRACING

Systems for approaching the tensions between individual interests and collective good rely on human rights and ethical frameworks for considering individual and collective morality and duty. While the tension between individual interests and collective good is not new, the COVID-19 pandemic, specifically the consideration of DCT, has led to the need for countries to consider it in unusually explicit (and quick) terms.[12] In what follows, this section outlines systems of thinking about the ethical issues of balancing individual rights and public health, with particular attention to their mutual compatibility. First, we look at law-based systems, considering appeals to human rights and conditions for their derogation. Next, we consider ethics-based systems, including the tensions between deontological and consequentialist normative moral theories, Beauchamp and Childress' principles of ethics, and the idea of collective duties. An analysis of the ethical considerations of DCT technology will contribute to the examination of the various pieces at play in the now more urgent question of when it is okay, and when it is not, to derogate individual interests for the good of the collective.

i: Law-Based Systems

United Nations Human Rights

There is ample hesitation regarding DCT for COVID-19 grounded in a concern over their interference with human rights (HR) as articulated in the Universal Declaration of Human Rights

[12] Chia, T and Oyeniran, O. " Human health versus human rights: An emerging ethical dilemma arising from coronavirus disease pandemic." 2020.; Sun, N. *Applying Siracusa: A Call for a General Comment on Public Health Emergencies* 2020

(UDHR).[13] The tension between the right to privacy and the right to health[14], as articulated in the UDHR (United Nations, 1948), has become particularly apparent in the context of the pandemic. During the pandemic, a right to health might require a limitation on the right to privacy and right to freedom of movement. Digital contact tracing can be justified on the grounds of working in service of the right to health (Article 25), despite a limitation of the right to privacy (Article 5). There are systems to assess the derogation of individual rights for the collective good, and those will be discussed next. However, as we argue, fulfilling the right to health does not necessitate the limitation on the right to privacy.

Derogation of Human Rights: Siracusa Principles

Following the International Covenant on Civil and Political Rights adopted by the United Nations General Assembly in 1966[15], a more detailed account of the conditions under which the derogation of individual rights (as outlined in the International Covenant on Civil and Political Rights) is permissible under states of emergency is outlined by the United Nations Economic and Social Council in 1984 (UN Commission on Human Rights, 1984). These conditions, known as the Siracusa Principles, are used as a foundation for the analysis of how to approach rights' derogations in the context of public health emergencies.[16] The five criteria outlined in the Siracusa Principles for granting a policy permissible that limits individuals' rights to act in the collective interest are as follows: (1) the restriction of individual rights is in accordance with the law; (2) the restriction advances a legitimate objective of general interest; (3) the restriction is necessary to achieve the objective; (4) there exist no less restrictive means to achieve the objective; (5) the restriction is based on sound scientific claims and is not arbitrary or discriminatory.[17]

Some suggest that guidelines for the derogation of HR in states of emergency can be applied to the assessment of DCT and its ethical feasibility.[18] Morley et al. lay out 16 questions, based on the European Convention on Human Rights, the International Covenant on Civil and

[13] Freedom House. *States' Use of Digital Surveillance Technologies to Fight Pandemic Must Respect Human Rights. 2020*; Ryan, M. "In defence of digital contact-tracing." 2020: van Kolfschooten, H and de Ruijter, A. "COVID-19 and privacy in the European Union." 2020).
[14] See Articles 12 and 25 of the UDHR (United Nations, 1948).
[15] See Article 4.1 of *International Covenant on Civil and Political Rights*, 1966.
[16] Sun, N. *Applying Siracusa: A Call for a General Comment on Public Health Emergencies* 2020
[17] Sun, N. *Applying Siracusa: A Call for a General Comment on Public Health Emergencies* 2020; UN Commission on Human Rights. *Siracusa Principles on the Limitation and Derogation Provisions in the International Covenant on Civil and Political Rights*." 1984
[18] Morley, J. "Ethical guidelines for COVID-19 tracing apps." 2020.

Political Rights, and the United Nations Siracusa Principles, that determine whether DCT is ethically justifiable.[19] This justification is based on the notion that restriction of rights in the interest of public health can be permissible—even ethically-advisable—under emergency conditions.[20] There are, however, gradients of rights' limitations, and different forms of DCT infringe on the right to privacy to differing degrees, as will be discussed in section IV.

Beyond concerns about whether DCT restricts certain rights, and whether that restriction can be justified under rights' derogations frameworks, there remains skepticism on whether the technological approach to contact tracing is necessary and reasonable. Under Siracusa, the derogations of rights must be "necessary to achieve the objective", with no "less restrictive" options, and "not arbitrary."[21] Many governments and health officials enthusiastically and quickly adopted DCT applications, with limited evidence of effectiveness and widespread privacy qualms, prompting concern that officials are engaging in the practice of technological solutionism, or 'techno-solutionism'. [22] 'Techno-solutionism' is an ideological approach that attempts to reframe complex social issues as easily quantifiable problems, which can be resolved with carefully engineered technology-based solutions.[23] According to the logic of 'techno-solutionism', any failure of DCT applications to be effective in containing COVID-19 is a matter of re-engineering the technology to better address the social problem.

It is not straight-forward, however, whether technological solutions for contact tracing are necessary to contain the pandemic, or whether less privacy-invasive forms of contact tracing (manual contact tracing) could be used instead, or in partnership with, DCT. Additionally, technological solutions might be deployed to avoid politics and disarm political alternatives. [24] 'Techno-solutionism' is best understood within the broader concept of surveillance capitalism, which asserts that modern capital accumulation is increasingly based on the extraction and analysis of computer mediated data in 'everyday life' to predict and modify human behaviour for increased

[19] Morley, J. "Ethical guidelines for COVID-19 tracing apps." 2020.
[20] Ibid
[21] UN Commission on Human Rights. *Siracusa Principles on the Limitation and Derogation Provisions in the International Covenant on Civil and Political Rights*." 1984
[22] Milan, S. "Techno-solutionism and the standard human in the making of the COVID-19 pandemic". 2020; Morozov, E "The tech 'solutions' for coronavirus take the surveillance state to the next level." 2020
[23] Morozov, E. "The tech 'solutions' for coronavirus take the surveillance state to the next level." 2020
[24] Ibid.

production of revenue and/or market control.[25] Thus, DCT might be used in service of something beyond public health: it can be an instrument in the broader system of surveillance capitalism, serving economic interests of the private sector. Alternatively, governments and health officials may be deploying DCT applications as a political performance gesture to demonstrate concrete action against the COVID-19 pandemic. While DCT is not broadly "arbitrary", per se (they serve a particular interest and goal), it might be considered an arbitrary choice in the context of public health interests. Capitulating to reactive calls for urgency and allowing technology to direct policy risks ignoring the ethical and legal implications of prioritizing ineffective digital solutions on health and non-health outcomes. It is not enough to declare 'something is better than nothing', ignoring the opportunity costs of ineffective programming. [26]

ii: Ethics-Based Systems

Normative moral theories

In addition to examining systems for justifying the derogation of certain individual rights in the context of a public health emergency, ethical systems for understanding the relationship between the individual and the collective offer an important consideration of the ideological underpinnings. Two opposing normative moral theory camps, deontologists and consequentialists, provide groundwork for the consideration of balancing individual rights and interests and the collective good.

These theories consider how we ought to assess the morality of action. In the context of DCT, important ethical considerations answering to *what makes an action moral,* are critical for an analysis of the balancing of individual interests and collective good. Deontologists define morality by the action itself and call us to act (and not act) on the basis of the action's moral status. Consequentialism, on the other hand, a parent of utilitarianism, defines morality by the *effects* of actions, and therefore allows for "immoral" actions so long as they produce a state of affairs in line with "the Good."[27] Utilitarian thinking aligns with a prioritizing of public health over other aspects of well-being, such as data privacy. [28] "Negative contexts", such as the relative severity of

[25] Zuboff, S. "Big Other: Surveillance Capitalism and the Prospects of an Information Civilization." 2015
[26] Kitchin, R. "Civil liberties or public health, or civil liberties and public health?" 2020
[27]Moore, M., & Alexander, L. *Deontological Ethics.* 2007.
[28] Navajas, J et al 2020. *Moral reasoning about the COVID-19 crisis.* 2020

COVID-19, interestingly, seem to correlate with greater utilitarian (public health focused) orientations to presented dilemmas, such as the trade-off between virus control and data privacy.[29]

The Siracusa Principles, which allow a state to deny individual rights for the common good, can be considered as dependent on consequentialist claims; the *act* of restricting the right to privacy or freedom of movement is morally permissible insofar that it *results* in a better state of affairs. A deontological claim, then, might see the limit to the right to privacy required by DCT as morally wrong because the act of restricting rights is wrong in and of itself. Consequentialism seeks to maximize the good state of affairs (such as the public health status of a state), thus prioritizing a collective-focused conception of morality. Indeed, from a utilitarian (consequentialist) perspective, contact tracing is "beneficial if it saves only one life."[30]

Beauchamp and Childress' Principles of Ethics

Furthermore, consideration of the ethics of DCT can use the ethical principles first outlined by Beauchamp and Childress: autonomy, justice, non-maleficence, and beneficence.[31] Gasser et al. add to this list the principles of privacy and solidarity, citing Coughlin, and Nebeker et al. The principles of autonomy (with its antithesis being paternalism) and beneficence ("maximizing public benefit") might be seen as aligned with the tensions between individual rights and freedom and collective good (public health), respectively.[32]

Collective duties

Lastly, another way of approaching the ethics of DCT and the consideration of voluntary or mandatory systems, is to consider the concept of *duty*.[33] Contact tracing is only beneficial insofar as a group of people commit to using it; an individual DCT alone will see no benefits. Additionally, an individual may benefit from population contact tracing even if that particular individual does not participate (by reduced population infection rates). Thus, DCT cannot be fully justified on an individual level; one cannot easily claim, *I participate in contact tracing for me.*

[29] Navajas, J et al 2020. *Moral reasoning about the COVID-19 crisis.* 2020
[30] Rowe, F et al. "Contact-tracing apps and alienation in the age of COVID-19". 2020
[31] Beauchamp, L. "The "Four Principles" Approach to Health Care Ethics." 2007
[32] Gasser et al. "Digital tools against COVID-19: Taxonomy, ethical challenges, and navigation aid." 2020
[33] Igneski, V. *Collective Duties of Beneficence*. 2020

Violetta Igneski discusses the challenge of inherently collective problems with collective obligations to act by considering the concept of a *collective duty* (of beneficence).[34] In the case of DCT, we can ground a moral requirement (or obligation) to take part in contact tracing by appealing to a version of the collective duty of beneficence that Igneski presents. As Riemer et al. write, the contact tracing participation "poses a collective action problem: everyone would benefit from wide-spread proximity tracing, but the benefits for the individual are indirect and limited."[35] 2020). A sense of collective duty can be considered through the cultural context, specifically in individualistic versus collectivist societies. Collectivist societies might find the notion of collective duties more palpable; despite little individual benefit from contact tracing, the importance of it for the good of the collective holds sway, as will be discussed in section IV.

IV: CONSIDERATIONS FOR DIGITAL CONTACT TRACING APPLICATIONS

There are multiple considerations when it comes to DCT applications, with the first being the technology the application uses to identify close contacts. Global Positioning System (GPS), Bluetooth, and Radio-frequency Identification (RFID) are currently the main technologies used in DCT applications. Each option has benefits and drawbacks with regards to its accuracy, privacy, and range. The first option, GPS, works by recording the GPS data of users to monitor if they have come into contact. The accuracy of GPS is typically between 5 and 20 meters, while public health officials typically recommend avoiding close and prolonged contact and maintaining a distance of at least 2 meters.[36] The use of GPS is further limited, as it does not work indoors, and its performance is degraded in the shadow of large buildings and during thunderstorms and snowstorms. GPS also takes several minutes to establish the location when the device is first turned on or brought outdoors. The next option is Bluetooth, which communicates with nearby devices to record proximity. Bluetooth can communicate with devices up to 30 meters apart, with the nearness estimated by the Received Signal Strength Indicator (RLSS). The accuracy of the RLSS can be reduced if the device is in a bag or pocket, and Bluetooth cannot detect if there are any barriers such as walls or windows between devices. Bluetooth requires users to have the DCT

[34] Igneski, V. *Collective Duties of Beneficence*. 2020
[35] Riemer et al. "Digital contact-tracing adoption in the COVID-19 pandemic." 2020
[36] Kitchin, R. "Civil liberties or public health, or civil liberties and public health?"

application running in the background at all times, which drains the device's battery. Although there are limitations to Bluetooth, the improved accuracy and safeguard for location privacy makes it more suitable for DCT.[35] RFID has also been studied as a technology for DCT in more localized settings, where a physical tag is attached to a person or object and electromagnetic fields identify and track tags.[37] Although they may be viable for localized contact tracing within a setting such as a hospital, it would be impossible to scale it up to the general population due to the relatively short range of RFID and the need for millions of tags. Other technologies that have been considered for DCT include WiFi Based Positioning, Cellular Network Based Location Calculation, and Near Field Communication. However, these technologies have been deemed unviable for DCT due to issues with accuracy, privacy, and limited range. [38]

The next consideration for DCT applications is the type of system architecture used for data collection. The three options are a centralized, decentralized, or hybrid system architecture with varying degrees of functionalities performed on a central server and the user's device.[39] In the centralized system architecture, users pre-register with the central server, and a privacy-preserving Temporary ID (TempID) is generated for each device. Devices that the user comes in close proximity to are then able to exchange these TempIDs using Bluetooth. Once a user tests positive for COVID-19, they can choose to upload all of the stored TempIDs to the central server so individuals at risk can be notified. The decentralized system architecture transfers the responsibility for key functionalities to user devices to reduce involvement of the central server. The user devices generate random seeds that are used in tandem with the current time to generate privacy-preserving pseudonyms or 'chirps' that have a lifetime of a minute. The chirps are then exchanged with devices within close proximity. When a user tests positive for COVID-19, they can upload their seeds with the time to the central server so other users can download these seeds to reconstruct the chirps using the time information to determine if they were in close proximity to an infected user. In the hybrid system architecture, functionalities are divided between the central server and user devices. The user devices are responsible for TempID generation and management to ensure privacy and anonymization while the central server is responsible for risk analysis and notifications for at-risk contacts. This structure provides the central server the

[37] Chowdury, M et al. 2020. "COVID-19 Contact Tracing: Challenges and Future Directions."
[38] Ibid.
[39] Ahmed N et al. "A Survey of COVID-19 Contact Tracing Apps." 2020.

statistics needed to identify cluster exposures, and as encounter information is only retained on the server, this avoids the potential for de-anonymization attacks that are possible in the decentralized system architecture. Also, risk analysis and notifications are considered a sensitive process best handled by the government.[40]

There are three classifications of data stored: the personally-identifiable information, the contact advertisement messages, and the social/proximity graphs (interactions between users and people they came into contact with). [41] The security of each system architecture varies based on the form the data is in and what data is accessible through the server. In the centralised architecture, the servers have access to all three types of data, thus if the server is compromised, all of the data would be accessible by malicious users. Thus, the centralized structure must be run in a secure environment, have proper authentication and access control mechanisms. In the decentralized structure, it is possible for a malicious user to launch a traffic analysis attack to identify the COVID-19 positive user. The hybrid architecture has additional advanced privacy enhancement methods offering the best protection for user data. The primary type of attacks to which contact tracing apps are vulnerable are replay and relay attacks. These work by the adversary capturing the advertised message by a user and relaying it at the same location and extending the range, or they can replay at a later time leading to false notifications. The centralized architecture can be vulnerable to replay attacks that occur before the TempID expiry time. The chirp mechanism of the decentralized architecture provides a safeguard against replay attacks, but relay attacks are still effective. Replay attacks are not possible with the hybrid system architecture but they are vulnerable to relay attacks. [42]

V: ANALYSIS AND IMPLICATIONS FOR MIXED CONTACT TRACING

This section examines the implementation of DCT applications in three case study contexts, and analyses the key ethical, legal, and technological considerations introduced in *Section III* and *IV* consistent with a mixed contact tracing approach. Key considerations include, *beneficence and effectiveness, adoption, privacy and autonomy,* and *non-maleficence*. This

[40] Ahmed N et al. "A Survey of COVID-19 Contact Tracing Apps." 2020.
[41] Ibid
[42] Ibid

analysis informs a series of comprehensive recommendations for the effective implementation of national DCT applications for COVID-19 presented in Section VI.

i: Beneficence and Effectiveness

Tensions between civil liberties and collective good cannot be fully addressed unless public beneficence is clearly defined.[43] Therefore, to ensure that DCTs are legal and ethical, according to the standards discussed in *Section III*, government officials must establish a reasonable expectation of public benefit from employing these applications. Morley et al. present guidelines for assessing whether DCT is ethically justifiable, including asking: Is the app necessary? (Question 1) and, Is it sufficiently effective, timely, popular and accurate? (Question 3). [44] These questions will be considered in what follows, as they are critical for an assessment of beneficence. Despite the ongoing development and implementation of DCT applications, there is limited evidence-based research demonstrating their effectiveness for volume of identified cases and ultimately a decrease in deaths.[45] Prior to the COVID-19 pandemic, testing of DCT applications was limited to relatively small interventions or simulated laboratory settings, raising additional concerns for their risks at scale. [46]

All three selected countries announced intention to develop and use digital contact tracing as early as of March 2020, raising concerns about the proper weighting of different policy options, having sufficient time for political and public debate, and transparently making decisions. Norway was the first country to officially launch its DCT app on April 16, 2020, followed by the launch of DCT in Ireland and Canada in July of 2020.

The use of DCT tools was justified in all observed countries as a tool that helps combat the pandemic and that will produce public benefits. In Ireland, decision-making during the pandemic is guided by an ethical framework, emphasizing principles of minimizing harm, proportionality, solidarity, fairness, duty to provide care, reciprocity, and privacy.[47] Similarly, the Canadian Public Health Agency developed "The Public Health Ethics Framework: A Guide for Use in Response to

[43] Gasser et al. "Digital tools against COVID-19: Taxonomy, ethical challenges, and navigation aid." 2020
[44] Morley, J. "Ethical guidelines for COVID-19 tracing apps." 2020.
[45] Budd, J. "Digital technologies in the public-health response to COVID-19." 2020; Kitchin, R."Civil liberties or public health, or civil liberties and public health?"; Nature, 2020
[46] Kitchin, R. "Civil liberties or public health, or civil liberties and public health?' 2020
[47] Department of Health, Ethical Framework for Decision Making in a Pandemic, 2020

the COVID-19 Pandemic in Canada", highlighting trust and justice as two of the most important principles that should be upheld in procedural considerations when weighting policy options, given special attention to principles of effectiveness, proportionality, reciprocity and precaution[48]. In both country authority to develop and deploy the DCT were drawn from legal acts governing respective health institutions: the Department of Health Act[49] in Canada and the Health Act[50] which establishes Health Service Executive in Ireland. In Norway the legal basis for the DCT app can be found in so called "Corona Act", a temporary enabling bill, that among other, stipulates that any participation in an electronic tracing system must be voluntary and that system must provide comprehensive, understandable, and easily accessible information.[51]

All three observed countries did have some type of official validation tests and protocols prior to the launch of the apps. Content of the Irish Covid Tracker was pre-tested by the Economic and Social Research Institute through a behavioural pre-testing study of Covid Tracker, emphasizing three main dimensions: privacy assurance, goal-framing, and structure of the exposure notification.[52] In Canada, there was a short period of beta testing (2-4 days), with more than 6,000 people participating.[53] In Norway, Smittestopp was validated through app developers, testing select municipalities and running controlled tests using students.[54] This pre-testing phase strengthened the argument for using DCT tools, since cases not detected through manual contact tracing were registered; however, the low number of infectious persons and app users in Norway made it difficult to assess the effectiveness.[55]

Considering the growing demand for health services and the scarcity of health resources, economic evaluations have become fundamental in the allocation and prioritization of public funds. As a critical component of establishing reasonable expectation of public benefit, governments are legally and ethically responsible for demonstrating relative value for money

[48] Public Health Agency, The Public Health Ethics Framework: A Guide for Use in Response to the COVID-19 Pandemic in Canada, 2020
[49] Department of Health Act, 1996
[50] Heath Act, 2004
[51] The Law Library of Congress, Regulating Electronic Means to Fight the Spread of COVID-19, 2020
[52] Julienne, Hannah et al. "Behavioural pre-testing of COVID Tracker, Ireland's contact-tracing app." (2020).
[53] Public Interest Advocacy Center, A "Privacy-First" Canadian Public Policy Approach to Digital Contact Tracing Technology ("DCTT") Related to COVID-19 & Future Pandemics"
[54] Naseer at al, Use of the Smittestopp app for contact tracing: validation study protocol, Norwegian Institute of Public Health and Simulate Research Laboratory
[55] Ibid

spent.[56] Surprisingly, none of the governments in the three case studies conducted a health economic evaluation on DCT applications, according to the standards established by their respective health economic institutes (Canadian Agency for Drugs and Technologies in Health or *CADTH* in Canada, Health Information and Quality Authority or *HIQA* in Ireland, and Norwegian Health Economics Administration or *HELFO* in Norway). With the estimated costs of developing and deploying DCT applications in the three countries ranging from $500,000 (CND) in Canada[57], $1.26M (CND) in Ireland[58], and $2.3M (CND) in Norway[59], it is essential to conduct health economic evaluation on DCT applications. Without this evaluation, public beneficence is further decreased as the potentially costly development and deployment of DCT applications may outweigh any potential benefits.

It should be noted that this approach does not dismiss any public health interventions that present risk or limited evidence, but instead, insists that public beneficence be equally considered. With DCT applications in the early development and adoption phase, using a mixed approach for contact tracing allows for further research to develop while mitigating the risks of over-reliance on technical strategies.

ii: Adoption

Achieving broad adoption of DCT applications within target populations is critical for their effectiveness, particularly when installation is voluntary in Canada. Public health models indicate that at least 60% of the population must adopt the DCT application to ensure its effectiveness.[60] However, while research indicates a high willingness to install DCT applications amongst populations in North America and Europe,[61] uptake by target populations has been discouragingly low. [62] Amongst the three case studies, Ireland's COVID Tracker recorded the highest rate of adoption by far at 34%; however, none of the three case studies were able to reach the 60 percent adoption threshold, see *Table 1*.

[56] Palmer, S., & Torgerson, D. J. 1999. Economic notes: definitions of efficiency. 1999
[57] Hill, B. & Pazzano, J. "20 million Canadians still don't have full access to the COVID Alert app. Why?" 2020
[58] Carroll, R. "Cheap, popular and it works: Ireland's contact-tracing app success." 2020
[59] Sandvik, K. B "Smittestopp": If you want your freedom back, download now." 2020
[60] Ferretti et al., Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. 2020
[61] Altmann et al. "Acceptability of App-Based Contact Tracing for COVID-19: Cross-Country Survey Study."2020
[62] Munzert, S. "Tracking and promoting the usage of a COVID-19 contact tracing app." 2021

Table 1: DTC's Overview and Uptake as of March 30th, 2021

	Canada: COVIDAlert*	Ireland: COVID Tracker	Norway: Smittestopp
Total Downloads	6, 413, 483	1,300,000 active users 2,480,000 app registrations	976,600
Download Percentage	16.5%	34%	18.3%
Reported Infections	22,884	14, 717	2,194
Technology	Apple/Google – Bluetooth, Decentralized	Apple/Google – Bluetooth, Decentralized	Apple/Google – Bluetooth, Decentralized
Developer	Blackberry/Shopify	HSE - Ireland's Health Services	Norwegian Institute of Public Health

*Currently 9 of the 13 provinces and territories have adopted COVIDAlert and allow users to upload a positive diagnosis key.

Data Retrieved from COVID Tracker, Smittestopp and the Government of Canada, Download COVID Alert Today."

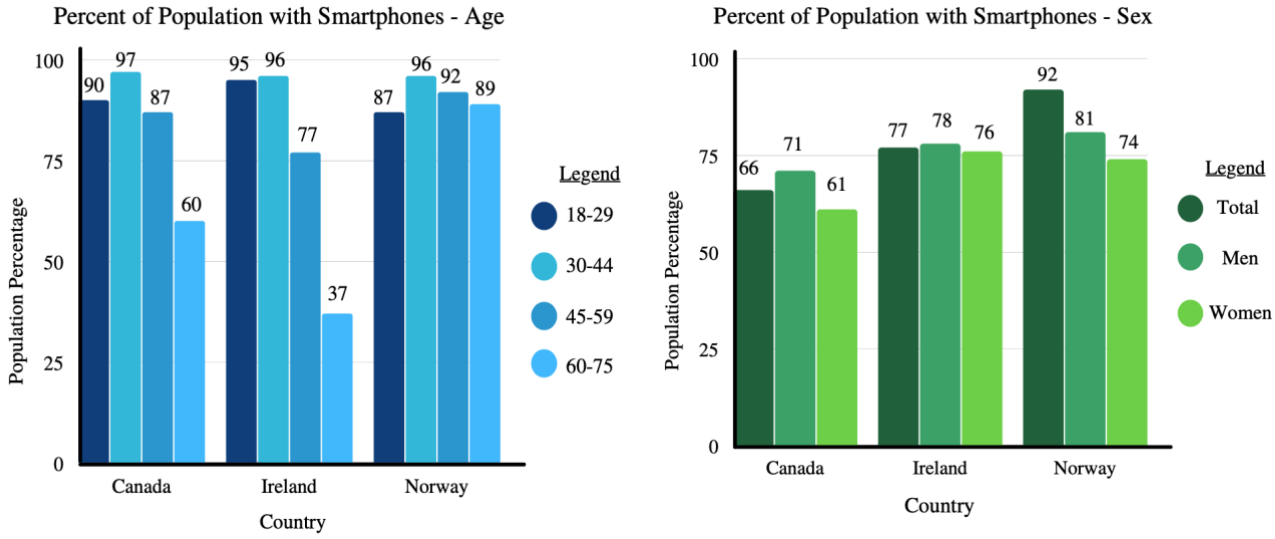
These findings raise important questions about existing barriers preventing target populations from adopting DCT applications, aside from the previously mentioned ethical and practical concerns of unequal access to smartphone technologies.[63] Hesitancy to adopt DCT applications can arise from a broad selection of social factors, including skepticism of effectiveness, concerns for privacy and security, and mistrust in governments and private technology firms.[64]

An additional factor that can impact adoption is age, race, and gender. Therefore, avoiding discrimination and preventing digital inequality are important factors in adherence to the principle of solidarity and justice.[65] Indeed, the Morley et al. guidelines on accessing the ethical permissibility of apps require that the app be equally available and accessible (Question 14 and 15), appealing to the principle of justice.[66] Figure 1 illustrates the level of smartphone users in all three observed countries based on age and gender. The major concern with avoiding discrimination

[63] Parker, M et al. 2020. "Ethics of instantaneous contact tracing using mobile phone apps in the control of the COVID-19 pandemic." 2020
[64] Altmann et al. "Acceptability of App-Based Contact Tracing for COVID-19: Cross-Country Survey Study."2020
[65] Gasser et al. "Digital tools against COVID-19: Taxonomy, ethical challenges, and navigation aid." 2020
[66] Morley, J. "Ethical guidelines for COVID-19 tracing apps." 2020.

and preventing digital inequality with the implementation of DCT tools lies in ensuring that particular groups most vulnerable to the pandemic are not excluded.

Figure 1: Percent of Population with Smartphones



Lastly, mixed contact tracing is only beneficial insofar as a group of people commit to using it; an individual adopting DTC alone will see no benefits. Reasons for adopting DTC might appeal to the idea of "collective duties of beneficence", [67]as discussed. Ireland, Norway, and Canada are all defined as individualist societies with individualism scores of 80, 70, and 69, respectively, where a higher score indicates stronger individualist tendencies.[68] In Ireland, there is high population compliance with the contact tracing app, where people often cite the reason for their compliance as "a sense of responsibility to the wider community."[69] This manner of justification appeals to concerns for collective good (public health) and collective duty, echoing the notion of collectivism, yet contradicting the individualistic score on the Hofstede scale. This might be explained by the work a crisis can do to bring people together. [70] Similarly, Norway also showed high collectivism which may explain the high levels of adherence to public policies and

[67] Igneski, V. *Collective Duties of Beneficence.*2020
[68] Hofstede, G. "Dimensionalizing Cultures." 2011. Hofstede Insights. n.d. *Country Comparison*. Hofstede n.d.
[69] O'Callaghan et al. "A national survey of attitudes to COVID-19 digital contact tracing in the Republic of Ireland." 2020
[70] Warner-Søderholm, G. "Culture Matters: Norwegian Cultural Identity Within a Scandinavian Context."2012

the government's call to people's solidarity.[71] Preliminary studies show that most of Canadians are following the public policy requirements[72] and that non-compliance is relatively low[73]; however public opinion surveys show willingness to download the DCT app are at relatively low levels (around 30%).[74]

iii. Privacy and Autonomy

Employing a mixed approach to contact tracing can pose threats to an individual's privacy and autonomy[75] as more personal information is collected and stored by public health agencies. With data being collected, stored and used by public health officials via apps and manual methods, it is essential to examine the laws in place to protect privacy across the observed cases.

Private Sector Privacy Laws

In all three countries, robust privacy laws and regulations to protect the collection of personal information by public and private actors have been implemented. Albeit one is substantially more impuissant than the others. Across the cases there are two distinct laws for governing data collection by private sector actors. For members of the European Union (hereby: EU) and the European Economic Area, the General Data Protection Regulation imposes privacy and security standards and obligations onto organizations so long as they target or collect data related to citizens in the EU.[76] The GDPR came into effect in May 2018 with the objective of harmonizing data protection laws across the European Union, enhancing citizens' control over their personal data.[77] The GDPR includes a robust set of privacy laws to protect citizens' data. Most notably, Article 6.1 states that data processing must be necessary for the performance of a task carried out in the public's interest; Article 9.1 notes the processing of special categories of personal data, stating that personal data revealing race, ethnic origin, religious beliefs, genetic or

[71] Helsingen, Lise et al. "The COVID-19 pandemic in Norway and Sweden–threats, trust, and impact on daily life: a comparative survey."
[72] Weber, Bob, "Experts study how coronavirus pandemic affects trust in officials, ourselves" 2020
[73] Daoust, Jean-François, "How to survey citizens' compliance with COVID-19 public health measures: Evidence from three survey experiments."
[74] Innovative Research Group, "Public opinion research: Covid-19 contact tracing." 2020
[75] Gasser et al. "Digital tools against COVID-19: Taxonomy, ethical challenges, and navigation aid." 2020
[76] Tufts University. "European Economic Area General Data Protection Regulation (GDPR)."
[77] Sanchez, Irene Reverte. "GDPR and Canadian organizations: Addressing key challenges."

biometric data and data concerning health is prohibited; and Article 17 states the right to erasure if personal data is no longer necessary or consent is withdrawn.[78]

Conversely, in Canada, privacy law operates on multiple jurisdictional levels. Federally, the Personal Information Protection and Electronic Documents Act (hereby: PIPEDA) governs personal information collected and used by private sector organizations. Since privacy law is multijurisdictional, there is significant overlap between provincial and federal laws. Since seven of the ten provinces have private sector privacy laws that have been deemed similar or substantially similar to PIPEDA, these provincial laws take precedent. A provincial privacy law is considered substantially similar to PIPEDA if it provides independent oversight, the power to investigate, and authorizes the collection, use, and disclosure of personal information for legitimate purposes.

Even with the regulatory power and legislation promulgated by the GDPR, it is evident that violations of user privacy are possible. Following the release of the Smittestopp app, the Norwegian Data Protection Authority opened an investigation into the data this application was collecting. This body found that the app does not constitute "a proportional invasion of the individual user's right to privacy".[79] Indeed, one requirement of the guidelines for an app's ethical justifiability is ensuring that the technology is proportionate, i.e. does the resulting beneficence outweigh potential risks? (Question 2).[80] The first iteration of the Norwegian app failed this requirement; following the warning from the Data Protection Authority, the Institute of Public Health decided to temporarily ban the app and delete all collected information[81]. Since removing this app, Norway has since re-released Smittestopp to comply with data protection policies.

Public Sector Privacy Laws

Each country in this analysis has privacy laws that govern data collected and used by public institutions. The Privacy Act, 1985 in Canada protects the information held by government institutions and provides citizens with a right to access this information. As such, Section 6.3 of the Privacy Act stipulates that a government institution shall dispose of personal information in

[78] The General Data Protection Regulation, Article 6.1, 9.1, 17
[79] Bergstrøm, Ida Irene. "Norway's coronavirus tracing app halted by Data Protection Authority – too invasive and not useful." 2020
[80] Morley, J. "Ethical guidelines for COVID-19 tracing apps." 2020.
[81] Ursin, Gøril, Ingunn Skjesol, and Jonathan Tritter. "The COVID-19 pandemic in Norway: The dominance of social implications in framing the policy response." 2020; Martin, Tania, et al. "Demystifying COVID-19 digital contact tracing: A survey on frameworks and mobile apps." 2020

accordance with regulations, directives, or guidelines issued by the designated minister. [82] In Ireland, privacy rights are not protected by a specific national legislation. Instead, these rights are protected under section 40.3 of the Irish Constitution which states: "The right to privacy is protected by the Irish Constitution, and by European and international human rights instruments."[83] Lastly, in Norway, rights to privacy are codified in section 102 of the Norwegian Constitution which reads: "everyone has the right to the respect of their privacy and family life, their home and their communication."[84]

In Canada, taking a mixed approach to contact tracing means increasing manual and digital contact tracing efforts. This would entail Canadians disclosing information on recently visited locations, personal associations, employer, home address, and diagnosis status. These pieces of information can all pose a large threat to individuals' personal and health information. This is especially the case when a Canadian voluntarily uploads their positive diagnosis key to COVIDAlert which then shares more personal information to a centralized server. However, with strong data protection laws, the threats to individuals' privacy being compromised is minimal.

iv: Non-maleficence

Setting specific objectives, avoiding repurposing, and setting an expiration date are all important elements in ensuring that the healthcare intervention follows the principles of non-maleficence, justice, and autonomy.[85] Furthermore, the guidelines on the ethics of DCT that Morley et al. present require that the derogation of rights (such as the right to privacy) be temporary, with an explicit end date (Question 4). The Irish Covid Tracker's primary function is facilitating contact tracing; however, the app also allows users to check updated news and information about the pandemic and can be used as symptom checker. The Irish Council for Civil Liberties, while praising efforts of the Government to be transparent, has raised several concerns with the Covid Tracker app. With multiple functions, Covid Tracker extends the single purpose of contact tracing. [86] The main concerns about the old Norwegian app that were raised was using the app for purposes other than contact tracing, as the data collected were also used for research

[82] The Privacy Act, 1985. S 6.3
[83] Irish Constitution s.40.3
[84] Norwegian Constitution, s. 102
[85] Gasser et al. "Digital tools against COVID-19: Taxonomy, ethical challenges, and navigation aid." 2020
[86] Irish Council for Civil Liberties, HSE Covid Tracker App: Pre-Release Report Card, 2020

purposes and there were clauses that allowed for the indefinite storage of data, contradicting the requirement that extreme measures be temporary.[87] The new Norwegian app shares the name with the old one, however there are some important changes: the new app only uses Bluetooth, it is only used for infectious tracking, and data is being stored only on the smartphone.[88] The single purpose of DTC was stressed in Canada by emphasizing that Covid Alert is not a contact tracing tool, but an exposure notification tool. However, data and app metrics are collected by Health Canada for the purpose of "measuring and encouraging app uptake" as well as for performance analytics.[89] Major concerns in regard to the purpose and data retention are loosely set time limits and exemptions clauses. Namely, IP addresses can be retained for a duration ranging from 3 months to 24 months; and even though the expiration date is set at 30 days from the official declaration of the end of the pandemic, the IP addresses could be retained longer on the AWS for security reasons.[90]

VI: RECOMMENDATIONS

The following recommendations are based upon the evidence-based literature review and analysis of three case studies presented in this paper and are intended to inform the decision-making process of government officials and health authorities in Canada evaluating national DCT applications within a mixed contact tracing approach. Recommendations promote the maximization of public beneficence, while reinforcing a balanced approach that reconciles privacy rights and collective benefit.

1. *Develop a DTC application using Bluetooth with a hybrid system architecture to be used in combination with manual contact tracing.*

   Currently, Bluetooth presents the best choice of technology to identify close contacts that may be exposed by an individual that has tested positive for COVID-19. The hybrid system architecture provides the most appropriate choice for ensuring user privacy and security, while also providing public health benefits by allowing for the central server to identify exposure clusters and for authorities to handle risk notifications. Allowing

[87] Morley, J. "Ethical guidelines for COVID-19 tracing apps." 2020.
[88] Norweigian Health Network. "What is the difference between the new and old Smittestopp apps, 2021."
[89]Government of Canada. "COVID Alert: COVID-19 Exposure Notification Application Privacy Assessment." 2021
[90] Public Interest Advocacy Center, A "Privacy-First" Canadian Public Policy Approach to Digital Contact Tracing Technology ("DCTT") Related to COVID-19 & Future Pandemics." 2020

authorities to handle risk notifications is essential to ensure compliance with self-isolation requirements. The use of the central server does present some risk to personal data as a result of security concerns, thus appropriate precautions must be taken. Manual contact tracing must be offered as well to reach the most at-risk populations that are the most unlikely to have smart devices as well as to reach individuals who choose not to make use of DTC applications due to privacy or security concerns.

2. *Ensure that the DCT application approach aligns with the current body of evidence demonstrating clear effectiveness for health and non-health outcomes, consistent with national health intervention adoption standards such as health economic evaluations.*

    Evidence of the effectiveness of DCT applications for improving health and non-health outcomes remains in its infancy; however, new evidence-based research emerges daily as national DCT applications continue to be implemented and evaluated in countries around the world. In a rush to respond to the COVID-19 pandemic, many governments deployed DCT applications with limited testing or evidence. While this paper acknowledges the challenges of conducting research on DCT applications due to legal regulations and application designs intended to protect user privacy, it also stresses the importance of maintaining rigorous evidence-based testing and evaluation routinely conducted for health interventions integrated into the health system. Economic evaluations, such as cost-effectiveness analyses, are fundamental tools for demonstrating the potential health and non-health outcomes of health interventions against alternative options, and are highly recommended for evaluating DCT applications. While health officials are responsible for applying the current body of evidence for DTC applications to demonstrate a reasonable expectation of public benefit, they are also responsible for clearly communicating the evidence and decision-making process with the public to facilitate adoption.

3. *Implement one national privacy regulation similar to the GDPR to address many of the privacy issues that currently leave the sensitive and personal information of Canadians exposed*.

The Privacy Commission of Canada should work with the provincial and territorial privacy commissions to implement a new unified privacy legislation for both public and private actors that mirrors the previously discussed Articles of the GDPR. This new privacy legislation should include a similar section to Article 17 of the GDPR on the right to be forgotten so Canadians do not require ministerial or legal approval for their data to be deleted. A section similar to GDPR Article 6.1 is imperative for setting limitations on data collection and retention to ensure that Canadian data is not unnecessarily collected by private and public actors or used beyond public health original purposes. Lastly, a section similar to Article 24.1 would implement tangible lines of accountability and transparency to protect the personal and sensitive data of Canadians that is not adequately secured and crosses jurisdictional boundaries. Implementing these specific laws will address the gaps in Canadian privacy law, increase the trust in government, and ultimately enhance the success of a hybrid contact tracing approach.

4. *DCT applications should be implemented alongside broad advertising and public media campaigns addressing public privacy concerns and technological support, and appealing to the utility of DCT at the collective level.*

Effectiveness of DCT applications is dependent upon an adoption rate of at least 60% of the population. Despite indications of a high willingness to install DCT applications, adoption rates in target populations remain discouragingly low, indicating substantial barriers to adoption. Adoption hesitancy is suggested to be the result of a broad selection of social factors, including widespread skepticism of their effectiveness for reducing transmission of COVID-19, concerns for privacy and cybersecurity, and mistrust in governments and private technology firms. Furthermore, collectivist modes of thinking might affect adoption of DCT; in more collectivist societies, COVID-19 appears to spread slower than in individualistic societies[91], and people in more collectivist societies have higher compliance with COVID-19 response measures owing to lower concerns for privacy (that contact tracing apps may infringe upon) and a greater concern for social benefits of pandemic control measures.[92] There is evidence that collectivism is strongest in times of

[91] Jiang, S et al. "Impacts of Cultural Difference on the Transmission of COVID-19Individualism vs. Collectivism." 2020.
[92] Kim, J., & Kwan, M. "An Examination of People's Privacy Concerns, Perceptions of

societal struggle and weakest when times are good.[93] Thus, perhaps even in individualist societies like Canada, during the undoubtedly hard times of the pandemic, collectivist tendencies increase. In response, it is recommended that DTC applications be implemented alongside a broad advertising and public media campaigns addressing public privacy concerns, technological support, and potential for collective beneficence. Public health messaging should appeal to the collective good that results from DCT, focusing on the role of individuals in coming together to address the pandemic. Financial incentives or smartphone device subsidies may also be considered to further expand adoption of DCT applications.

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[93] (Lindell, M and Sigfrids, C. *Culture and leadership in Finland*, 2007; Warner-Søderholm, G. "Culture Matters: Norwegian Cultural Identity Within a Scandinavian Context." 2013

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