Ethical Concerns of COVID-19 Contact Tracing: A Narrative Review

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Abstract. Contact tracing has been widely adopted during COVID-19 to curb the spread of infection. Despite its effectiveness, ethical issues abound and many people are not willing to use it. Toward understanding the ethical issues arising from contact tracing and informing future epidemic intervention, we conducted a narrative review of 26 papers addressing ethical concerns of COVID contact tracing (N=26). The issues identified by researchers included data leakage, surveillance, lack of accessibility, etc., and proposed solutions included data minimization, transparency, voluntary and temporary use, adhering to data protection standards, designing affordable wearable devices, etc. Based on the findings, we propose research and design implications to make future epidemic contact tracing effective and ethical at the same time.

Keywords: COVID contact tracing · Privacy · Accessibility.

1   Introduction

The COVID-19 pandemic has greatly bothered people's lives since its outbreak. Different strategies were adopted to suppress the virus transmission. Medical measures, such as cascaded therapy systems, anti-COVID drugs, and vaccines, have been developed. Public health strategies, such as mask wearing, social distancing, frequent sanitization, and digital contact tracing techniques, were also implemented to curb the epidemic. Among them, contact tracing is the most technology-centric approach, relying heavily on digital technologies such as smartphones and people's mobility data. Simply put, contact tracing curbs the spread of infection by identifying people who might have been infected or exposed to contagious individuals. Digital contact tracing has been extensively utilized during the COVID-19 pandemic, sometimes used in combination with manual contact tracing [7].

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With the end of the pandemic in sight, the efficacy and public engagement of contact tracing have been retrospectively evaluated by researchers. Several countries and regions, where collectivism is valued, including China, Singapore, and Hong Kong, achieved remarkable epidemiological success through contact tracing techniques. One major reason behind their success was the mandatory use of contact tracing apps, resulting in a higher level of technology uptake and adherence, which was key to the efficacy of contact tracing [15]. In other countries which did not force people to use contact tracing apps, the uptake rate could hardly reach 60% [25], which was a threshold to make contact tracing effective [18]. The prevalent ethical issues of contact tracing, such as privacy concerns, have limited people's willingness to use it [15, 2], though people were sometimes ready to sacrifice their individual privacy for the wider goal of public health [39, 30, 22, 20].

Toward understanding main ethical concerns surrounding COVID contact tracing and identifying potential solutions, we conducted a narrative review of 26 relevant papers. We aimed to answer the following two research questions (RQs):

– **RQ1:** What are the major ethical issues raised by COVID contact tracing?
– **RQ2:** What are potential solutions to these ethical issues?

Our analysis concluded two main ethical issues that could radically lower the level of contact tracing uptake: privacy concerns and a lack of accessibility. Privacy concerns may strongly affect people's willingness to use contact tracing apps and manifest itself in two ways, namely, data leakage and government surveillance. The lack of accessibility of digital contact tracing, which required the use of smartphones, effectively marginalized financially vulnerable populations, as well as certain demographics, such as older adults and children. Limited participation from these populations not only hindered the success of contact tracing, but also put them at higher health risks. Technological and administrative solutions have been proposed to increase the uptake and thus efficacy of contact tracing. We further synthesized research and design implications for future epidemic intervention based on the evidence.

Our contribution is two-fold. First, we summarized ethical issues arising from COVID contact tracing, including the sporadically expressed ones, to present a high-level understanding of its ethical aspect. Second, we outlook effective and ethical data solutions for future epidemic intervention based on the lessons learnt from the COVID-19 case.

2   Background: AI and ICT for COVID-19

During the COVID-19 pandemic, Artificial Intelligence (AI) and Information and Communications Technology (ICT) played crucial roles in various fields, including diagnosis, public health, clinical decision-making, therapeutics, resource prioritization, virus tracking, etc. [35, 13]. Although the applications of AI and ICT have produced positive outcomes, ethical principles were often compromised

during their deployment, such as autonomy, privacy, and fairness [37]. Veinot et al. warned that unethical utilization of AI could adversely affect already vulnerable populations [36]. Contact tracing has attracted wide attention in epidemic control but the numerous ethical concerns raised may arise again in a future pandemic [28]. Thus, it is of timely interest to comprehensively understand the outcomes of contact tracing and come up with a more ethical approach to contact tracing and epidemic intervention in general.

3   Method

We conducted a narrative review by analyzing 26 papers related to contact tracing during COVID-19 with ethical relevance. We searched Google Scholar for articles published between January 1, 2020 and February 28th, 2023. Search terms included ("SARS-CoV-2" OR "COVID-19") AND "contact tracing" AND "ethical issues". A final set of 26 papers was used for later qualitative synthesis.

We started by summarizing main research findings of the papers, especially regarding ethical issues and corresponding solutions. Two authors independently conducted the thematic coding [10] and used mind-mapping to organize the findings into a hierarchy of themes. Discussions were held regularly to reach a consensus and arrive at the current results.

4   COVID Contact Tracing and Privacy Concerns

Privacy concerns are expressed in two ways. On the one hand, people are fearful that their mobility data and personal information collected by contact tracing apps may be acquired by unauthorized individuals, leading to privacy breaches. On the other hand, people are not comfortable with the government collecting citizens' data and intruding their private realm. Distrust toward governments was commonly expressed.

4.1   Data Leakage

De-anonymized information is likely to put contact tracing app users at risk, especially vulnerable groups, leading to stigmatization [39]. For instance, gay people in Morocco were outed through proximal location tracking [5]. Even anonymous information sharing could lead to data leakage [23, 4, 19, 32]. By contributing data anonymously, one also revealed information about other people [6]. Individuals' behavior and choices could be easily inferred based on "group" data [11, 5]. In the case of contact tracing apps, one may receive a notification telling them to "stay inside" or "get tested" based on anonymized geo-location and biometric data of the people in their neighborhood — similar information inference attacks apply to this scenario. Ali Alkhatib showed how even the well-intentioned, privacy-preserving digital contact tracing apps risked trampling upon delicate balances in social and natural ecologies [5].

One interesting phenomenon is that the context of COVID-19 prevention appeared to increase people's willingness to share personal information [30]. A similar finding was that of Jahari et al. who found that reciprocal benefits and reputation enhancement mediated the relationship between privacy concerns and intention to use contact tracing applications; people were more willing to forsake privacy if they gained societal benefits or reputation [20]. In some contrast, a study found that participants concerned about the disease were more concerned about privacy and more unwilling to use contact tracing apps [12].

4.2   Surveillance

Surveillance often came in the form of manipulation or coercion. Governments may practice societal exclusion, i.e., limiting people's social participation, to force them to use contact tracing apps [23, 3]. For example, in China's excessive measures of zero-COVID policy, the government only granted people access to public venues if they could prove that they were not infected with or exposed to COVID-19 with a contact tracing app [41]. The Indian government's Aarogya Setu app was made mandatory for use in several public contexts [8] despite collecting highly intrusive location and biometric data [32].

In authoritarian regimes such as China, the implementation of contact tracing has expanded the central government's power over people's political and data rights [33]. The removal of local power in pandemic administration has led to the production of a unified national subject. Such concerns also existed in relatively democratic countries. For instance, Israel passed a legislation that allowed the government to track the mobile phone data of individuals suspected to be infected [34]. The South Korean government has also maintained a public database of known patients which contained information about their occupation, age, gender, and travel routes [21]. A major concern arising from the expansion of governments' power is that increased surveillance and harsher law enforcement tend to "stick" after they are justified by crisis events, evidenced by such cases as the persistence of Homeland Security activities against terrorism in the United States following the 9/11 tragedy [24]. This is a serious concern which was also highlighted in a systematic review on the topic: habituation to security policies may lead to discrimination and cause distrust, imperiling long-term health [3].

The adoption of contact tracing apps in China, Hong Kong, Singapore, Israel, South Korea, and India has caused the governments to experience varying levels of distrust from their citizens [24, 19, 8]. Public distrust in centralized data governance and data privacy risks have long existed, but were exacerbated by COVID-19. Further, people thought governments were unable to tame the *dataveillance* practices routinely carried out by corporate actors, showing the major limitations of the current data governance models [26]. The inclusion of large corporate technology companies in health, which is monopolistic in nature, has also been questioned, being termed the "googlization" of health crisis management [23]. Doubts have been cast over whether it is wise to risk access to such data by technology companies with their business models focusing on harnessing data for profit, because they might affect public policy for financial gains [3].

5   COVID Contact Tracing and Accessibility

Accessibility of contact tracing apps may further hinder its wide adoption and thus efficacy. Several papers pointed out that the efficacy of contact tracing apps heavily relied on the number of users [17, 18, 3]. For example, Hinch et al. suggested that the epidemic could only be stopped if up to 60% of the whole population used the contact tracing app and adhered to its public health recommendations [18].

Contact tracing apps often required the use of smartphones and mobile Internet access. However, smartphones were not financially accessible to a large portion of the global population, and even older smartphones were not always able to run digital contact tracing apps [5]. Children and older adults needed extra protection since they were physically vulnerable, but most of them were not able to use a smartphone device, which put them at higher risks [40, 5]. Advocation of adoption of contact tracing technology might aggravate inequalities in society due to existing unequal access to technology [19]. This reduces the accuracy of any models based on the contact tracing data, and policy makers should thus integrate factors of inclusion and accessibility into data solutions beforehand [5].

6   Solutions

Trust is essential to the general effectiveness of contact tracing [29]. To mitigate the aforementioned ethical issues of contact tracing and raise people's trust and willingness in using the technology, technological and administrative solutions have been proposed.

6.1   Data Minimization

Some researchers argued that where people got in contact with an infected individual was not important; what mattered was proximity to a contagious person. They suggested that it was neither necessary nor useful to collect sensitive location data, such as GPS or radio cell data [1, 19]. The principle of data minimisation is that "a data controller should limit the collection of personal information to what is directly relevant and necessary to accomplish a specified purpose." In the case of contact tracing which has raised major concerns about privacy breaches, it is of vital importance to implement the data minimization principle in its deployment.

6.2   Transparency

Informed consent and transparency about data sharing and usage can mitigate some privacy concerns [31]. Making contact tracing apps open-sourced may help keep them transparent, avoid the misuse of the technology for surveillance, and raise people's trust [16]. A trade-off between transparency and voluntariness was

expressed by Afroogh et al: they felt that compulsory use of tracking apps was more transparent [3]. False expectations should be prevented. The government should make an effort to clearly communicate the goals and functions as well as possible benefits, risks, and limitations of the contact tracing apps to the public in advance [29]. Only in this manner, can a trusting relationship between the government and the public likely be built.

6.3   Voluntary and Temporary Use

Lanzing argued that the use of contact tracing apps should be voluntary, and pre-conditional social participation should be prohibited [23]. This view is also echoed by others [32, 19, 3]. The coercive use of contact tracing in China, the restriction of people's mobility, and the sanction of online discussions on such issues [14] have been a major human rights disaster [41].

It is also a common belief that contact tracing apps should only be used during the pandemic and the data should be destroyed after the pandemic is over. Thus, a review and exit strategy must be in place to establish when and how fast this should happen by an independent body [27].

6.4   Adhering to Data Protection Standards

Adhering to data protection standards can help ensure accountability of contact tracing practices. Sowmiya et al. suggested building contact tracing apps upon the Advanced Encryption Standards (AES) encryption standard and random cloud storage for protecting the collected data [32]. Idrees et al. listed the rights conferred under the General Data Protection Regulation (GDPR), and argued that they needed to be enhanced in the context of healthcare data [19]. More auditing efforts are needed to assess the adherence of contact tracing apps to data privacy and security standards, and thus ensure accountability and people's data rights.

6.5   Decentralized vs Centralized Contact Tracing

Idrees et al. proposed a blockchain-based digital contact tracing technique which could effectively provide contact tracing functionalities without compromising users' privacy or confidentiality [19]. According to them, a blockchain provided users with total control over their data throughout the data life cycle and allowed for withdrawal at any time. Moreover, the data stored were encrypted, time stamped, and immutable, making access by unauthorized individuals impossible, which promoted transparency and eliminated discrepancy. Surveys of contact tracing apps revealed a mix of centralized and decentralized architectures with proximity-based methods largely being decentralized while location-based ones being centralized [32, 4, 19].

Grekousis & Liu argued that while a decentralized architecture offered more privacy, it was not as efficient as its centralized counterpart [17]. Ahmed et al.

further stated that none of the centralized, decentralized, or hybrid architectures were impervious to attacks, and even privacy-preserving mechanisms could be subverted [4]. Since decentralized systems were not inherently safe, White & van Basshuysen proposed that if the likelihood of a system being effective was higher, a higher level of risk for privacy should be regarded as acceptable [38]. It has been posited that even centralized systems with enough privacy safeguards are justified as public health interventions in a pandemic [8].

6.6   Affordable Wearable Devices to Improve Accessibility

Making contact tracing more accessible to all demographics both helps improve its efficacy and benefits a wider population. However, smartphones which contact tracing apps rely on are not accessible to financially vulnerable groups, children, and older adults [5, 3]. Grekousis et al. suggested that efforts should be devoted to creating stand-alone, smaller, and cheaper wearable devices with low energy consumption so that they could be distributed freely among economically or physically vulnerable people in future pandemics [17].

7   Discussion

7.1   Research Implications: Epidemic, Data Governance, and Surveillance

Despite the proven effectiveness of contact tracing apps in curbing the pandemic [24], spontaneous and wide adoption of contact tracing is not very likely. Relatively democratic governments like the US seldom forced their citizens to use contact tracing apps. As a result, fewer than 60% of the people in these countries used them, making them less effective [18]. On the contrary, some countries like China enforced the use of contact tracing apps more strictly, experiencing varying levels of distrust from their citizens [24].

People widely express their concerns over data privacy. In times of crisis, they experience additional concerns of governmental surveillance, which might stick after the crisis [24]. People showed a low level of trust toward the centralized data governance model, and did not believe the governments could effectively manage the collected data [26]. While researchers have suggested making contact tracing apps adhere to security and privacy standards [32], centralized data governance by governments is intrinsically harder to regulate since it is less subject to auditing compared to their corporate counterparts, especially in authoritarian regimes. Future research could explore the public attitudes toward contact tracing in countries with different levels of democracy and collectivism.

7.2   Design Implications: Toward Effective and Ethical Contact Tracing

To address people's privacy concerns of contact tracing apps, various solutions have been proposed in prior literature, such as minimizing data collection [1],

transparently communicating benefits and risks of contact tracing [29], making the use of contact tracing apps voluntary [23] and temporary [27], and adhering to data protection standards [32]. Neither decentralized nor centralized architectures could fully address the privacy concerns [4], and researchers generally accepted the trade-off between privacy and efficacy [38]. Research efforts are urgently needed to develop more privacy-preserving contact tracing technologies without degrading their efficacy.

While accessibility issues of contact tracing apps may prevent them from achieving their efficacy and wider social benefits [5], researchers have suggested the creation and distribution of affordable wearable devices to replace smartphones [17]. Such designs and controlled experiments would be valuable.

8   Conclusion

In this paper, we conducted a narrative review to understand ethical issues of COVID contact tracing apps and potential solutions. Privacy concerns center around data leakage and surveillance, accompanied by people's long-standing distrust toward the government. Accessibility issues prevent contact tracing from fulfilling its potential in curbing the pandemic and benefiting the wider population. Unfortunately, no solutions so far could achieve a satisfactory level of privacy, leading to insufficient community uptake except when enforced strictly. Based on existing evidence and solutions, we proposed design and research suggestions for effective and ethical contact tracing.

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