

Use of mobile phone apps for contact tracing to control the COVID-19 pandemic: A Literature Review

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Abstract

Background: Contact tracing is a widely adopted surveillance system that is used to identify, evaluate, and handle people who have been exposed to novel infectious diseases. The mobile phone apps using a digital technological system, called “proximity tracking,” is used as a surveillance system to control the COVID-19 pandemic.

Objective: This aim of this review is to examine the use of mobile phone apps for contact tracing to control the COVID-19 pandemic worldwide.

Method: A search of different electronic databases, such as PubMed, PubMed Central, Google Scholar, and Google, was carried out using search items ‘mobile app,’ ‘tracing’, and ‘COVID-19’. The search was conducted between 18 to 31 May 2020.

Findings: The search revealed that a total of 15 countries in the world developed and actively using 17 mobile apps for contact tracing to control the COVID-19 pandemic during the selected time frame. China and Malaysia were only using two apps. Out of 17 apps, three were protected by the country’s data protection laws. The results indicate that the mobile apps were used to monitor self-isolated individuals, identify individuals not wearing masks, whether they had close contact with an infected person, provides exact time and place of the encounter, and possible risk of infection.

Conclusion: Contact tracing is found to be an essential public health approach to fight the spread of COVID-19 pandemic and other novel infectious diseases. However, caution is warranted to generalize the usability of apps, especially in the LMICs, and to address the concerns regarding data anonymizing, data privacy and usage, and data rights.

Keywords: COVID-19 pandemic, Mobile phone apps, contact tracing, prevention, data privacy.

Introduction

The newly found zoonotic viral infection known as COVID-19 affecting people globally by causing major health crisis [1]. With more than 5,550,000 cases globally and claiming the lives of more than 350,000 people worldwide, COVID-19 has spread overwhelmingly, affecting every part of the world directly or indirectly [2]. The practical options to control the spread of the infection are antiviral therapy and vaccination, but they are under research and development [3]. In light of the pandemic, countries worldwide imposed strict public health and social measures such as border lockdown, a national advisory to stay-at-home among many other orders, with the sole aim of reducing the spread of the virus [2]. As the countries gear up to ease the lockdown, vigorous surveillance techniques have to be kept in place to maintain the consistent decline of new positive cases of COVID-19 [2]. Moreover, some of the countries have already experienced the ‘second wave’ of coronavirus cases. An alternative to the lockdown approach, scientists have thus proposed an app-based contact tracing to keep the epidemic in check [4].

According to World Health Organization (WHO) guidelines, member states are obligated to put a surveillance system in place and attain critical and evidence-based data for their COVID-19 response while keeping in check the unambiguousness and privacy concerns of the community [2]. Digital technologies, when combined with artificial intelligence, could prove to be an asset to public health workers in terms of rapid reporting, data collection, and analysis [5-6]. Contact tracing is a widely used surveillance system. It works by identifying, evaluating, and handling people who have been exposed to the disease or have been in contact with a person exposed to the disease. Early detection and reporting can prove to be useful in breaking the transmission chain of the virus [2]. A digital technological system, called the “proximity tracking” is gaining popularity worldwide and is now a widely used surveillance system for COVID-19 [7]. Scientists have

recommended using a mobile tracing app to control the epidemic. To reduce the spread of the infections, it is essential to find all the people who came in close contact with COVID-19 diagnosed individual [4]. Proximity tracking calculates whether two devices (e.g., smartphones) near enabled the spread of the virus from an infected individual to an uninfected individual. A person is notified if exposed and necessary measures can be taken by the health officials [8]. Many countries have come up with their contact tracing apps and the devices have already become popular among the users. A recent study in the UK, 74% of respondents had expressed their said they would definitely or probably download/install a contact-tracing app [7]. As a majority of the people are interested in using the app and having a smartphone even in the low- and middle-income countries (LMICs), proper use of an app could be a potential strategy to ensure the contact tracing. However, the available apps have not been compared and contrasted regarding development, confidentiality, popularity, and user-friendliness. Therefore, we aimed to this conduct review to examine the use of mobile apps in different countries to trace and detect COVID-19 infected to control the pandemic. The apps can guide managing the transmission in the countries where the epidemic is in the active form and to prevent further waves in the countries where the pandemic has been controlled.

Method

Academic databases/search engines such as PubMed, PubMed Central, Google Scholar, and Google were used to gather information on the usage of a mobile application for tracing COVID-19. The following search terms are used alone or in combination: ‘mobile app,’ ‘tracing’ and ‘COVID-19’. The reference lists from retrieved articles were also examined manually for relevant evidence. The search was conducted until 31 May 2020.

Results and Discussion:

The search revealed that a total of 15 countries in the world developed and actively using 17 mobile apps for contact tracing to control the COVID-19 pandemic during the selected time frame (Table 1). China and Malaysia were only using two apps. Out of 17 apps, three were protected by the country's data protection laws.

Table 1: Key characteristics of mobile app for COVID-19 tracing by different countries

Name of the app	Country	Method of data collection and type of data	Protected by Data Protection Law	Storage Policy
COVIDSafe	Australia	Name, mobile number, postcode and age	Yes	All storage data will be deleted after the pandemic
BeAware	Bahrain	Self-isolated individuals locations are traced and monitored by electronic bracelets	Not available	Not available
Facial recognition technology	China	The surveillance system can detect fever with a 0.3°C margin of accuracy and can identify individuals not wearing a face mask	Not available	Not available
Mobile payment systems (Ali Pay and We Chat)	China	Combine the users' data such as location, health and also financial data and then, generates a tailored personal infection risk status	No	Not available
The e-Rouška	Czech Republic	Only identifies the people a person has been in contact with by tracing the location	Yes	Data is only accessible for the epidemiological purpose
CoronaApp	Columbia	Symptoms, receive preventive advice and locating individuals	Not available	Not available
GH COVID-19 Tracker App	Ghana	Can trace anyone who has come in contact with an infected person	Not available	Not available
VirusRadar	Hungary	If an individual is infected, the app user will be asked to share the information with the health authorities.	Yes	Stored on the device for 14 days
Rakning C-19	Iceland	Tracks users' GPS data to collect information about the users' encounters		The data is stored only on the phone and is accessible only to the user. The information is stored for 14 days and then deleted.
AarogayaSetu	India	Tracks location and Bluetooth contact but also assigns color-coded badges indicating infection risk.	No	The information stored is deleted after 30 days in case a person wishes to opt-out
HAMAGEN	Israel	Uses GPS location of the phone to notify the user if s/he happens to cross a COVID19 positive person and provides the exact time and place of the encounter.	Not available	Not available

MyTrace	Malaysia	A community-driven application that assists users to exchange proximity information between each other once the app detects another device with the installed app		
MySejahtera	Malaysia	Personal data as, name, ID number, postcode	No	
NZ Covid Tracer app	New Zealand	Personal data, a digital diary of different locations that have been visited		
Smittestopp	Norway	Collects data about the movement pattern of the users, and in case of one them has been in close contact with another user who is diagnosed with COVID-19		The users' data is anonymized and data older than 30 days are deleted continuously
Tatamman	Saudi Arabia	The app provides services to identified cases for follow-up and lab test results as well as users who were in contact with confirmed cases	Not available	
TraceTogether	Singapore	Allows exchange short-distance Bluetooth signals; therefore, everyone can detect other TraceTogether users and alert whenever someone comes into contact with a COVID-19 patient to take the precautions		The data are automatically deleted every three weeks if the user doesn't come into contact with a positive case during this period

COVIDSafe

Australia is one of the countries which is affected by the current COVID-19 pandemic, and the adverse effects of the crisis have spilled over different sectors in the country, such as; healthcare, trading, energy, finance and tourism [9] The current reported cases (30 June 2020) are 7,834, as the majority of them between (20-29) years old. The total 104 death cases with the majority between (89-89) years old and the country showed high promising recovery rates with 7,037 cases.[10]. Australian authorities developed COVIDSafe as a contact tracing app [10], which is the only Government approved app [11]. This app started functioning from 26 April 2020 and gathered personal details like name, mobile number, postcode and age range. A unique encrypted code is generated after creating a confirmatory text message. It is highly sophisticated and works by using Bluetooth signals to record encrypted data about close contacts with other users. Data-protection laws still protect this revolutionary app through the Privacy Amendment bill [10]. After the diagnosis of COVID-19, immediate communications are verbally recorded and then uploaded into the COVIDSafe app storage system. Health officials analyze the gathered information to trace and control the pandemic spread. As an element of data protection, the infected person's details will not be disclosed. The users are advised to delete the app and all stored information destroyed only once the pandemic ends. The data on the patient and their contacts stored in the secured system will be removed only at the end of the pandemic, which unfortunately looks remote, and hence of serious security concern. However, the deletion of personal information from the storage system can be requested [11].

BeAware

Bahrain is a developing country, which is not also immune to the pandemic like their neighboring countries in the Arabian peninsula [12]. The first two cases were reported on the 24 February 2020 and the first death case on the 16 March 2020. The curve kept increasing slowly and reported cases were low until 11 April, and afterward, it started growing massively, and the peak of the evidence was recorded on the 13 June. And up-to-date (30 June 2020), Bahrain recorded 26,239 cases and 84 deaths [13-14]. The Kingdom of Bahrain authorities developed BeAware app [15]. It tracks COVID-19 patients using wearable electronic bracelets and alerts the government about any suspicious activity, and tracks movement through Bluetooth with GPS. Self-isolating people are advised to set their location. For monitoring, the Ministry of Health requests pictures which have to show the users' face and bracelet. The monitoring center is alerted if the wearer moves 15 meters away from their phone. Violations are punished with penalties and/or a jail term. Removing or tampering with the bracelet is considered a breach. The users are required to charge their devices and make sure that the location and internet connection is on.

Facial Recognition Technology

China is the first country to report COVID-19 cases, the pandemic that contributed to enormous adverse impacts globally. The first case in Wuhan was published back in late December 2019 [16]. Afterward, the cases started to increase until it peaked on 3 February 2020, whereas, the death rate was rising since the 11 January and onward [17]. The Chinese Government placed high measures of quarantine and social distancing on the affected areas [16], which resulted in a marked decrease

in both confirmed and death cases, as after 17 April and the total confirmed cases and deaths until 30 June is 85,227 and 4,648, respectively [17].

China has repurposed the existing digital surveillance system to cover COVID-19 contact tracing. This system can detect fever with a 0.3°C margin of accuracy and can identify individuals not wearing a face-mask. The highly sophisticated facial recognition technology has been developed by Sense Time and Megvii, which are high-tech Chinese firms with expertise in this field. Sense Time has developed a temperature detection software. Enforcement of these gadgets to control the spread of COVID-19 has been promoted and supported by the Chinese Government [18]. The Government considers this as an approach that would allow COVID-19 infected people to resume healthy lives with thorough monitoring [19]. Mobile payment systems encompassing touchless money transfers and mobile wallets are popular digital payment apps in China, these apps combine the users' data such as location, health, and financial details and then, generates a tailored personal infection risk status. This runs in collaboration with government agencies, which then decides the users' status of accessing transport, shops, and other public spaces [19]. However, with private technology companies involved in data collection and reluctance to share information on a local level has hindered the government's ability to limit the spread of COVID-19 towards the earlier stages of the outbreak. Ant Financial is a sister concern of the technology giant, Alibaba. Ant Financial has leveraged the Alipay Health Code, which places the public in color-coded categories for risk of COVID-19, based on collected and self-reported data. This then dictates their freedom of movement, including the freedom to travel. The green band allows unrestricted travel, and yellow recommends a week of quarantine, and red imposes a two-week quarantine [20].

e-Rouška

The first three cases of COVID-19 in the Czech Republic were reported on 1 March 2020 since then, the number of cases went up to 9226, with 319 reported deaths [21]. To slow the spread of the virus, a project was created within the COVID19CZ initiative (a joint venture of Czech technology companies and IT enthusiasts to fight COVID-19) and ran under the auspices of Ministry of Health of the Czech Republic. The project was named “The e-Rouška” (e-facemask) and aimed to help hygienists in recognizing the people at high risk of infection by easy and sufficient identification. The data stored is only accessible to the hygienists for epidemiological purposes [22]. The app helps in separating the exposed from healthy individuals and identifying the people who were insignificant contact (longer than 15 minutes for a distance of fewer than 2 meters) with the infected. It is believed to aid in the gradual release of the national quarantine and decreasing the effects of the pandemic on the society and economy [22].

CoronApp

In Colombia, the pandemic followed an exponential trend since the first case was reported back on 6 March 2020, where the most affected age group is ≥ 60 years [23]. Currently (30 June), the total confirmed cases are 91,769, and deaths are 3,106, and the peak of the pandemic is not yet recognized at the country’s curve as the cases are nevertheless on the rise [24]. The Government approved CoronApp-Colombia app allows provisions for users to register friends and family, and can report health information including symptoms, receive preventive advice, and updated information about the virus in addition to being able to locate where cases are located in the map [25]. Authorities removed contact tracing feature after experiencing glitches and adopted Apple, and Google’s contact tracing technology [25].

GH COVID-19

Ghana reported its first COVID-19 case on 12 March and as of 28 May 2020, Ghana has 7,768 positive cases with 35 deaths [26]. On 12 April 2020, ministries of Communications and Health launched a mobile app for contact tracing known as “GH COVID-19 Tracker App”. Ghana reports 4,786 collected with enhanced contact tracing and a test positivity rate of 3.18 with contact tracing’s assistance [26]. The app works by identifying suspected cases with testing and tracking contacts of confirmed positive cases of COVID-19. The app works through mobile network platforms and can trace the recent locations visited by the individual and notify if a person needs to self- quarantine following exposure. The collection and availability of data through the app have been a significant aid in Ghana’s battle against COVID-19 [27].

Virus Radar

The first case of COVID-19 was reported on 4 March 2020. As of 29 May 2020, Hungary recorded 3,841 confirmed cases of COVID-19, with 517 deaths [28]. The Ministry of Innovation and Technology announced an official COVID-19 tracker app called “VirusRadar” on 13 May [29]. Developed by Nextsense, the app used the company’s contact tracing technology and was donated to authorities as support against the COVID-19 fight [29]. The app uses Bluetooth technology and exchanges encrypted, anonymized data with other app users, measuring the distance between the phones. The information collected is stored on the device for 14 two weeks. If an individual is infected, the app user will be asked to share the information with the health authorities. The data collected is stored on a safe server managed by health authorities and neither the location is tracked, nor personal information is disclosed [29].

Rakning C-19

Iceland started its coronavirus fight from 28 February 2020 with its first reported case. As of 27 May, a total of 1,315 COVID-19 positive cases and ten deaths have been reported [30]. Rakning C-19 was launched in early April and tracks users' GPS data to collect information about their encounters and allowing investigators to trace the exposed individuals [31-32]. With nearly 40% of citizens using the app, it has the most significant penetration rate of all contact trackers worldwide [31]. The country has managed to flatten the curve, and the numbers have been stagnant for several weeks. The last recorded COVID-19 end was on 19 April, and the country has not undertaken drastic social measures like the rest of the world. It is focused mostly on a mixture of social distancing, "bubble strategy" of dividing workplaces, and schools into isolated units with do not interact with each other. The success has been attributed to aggressive testing, tracing, and isolation by the government [31]. Once installed, the app runs in the background and saves the location of the phone numerous times in an hour. The data is stored only on the phone and is accessible only to the user. The information is stored for two weeks and then deleted.

AarogayaSetu

As of 31 May 2020, India has 89,995 confirmed cases of COVID-19 and 5164 deaths [33]. On 2 April 2020, India launched its mobile tracing app known as "AarogayaSetu" which is aimed at facilitating the efforts of limiting the spread of the virus in India [34]. As of 26 May, the app has over 114 million users, more than any other contact tracing app in the world and is available in 12 languages on Android, iOS, and KaiOS platforms [34]. AarogayaSetu, unlike other similar apps, is a massive all-in-one undertaking that not only tracks the location and Bluetooth contact but also assigns color-coded badges indicating infection risk.

India is the only democratic country in the world, making the coronavirus app mandatory for its citizens. However, the country lacks a national data privacy law, and thus there is ambiguity as to who can access the data from the app. There are concerns regarding blurring the line between voluntary and mandatory, between preserving and overtaking the privacy [35]. The app pioneers new data-driven flattening of the curve using “syndromic mapping.” So far, the app has reached out to more than 900,000 users and is useful in advising quarantine, testing, or precaution. The overall COVID-19 positive rate is around 4.65% and among those who were instructed to get tested, 24% have been found positive for COVID-19 infection. The app has identified nearly 3,500 hotspots across India using the “syndromic mapping” approach and these predicted hotspots were confirmed as real hotspots in 17-25 days [35].

HAMAGEN

As of 30 May 2020, Israel has 16,809 confirmed COVID-19 cases with 281 deaths [2]. Developed by the Ministry of Health (MOH), the contact tracing app is named “HAMAGEN” was launched on 22 March 2020 [36]. The app uses a phone GPS location to notify the user if he/she happens to cross a COVID-19 positive person and provides the exact time, and encounter location. The user is then able to review, confirm, or reject the notification manually. The cross-referencing of the GPS history is done with the epidemiological data of the MOH and is stored only on the user’s phone and is inaccessible to any third party. The app’s control system is voluntary and provides sole discretion to the user [36].

MySejahtera

By the end of January 2020, the COVID-19 patient numbers have been growing exponentially in Malaysia. Consequently, Malaysia has the highest number of cases within Southeast Asia at that

time [37]. Three main tracking applications were developed by different governmental entities to control the COVID-19 spreading. The first one is MyTrace, which is a community-driven application that assists users to exchange proximity information between each other once the app detects another device with the installed app [38]. Therefore, MyTrace is enabled to identify users who were close to infected individuals. It was developed through internal collaboration between eight governmental agencies, the International Islamic University Malaysia, and Google. The second one is MySejahtera, which helps the users to perform a self-assessment and monitor progress, as well as allows the MOH to provide any immediate interventions when it is required [38]. The third one is Gerak Malaysia, which gives users access to get traveling permission during the moving control order [39]. Additionally, it allows the MOH in tracing the movement of the users and potential patients' contacts. However, this app collects a lot of personal data like name, ID number, postcode, which raise a concern regards data privacy and usage.

NZ Covid Tracer app

New Zealand is one of the countries that controlled the pandemic and is raising promising results so far. The country recorded the first COVID-19 case and death (28 February and 29 March 2020, respectively) [40]. Since the new COVID-19 pandemic, contact tracing is a top priority with the purpose of identification and isolation of people who have been exposed to an infectious case, to prevent onwards transmission from the contact to others [41]. The tracing chiefly was done by medical, health, and public health staff who are specialists in infectious disease control. Moreover, the MOH in New Zealand has launched the NZ Covid Tracer app on 19 May 2020 as part of their contact tracing strategy [42]. The app requires to set up an account that includes personal data [42]. Amid registration, the user needs to create a digital diary of different locations that have been

visited. If the user were identified as close contact to a COVID-19 case, the National Close Contact Service would contact the user to provide the necessary advice and arrangement. Additionally, they will collect further information about the social circle of the users to identify whether anyone may also have exposure to the virus [42].

Smittestopp

Since the first detected case of COVID-19 in Norway in February 2020, the public health authorities have provided advice on well-known infection control measures, such as hand hygiene, sneezing and coughing habits, isolation of individuals with COVID-19 symptoms, avoid unnecessary travels, work from home if possible and tracing of contacts of confirmed cases [43]. To limit the transmission of coronavirus, the health authorities have developed the Smittestopp, which is an app supported at Apple and Google Play stores [43]. The Smittestopp collects data about the movement pattern of the users, and in case one of them has been in close contact with another user who is diagnosed with COVID-19, the app will provide a piece of advice about how to limit the transmission. The users' data is anonymized and data older than a month are deleted continuously [44].

Tatamman

In Saudi Arabia, the pandemic recorded high rates until now, as the first case was reported on 2 March 2020, and the earliest death on 24 March. Since these dates, the cases count is increasing, as the country is still going toward the peak, and the total recorded cases until 30 June 2020 is 186,436 and 1599 deaths [45]. The MOH has launched an app called “Tatamman” as part of its qualitative initiatives to prevent COVID-19 spread [46]. According to MOH, the app aims to who are self-isolating or in quarantine to provide prevention and enhance their recovery procedures,

respectively. The app provides services to identified cases for follow-up and lab test results as well as users who were in contact with confirmed cases [47]. Moreover, all citizens returning from abroad need to wear bracelets that are linked to the same app [47].

TraceTogether

Singapore's first COVID-19 cases were identified at the beginning of March 2020. Therefore the government starts to implement public health measures to control the spread and flatten the curve [48]. The government launched the TraceTogether application on 20 March 2020 in their efforts to combat and mitigate the range of COVID-19 through community-driven contact tracing [48]. This mobile app was developed by the Government Technology Agency, in collaboration with MOH [48]. The application allows exchange short-distance Bluetooth signals; therefore, everyone can detect other TraceTogether users and alert whenever someone comes into contact with a COVID-19 patient to take the precautions. The application only requests a registered phone number, and there is no further information is collected. Additionally, the data are automatically deleted every 21 days if the user doesn't come into contact with a positive case during this period [48].

So many countries in the world so far have developed and launched applications with a purpose to control the spread of COVID-19. The main strength of apps is its 'novelty-effect,' which is helping the health authorities to monitor and diagnose the infected individuals. According to AmnestyInternational, Bahrain's 'BeAware Bahrain,' Kuwait's 'Shlonik' and Norway's 'Smittestopp' apps are found to be "the most alarming mass surveillance tools" and compromise users' privacy as the apps "actively carrying out live or near-live tracking of users' locations by frequently uploading GPS coordinates to a central server." [49]. This recent coronavirus infection

has affected a large population globally, so a universal mobile application system can be developed that will incorporate all vital features to locate, monitor and to send alerts and connectivity with the health authorities and government officials so they can take immediate measures to control the spread of infection. This is the first such kind of review to compare and contrast the available apple and their applicability in controlling the pandemic.

The applications mostly supported Apple and Google Play stores and were created in the spoken languages in the countries as well as English. However, this strategy has raised concern regards the data anonymizing, data privacy and usage[50], particularly the involvement of Google and Apple who could have access to the database which imply the question whether are the data rights being safeguarded [7], as well as lacking policy that will give privacy considerations when designing contact tracing apps [50]. The use of a mobile app for tracing COVID-19 positive patients may produce inaccurate data and some instances using the app can be troublesome. It should be noted that this form of the mobile app is not a substitute for treatment or necessary follow-up. Maintenance of this system can be difficult as it would require backup systems in case of problems with the transmission. It's unlikely that the users are at risk even in case of transmission issues as senders are usually notified. The systems require to meet data protection guidelines and also privacy and confidentiality requirements.

Moreover, the applications are installed voluntarily. Therefore it doesn't ensure full public engagement. Till now, there is no scientific evidence that correlates the effectiveness of mobile applications and COVID-19 contact tracing. Moreover, there is no available data regards the number or percentage of people who have installed the app and are using it regularly. Additionally, the mobile applications are a continuous work that is in progress and updated periodically. Therefore, the collected information may always change, which will affect data analysis. The

search was not systematic. Not all databases have been searched. No previously tested or valid instrument was used to evaluate the apps.

Conclusion

The review reveals that the use of mobile technology is helping the health authorities to monitor and diagnose the infected individuals and thus controlling the infection to spread. The COVID-19 pandemic affected the health facilities' responses even in developed countries with proven and state of the art modern healthcare systems [51]. With proper utilization of these mobile contract tracing apps, it would be possible to control, detect the clusters and predict next waves during this current pandemic and future disease outbreaks. However, strong caution is warranted to generalize the usability of apps, especially in the LMICs, and to address the concerns regarding data anonymizing, data privacy and usage, and data rights.

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