Review Article

Exploring the role and mechanism of COVID-19 apps in fighting the current pandemic

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INTRODUCTION

The World Health Organization declared the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (COVID-19) outbreak as a pandemic on March 11, 2020. This highly contagious viral disease has now spread across the globe to more than 213 countries with 17,771,634 confirmed cases of COVID-19 disease including 683,278 deaths reported to the World Health Organization (WHO).[1] COVID-19 spreads by droplet transmission causing a spectrum of illness from simple sore throat to viral pneumonia.[2] Serious illness requires hospital admission and may need ventilatory support.[3] To prevent the spread of this contagious virus, national governments have introduced “lockdown” measures with infection control strategies including “social distancing” and “self-isolation” guidelines which severely restricts the movement of people and affects their daily life.[4] The World Health Organization has urged countries to scale up the testing, isolation, and contact tracing of COVID-19 patients to combat the pandemic and this process has been supported by recent interventions.[5] Over recent years, the number of individuals with access to a smartphone has risen exponentially.[6] Smartphone technology (SMT) on its own and as extension of telemedicine has significant applications in the current COVID-19 pandemic.[7] It has a significant role which is monitoring and managing chronic conditions such as diabetes and hypertension.[8]
Further extended with introduction of mobile contact tracing applications (app) to support global effort to control the pandemic. Various national governments have launched mobile COVID-19 contact tracing applications (apps) to monitor and minimize the spread of COVID-19 thus being able to safely reduce lockdown measures.\textsuperscript{10,11} India, with its limited health resources, has been significantly affected by the COVID-19 pandemic due the strict "lockdown" measures and application of infection control strategies to prevent the spread of coronavirus SARS-CoV-2 outbreak.\textsuperscript{12} We explore the characteristics of various COVID-19 apps and especially the Aarogya Setu COVID-19 app from India in its role in fighting the current pandemic. However, as COVID-19 is still evolving with new features and information being available everyday as such this article highlights the overall mechanism of COVID-19 app in contact tracing philosophy and the current available knowledge.

COVID-19 APPS

COVID-19 apps are mobile software applications that use digital tracking to aid contact tracing in response to the COVID-19 pandemic, that is, the process of identifying persons ("contacts") who may have been in contact with an infected individual. These apps are designed to be downloaded on people's smartphones or tablets to keep track of when they come in contact with each other and for how long by Bluetooth wireless signals. Some of these also use Global Positioning System (GPS) location data.

CONTACT TRACING

Contact tracing is used to slow down the spread of viral outbreak. Contact tracing has been credited with helping lifting "lockdown" restrictions in other countries such as South Korea and Germany when combined with other measures.\textsuperscript{13} The COVID-19 App will work with other contact tracing strategies, for example, manual and web-based contact tracing systems to (i) identify people at risk of infection so they can take action to protect themselves, others, and the wider health-care system in curtailing the virus outbreak, (ii) contact tracing can then determine who should be tested or asked to self-isolate or given advice, (iii) it can reveal how the disease is spreading, and (iv) help prevent a "second wave" of COVID-19. The Bluetooth technology allows phone users who have downloaded the COVID-19 app to communicate with each other. This identifies people with suspected COVID-19 and further action can be undertaken following assessment. The GPS location technology helps to trace wider contacts.

Application in the current pandemic

Table 1 shows basic applications of COVID-19 app in the current pandemic.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|p{0.5\textwidth}|}
\hline
Number & Applications & Description \\
\hline
1 & Identify & Identify symptomatic person, Confirm identity of COVID-19-positive patient, Alerts results of COVID-19 tests \\
2 & Contact tracing & Trace contacts of symptomatic and or positive patient, Advice contacts at risk about self-isolation, testing, quarantine procedures, Support them with appropriate information and advice \\
3 & Tracking & Track active cases, Track contacts of symptomatic and or positive patient, Track distant contacts, for example, public transport \\
4 & Monitor & Movement of active cases and contacts, Quarantine and containment zones regulations, "Hot clusters" or "Confirmed clusters", Health of people in containment zones \\
5 & Advice & Self-isolation COVID-19 test, Where to seek treatment, support, and alleviate concerns about mental well-being \\
6 & Education and information & Highlight COVID-19 developments to public, Health information campaigns, Publish latest health recommendations, Tools for self-care. \\
7 & Research & Epidemiological data collection for future preparation, "Syndromic mapping" for modeling studies. \\
\hline
\end{tabular}
\caption{Basic applications of COVID-19 app in the current pandemic.}
\end{table}

a. Early detection and diagnosis of infection: The COVID-19 app allows exchange of a key code in between smartphone users after the app has been downloaded. Following reporting of an infected status on the individual smartphones, this information is collected by a centralized or decentralized database. NHSX and Aarogya Setu have opted for a centralized database so the contact matching happens on a central computer server rather than individual smartphones. Notification to the database triggers an alarm and alerts are cascaded to contacts that have interacted with suspected patient's smartphones. These contacts are then traced and risk assessment done. Following risk assessment decision regarding COVID-19 testing or self-isolation advice or monitoring of symptoms with support is given. Depending on the COVID-19 test results, further steps are undertaken [Figure 1] to support the person.

b. Identify “Clusters” or “Hotspots” of infection: By contact tracing in a community, clusters or hotspots can be found. This will help epidemiologist to learn how the coronavirus has spread and precise dynamics of transmission. It will help in understanding the demographics involved in this infection and shed light on intrahousehold and/or community spread. Cluster assessment will also help to analyze socioeconomic
areas predominantly affected and the influence of high-density population in the spread of COVID-19.[9]

c. “Location App:” Some of these contact tracing apps are combined with a “location tracking” smartphone application which will let trace location and movements of an infected person and others they may have been in contact with using GPS, for example, travelers on public transport or visitors in a supermarket, for example, Aarogya Setu app.[11] This mechanism also allows monitoring of the pandemic as well.

Overview of current COVID-19 apps

There have been a number of COVID-19 apps developed by several institutions and government agencies around the world. Table 2 gives an overview of the characteristics of various COVID-19 apps currently available. Many of them function similarly differences are highlighted in the table. These are at separate stages of application in the current pandemic and use platforms such as Apple iOS and Google Android systems. There has been a surge in the number of mobile phone apps that attempt to monitor and prevent the spread of the virus. The first such app was the TraceTogether App, developed by the Singaporean government and first released on March 20, 2020.[13] This app makes use of the phone’s Bluetooth contact tracing to communicate with other phones in the vicinity. When a person tests positive for COVID-19, the phone then catalogs all the people whom that phone had been in close proximity and allows the government to contact trace these phones for potential viral transmission. Experiences of countries such as South Korea and Germany where mobile-based contact tracing has helped in reducing the spectrum of the pandemic have encouraged various national governments to develop and utilize them in their own countries to stem the spread of COVID-19. [10,11,14-19] Following the initial control of the spread of infection, the process should provide geographical evidence to support removal of “lockdown” measures with an extended belief that mobile contact tracing with other contact tracing strategies and infection prevention measures will eventually help to prevent a “Second wave” of the virus outbreak.

The success of various COVID-19 apps will, however, depend on the uptake of the application system. Academics estimate 80% of the smartphone users which is about 60% of the population will have to actively use it. Second, it is a technology-dependent process hence people should be able to navigate the system.

Security concerns

Researchers have warned use of the application system can pose a risk to users. The use of centralized database has triggered security concerns about data privacy; however, the Government of India and National Cyber Security Centre have tried to allay these concerns.[11,20] NHSX believe centralized database will give better insight into how the disease spreads and helps it to make the app more efficient. However, this has highlighted privacy concerns. A decentralized database on individual smartphones has been put forward by Apple and Google who suggest their system makes it harder for data breaches. The debate continues with privacy protection remediation steps underway.

Aarogya Setu and India’s effort to fight the pandemic

On April 2, 2020, the Government of India introduced an ambitious project to curb the spread of the COVID-19 pandemic with its own Aarogya Setu COVID-19 contact tracing app.[11] Aarogya Setu is an open-source cross-platform for tracking mobile applications developed by the National Informatics Centre and comes under the Ministry of Electronics and Information Technology. This app is designed to help control the spread of coronavirus and make its information accessible to the common people. Currently available in 12 different languages and as of May 2, 2020, the app has more than 115 million users, which is more than any contact tracing app in the world. The Aarogya Setu app uses data provided by users, Bluetooth and location generated social graph to track if one has come close to anyone who could have tested COVID-19 positive. With the Bluetooth feature, it tries to determine the risk if one has been near (within six feet) of a COVID-19-infected person by scanning through the database of known cases across India. Using location information, it determines whether the location of an infected person is amongst an infected area. Thus, it provides a mobile tracking and tracing service which is monitored by the Government of India with the aim of controlling the spread of disease and eventually permits lifting the lockdown and other restrictive measures.

The Aarogya Setu app is mandatory to be download by all public health officials including people residing in the isolation and containment zones. The biggest difference between the Aarogya Setu app and Google and Apple technology is that the former uses both Bluetooth and GPS location data while the latter is only dependent on Bluetooth to function. Almost 98% Aarogya Setu users are Android platform.

As with other COVID-19 apps, there have been concerns about security and data privacy. There is an apprehension that since the location app linked with it may be used by law enforcement officials to monitor movement, quarantine, and self-isolation restrictions and if found in breach of them leading to punitive actions. However, people have been reassured about the need of monitoring to control the spread of the virus outbreak and also that the users’ data in the app are secure. To make it transparent and with the philosophy of providing transparency, privacy, and security in line with India’s policy of Open Source Property, the source code of Aarogya Setu has been made open source on May 24, 2020. The terms and privacy policy have been changed. This suggests only data relevant to COVID-19 infection will be collected.
| Name               | Country       | Platform | Offered by                          | Technology | Size (mb) | Type                            | Open source? | Deletion of data time bound or not | Concerns                                      | Version |
|--------------------|---------------|----------|-------------------------------------|------------|-----------|---------------------------------|--------------|-----------------------------------|-----------------------------------------------|---------|
| COVID Safe         | Australia     | Both     | Australian Department of Health     | Both       | 5.77      | Automate contact tracing        | No           | Yes                               | Data privacy and connectivity issues          | 1.0.17  |
| Aarogya Setu       | India         | Both     | NIC e-Gov mobile apps               | Both       | 2.8       | Contact tracing                 | Yes          | Yes                               | Data leak                                    | 1.1.3   |
| Be Aware           | Bahrain       | Both     | Information and e-government authority | Both       | 8.7       | Tamper-proof GPS tracking bracelet | No           | No                               | Poor networking                              | 0.1.5   |
| CoronApp           | Colombia      | Both     | INS.GOV                             | Bluetooth  | 8.1       | Incorporates technology from pioneer contact tracing | Yes          | No                               | Inaccuracies in logging contacts              | 1.2.45  |
| eRouska (eFacemask)| Czech Republic| Android  | Ministerstvo zdravotnictvi Ceske republicy | Bluetooth  | 3.26      | Anonymized Bluetooth identification | Yes          | Yes                               | NO English Version                           | 1.0.437 |
| GH-COVID 19        | Ghana         | Android  | IQUENT Technologies                 | GPS        | 12.6      | Telephone data contact tracing  | No           | No                               | Security breach                             | 1.0     |
| Virus Radar        | Hungary       | Android  | Biztributor                         | Bluetooth  | 10.33     | Random Bluetooth contact tracing| Yes          | Yes                               | Contact lagging issues                        | 1.0.0   |
| Rakning C-19       | Iceland       | Both     | Embettli landlaeknis                | GPS        | 10.50     | Location data for contact tracing| Yes          | Yes                               | Frozen data registration                     | 1.1.0   |
| HaMagen             | Israel        | Both     | Israel Ministry of Health           | GPS        | 26        | Cross Referencing GPS           | Yes          | Yes                               | Multiple patch problem                       | 1.3.8   |
| AMAN App            | Jordan        | Android  | Jordan e-Gov Program                | Both       | 3.8       | Contact tracing                 | No           | Yes                               | Technical Wi-Fi Glitch                       | 1.0     |
| MyTrace            | Malaysia      | Android  | Government of Malaysia              | Both       | 30        | Proximity information           | Yes          | Yes                               | Data privacy                                 | 1.0.30  |
| NZ-COVID Tracer    | New Zealand   | Both     | Ministry of Health NZ               | Both       | 9.8       | Contact proximity tracing       | Yes          | Yes                               | Poor designing                               | 1.0.2   |
| StopKorona!         | North Macedonia| Both     | Ministry of Information Society and Administration | Bluetooth  | 15        | Bluetooth-based contact tracing| Yes          | Yes                               | Data leak                                    | 1.1.0   |
| Smittestopp        | Norway        | Both     | Folkehelseinstituttet               | Both       | 4.2       | Anonymized movement about data patterns | Yes          | Yes                               | Security concerns                            | 1.2.0   |
| TraceTogether       | Singapore     | Both     | Government Technology Agency        | Bluetooth  | 4.1       | Bluetooth proximity data        | Yes          | Yes                               | Battery draining problem                     | 1.8.1   |
| NHS Covid19        | United Kingdom| IOS      | NHSx                                | Bluetooth  | 5.7       | Web-based contact tracing       | Yes          | Yes                               | Data privacy                                 | 1.0.1   |
| CoronaMap Saudi     | Saudi Arabia  | Both     | National Health Information Centre (NHC) | Bluetooth  | 9.7       | Bluetooth proximity data        | Yes          | Yes                               | Concerns about accuracy of the data collection and privacy (Ref 2) | 2.0.3   |
| SwissCOVID         | Switzerland   | Both     | Swiss Federal Institute of Technology | Bluetooth  | 9.8       | Bluetooth proximity data        | Yes          | Yes                               | Concerns about privacy (Ref 1)               | 1.0.3   |

Ref 1: https://wwwswissinfo.ch/eng/swiss-to-pioneer-use-of-coronavirus-tracing-app-in-europe/45823496; Ref 2: https://www.barrons.com/news/contact-tracing-apps-which-countries-are-doing-what-01588092604 (Contd.)
The Aarogya Setu app has several advantages compared to other COVID-19 contact tracing apps with possibly the most reach and impact nationally, while pioneering new data driven epidemiology logical flattening of the curve through "syndromic mapping.” This approach of “syndromic mapping,” combined with principals of path tracing and movement patterns COVID-19-positive people, thus permits epidemiology modeling. The platform has been able to reach many users and helps advise them for quarantine, caution, or testing providing much needed education and information about COVID-19 to the general population. Analytics of Bluetooth contacts and location data has also helped identify potential hotspots with higher probability of COVID-19 cases allowing state governments and district administrations and health authorities to take necessary steps to contain the COVID-19 pandemic. The precision achieved by a combination of Bluetooth-based contact tracing and identification of hotspots will hold the key to effectively break the chain of infection, flattening the curve, and thus save lives in India.

**CONCLUSION**

The various COVID-19 apps will complement contact tracing system to assess and prevent viral transmission. There are various advantages of using the app with some concerns. However, we believe that the test, track, trace, and support policy will play a key role in suppression of the current pandemic and help in prevention of a second wave of the coronavirus outbreak.

**Declaration of patient consent**

Patient’s consent not required as there are no patients in this study.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. World Health Organisation Dashboard Coronavirus; 2020. Available from: https://www.experience.arcgis.com/experience/685d0ace521648f8a5beeeeee1b9125cd. [Last accessed on 2020 Jun 12].
2. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel Coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2020;382:727-33.
3. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: A single-centered, retrospective, observational study. Lancet Respir Med 2020;8:475-81.
4. Centers for Disease Control and Prevention; 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/index.html. [Last accessed on 2020 May 21].
5. World Health Organization. Coronavirus Disease (COVID-19) Advice for the Public; 2020. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public. [Last accessed on 2020 May 21].
6. Hellewell J, Abbott S, Gimma A, Bosse NI, Jarvis CI, Russell TW, et al. Feasibility of controlling COVID-19 outbreaks by isolation of cases and contacts. Lancet Glob Health 2020;8:e488-96.
7. Ofcom. The UK is Now a Smartphone Society the Communications Market Report 2015. London: Ofcom; 2015. Available from: https://www.ofcom.org.uk/about/ofcom/latest/media/mediareleases/2015/cmr-uk-2015. [Last accessed on 2020 Jun 12].
8. Iyengar K, Upadhyaya GK, Vaishya R, Jain V. COVID-19 and applications of smartphone technology in the current pandemic. Diabetes Metab Syndr 2020;14:733-7.
9. Ghosh A, Gupta R, Misra A. Telemedicine for diabetes care in india during COVID19 pandemic and national lockdown period: Guidelines for physicians. Diabetes Metab Syndr 2020;14:273-6.
10. NHS COVID-19 App; 2020. Available from: https://www.nhs.nhs.uk/covid-19-response/nhs-covid-19-app. [Last accessed on 2020 Jun 12].
11. Government of India. Ministry of Electronics and Information Technology. Aarogya Setu; 2020. Available from: https://www.aarogyasetu.gov.in. [Last accessed on 2020 Jun 12].
12. COVID-19 India; 2020. Available from: https://www.mohfw.gov.in. [Last accessed on 2020 Jun 12].
13. Trace Together, Safer Together. Available from: https://www.tracetogether.gov.sg. [Last accessed on 2020 Jun 12].
14. Yong SE, Anderson DE, Wei WE, Pang J, Chia WN, Tan CW, et al. Connecting clusters of COVID-19: An epidemiological and serological investigation. Lancet Infect Dis 2020;20:809-15.
15. COVID Safe App; 2020. Available from: https://www.health.gov.au/resources/apps-and-tools/covidsafe-app. [Last accessed on 2020 Jun 12].
16. Be Aware Bahrain; 2020. Available from: https://www.apps.bahrain.bh/cmswebapplication/action/appstoreaction. [Last accessed on 2020 Jun 12].
17. Corona App; 2020. Available from: https://www.minsalud.gov.co/english/paginas/coronapp----colombia,-the-application-to-follow-the-evolution-of-the-coronavirus-in-the-country.aspx. [Last accessed on 2020 Jun 12].
18. eRouska; 2020. Available from: https://www.github.com/covid19cz/erouska-android. [Last accessed on 2020 Jun 12].
19. HaMagen; 2020. Available from: https://www.govextra.gov.il/ministry-of-health/hamagen-app/download-en. [Last accessed on 2020 Jun 12].
20. National Cyber Security Centre (NCSC), NHS COVID-19 App Security; 2020. Available from: https://www.ncsc.gov.uk/blog/post/nhs-covid-19-app-security-two-weeks-on. [Last accessed on 2020 Jun 12].

How to cite this article: Iyengar KP, Jain R, Samy DA, Jain VK, Vaishya R, Suraliwala K. Exploring the role and mechanism of COVID-19 apps in fighting the current pandemic. Indian J Med Sci 2021;73(1):36-40.