Proceedings of the 2nd International Conference on Modern Medicine and Global Health
DOI: 10.54254/2753-8818/27/20240727

Role of digital epidemiological technologies in controlling COVID-19: Cases review

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Abstract. The pandemic of COVID-19 had not only been testing the existing health care system globally, but also highlighting the need for more innovative and adaptive methods in dealing with new health threats. Digital technology become one of the most effective and efficient strategies in terms of controlling and monitoring the outbreak of this disease. These digital strategies will serve a significant role in providing valuable insights in disease and virus control for any upcoming event. This paper aims to discuss and evaluate the roles of digital technology methods in addressing COVID-19 pandemic, while focusing primarily on two case studies: COVIDSafe App from Australia and the EU's Digital COVID Certificate. While confronting the challenge raised by COVID-19, the world had invented critical digital tools as instruments to monitor, track, and manage the spread of virus. By taking a deeper look at the history, technology, and application of the successful cases, the author hopes to draw important lessons from these experiences, and foreshadowing some broader potentials for their future development and usage. Additionally, the author also analyzes the legal and privacy concerns that may come with the adaption of digital technology in fighting the pandemic, and underscore the implication of technological methods advancement for future health crisis.

Keywords: Digital Epidemiology, COVIDSafe, EU Digital COVID Certificate, Digital Technology.

1. Introduction

In early 2020, an unprecedented crisis emerged from China, spreading rapidly to the rest of the world in a fashion that had yet to be seen in modern health care and public health fields. Later identified as COVID-19, the pandemic had not only been testing the existing health care system globally, but also highlighting the need for more innovative and adaptive methods in dealing with new health threats. Despite the uncertainty, digital technology had found its way in becoming one of the most effective and efficient strategies in terms of controlling and monitoring the outbreak of COVID-19. These digital strategies will serve a significant role in providing valuable insights in disease and virus control for any upcoming event. This paper aims to discuss and evaluate the roles of digital technology methods in addressing COVID-19 pandemic, while focusing primarily on two case studies: COVIDSafe App from Australia and the EU's Digital COVID Certificate. While confronting the challenge raised by COVID-19, the world had invented critical digital tools as instruments to monitor, track, and manage the spread of virus. By taking a deeper look at the history, technology, and application of the successful cases, the author hopes to draw important lessons from these experiences,

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2. Overview of digital epidemiology

Digital epidemiology has been on a rapid rise for the past decade [1], data generated from all sorts of sources have been accumulating, which could be used for the purpose of public health. But firstly, it is necessary to address the question of what is digital epidemiology. “Digital” being the key part of the term digital epidemiology frames the direction of the definition. Dr. Salathe defined digital epidemiology in his article as epidemiological work that utilizes data not originally generated for doing epidemiology [1]. These data sources include but not limited to social media (Instagram, Facebook, and etc.), search engines, cellular data, data captured by sensors, and many more [2]. These data are to enhance the existing epidemiological approaches and to adapt to new public health threats more rapidly.

One of the most well-known early digital epidemiology examples is Google Flu Trend [1]. It aims to analyze flu outbreaks using search queries [3] and demonstrated the potential of such digital methods being successful in helping health care professionals and epidemiologists in disease surveillance. However, there were issues with Google’s approach into digital flu monitoring. Over-estimation and lack of transparency are the main problems that Google Flu Trends were having [1, 3]. But it ultimately underscored the need for further refinement in digital epidemiological methods. As time passed and technological advancement took place in the following years, the employment of more enhanced tracking, data collection, and data analysis ability eventually lead to various application of digital epidemiological strategies against COVID-19.

In the present, the author categorizes some key components of digital epidemiology in this section. As there are mainly three critical parts of every digital epidemiological method: data collection, data analysis, and data integration. Data collection refers to the gathering of data from various sources, these data could be numbers, locations, and etc. Data analysis involves the processing of data collected, such mechanism could employ machine learning, digital data analysis, and many more in order to extract valuable insights. The last step, data integration, calls to the application of the results of data analysis. Devices like smartphones could potentially benefit significantly from the data to carry out applications that helps controlling any health threats (Figure 1).

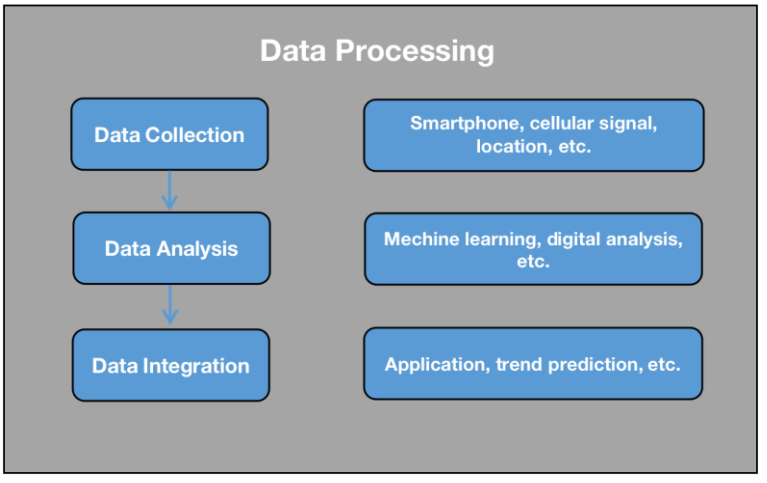

Figure 1. The main data processing of digital epidemiology.

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3. Application of digital technologies in epidemiology

3.1. Case one: COVIDSafe

COVIDSafe tracking application for smartphones was developed and launched by the Australian government with the purpose to combat against the spread of COVID-19 virus in Australia. The app mainly has the function of tracing existing infected cases, and notifying potential contacts. Bluetooth and smartphone technology had played an critical role in enabling the successful operation of the concept of real-time tracing app like the COVIDSafe. Individuals were able to be notified if they were in close proximity to a confirmed case. This was done through Bluetooth signaling by each signed-up app user's phone. However, despite its effective functions, there remains some concerns surrounding the privacy issues of COVIDSafe.

The function of COVIDSafe's tracing and tracking mainly rely on Bluetooth technology. Bluetooth data exchange also ensures that each user's private data would not be shared or leaked to unwanted parties. The basic principle of how COVIDSafe works involves the exchange of data between smartphones. When two individuals come into close contact, their smartphones would initiate data exchange, these interaction is encrypted as to protect user's privacy. Information being exchanged will also sorely be stored on individual devices' local storage. If an individual has been confirmed positive for COVID-19, they have the option to upload their infection status to a government server. Therefore, individuals could be notified when they have been in close contact with a confirmed case, hence being able to seek further help from health authorities.

The app COVIDSafe is significant in terms of being a crucial tool in containing and controlling the spread of virus in Australia. Its aim was to reduce transmission and prevent potential outbreaks. The application offered a more streamlined way to employ tracing and tracking within communities. Being able to trace close contacts and noticing them in a short time frame is critical for breaking the chain of infection in a epidemiological outbreak. Also, COVIDSafe served as a tool to help authorities to reach a broader population when it comes to tracking of health. It is extremely time-consuming and less effective to manually record and track transmission data, especially in more crowed areas. COVIDSafe had become a successful digital methods to resolve challenging tasks in a rapidly spreading and highly contagious pandemic.

However, although the COVIDSafe application had its success in areas of tracking, it did also face some concerns and limitation about uptake rate and individual user's privacy protection. A tracing application rely heavily on the total amount of users who download and use the app, as the more people have the app, the more data it can collect and analyze. However, the uptake and adoption rate of COVIDSafe app was not as high as anticipated [4]. Data has shown that about one-third of the participants in a survey about COVIDSafe app had not downloaded the application due to multiple reasons, including lack of health concerns, technical difficulties, privacy concerns, and more [5]. Without a large population pool, tracking app like COVIDSafe might fall short of performing as good as predicted. Additionally, there have been concerns about data privacy from individuals who chose not to download the app. This factor covalently attributes to the reason why there is a lower-than-expected uptake rate. A survey carried out by Thomas revealed that among those surveyed, 25% did not download the COVIDSafe application due to privacy concerns (2020) [6].

Overall, COVIDSafe tracking application serves an important role in controlling and monitoring the spread of COVID virus in Australia. It eased the pressure on health authorities in terms of data collection, case tracking, and exposure notification. However, there are lessons to be learned from this experience. Uptake rate among citizens is critical for the performance of a tracking application, governments have to address the issues around people's concerns on privacy, technical difficulties, and data process in order to generate better strategies for the future [6].

3.2. Case two: EU Digital COVID Certificate

In response to the emergence of COVID-19 virus in Europe, the Europe Union (EU) approved and launched a crucial digital strategies named "EU Digital COVID Certificate" in 2021, aiming to

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facilitate movement and control the spread of virus within EU countries [7]. This move had been discussed and debated among EU members for a long period of time before passing [7], the application of this digital certificate would be beneficial for free traveling of people within the EU countries, without any more restrictions like quarantine or testing [7]. This method is important in maintaining the freedom traveling, boosting harmed economy, and controlling spread of COVID-19 virus.

The EU Digital COVID Certificate involves three main certificates. First one being a vaccine certificate, which documents the status of vaccination of an individual [7]. The second one is a certificate for recent testing. This certificate includes the detailed data about an individual's recent COVID-19 test, which could be PCR or rapid test [7]. And finally, a certificate for recovery, as one could potentially have recovered from a COVID-19 infection [7]. These component of the EU COVID Certificate enables the possibility of authorities across the EU to conveniently check and monitor one's health status. Additionally, the appearance of QR code generated when completing the certificate offers an efficient way for travelers to easily showcase their status to authorities, hence providing a free and swift experiences while traveling.

The significance of the EU Digital COVID Certificate in guaranteeing free traveling and disease control cannot be overlooked. It raised an effective way to balance the need for traveling and virus control. As free traveling is critical for the economy of EU countries. A traditional approach towards travel, including restriction, mandatory testing, and isolation could potentially harm each EU members' benefits. Hence, establishing a convenient and cost-efficient way to manage traveler in the time period of a pandemic was an excellent digital epidemiological method. A side effect that could be easily ignored, but benefits disease control greatly was the impact on vaccine uptake by EU Digital COVID Certificate. As the potential benefits from being vaccinated are reflected on EU Digital COVID Certificate, which further lead to free traveling among EU member states.

However, the EU Digital COVID Certificate is also accompanied by concerns and issues. One big issue around the certificate is the potential discrimination towards vaccine uptake between different states [8]. As different EU member states had different economic development level, the availability of vaccines varies dramatically. Hence those who did not have a quick contact to vaccine might face a potential delay in obtaining the certificates. Also, different states have different policies on vaccine shots and doses, leading to a complex situation where individuals from different member states might have same status on certificate but different vaccination level [7].

Other concerns about the digital certificate are related to fake certificates and data safety [8]. EU law enforcement agency had shown concerns about fake certificates and illegal trading of these certificates among member states [8]. This could be detrimental to the system of digital certificates, as traveling of infected patients is highly risky for the health safety of any communities in EU. Also, fake certificate might negatively affect the trust from citizens towards such centralized digital epidemiological method. Another concern about the certificates is data safety. As the sharing of data with countries outside of EU could lead to the data being used for purposes unrelated to epidemiology or the health fields [8].

4. Application prospective of digital technologies in epidemiology

Newly invented technology and enhanced existing methods are appearing more and more often, they are critical for the adaption of a more digital approach to epidemiology, especially after the pandemic of COVID-19, which have been constantly challenging the current health system. By reviewing the examples of COVIDSafe and EU Digital COVID Certificate, it can be argued that these digital technologies have been serving great roles in combating the spread of virus among individuals, while being truly helpful for epidemiology professionals and authorities. The COVIDSafe application in Australia has offered valuable experiences in the employment of tracking apps within a relatively broad population base. It successfully guarded the health of public by notifying the individual and health authorities about close contacts in a time-saving and cost-efficient fashion. However, we also need to consider its flaws, which includes the suboptimal uptake rate by citizen [4]. EU Digital

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COVID Certificate had a different role in mainly contributing to the opening of free travel within EU. While being successful in achieving a safer cross-border traveling experience, its flaws in potential vaccine and resource discrimination and data safety remained [7, 8].

Learning from the experiences discussed above is the key in developing and launching better digital epidemiological strategies in the future. As more people realize the importance of digital epidemiology, such mistakes made previously in the COVID-19 pandemic would be crucial for authorities to re-evaluate their decisions and hopefully invest more on digital epidemiological approach.

5. Conclusion

In conclusion, this paper has given some insights on the basic of digital epidemiology and digital technologies regarding epidemiological issues. By evaluating two distinct but important digital epidemiology application cases in the COVID-19 pandemic: COVIDSafe App and EU Digital COVID Certificate, the author hopes to showcase the importance of digital approach towards health threats like the COVID-19 virus. These case studies shed lights on the potential usage of technologies and data in fighting a global health pandemic. The field of epidemiology will inevitably evolve in order to respond to the changing landscape of diseases and other health threats. There are likely to be more digital strategies being employed in the field of epidemiology in order to prepare us for a more challenging world of public health. One key point that needs to be addressed by the global communities is the equal access to digital epidemiological tools. Technology needs to be vastly available to the public to offer its full potential, and to be an irreplaceable tool in guarding us from health threats in the years to come.

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