Submitted: 25 August, 2021 Accepted: 12 October, 2021 Published: 08 November, 2022 DOI:10.22514/sv.2021.229

Open Access
Signa Vitae

COMMENTARY

Digital technology to control COVID-19 in China: issues, challenges and implications for the healthcare system

Jianliang Xiao[1], Ruilian Zhang[2,*]

[1]School of Public Administration, Hohai University, 211100 Nanjing, Jiangsu, China
[2]Sustainable Minerals Institute, The University of Queensland, 4072 Brisbane, Australia

***Correspondence**
ruilian.zhang@uq.edu.au
(Ruilian Zhang)

Abstract

In the current era, public health crises are presenting new systematic and cross-border characteristics and uncertainty. Public health crises are challenges for governments and health systems. The development of digital technology has changed the world and connected it as a "village", and digital technology has played a critical role in providing support during public health crises over the past three decades. From the perspective of empowerment theory, we explore the role of digital technology in responding to the COVID-19 pandemic and digital technology approaches to controlling COVID-19 in China. Accordingly, we identify the challenges of using digital technology to control public health crises, including the imbalance of the rights and responsibilities of governance subjects, the incompatibility of the governance model and digital technology and the inadequate application of digital technology. Considering implications for the successful prevention and control of COVID-19, we suggest that the government should improve the balance of rights and responsibilities for coordinated crisis governance, link digital technology and the governance system and broaden the grassroots governance community.

Keywords

Public health crisis; Digital technology; Healthcare system; Challenges; COVID-19

1. Introduction

Around the world, different countries' development histories, socio-political and economic systems, and cultural backgrounds have determined their different approaches to governance. In the face of the global outbreak of coronavirus disease 2019 (COVID-19), the response strategies adopted by different countries have varied widely [1]. The governments of some countries or regions, in line with practices in China, have adopted active measures to fight the pandemic for all people, regardless of the cost of saving lives [2]. Some Western governments, such as those of the United Kingdom and Norway, have advocated a passive response by promoting herd immunity, which means that sixty percent of adults may have to be infected to achieve collective immunity [3]. For those young people who do not consider the society/herd immunity, they are bearing the brunt of the next waves. In constructing a digital governance model and exploring the rule of law, scholars have clearly stated that it is necessary to "establish and improve the system and rules of administration using the internet, big data, artificial intelligence and other technical means as well as promote the construction of digital government, strengthen the orderly sharing of data, and protect individuals in accordance with the law" [4]. In practice, however, due to the impact of public governance on the transmission system and institutional inertia in addressing long-standing abuses, the implementation and promotion of digital governance models have not received adequate attention [5, 6].

In the prevention and control of the COVID-19 pandemic, the role and functions of digital governance have gradually been recognized by governments, markets, society and the public. Compared to the management and dissemination of information in the traditional public governance model, the digital governance model has the advantage of superimposing the health crisis and governance crisis to form a double dilemma [7]. For instance, digital technology has been used not only for diagnosis/monitoring, but also for conducting experimental studies which opened new venues on the impact of COVID beyond the mere biology. In particular, digital technology-based studies have shown that COVID-related restrictions determined negative effects on psychological aspects such as emotional processing [8] and behavioural aspects such as eating attitudes, also in healthy populations [9].

Existing research has mainly focused on the effects of digital crisis management, which refers to the application of digital technology for crisis management [10, 11]. Some scholars have pointed out that the health quick response (QR) code uses three colours (green, yellow and red) to manage the health status of residents. This strategy provides an efficient

and flexible approach that can be used to prevent and control the spread of COVID-19 based on personal solutions, greatly improving the working efficiency of digital crisis management [12]. Others have systematically analysed the role of artificial intelligence, big data, geographical information systems (GISs), information visualization, image recognition and other technologies in pandemic prevention and control monitoring. Some researchers believe that digital technology can improve the timeliness of pandemic monitoring and the pertinence of prevention and control methods so that decision-making agencies, public health agencies and pandemic prevention agencies can better predict, control, and prevent the spread of pandemics among humans, animals and plants and treat infected persons [13, 14]. However, the above mentioned research highlights the advantages of technology for digital crisis management operations while ignoring governing bodies as well as the characteristics of tension and challenges that may exist. Therefore, this study examines the Chinese government in an effort to rethink public digital technology and to enable the co-governance crisis management process. We aim to combine government practices in fighting the COVID-19 outbreak with direction and guidance for preventing and controlling new waves of the COVID-19 pandemic.

We mainly explore the characteristics, approaches, challenges and implications of using digital technology to control COVID-19 in China. Our major contribution of this research has enriched the concepts of social action and self-help in empowerment theory. Five sections follow this introduction. Section 2 introduces the theory and characteristics of the digital technology used in COVID-19 prevention and control. Section 3 describes the digital technology approaches to controlling COVID-19. Section 4 explains the challenges facing the control of public health crises. Section 5 presents the implications for applying digital technology to control COVID-19. Section 6 concludes the paper.

2. The role of digital technology in responding to COVID-19

As the first country to deal with the pandemic, China has shown outstanding performance in monitoring and preventing the spread of the pandemic. The entire country was mobilized, and everyone joined in the battle. After a fierce struggle, China became one of the first countries in the world to control the rapid spread of the pandemic [6]. China not only gained a critical window for worldwide pandemic prevention and control in the early stage of the COVID-19 outbreak and defended the world's regional front line for pandemic prevention and control but also accumulated experience in the global fight against the pandemic that has frequently been confirmed by the World Health Organization [1, 2]. Digital technology plays a crucial role in controlling inflammatory diseases such as COVID-19 and has left a strong mark on the monitoring and control of the pandemic.

2.1 Empowerment theory

The concept of empowerment originated from sociology and first appeared in the fields of social action and self-help before being widely used to describe the behaviours of socially disadvantaged groups to gain equal rights and enhance self-control [12]. In short, empowerment refers to a certain capacity and embodied energy. This concept was subsequently applied in the fields of business and management from two main perspectives: employee empowerment, emphasizing the decentralization of managerial power and more employee autonomy, and customer empowerment, emphasizing customer initiative and constituting the main body of corporate value cocreation [15]. The concept of empowerment has natural applicability to the field of disaster relief and public health crisis management [16, 17]. The self-help perspective in the initial concept of empowerment is instructive for subjects facing major crises and disasters. Related research has found that through collective action, shared cognition, and collaborative control, communities (basic-level organizations) can be further empowered for disaster relief [18].

2.2 The role of digital technology in responding to the COVID-19 pandemic

First, in monitoring and controlling the pandemic, digital technology helps to accurately monitor the dynamics of the pandemic, analyse and judge risks, and optimize the allocation of materials, demonstrating the powerful advantages of precision and efficiency [19]. Digital technology can be used for the full dynamic monitoring of the health of the population by forming a network of real-time monitoring in a grid system. Once an infected person is identified, the population associated with the infected person can be quickly analysed and closely tracked, and joint prevention and control can be carried out [20, 21]. Big data efficiently integrates data resources, mines analysts' trace data to predict the risk of infection, and helps achieve accurate pandemic prevention and control. Artificial intelligence technology can be used to implement high-precision standards for testing virus mutations, to determine the need for virus booster vaccinations, and to manage drug development [22].

Second, in the process of returning to normal life, health codes, online offices, online education, and purchases and delivery on behalf of others have brought convenience to people's productivity and private lives [7, 12]. The health code is one of the major highlights of how digital technology can be used to fight the pandemic. The health code can monitor not only the dynamic trajectory of people but also their health [13]. In addition, digital technology has helped public services, online offices, and online teaching become the norm, making it convenient to purchase general services online to effectively reduce personal contacts and exchanges and thus contributing to the effective prevention and control of the pandemic [23].

In regard to the digital health code, for example, the purpose of each country's health code is to track and monitor users to identify potential risks and to respond in time [12]. However, there are differences in specific methods. China and South Korea belong to one category, other countries belong to another category, and the internal health codes of the two categories differ [14]. The Chinese and South Korean health codes are government mandated; thus, they are relatively rich in collected data. In South Korea's early implementation, government agencies were able to obtain user information

TABLE 1. Contact tracing apps developed in different countries and vaccination status.

Country	Name	Connection method	Development body	Data monitoring	Voluntary	Vaccination rate
China	Health code	Mobile networks	Government + Company	ID info + location + tracking	Yes	76%
South Korea	Corona 100m	Mobile networks	Government + Company	ID info + location + video monitor + credit card info	Yes	74%
Singapore	Trace together	Bluetooth	Government	Anonymous tracking (Bluetooth match)	No	79%
USA	Contact tracing	Bluetooth	Google + Apple	Anonymous tracking (Bluetooth match)	No	63%
UK	NHS	Bluetooth	Government	Anonymous tracking (Bluetooth match)	No	71%
Germany	CoronApp	Bluetooth	Arago	Anonymous tracking (Bluetooth match)	No	67%
France	Stop Covid	Bluetooth	Government	Anonymous tracking (Bluetooth match)	No	74%
UAE	AIHosn	Bluetooth	Government	Anonymous tracking (Bluetooth match)	No	92%
Australia	Check in	Mobile networks	Government	Anonymous tracking (Bluetooth match)	Yes	62%

Note: Vaccination rate data are extracted from 'Our World in Data'. Vaccination rate is before 1st October 2021.

and publicly shared location and trajectory information for each confirmed person's previous interactions with other users [20]. China had a similar approach, announcing the daily-life trajectory of confirmed cases and seeking close contacts to follow the chain of infection. However, the system exists mainly in the form of information release, and practices vary in different parts of the country [21]. The main difference in the implementation of health codes in other countries is the governmental approach. The government public health departments or science and technology departments of Singapore, France, the United Kingdom, and the United Arab Emirates (UAE) are actively developing software, whereas those of the United States and Germany are not; however, there are no hard-and-fast rules on mandatory use. People are merely encouraged to install the software [4, 5]. The UAE is slightly more formal, emphasizing that people should install and use this software. In China and South Korea, the most fundamental difference is that the data collection methods rely on mobile phones for Bluetooth short-range exchange of data and identification with the implementation of the minimum principles to collect user data (see Table 1 below).

2.3 Approaches to controlling COVID-19 through digital technology

The COVID-19 pandemic is raging around the world, and it is another public health crisis following severe acute respiratory syndrome (SARS) in 2003 that has tested governance. In the fight against the COVID-19 pandemic, in which digital technology is fully involved, the actions of the Chinese government, enterprises, society, and citizens reflect many characteristics of the coordinated governance of public crises: (1) multiple subjects involved; (2) an open and shared information platform; (3) a collaborative scheduling system for multiple subjects; and (4) a public service supply system.

2.4 Multiple subjects involved

COVID-19 pandemic prevention and control involve multiple governance subjects, such as the government, enterprises, nongovernmental organizations, and citizens [4]. Currently, the COVID-19 pandemic prevention and control system are a multidimensional system that combines physical space, social space and digital space. Physical space reflects pandemic prevention, and the control system needs to be continuously supplied by the outside world and service exchange [12]. It includes the placement of case rescue and protection, the supply of medical services, and the guarantee of production and living materials. Social space reflects the overall planning and development of economic and social work under the premise that the pandemic prevention and control situation is improving. It includes public opinion guidance with the goal of educating public sentiment and implementing preferential policies [14]. Digital space reflects wider and deeper collaboration, both to expand the sharing of spatial data and to establish credible and accurate data to ensure cross-validation of the data governance management mode. For example, after the outbreak, health authorities shared information on confirmed and suspected cases. The public security department collected information about close contact among people associated with particular vehicles, and the transportation sector compared personal tracking information with vehicle information and airport and railway station usage information. Multisectoral collaboration provides critical information on confirmed cases and slows the spread of COVID-19 [5].

In addition, the COVID-19 pandemic prevention and control

system has nonlinear characteristics. It involves multiple participants, such as administrative systems, medical institutions, enterprises, and community residents, among whom interactions are complicated and not simply linear [7]. This system may be constructed in two or even multidirectional ways, such as negotiation, cooperation or competition. Furthermore, although the number of digital technologies has gradually deepened the governance system, at the beginning of the crisis, there was no particular manifestation of digital governance [14]. For example, the distribution of relief supplies was still stuck in the era of letters of introduction, and the time needed for pandemic notification was subject to delays. These issues reflected the existence of traditional governance structures and changes in the social system that would inevitably lead to incorrect uses of sophisticated digital technology. Therefore, for the COVID-19 pandemic prevention and control system to achieve and maintain an orderly and stable structure, it was necessary to upgrade the collaboration system through information sharing and cooperation among multiple subjects [15].

2.5 The open and shared information platform

As a public crisis, the COVID-19 pandemic has cross-regional characteristics; thus, there was an urgent need to establish a cross-regional coordination approach to deal with governance challenges [19]. The problem of collaborative governance is the integration of data and the sharing of information. Only by effectively integrating information and making it publicly known on a shared platform can data references be provided for subsequent collaborative actions and for research on and the assessment, prevention and control of the pandemic in the early and medium terms as well as the subsequent recovery period [20].

After the outbreak of the pandemic, 28 provinces, autonomous regions, and municipalities across the country cooperated with Alibaba to launch the Digital Pandemic Prevention System [4]. The system is divided into four main modules: residents, community streets, medical disease control, and government management. The content includes pandemic information collection, active declaration and pandemic clue provision, and real-time pandemic tracking. In addition, AutoNavi launched the COVID-19 Pandemic Map to help determine the location of confirmed cases and to publish the population density heat map to provide action guidelines for necessary travel [5]. Baidu Maps and many other technology companies launched the patient peer query tool, which helps provide emotional relief to the public. Meanwhile, information sharing further strengthened the supervision of pandemic prevention and control among the masses. The uninterrupted 5G live broadcast of the construction of the Huoshenshan and Leishenshan hospitals by China Central Television's (CCTV's) caused spectators of the construction process to become the strongest cloud supervisor in history [15].

2.6 The collaborative scheduling system for multiple subjects

From the perspective of collaborative governance theory, the goal of the collaborative governance of public crises is to achieve synergy among various subsystems. In the fight against COVID-19, due to digital technology intervention in the market supply, emergency rescue services, the government, internet companies, and volunteer organizations could collaborate to support all kinds of resources, production, system chips, supply and use to meet various needs [15]. In terms of market supply, in response to the problem of vegetable supply in some areas affected by the pandemic, the Ministry of Agriculture and Rural Affairs issued an emergency notice on January 29, 2020, requiring agricultural and rural departments at all levels to formulate emergency plans, increase productivity, and cooperate with the relevant departments to ensure an adequate vegetable supply [6]. This vegetable supply provided solid material guarantees for the fight against the pandemic. In terms of emergency rescue, when the pandemic broke out, 22 national emergency medical rescue teams from different provinces rushed to Hubei, where they were stationed at various shelter hospitals and became the main force for treating patients [1]. The level of private rescue is reflected in the fact that volunteers from all over the country use the online + offline service model to quickly meet various emergency rescue needs. Online services provide support mainly for needs assessment and psychological counselling for people in the hardest-hit areas of the pandemic. Offline services, mainly charitable donations, material operations and public services, have played an important role in additional services for professional teams [7].

2.7 The public service supply system

In this pandemic, the main problem has been the contradiction between limited services and unlimited demand. If public service resources are exported only by the government, problems such as bottlenecks, resource overload and limited output occur, prompting all governance entities to reach a consensus: the government, the market, and society, as sources of the public service supply, must jointly bear the unlimited demand for services during temporary pandemic outbreaks [1, 2]. Therefore, with the help of digital technology, the government's mobile government, the platform economy of internet companies, and the grid governance of the community coordinated and cogoverned to jointly respond to people's service needs and resource requests. During the special period of pandemic prevention and control, to ensure the orderly progress of production and life, the governments of Guangdong, Zhejiang, Shanghai, Fujian and other provinces and cities gave full play to mobile government affairs, advocating the implementation of one network to handle services that are frequently used and urgently needed by citizens and simplifying and optimizing the online service process [14].

At the same time, local governments successively launched services related to pandemic prevention and control through service portals such as WeChat and Alipay Mini Programmes, providing services such as pandemic dynamics, protection information, pandemic rumours, online free clinics, and fever

clinics. The provision of such services enabled people at the grassroots level to grasp the current situation of prevention and control in a timely manner, resolved doubts, answered questions, and objectively soothed the social emotions that emerged during this extraordinary period [22].

In particular, community grid management is an important link in the fight against the pandemic. Because COVID-19 has the characteristics of human-to-human transmission, the state passed requirements for residents to congregate as little as possible and to stay home; thus, it was able to take full advantage of community grid digital platforms. Externally, the community grid and government made it convenient for grid members to report the pandemic situation to the platform in a timely manner. Internally, community grid members can receive feedback from residents at any time through the platform [24, 25].

3. Challenges facing the control of public health crises

3.1 The imbalance of the rights and responsibilities of governance subjects in a public health crisis

The collaborative crisis governance structure based on digital technology uses multiple nodes to jointly maintain data and develops a corresponding power allocation and decision-making approach. This approach requires the organizational structure of collaborative governance to consider both the horizontal and vertical dimensions of organizational design. The horizontal dimension involves the realization of collaborative governance through information exchange, resource sharing, and joint action among different departments and subjects. The vertical dimension involves the promotion of collaborative governance through authoritative guidance and hierarchical connections [2]. However, due to unclear rights and responsibilities, governance subjects will have problems with each other, leading to ineffective decision-making. This situation is particularly evident in the horizontal coordination relationship. The multiple legal subjects involved experience a lack of clearly defined status and means for crisis management; thus, the rights of participants are unclear and not standardized [4]. The regulation of the status is there, and yet the transmission of the virus has been extremely fast. Knowledge management and coordination will help alleviate the bottlenecks. For example, regarding the early assessment and warning of the COVID-19 pandemic, first, the law had extremely vague requirements for experts from the Center for Disease Control and Prevention (CDC) to respond to public health event [5]. Second, the lack of practical operational norms made it difficult for experts to enter the pandemic assessment and decision-making mechanism in a timely manner in response to the phenomenon of human-to-human transmission. This difficulty delayed the optimal period for pandemic management and control.

3.2 Difficulties in the compatibility of the governance model and digital technology

Digital technology has shone in the fight against the COVID-19 pandemic owing to a great release of energy and because it has enabled social governance in the field based on the continued strong development of broad prospects [12]. With the deepening application of digital approaches and the rapid upgrading of digital capabilities, digitally enabled public governance differs from the function-centred concept of the traditional governance model. It increasingly emphasizes a citizen-centred strategy, with the aim of improving governance efficiency and optimizing the customer experience of public services [15]. This means that the social governance model should be compatible with digital technology in a downward-facing and inclusive reform. However, the current collaborative governance crisis model has not completely broken through the operational logic of the traditional administrative system and it has encountered obstacles related to compatibility and matching with digital technology [4, 5].

Additionally, there is a lack of unified calibration and standards in the construction of government information systems are lacking, resulting in repeated reconstruction and the fragmented distribution of data resources. It makes difficult to realize a cross-regional and cross-departmental information interconnection [14]. The reason is that participants in different regions, levels and departments have not yet formed a mature sharing mechanism. For example, in the early stage of the pandemic, it was difficult to establish a complete chain for the emergency logistics system based on informatization and big data due to local card setting, road segmentation and even regional discrimination. This difficulty led to delays in emergency logistics, a supply-demand mismatch and low efficiency [3]. Additionally, the governments in some regions fought their own battles, formulated various local policies and focused on their own pandemic prevention software and systems, which made it difficult for them to be compatible and coordinated with other jurisdictions.

3.3 The inadequate application of digital technology

In the early stage of pandemic prevention and control, digital technology lacked the last mile in terms of its intervention in collaborative crisis management. As a result, technology, products, and services failed to sink to the grassroots level [21]. For example, in Hubei Province, where the pandemic situation was serious, those collecting community household information and statistics needed to make up lessons on the spot due to residents' inability to grasp basic information. There was a time lag between the release and implementation of documents for the benefit of the people related to the pandemic situation and the community [14]. The allocation of relief materials stopped at the Red Cross because there was no letter of introduction. Such problems reveal that there are still weak links in the construction of digital infrastructure at the grassroots level. There are three main reasons. First, the grassroots level and higher levels have not yet established a functional data sharing system [1, 2]. Second, grassroots governance is still in the stage of filling out forms to fight the pandemic, manual operation and multilevel management. The segmentation of various departments is a serious problem, resulting in redundant work and low efficiency. Third, formalist thinking still exists, condoning certain phenomena of mediocre

and lazy government [4, 5].

4. Implications

4.1 Balance the rights and responsibility for different stakeholders

The essence of collaborative governance is the diversification of governance subjects, which means that power should be allocated to markets, social organizations and citizens outside the government, and that the corresponding responsibilities should be assigned [1, 2]. In particular, digital economy platform must be used to build two-way information communication. It is critical to mobilize enterprises, non-profit organizations, citizens and other entities outside the government to participate in collaborative crisis management, build a larger and broader crisis prevention and control information platform, and improve the emergency material allocation mechanism based on clear responsibilities and rights [26, 27]. Additionally, it is necessary to improve the assessment and evaluation incentive mechanism for nongovernmental entities that actively participate in the collaborative governance of crises and fulfil social responsibilities. Thus, material incentives, such as financial support and spiritual incentives, such as authorization and praise, must be provided [28].

4.2 Link digital technology and the governance system

The key to collaborative governance is to reverse the situation of separate governance. To promote information sharing and business collaboration, it is necessary to implement a linkage mechanism between digital technology and the governance system [29]. It is critical to allow technology to support social collaborative governance through the optimization of internal mechanism and the innovation of external means. At the technical level, we should build multidimensional data aggregation and drive business collaboration digital platforms [24]. At the system level, a unified framework should be formed for horizontal multidepartment joint construction projects. Vertical joint construction projects between the central government and local governments must be coordinated [15].

4.3 Broaden the grassroots community governance

Refined governance is the future trend of social governance. Refined governance must realize not only the transformation of governance units from the macro to the micro level but also the transformation of governance from a resource flow to a data sharing model [4]. Therefore, communities must be considered the last mile of collaborative governance to bring services to local communities [5]. In practice, first, we should be skilled at using digital technologies such as big data to establish a digital office system that is interconnected between rural areas and communities, townships and streets and we should expand this system to public service fields related to health. Second, we should change the means of collecting grassroots data from traditional means of tabular collection to digital means of intelligent apps [13]. Third, we should build a health big data sharing platform between grassroots units and local medical institutions and higher-level medical institutions to prevent residents from establishing new diagnosis and treatment records and health files at any time when they are in different places. In this way, higher-level and subordinate hospitals can smoothly carry out telemedicine [1, 2]. In summary, sinking good technologies and products verified by the market to the grassroots level and making them available to the public will help to broaden the welfare coverage of digital technology [30, 31].

5. Conclusions

COVID-19 not only threatens human health but also has a major adverse effect on social development. In fighting the pandemic and protecting the lives of citizens, medical workers, biomedical experts and relevant pandemic prevention units have paid a heavy price [24]. Loopholes in public health and pandemic prevention systems have been highlighted. In this research, we identify the challenges of using digital technology to control public health crises, including an imbalance of the rights and responsibilities of governance subjects, difficulties in the compatibility of the governance model and digital technology and the inadequate application of digital technology [1]. Considering the implications for the successful prevention and control of COVID-19, we suggest that the government should balance the rights and responsibility for crisis governance stakeholders, link digital technology and systems and broaden the community of grassroots governance.

At present, COVID-19 has spread to more than 100 countries and regions. Many countries failed to achieve effective prevention and control in the early stage of the pandemic, leading to the rapid spread of the disease [2]. In facing the delta strain of COVID-19, it is important to pursue the correct path to save lives and to enable the economy to recover by reviewing possible improvements to the health system. From our citizen's view, the application of digital technology to control the spread of COVID-19 is necessary and critical in China although it has been criticised by Western medias. Furthermore, the digital approach has contributed to tracing close contacts, saving lives and slowing the spread of COVID-19. As citizens affected, our personal privacy might have to be sacrificed in the process of tracking this disease. Therefore, it is crucial to find the optimal balance to control the pandemic without major economic or personal sacrifices.

AUTHOR CONTRIBUTIONS

JX—Conceptualization; Writing-original draft; Writing-reviewing & editing; Funding acquisition; RZ—Conceptualization; Writing-original draft; Writing-reviewing & editing; Supervision.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

ACKNOWLEDGMENT

Thanks to all the peer reviewers for their opinions and suggestions.

FUNDING

This research was funded by the Research Innovation Program for College Graduates of Jiangsu Province, grant number KYZZ_0158.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Xing C, Zhang R. COVID-19 in China: Responses, Challenges and Implications for the Health System. Healthcare. 2021; 9: 82.
[2] Zhang J, Zhang R. COVID-19 in China: Power, Transparency and Governance in Public Health Crisis. Healthcare. 2020; 8: 288.
[3] Yuan B, Jian W, He L, Wang B, Balabanova D. The role of health system governance in strengthening the rural health insurance system in China. International Journal for Equity in Health. 2017; 16: 44.
[4] Qiao Y, Sun Z. On active government-a comparative study of government models under market economy conditions. Journal of Jiangnan Social University. 2001; 02: 33–37.
[5] Ling J, Hou C. From "active government" to "self-control government": the portrait of government in modern university governance in the new era. Fudan Education Forum. 2020; 18: 32–38.
[6] Burki T. China's successful control of COVID-19. The Lancet Infectious Diseases. 2020; 20: 1240–1241.
[7] Guo X, Liu B. Winning Fast: The National Governance System in Crisis Management——Taking the response to the COVID-19 pandemic as an example. Zhongzhou Academic Journal. 2020; 04: 10–19. (In Chinese)
[8] Cecchetto C, Aiello M, Gentili C, Ionta S, Osimo SA. Increased emotional eating during COVID-19 associated with lockdown, psychological and social distress. Appetite. 2021; 160: 105122.
[9] Osimo SA, Aiello M, Gentili C, Ionta S, Cecchetto C. The Influence of Personality, Resilience, and Alexithymia on Mental Health During COVID-19 Pandemic. Frontiers in Psychology. 2021; 12: 630751.
[10] Pan X. Application of personal-oriented digital technology in preventing transmission of COVID-19, China. Irish Journal of Medical Science (1971 -). 2020; 189: 1145–1146.
[11] Kapoor A, Guha S, Kanti Das M, Goswami KC, Yadav R. Digital healthcare: the only solution for better healthcare during COVID-19 pandemic? Indian Heart Journal. 2020; 72: 61–64.
[12] Ye Z, Wang L, Tian H. Digital government and data governance from the perspective of government responsibility system construction. Chinese Administration. 2018; 7: 57–62.
[13] Murray CJL, Alamro NMS, Hwang H, Lee U. Digital public health and COVID-19. The Lancet Public Health. 2020; 5: e469–e470.
[14] Cheng YD, Yu J, Shen Y, Huang B. Coproducing Responses to COVID -19 with Community-Based Organizations: Lessons from Zhejiang Province, China. Public Administration Review. 2020; 80: 866–873.
[15] Chebat J, Kollias P. The Impact of Empowerment on Customer Contact Employees' Roles in Service Organizations. Journal of Service Research. 2000; 3: 66–81.
[16] Sun J. Precise efforts and proactive actions to give full play to the key role of big data applications in pandemic prevention and control [EB/OL]. 2020. Available at: https://www.chinathinktanks.org.cn/content/detail/id/l1xtkp51 (Accessed: 2 November 2021).
[17] Beaunoyer E, Dupéré S, Guitton MJ. COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. Computers in Human Behavior. 2020; 111: 106424.
[18] Kwok AH, Becker J, Paton D, Hudson-Doyle E, Johnston D. Stakeholders' Perspectives of Social Capital in Informing the Development of Neighborhood-Based Disaster Resilience Measurements. Journal of Applied Social Science. 2019; 13: 26–57.
[19] Hassounah M, Raheel H, Alhefzi M. Digital Response During the COVID-19 Pandemic in Saudi Arabia. Journal of Medical Internet Research. 2020; 22: e19338.
[20] He W, Zhang Z, Li W. Information technology solutions, challenges, and suggestions for tackling the COVID-19 pandemic. International Journal of Information Management. 2021; 57: 102287.
[21] Intawong K, Olson D, Chariyalertsak S. Application technology to fight the COVID-19 pandemic: Lessons learned in Thailand. Biochemical and Biophysical Research Communications. 2021; 534: 830–836.
[22] Sun Z, Cheng X, Zhang R, Yang B. Factors Influencing Rumour Re-Spreading in a Public Health Crisis by the Middle-Aged and Elderly Populations. International Journal of Environmental Research and Public Health. 2020; 17: 6542.
[23] Sun Z, Yang B, Zhang R, Cheng X. Influencing Factors of Understanding COVID-19 Risks and Coping Behaviors among the Elderly Population. International Journal of Environmental Research and Public Health. 2020; 17: 5889.
[24] Papouli E, Chatzifotiou S, Tsairidis C. The use of digital technology at home during the COVID-19 outbreak:Views of social work students in Greece. Social Work Education. 2020; 39: 1107–1115.
[25] Shah SGS, Nogueras D, van Woerden HC, Kiparoglou V. The COVID-19 Pandemic: A Pandemic of Lockdown Loneliness and the Role of Digital Technology. Journal of Medical Internet Research. 2020; 22: e22287.
[26] Ting DSW, Carin L, Dzau V, Wong TY. Digital technology and COVID-19. Nature Medicine. 2020; 26: 459–461.
[27] Vargo D, Zhu L, Benwell B, Yan Z. Digital technology use during COVID -19 pandemic: A rapid review. Human Behavior and Emerging Technologies. 2021; 3: 13–24.
[28] Wang J, Zhang R. COVID-19 in Rural China: Features, Challenges and Implications for the Healthcare System. Journal of Multidisciplinary Healthcare. 2021; 14: 1045–1051.
[29] Whitelaw S, Mamas MA, Topol E, Van Spall HGC. Applications of digital technology in COVID-19 pandemic planning and response. The Lancet Digital Health. 2020; 2: e435–e440.
[30] Hopman J, Allegranzi B, Mehtar S. Managing COVID-19 in Low- and Middle-Income Countries. Journal of the American Medical Association. 2020; 323: 1549.
[31] Ahmad AR, Murad HR. The Impact of Social Media on Panic during the COVID-19 Pandemic in Iraqi Kurdistan: Online Questionnaire Study. Journal of Medical Internet Research. 2020; 22: e19556.

How to cite this article: Jianliang Xiao, Ruilian Zhang. Digital technology to control COVID-19 in China: issues, challenges and implications for the healthcare system. Signa Vitae. 2022; 18(6): 103-109. doi:10.22514/sv.2021.229.