Editorial

Applications of Digital Health in Public Health: The China Experience

Io Hong Cheong,[1] **Hui Wang**[1]

[1]State Key Laboratory of Oncogenes and Related Genes, Center for Single-Cell Omics, School of Public Health, Shanghai Jiao Tong University School of Medicine, Shanghai 200025, China.

Address correspondence to Hui Wang (huiwang@shsmu.edu.cn).

Source of support: None. Conflict of interest: None.

Received: Sep 14, 2021; Revision Received: Jan 8, 2022; Accepted: Jan 27, 2022

Cheong IH, Wang H. Applications of digital health in public health: the China experience. *Innov Dig Health Diagn Bio*. 2022; 2:48–50. DOI: 10.36401/IDDB-21-05.

Epidemiological studies provide the evidence basis for many public health decisions. There are many such examples, including but not limited to tobacco control motivated by the discovery that smoking causes a host of diseases,[1] the evidence-based regulation of environmental[2] and occupational agents[3] shown to cause cancer and other diseases, and identification of remediable risk factors for coronary heart disease.[4] Most of our current knowledge and understanding was developed using conventional research methods, tools, and models;[5] for example, questionnaires/surveys to consult social behaviors, and administration records to understand the prevalence, incidence rates, and future demands on healthcare. The integration of those conventional methods in recent years with advanced biotechnology, such as cell culture and molecular tools, has created a substantial volume of updated public health protocols, currently in use.[6] For example, preventive measures of infectious disease agents require knowledge of the molecular aspects of viruses, transmission mechanisms, and so on.[7] For noncommunicable diseases, histopathological knowledge provides operational guidance for diagnoses and therapies.[8] Moreover, the integration of epidemiological, biological, and social-behavioral aspects takes the epidemiological science a step further, forming a key component for public health communications.[9] The emergence of mobile technology, as tested at scale through the current pandemic for both communicable and noncommunicable diseases,[10,11] opens a new chapter to the public health domain: Digital Health.[12,13] This article highlights key digital health concepts, as they have emerged globally and have been implemented on the ground in China, in order to address some of the latest public health demands.

One such example, implemented at scale, is the use of a digital color-coded system to replace traditional paper health declarations.[14] Traditional health declaration forms in China required individuals to fill in their personal information on paper, with some questions to self-declare an individual's health status. These questionnaires were assessed manually at healthcare centers, a process that was often time-consuming with high likelihood of erroneous information provided and/or assessed, resulting in eventual loss of overall data quality. The paper forms were then archived at a warehouse, using a manual index system. In response to the recent coronavirus disease 2019 (COVID-19) outbreak, and the limitations in travel, a digital health code system was developed.[14] This system integrated the following components: identity verification used as the common reference point, residence, and contact information. Body temperature, basic travel history, nucleic test results, and vaccination records can all be added to this central informational core in a dynamic format by different locations where the individual is able to access services. Consequently, and based on this information, the system will then generate a colored QR code to identify if one person is healthy (and as a result can have unrestricted access to certain facilities or venues) or would need to engage further with healthcare services.[14] Such systems, when applied over a period of time, can also be used to stratify high-risk groups during public health emergencies, significantly reducing contact tracing times. There are numbers of public health surveillance trials conducted in China, the system includes a handheld mobile device collecting epidemiological data; these studies already suggested specific patterns to different groups. The future prospect is to integrate higher-resolution clinical data, such as genomic data; the limitations are high cost for such technology and a defined legal framework.

The emerging challenges to implementing such digital health systems are the connectivity and disparities between different data infrastructures. Specifically, countries with high connectivity and mobile phone penetration were able to introduce such digital health systems during the pandemic,[15–17] although doing so was more challenging in resource-restricted settings.[18,19] In the case of China, the National Health Commission published a Notice [20] to provide administrative support and guidance to local authorities about how these data should be added to the system, requested, shared, and interpreted. This guidance has allowed for key parameters between different data infrastructures to be harmonized nationwide. During the pandemic, we used a "user-authorized" mode for accessing data. This mode allows users to agree or disagree electronically within the current framework, maintaining privacy and ethical compliance. Another limitation to the implementation of such digital health platforms concerns the training of staff as well as those who have no access to digital devices; for example, elderly populations or those affected by lack of available infrastructure and populations with low digital literacy.[21] Therefore, such a system must be accompanied by careful planning (in the case of infrastructure and digital education) and allow for grace periods while being integrated into routine healthcare systems, although in the case of the pandemic, such a grace period was severely shortened.

The scrutiny of the methods and results of epidemiological research is understandably intense, given its vital contribution to public health and decision-making. Part of this scrutiny emanates from the fact that observational epidemiologic studies may be affected by various biases that can impair their validity, and that are generally not present in experimental investigations.[22] On the other hand, the major strength of epidemiology, as in the case of the Chinese application of digital health, is that it is based on real-world conditions. We are expecting to see the rapid expansion of such applications in digital health, both in China and globally, where calls for such frameworks will be considered within the local healthcare context as well as a potential link to international healthcare efforts.[23] To accommodate such demands, there will be a definite need to upgrade the capacity of healthcare infrastructure and facilities, adding yet another element to the list of competing priorities, especially in resource-restricted settings.

In conclusion, in our experience, an effective digital health implementation, such as the digital color-coded system that was implemented in China during the pandemic, required harmonization between infrastructures, such as technology and data banks, a well-defined administrative guidance, solutions for the potentially underserved populations, and sustainable specifications for the growth of digital health infrastructure as part of routine healthcare services in the future. These were indispensable elements in making the implementation of the system a success, but also demonstrate the necessary high bar that the effective introduction of future digital health solutions would need to achieve.

References

1. International Agency for Research on Cancer, WHO. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*. International Agency for Research on Cancer, World Health Organization; 2004.
2. Boffetta P, Jourenkova N, Gustavsson P. Cancer risk from occupational and environmental exposure to polycyclic aromatic hydrocarbons. *Cancer Causes Control*. 1997;8:444–472.
3. Lissner L, Kuhl K, Knaupinen T, Uuksulainen S. *Exposure to Carcinogens and Work-related Cancer: A Review of Assessment Methods*. European Risk Observatory Report. European Agency for Safety and Health at Work; 2014.
4. Torpy JM, Burke AE, Glass RM. Coronary heart disease risk factors. *JAMA*. 2009;302:2388.
5. Davey Smith G. Post-modern epidemiology: when methods meet matter. *Am J Epidemiol*. 2019;188:1410–1419.
6. Smith GD. Epidemiology, epigenetics and the 'Gloomy Prospect': embracing randomness in population health research and practice. *Int J Epidemiol*. 2011;40:537–562.
7. Delva W, Wilson DP, Abu-Raddad L, et al. HIV treatment as prevention: principles of good HIV epidemiology modelling for public health decision-making in all modes of prevention and evaluation. *PLoS Med*. 2012;9:e1001239.
8. Ludvigsson JF, Lashkariani M. Cohort profile: ESPRESSO (Epidemiology Strengthened by histoPathology Reports in Sweden). *Clin Epidemiol*. 2019;11:101–114.
9. Nishi A, Milner DA Jr, Giovannucci EL, et al. Integration of molecular pathology, epidemiology and social science for global precision medicine. *Expert Rev Mol Diagn*. 2016;16:11–23.
10. Whitelaw S, Mamas MA, Topol E, Van Spall HGC. Applications of digital technology in COVID-19 pandemic planning and response. *Lancet Digit Health*. 2020;2:e435–e440.
11. Garg S, Williams NL, Ip A, Dicker AP. Clinical integration of digital solutions in health care: an overview of the current landscape of digital technologies in cancer care. *JCO Clin Cancer Inform*. 2018;2:1–9.
12. Al Knawy B, Adil M, Crooks G, et al. The Riyadh Declaration: the role of digital health in fighting pandemics. *Lancet*. 2020;396:1537–1539.
13. Kozlakidis Z, Abduljawad J, Al Khathaami AM, et al. Global health and data-driven policies for emergency responses to infectious disease outbreaks. *Lancet Glob Health*. 2020;8:e1361–e1363.
14. Nakamoto I, Wang S, Guo Y, Zhuang W. A QR code-based contact tracing framework for sustainable containment of COVID-19: evaluation of an approach to assist the return to normal activity. *JMIR Mhealth Uhealth*. 2020;8:e22321.
15. Park S, Choi GJ, Ko H. Information technology-based tracing strategy in response to COVID-19 in South Korea-privacy controversies. *JAMA*. 2020;323:2129–2130.
16. Hassounah M, Raheel H, Alhefzi M. Digital response during the COVID-19 pandemic in Saudi Arabia. *J Med Internet Res*. 2020;22:e19338.
17. Abbas R, Michael K. COVID-19 contact trace app deployments: learnings from Australia and Singapore. *IEEE Consumer Electronics Magazine*. 2020;9:65–70.
18. Celuppi IC, Lima GDS, Rossi E, et al. An analysis of the development of digital health technologies to fight COVID-19 in Brazil and the world. *Cad Saude Publica*. 2021;37:e00243220.
19. Bassi A, Arfin S, John O, Jha V. An overview of mobile applications (apps) to support the coronavirus disease 2019 response in India. *Indian J Med Res*. 2020;151:468–473.
20. [Notice on further promoting the "Internet + Medical Health" and "Five Ones" service actions] [in Chinese].

National Health Commission of the People's Republic of China. National Health Planning Issue 2020 (No. 22). 2020. Accessed Feb 21, 2022. www.nhc.gov.cn/cms-search/xxgk/getManuscriptXxgk.htm?id=15029c3f5e3f4dc78d6a7596567367c6

21. Nguyen A, Mosadeghi S, Almario CV. Persistent digital divide in access to and use of the Internet as a resource for health information: results from a California population-based study. *Int J Med Inform*. 2017;103:49–54.
22. Blair A, Saracci R, Vineis P, et al. Epidemiology, public health, and the rhetoric of false positives. *Environ Health Perspect*. 2009;117:1809–1813.
23. Labrique A, Agarwal S, Tamrat T, Mehl G. WHO digital health guidelines: a milestone for global health. *NPJ Digit Med*. 2020;3:120.