



Original Article/Research

## Mobile health in China: Does it meet availability, accessibility, acceptability and quality standards?

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## ABSTRACT

**Objective:** The objective of this article is to evaluate mobile health practices under China's health care system through the lens of the right to health framework and to offer directions for policy improvement.

**Method:** The theoretical framework of this article is made up of four essential elements of the right to health, namely availability, accessibility, acceptability and quality of health care. This approach has been applied by a broad range of stakeholders to assess national health programmes. In addition, a review has been conducted of literature published between 2015 and 2019 to determine the service categories of mHealth.

**Results:** The findings show that mobile health has been used in a wide range of practices for health care and well-being management. The assessment of mHealth practices under the AAAQ framework suggests that mobile health contributes to accessibility and efficiency and health promotion. However, some shortcomings are also identified.

**Conclusions:** To achieve sustainability of mHealth in the health care system and realise its potential, this evaluation points out four aspects of policy improvement. An integrated approach, a robust governance mechanism, a new legislative response and private sector engagement are required.

**Public interest summary:** The vibrant growth of mobile health has prompted an emerging need of integrating it to a sustainable service delivery system for achieving universal health coverage. To remove barriers for the implementation of mobile health nationwide, it is necessary to assess mobile health practices in the Chinese health care system as a whole. This article provides an evaluation of mobile health in China under the right to health framework (availability, accessibility, affordability and quality). It suggests that mobile health brings positive results but also unintended consequences, both for individuals and the health care system. Therefore, we point out that the integrated solution, the governance mechanism, the relevant legislation and private sector engagement should be further addressed in mobile health policy. The findings presented in this article indicate the current status and policy considerations for navigating the future direction of mobile health.

## Introduction

Every country is facing a move towards a more resilient and equitable health care system, which can realise access to necessary services for everyone. Digital health interventions, such as Mobile Health ('mHealth'), play a pivotal role in reaching this target. Through harnessing advantages of mobile technologies and data analytics, mHealth transforms health care, from resource allocation to personalised and precision medicine. The recent COVID-19 pandemic has also boosted the use of mHealth, providing constant medical services for tens of millions

of patients [1].

Despite rapid growth and promises, a sustainable contribution of mHealth to complex health care systems is not easy to achieve. Even as mHealth is once again placed in the spotlight, the debate pertaining to its benefits and drawbacks never ceases [2]. Failure to develop into long-term solutions remains the major challenge for this innovative health intervention [3]. However, digital interventions have not been adds-on but are seen as essential means to facilitate future health care delivery [4]. To improve health and reduce health inequalities, rigorous evaluation for the appropriate integration and use of technologies is thus

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of great importance [5].

The value and impact of mHealth is dependant on its contextual environment. In this study, we set the scene in China's health care system. Existing research of mHealth in China is almost exclusively limited to performance assessments in medical settings [6,7,8]. We attempt to close the gap by evaluating the practice and policy environment of mHealth in this health care system in light of the United Nations' right to health framework (availability, accessibility, affordability and quality, or 'AAAQ'). The distinctive and indispensable contribution of this framework is that it provides the conceptual and operational potential to the implementation of complex, costly and long-term health interventions [9]. By emphasising the realisation of the right to health as the ultimate goal of all health policies and programmes [10], this approach also echoes Universal Health Coverage under the UN Sustainable Development 2030 agenda. Hence, the adoption of this framework in our study contributes to a broader collaboration between the rights-based approach to health and social medicine research.

Against this background, we aim to:

- 1 Conceptualise mHealth and scope mHealth interventions.
- 2 Examine the impact of mHealth on the health care system in terms of AAAQ standards.
- 3 Point out considerations which may serve as a foundation for future mHealth policy improvement.

### The concept: how do we perceive mHealth?

The term mHealth has appeared in many reports, while the way in which it is interpreted may vary. According to the WHO, mHealth is defined as 'the use of mobile wireless technologies for health' [5]. mHealth includes a wide range of practices from mobile telehealth, remote monitoring to mobile access to electronic patient records and mLearning for physicians [4].

For the purpose of this article, we perceive mHealth as follows:

'mHealth' refers to health care and information exchanged through mobile devices, such as smartphones, tablets, wearables and sensors as well as mobile applications, which are intended to be used, alone or in combination for individuals, in support of health care and well-being management. It is especially related to the utilisation for increasing access to health care and empowering individuals to improve their own health status.

This understanding of mHealth reflects recent developments in technology and health. First, mHealth is boosted by mobile technology. The widespread use of mobile internet, 5G networks and smartphones has made digital solutions an integral part of people's daily lives in China. Second, the meaning of 'health' is changing. In contrast to the definition from WHO that 'health is a state of complete physical, mental and social well-being', the modern concept of 'health' formulated by Huber et al. stresses 'the ability to adapt and to self-manage' [11].

The above interpretation suggests that a paradigm with a substantive focus seems to be indispensable. mHealth primarily focuses on the individual. The core value of mHealth hinges on whether the individual actively uses it, makes a choice on the basis of information provided, and takes action in health care and well-being management. In this sense, mHealth is a user-driven intervention. mHealth is first and foremost meaningful for the individual. Recognising the role of individuals in mHealth echoes the individual's right to health and the transition to patient-centred care model, and it is also in conformity with the changing dynamic of health for individual adaptability.

The concept of mHealth in this article maintains the consistency and coherence with other relevant interventions under the WHO classification system of eHealth. mHealth, Telehealth, eLearning and Electronic Health Records are four categories under the overarching eHealth [4]. Amongst others, mHealth is based on the latest mobile communication technology. This significant advantage enables mHealth to achieve greater accessibility and personalisation than services previously offered

via broadband and telephone lines [4]. Therefore, there are overlaps between mHealth and other eHealth solutions, almost all of which can be transformed through mobile applications or mobile devices.

## Methods

### The AAAQ framework

The right to health as a fundamental right has been widely acknowledged. It is found in a number of international human rights instruments, most notably, in Article 12 of the International Covenant on Economic, Social and Cultural Rights. The authoritative interpretation concerning the four essential elements of the right to health is provided by General Comment 14 [12]. Availability means that the supply of health-related goods, services, facilities and programmes should be sufficient. Accessibility entails non-discrimination, physical and geographical accessibility, economic accessibility (affordability) and informational accessibility. Acceptability indicates that all health facilities, goods and services should be developed with consideration of medical ethics, culture and confidentiality. Quality requires goods and services to be scientifically and medically appropriate and of good quality. This framework serves as the theoretical foundation of our assessment of mHealth practices.

### Review methods and sample collection

A review was undertaken to understand the current status of mHealth practices in China (Fig. 1). Rather than presenting a systematic literature review, the aim is to determine categories of mHealth for further evaluation. The literature was limited to recently published (2015–2019) English articles, which were found using Google Scholar and PubMed. Keywords included 'mobile health', 'mHealth' in conjunction with 'China' in the title of articles or in both the title and abstract of articles. To avoid omissions, additional literature research was conducted by using extended keywords for the title and abstract of articles via Google Scholar, including 'internet hospital', 'smartphone apps', 'wearable device', 'mobile medical device' combined with 'China'. In addition, third-party industry reports were also used.

## mHealth practices and China's health care system

### Determining service categories of mHealth

Table 1 shows an overview of mHealth practices in China. Under the definition of mHealth we proposed, digital solutions used for training doctors are excluded. The results are presented in light of its purpose, matter, producer and end user. Our research found that mHealth has been applied to a wide-ranging domain for both patients and non-patients. For example, a particularly prominent advance is 'internet hospital', a mobile app-based platform that offers outpatient services parallel to those of conventional hospitals [13]. In addition, mHealth is adopted for disease management and personalised health care. Furthermore, the involvement of new stakeholders changes the ecosystem of health care that is traditionally dominated by medical institutions in the public sector.

### Challenges facing the health care system

The latest health care reform has made great progress on improving health equity, but challenges remain [14,15]. We present these new findings and challenges by employing the so-called 'WHO building blocks framework'. This summary serves as the contextual basis of mHealth assessment.

*Service delivery.* The key features of the service delivery include the public hospital-centric system and weak primary health care [16,17]. As China has not adopted a strict referral system, most patients tend to

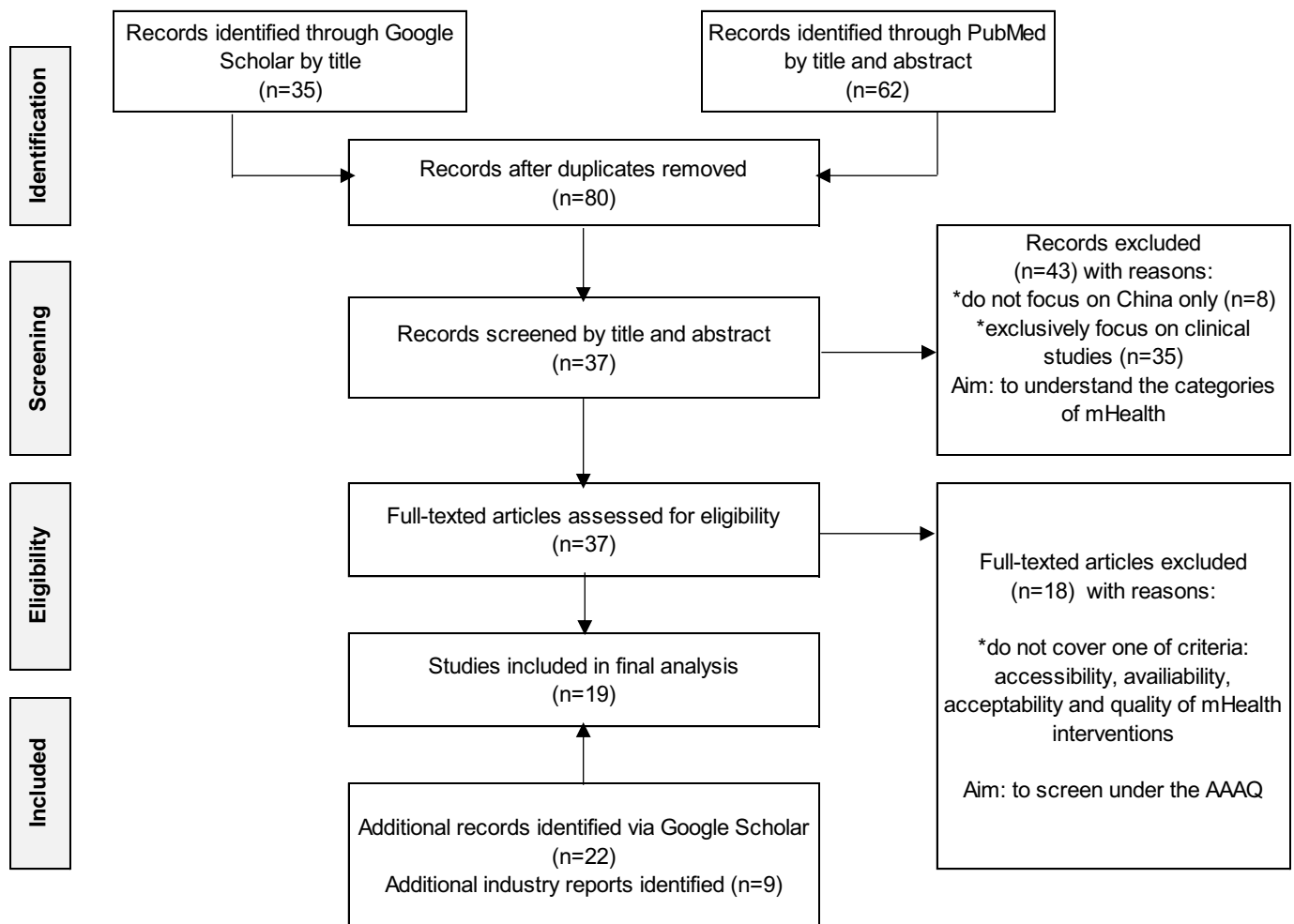


Fig 1. Study Flowchart.

bypass primary health care by visiting tertiary hospitals—the highest-level public hospitals in urban areas, even for mild conditions. The fragmented service delivery system and under-utilised primary health care, therefore, give rise to inefficient use or even misuse of medical resources, difficulty of accessing quality health care and lack of satisfaction by patients [14].

**Health workforce.** In 2018, the health workforce density in China (1.9 doctors per 1000 population) [18] was still below the actual average of the Organisation for Economic Co-operation and Development countries (above 3 doctors per 1000 population) [19]. However, the most critical problem of the health care workforce is the uneven distribution of doctors in urban and rural areas, which constitutes the key barrier to strengthening primary health care in China [16].

**Health information systems.** A recent study outcome suggests that over 90% of hospitals use electronic records [20]. However, the lack of a data consolidation platform makes it impossible to track patient medical records across different medical institutions.

**Access to essential medicines.** Studies reveal that hospitals have long been criticised for their profit-seeking behaviour, which led to serious societal problems, including disparities, health expenditure inflation and bribery [21]. Although the zero-profit drug markup policy brings positive changes, these problems are not fully solved. One of the immediate results is that the income of doctors who are still tied to hospital profits may have declined [14].

**Financing.** The public financing may have difficulties filling the funding gap independently. Statistics show that, between 2008 and 2017, the total health expenditure increased at an average annual rate of

12.2%, exceeding the annual GDP growth rate [14].

**Leadership/Governance.** The structure of government supervision in the health care system combines state and local level authorities. However, the weak implementation on health policies by provincial and local governments [14] and their limited vision and capacities [17] may impede the progress of health reform.

### Assessment of mHealth in terms of AAAQ

*Is the availability of health care services realised in the health care system by using mHealth?*

One aspect of availability is that health care services need to be in sufficient supply. By improving the operational efficiency, mHealth may facilitate availability of health care services. The best example is mHealth apps utilised for health care process optimisation (type 5 in Table 1). In 2017, 60% of 38,000 medical institutions offered appointment booking services via mobile applications [22]. A report shows that mHealth helps patients save approximate 2.5 h in their treatment processes [23]. However, availability has other aspects too.

It is questionable whether the current health care system can accommodate consistent availability of services rendered by mHealth (e.g. internet hospitals, type 1 in Table 1). In China, public hospitals play a primary role in delivering health care. Internet hospitals follow the same trend where those operated by tertiary hospitals are increasingly dominant. In 2019, there were 2749 tertiary hospitals with 2.06 billion patient visits annually. In contrast, the total number of primary health

**Table 1**  
Categories and examples of mHealth.

No.	Service type	End user	Service content	Matter	Main producer	Example
1	Diagnosis	Patients	Diagnostic services relating to common diseases, infectious illnesses, and chronic diseases.	Apps, online portals, devices	Public health providers, internet and technology company ('IT company')	The internet hospital is an online platform that provides remote medical consultations, e-prescriptions, medical record check, appointments, monitoring and pharmacy [38].
2	Treatment	Patients	Services focus largely on chronic disease management, medication adherence, patient education and adverse event maintenance.	Apps, website, devices	Public health providers, IT company, pharmaceutical and medical device company	mHealth applications can support self-management of diabetes in conjunction with external sensors [8].
3	Monitoring	Patients/ Non-patients	One type is used to generate medical data for medical diagnosis and treatment or detection of medical problems. The other type is used to monitor health data for achieving fitness goals and wellness management.	Apps, devices	Public health providers, IT company, pharmaceutical and medical device company	The mHealth applications can be employed for diabetes and hypertension disease monitoring [32].
4	Prevention	Patients/ Non-patients	Service content mostly relates to health preventive information.	Apps, devices, website	Public health providers, IT company	The WeChat is commonly used for health care promotion [28].
5	Operation	Patients	Health care process optimisation, such as patient registration, appointment bookings and reminders, electronic medical records, billing and mobile payment.	Apps, website	Public health providers, IT company	Patient satisfaction is improved by easily accessing medical information and managing waiting time in hospitals via mHealth applications [7].
6	Wellness	Non-patients	Healthy behaviour changes such as fitness maintenance, smoking cessation, diet control and maternal health.	Apps, devices	IT company, commercial company	The nutrition-related mHealth apps [34].

care institutions was 347 times more than the number of tertiary hospitals while patient visits reached 4.53 billion [24]. This highly competitive situation in tertiary hospitals implies that some overly crowded tertiary hospitals may not have the capacity to deliver medical services through the internet. Researchers have indicated that doctors might have to work overtime in order to meet additional requests from the internet diagnosis and prescription system [25]. Without further changes, some internet hospitals operated by tertiary hospitals are not likely to make a sustainable contribution to availability of health care in the current system.

In addition, it is necessary to consider whether the health workforce is ready to offer services via mHealth. Motivation should be tested in this scenario. An industry survey indicated that physicians were keen on providing medical services via digital platforms because it offered a new way to generate income and promote reputation [26]. Another study also predicted that an increased medical diagnostic service fee may become an incentive for doctors to quickly adopt this new way of health care delivery [27]. Taking into account the widespread profit-making practices at the institutional level, the most crucial question is how to motivate doctors to act in the best interest of their patients. Therefore, policymakers may need to evaluate mHealth payment policy built on the fee-for-service model, given that it might be tied to the income of doctors.

Furthermore, it may be necessary to check whether the full potential of mHealth has been realised. mHealth used for diagnostic and operational services is very popular, while services relating to disease monitoring and treatment are lagging behind, according to the report [28]. The internet hospital initiative is more likely to be an extension of offline hospital services by using a new mode of delivery. Yet, in an ageing society, the potential of mHealth assisting unmet needs in chronic disease management and personalised medical treatment has not been widely explored [28].

#### *Is accessibility of health care services ensured in the context of mHealth?*

Accessibility means that health goods and services are accessible to all without geographical and physical barriers. Many examples show

that mHealth practices are improving accessibility of health care services, as is most prominently evidenced by the internet hospital. Having health care delivered at home is realised by taking a few simple steps via mobile phones: initiating a video consultation, obtaining an e-prescription, ordering drugs at a pharmacy and having them delivered at home. By reallocating supplies of quality medical resources, the excessive concentration of quality medical resources in tertiary hospitals is countered, allowing residents living in rural areas to access them.

Accessibility also refers to informational accessibility. Individuals are entitled to obtain health information. Social media mobile apps (the fourth type in Table 1) have been widely employed for promoting preventive health care services with greater ease and efficiency. A quantitative investigation covering 32 provinces showed that around one-third of the study respondents frequently received and read health information via a social media application called WeChat [29]. Since everyone is not only an information receiver but also an information promoter, mHealth potentially maximises the participation of the general population and makes health information more accessible and acceptable.

Furthermore, accessibility is associated with non-discrimination and affordability. mHealth may not always be accessible to all groups of users. A steady decline in the numbers of mHealth users was identified along with increasing ages [6]. Likewise, the level of ICT-literacy constitutes a barrier for some participants to use mHealth solutions [30].

In terms of affordability, can mHealth ensure equal access to basic health care services for everyone? The profit motivation yielded a vibrant growth of internet hospitals owned by private enterprises in the market. News sources revealed that private internet hospitals tend to set their priority on people living in wealthier places [23]. Scholars have observed the existence of a parallel payment system, enabling doctors who work in public hospitals to conduct medical practice in private internet hospitals and charge out-of-pocket payments [31]. Perhaps it is too early to predict the impact of private internet hospitals for the entire health care system. Nevertheless, a review of private sector engagement and its pricing model appears necessary to guide future development of privatised mHealth.

### *Do mHealth initiatives comply with the requirements of acceptability?*

Confidentiality is closely related to acceptability in the context of mHealth. The users of mHealth interventions may be concerned how confidentiality relating to personal health data is handled. Empowering patients to access medical records via mHealth applications may shift the duties of health care professionals and medical institutions in taking care of personal health data with regard to third parties. A study indicated that almost all 234 mHealth applications investigated failed to mention the protection of user's information security on the user agreement form [32]. Given that the increasing use of mHealth accelerates the widespread sharing of health data, it raises important questions about how health data should be used in what way, and how individual interests would be protected.

### *Do mHealth interventions meet the criteria of quality of care?*

The safety of services delivered via mHealth (diagnosis and treatment, particularly) is of major importance. In certain circumstances, doctors may be unable to obtain a clear overview of the patient's condition via the internet. They might also fail to make an accurate diagnostic judgement on a basis of the medical records electronically stored in the system. Studies found practical problems of using mHealth, such as insufficient medical checks, inaccurate disease information and limited verification methods for patient identification [33]. In medical disputes, it may be difficult to distinguish liabilities of doctors, developers of mHealth devices, technology suppliers and the patients themselves.

Another safety issue is related to mHealth devices or applications used for non-medical purposes (type 6 in Table 1). Given the overwhelming diversity of mHealth, it is sometimes not easy for users to select the most suitable mHealth intervention for meeting their needs. Studies found that some mHealth applications were designed for multiple functions, covering diet control, physical activity monitoring and disease management [34]. Such multifunctional platforms present difficulties of drawing the line between mHealth used by the general population and mHealth used by patients. Clearly, the latter should meet higher standards because of patient safety. Therefore, the mHealth policy should include a robust governance mechanism which can respond to different types of mHealth interventions.

### **A way forward**

Positive and negative findings are identified in our assessment. On the one hand, mHealth contributes to systemic improvement relating to accessibility, efficiency and health promotion. On the other hand, problems deeply rooted in health care system constitute a barrier to sustainability and scalability of mHealth. To realise the potential of mHealth in strengthening the Chinese health care system and to ensure that everyone can benefit from mHealth, we point out some directions for future policy improvement. While we focus here on improvement in China, it would be also useful for other countries to do a check and learn the lessons.

#### *An integrated strategy*

China has developed a series of digital health policies (for internet medical services), which primarily addresses aspects of internet diagnosis and treatment, registration and licensing, and insurance [35,36]. However, strategic measures that help internet hospitals adapt to the health care system are missing. Given that most tertiary hospitals are overwhelmed, simply rolling out internet medical services nationwide through the efforts of top public hospitals does not seem feasible for the sustained development of internet hospitals. Moreover, this expansion of internet hospitals through large public hospitals may exacerbate uneven resource distribution between top-level hospitals and county-level

hospitals. Hence, the approach that integrating mHealth to the existing health care system is crucial. The starting point would be how we perceive internet medicine in future health care delivery. Taking the limitations of technology and patient safety into consideration, it is plausible to limit the range of diagnostic and treatment services available at internet hospitals, at least initially. This means that the current operational trend of internet hospitals which is dominated by tertiary hospitals could be rearranged towards primary health care. Connecting to primary health care institutions may keep the convenience and efficiency offered by the internet hospitals through mobile terminals and release the burden of tertiary hospitals, thus improving the availability of overall health care services. Furthermore, given the integration of internet hospitals, health policies that are associated with the incentive scheme, training plans of doctors and the health literacy education of marginalised groups need to be followed up.

#### *A well-aligned governance mechanism*

Scaling up mHealth on a national level will challenge the regulatory capacity in the health care sector. Each health care provider in each region has its own strategy to develop its internet hospital. The good thing is that this approach encourages competition and innovation. Nonetheless, a large amount of internet medical services following different paths and models would lead to difficulties in regulatory oversight in terms of safety and quality. Policymakers do come up with some solutions, for instance, using a provincially integrated internet supervision platform to monitor internet medical practices. However, the variation of governance capacity may challenge local governments in less developed areas due to the limited workforce and experience in monitoring internet medical practices. Therefore, policymakers may have to consider a coherent and coordinated supervising measure and operational standards for local authorities. Another example would be multifunctional mHealth applications used for self-monitoring (type 3 in Table 1). Given that it is sometimes difficult for users to distinguish between medical and non-medical purposes, an independent monitoring agency or a pre-screen scheme during registration would be helpful.

#### *A new legislative response*

As in many other countries, there is no unified legal framework governing mHealth in China. This results in new issues affecting the realisation of the individual's rights, given that most statutes were tailored to the conventional medical setting. For instance, the problem of determining liability is not likely to be easily solved. Under the Chinese Civil Code, the medical institution shall bear compensatory liability for the harm from medical care provided that the medical institution or any of its medical staff is at fault [37]. However, it is difficult to define 'fault' in the context of mHealth due to the involvement of multiple actors. Additionally, the use of personal health data and patient privacy would be big concerns. Whereas specific legislative responses to legal problems require further studies, these examples, nevertheless show the necessity of having a careful review of all relevant statutes.

#### *Private sector engagement*

We have seen the active involvement of private entities, being the principal driving forces of mHealth initiatives. Technology companies have become health care service providers, data users, and analysts of decision-makers. The changing position of these private actors has an impact on the health care system in various ways. From the perspective of the right to health, the first thing we need to address is the relationship between private-for-profit entities and health equity. The real-world practice shows that a doctor who works at a public hospital could be the same person who provides medical services at a private internet hospital. But the internet hospital may charge patients different prices for the same services. Favouring those who are able to pay seems

to assume that the overall efficiency of the medical resources would be improved. Yet, if those services are regarded as basic medical services, the efficiency provided by the private internet hospitals may exacerbate inequality instead of alleviating it. Therefore, clear guidance with regard to private and public sector engagement is of importance for balancing the diverse needs of individuals while adding value to the health care system as a whole.

### Limitations

The definition of mHealth we proposed for this article has a narrower scope of application, given that we place emphasis on end-users and the link to the right to health. In addition, the literature review of mHealth practices is not exhaustive because of limitations of the research strategy and the rapid development of mHealth technologies. For example, the study of English written articles may compromise generalisability of our results. mHealth apps designed by individuals or other organisations and published directly on App Stores also need to be evaluated. Furthermore, the adoption of a different theoretical approach may focus on other aspects, and even within the right to health framework, much remains to be explored to identify policy gaps. Hence, our approach is meant to introduce this useful framework for future research and the presented findings highlight only several priorities at the macro level.

### Conclusions

mHealth has experienced a sharp rise at recent years in China. The emerging mHealth derives from the rising numbers of ageing people, the huge demand for medical resources and difficulties of equitable access to health care. New technologies bring more hope to address these issues, but we also need to ensure mHealth is sustainable so that everyone can benefit. The assessment of mHealth practices under the AAAQ standards suggests that mHealth may bring positive outcomes while - to some extent - it may lead to unintended consequences, both for the interests of individuals and the entire health care system. To solve these problems, policymakers need to explore specific solutions that can integrate internet hospitals into the hierarchical medical system, strengthen governance approaches across different levels of local authorities, enact specific legislation for the protections of individuals' rights and to specify the role of the private sector in the health care domain. Ultimately, this may help mHealth fulfil its promise to deliver health care to everyone everywhere.

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### Declaration of Competing Interest

None declared.

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