

The promise of digital health technologies for integrated care for maternal and child health and non-communicable diseases

Téa Collins and colleagues argue that evidence based digital health can improve access to and the quality of integrated care, especially in low and middle income countries

The past decade has seen rapid growth in the use of information and communications technologies in healthcare worldwide. The covid-19 pandemic further accelerated the uptake of digital health, with the average growth of internet traffic in 2020 of 48% compared with pre-pandemic forecasts of average annual growth between 2016 and 2020 of 30%.¹ The effective use of adequately designed digital health technologies (box 1) has the potential to strengthen health systems and reduce health inequalities.² Digital health may increase access to and the quality of healthcare, particularly in remote areas; improve opportunities for integrated services throughout the life course; support healthcare workers in clinical decision making and facilitate their interactions with patients; and strengthen data collection and management for improved surveillance.

KEY MESSAGES

- Digital health solutions have the potential to strengthen health systems and help achieve universal health coverage
- The use of digital health technologies has been spreading rapidly, but it is essential to address the digital divide between high income and low and middle income countries, as well as within the countries
- Scale-up of digital health interventions will require strong governance mechanisms, regulatory frameworks, sustainable financing, and engagement of end users, such as patients, communities, healthcare workers, and public health practitioners at all stages
- Interdisciplinary implementation research will be crucial to guide the scale-up of digital health in low and middle income countries

The 2018 resolution on digital health adopted by the 71st World Health Assembly recognised the value of digital health technologies in supporting the sustainable development goals (SDGs) and universal health coverage (UHC).³ Building on this resolution, in 2019 the World Health Organization developed a global strategy on digital health, setting out a framework for action to scale up digital health globally and at national and sub-national levels.⁴

Digital health technologies have an important role in expanding patient centred, integrated care to prevent and control non-communicable diseases. Management of long term conditions involves complex interventions, and digital health technologies can facilitate better integrated care across levels and providers throughout the life span, including as part of maternal, newborn, and child health services. We use the examples of Vietnam and Kyrgyzstan to discuss how digital health technologies can enhance access to and the quality of integrated services for non-communicable diseases and maternal and child health, and suggest priority areas for action to increase the positive effect of digital health and help reduce some of its limitations, especially in low and middle income countries.

Benefits of digital health for integrated care

Within the context of integrated services for non-communicable diseases and maternal, newborn, and child health, digital transformation is not merely about new technology. It is about the development and adoption of appropriate, accessible, affordable, scalable, and sustainable person centred digital health solutions to change processes and improve the efficiency and quality of integrated care for the benefit of patients, healthcare providers, and the health system as a whole (fig 1).¹⁰

At the patient level, digital health technologies can promote healthy behaviours and enhance preventive care for women of reproductive age who are at risk of or living with non-communicable diseases.¹¹⁻¹³ As an example, around 260 million women have diabetes globally, and it is becoming the most common pre-existing medical condition complicating pregnancies, leading to miscarriages, maternal and perinatal death, and congenital malformations.¹⁴ Optimal preconception health education and care for women of reproductive age and their partners can increase the chances of safe motherhood and the birth of a healthy infant.¹⁵ However, less than half of women in low and middle income countries receive

Box 1: Definitions of digital health and related interventions

- *Digital health*—An umbrella term referring to the systematic application of information and communications technologies, computer science, and data to support informed decision making by individuals, the health workforce, and health systems, towards strengthening resilience to disease and improving health and wellness⁵
- *eHealth (electronic health)*—Use of information and communications technologies in support of health and health related fields, including healthcare services, health surveillance, health literature, and health education, knowledge, and research⁶
- *Telemedicine*—Provision of healthcare services at a distance through telecommunications platforms (eg, patient evaluation or diagnosis through online consultations)⁷
- *Telemonitoring*—Remote monitoring of patients' health or diagnostic data enabled by digital technologies (eg, implanted sensors)⁸
- *Digital therapeutics*—Evidence based treatments delivered using digital technologies (eg, smart inhalers for respiratory conditions or continuous glucose monitors for diabetes)⁸
- *mHealth (mobile health)*—A component of eHealth. It refers to the use of mobile and wireless technologies to support health objectives⁹

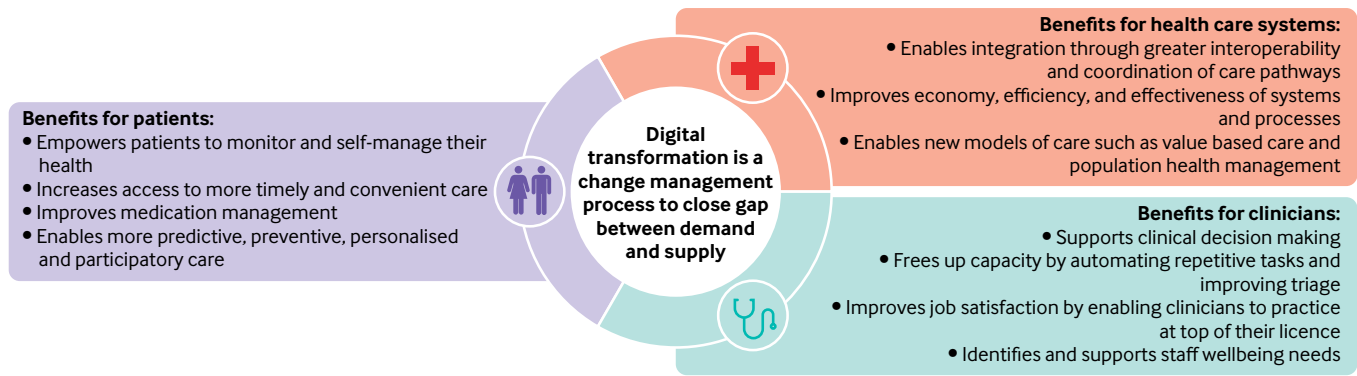


Fig 1 | Benefits of digital transformation (reproduced with permission¹⁰)

preconception advice. Systemic barriers to accessing preconception care can be reduced through the use of digital health applications designed to address the challenges of distance, cost, waiting time, and availability of specialised care.^{7 14}

At the provider level, several improvements to the quality of integrated care have been made possible by digital health interventions in low and middle income countries. For instance, digital technologies can improve providers' ability to register patients' data and better monitor their care through electronic medical records.^{16 17} In areas with a shortage of qualified mental health professionals, digital technologies can facilitate remote training for local community health workers to help identify and treat common mental health problems during pregnancy. Telemedicine can also reduce treatment gaps by connecting patients in rural or underserved communities to qualified providers through their smartphones.¹⁸⁻²⁰

At the health system level, digital health technologies bring unique opportunities for improving access to and the quality

of integrated care. In particular, robust electronic health records simplify the planning, execution, and evaluation of interventions during pregnancy.¹⁹ Moreover, integrating digital health interventions into antenatal care along with better streamlined services saves lives and resources, especially in low and middle income countries.²⁰ For example, it was estimated that scaling up the mCare programme in Bangladesh could prevent as many as 3076 deaths among new mothers and infants from 2018 to 2027 at an incremental cost of \$43m over the 10 years.²¹ The digital intervention package with both supply side and demand side promotion components includes pregnancy surveillance using a mobile phone based system by government community health workers and automated SMS and home visit reminders to pregnant women sent before scheduled antenatal visits. However, initial investments are needed to establish a sustainable financing model.²²⁻²⁴

Interviews with healthcare providers from Vietnam and Kyrgyzstan, conducted as part of a WHO assessment for its project to improve the quality of hospital

care to reduce maternal, newborn, and child deaths, highlight the perceived benefits and challenges of using digital interventions to integrate maternal and child care with that for non-communicable diseases (boxes 2 and 3). Table 1 provides an overview of the digital interventions implemented in the two countries at the time of the assessment.

Digital health is not a panacea

Although digital health technologies have the potential to enhance integrated non-communicable disease and maternal, newborn, and child care in low and middle income countries, big challenges remain. Like other health interventions, digital health has its limitations. Firstly, as countries are promoting greater adoption of digital health, the challenge remains to ensure that everyone has unimpeded access to information and communications technologies. In 2019, 89% of households in high income countries were using the internet versus less than 10% in low and middle income countries. In Africa, mobile devices cost around 63% of the average monthly income. Globally, nearly 2.5 bil-

Box 2: Digital health technology in Vietnam

Vietnam, with a population of about 99 million, has experienced substantial economic growth over the past 20 years, with the annual per capita earnings rising 2.7-fold between 2002 and 2020, and reaching almost \$2800 (£2200; €2500) in 2022. Between 1990 and 2015, Vietnam reduced its maternal and infant mortality by 60%, from 139 maternal deaths per 100 000 live births in 1990 to 54 in 2015. Non-communicable diseases currently account for 77% of all deaths. The healthcare system in Vietnam is mixed public and private, with a large portion of services being delivered through public hospitals. Health coverage is provided to 90% of Vietnam's population and is targeted to reach 95% by 202^{5,25-27}

Perceived benefits

Interviewed healthcare providers from several hospitals reported having observed shorter waiting times for patients when digital technologies were used. Further reported benefits included improvements in the early detection of non-communicable diseases, treatment coordination, and information sharing between providers, which enhanced overall case management and helped prevent pregnancy complications. Overall, respondents thought digital health had made it easier for mothers and children to access the healthcare system.

Perceived challenges

Hospital staff reported facing several challenges during Vietnam's digital transition, including inadequate information and communications technology infrastructure, insufficient technical support, limited existing technical knowledge, and inadequate data storage. Limited use of digital applications by healthcare providers, lack of funding, and poor health literacy in the community were also mentioned as important challenges

Box 3: Digital health technology in Kyrgyzstan

Kyrgyzstan is a lower middle income country with a population of 6.6 million and a gross domestic profit (GDP) of \$1166 per capita. It has made large investments in its primary care system for the past 30 years, spending 8% of GDP on healthcare. Between 1996 and 2016, the average life expectancy increased from 66.5 years to 71 years. However, non-communicable diseases account for 80% of all deaths in Kyrgyzstan, posing a serious economic burden, equivalent to about a 3.9% loss of GDP every year.^{28 29}

Perceived benefits

Interviewed hospital staff in Kyrgyzstan reported observing several major benefits as the health system becomes more digitalised, including reduced waiting times for patients and time saved by providers both in the documentation and in deciphering illegible handwriting. Other advantages include fewer lost files, better continuity of care, and case management. The availability of telemedicine and greater capacity for staff training were also reported as important benefits of the digitalisation process. One respondent had been involved in developing and adopting a mobile app for parents on child development, designed to provide parents with expert advice on child health and development, including nutrition, breastfeeding, early learning, the importance of play, responsible parenting, and child protection and safety.

Perceived challenges

Major reported challenges to the implementation of digital interventions include low health literacy, discomfort among older staff using new technologies, and poor quality of information provided by patients. Infrastructure barriers such as unreliable internet connection and lack of computer equipment and technical support were also reported as challenges to digital transformation. Finally, the loss of “live” contact between doctors and patients was an additional challenge.

lion people live in countries where the cost of the cheapest smartphone is more than 25% of an average monthly income.³⁰ Within countries, a digital divide can exist between urban and rural populations, educated and uneducated individuals, and different socioeconomic groups.

Secondly, digital health cannot fix broken healthcare systems; nor can it entirely replace in-person care.³¹ Digital interventions that fail to connect patients to a high functioning continuum of care are not only unpopular but ineffective.^{20 32} Moreover, digital health is limited by its users’ digital health literacy, willingness to use digital health applications,³³⁻³⁵ and sociocultural or accessibility barriers. Hence, digital health is only as useful as patients’ and providers’ ability to use it, and interventions designed without engaging end users may exacerbate health disparities rather than reduce them.^{36 37}

Digital health should be seen as a tool to strengthen patients’ relationships with providers and enhance their engagement with the healthcare system.³⁸

Another shortcoming of many digital health interventions is that they are developed as pilot projects with no long term planning for their integration into the existing architecture of national health systems.^{24 31 39 40} If created in a silo without sustainable supporting infrastructure or funding, and in the absence of a conducive governance environment, digital interventions are destined for eventual failure, especially in low and middle income countries, where the cost effectiveness of solutions and digital literacy constitute major obstacles to digital health transformation.^{34 41} Furthermore, many digital health interventions for the prevention and management of non-communicable diseases have not been

rigorously evaluated, and best practices are yet to be identified.^{21 42}

Priorities for realising the potential of digital health

We propose three priority areas for action that policy makers should consider to scale up the effective use of digital health technologies at national level.

Establish and strengthen governance and financing mechanisms

National digital health strategies and policies need to encourage intersectoral cooperation to break down silos by involving all relevant stakeholders from the start. The cooperation of the public and private sectors can offer sustainable funding, supportive infrastructure, and technical know-how to scale up sustainable solutions that are well aligned with local culture and socioeconomic, legal, and regulatory

Table 1 | Digital health interventions at the patient, provider, and health system levels in Vietnam and Kyrgyzstan

Level	Vietnam	Kyrgyzstan
Patient	<ul style="list-style-type: none"> • Citizen based reporting/citizen report cards • Targeted patient communications • Personal health tracking 	<ul style="list-style-type: none"> • Citizen based reporting/citizen report cards • Targeted and untargeted patient communications • Patient-to-patient communications • Patient financial transactions
Provider	<ul style="list-style-type: none"> • Laboratory and diagnostics imaging management • Electronic patient identification, registration, and health records, including population databases (eg, for diabetes, cancers, or cardiovascular diseases) • Health provider decision support (including through telemedicine) • Referral to specialised services for coordinated continuous care and effective follow-up • Adherence of healthcare services to care plans, guidelines, and protocols • Prescription and medication management • Assessment of capacity of healthcare provider(s) 	<ul style="list-style-type: none"> • Laboratory and diagnostics imaging management • Electronic patient identification, registration, and health records, including population databases (eg, for diabetes, cancers, or cardiovascular diseases) • Healthcare provider decision support (including through telemedicine) • Referral to specialised services for continuous care and effective follow-up • Adherence of service delivery to care plans, guidelines, and protocols • Scheduling and activity planning for healthcare providers • Prescription and medication management • Healthcare provider training • Supportive supervision, and appraisal for performance improvement
Health system	<ul style="list-style-type: none"> • Public health event notification • Human resource, supply chain, and equipment and asset management • Civil registration and vital statistics • Health financing 	<ul style="list-style-type: none"> • Public health event notification • Facility, human resource, supply chain, and equipment and asset management • Civil registration and vital statistics • Health financing

Box 4: Cooperation of Ethiopian government and consortium of partners to scale up digital health²

Ethiopia, as the fastest growing economy in Africa and the second most populous country in the region with more than 117 million people, aims to reach lower middle income status by 2025 and achieve the sustainable development goals by 2030. As part of the country's ambitious growth agenda, in August 2020 the Ethiopian Ministry of Health launched a Digital Health Innovation and Learning Centre, where experts can develop digital health tools, promote best practices, and scale up innovations.

In May 2021, the government awarded a telecom licence to a consortium of companies (Vodafone and Vodacom, the British development finance agency CDC Group, and Japan's Sumitomo Corporation) that plans to create jobs for 1.5 million citizens and invest more than \$8bn in upgrading digital health infrastructure and facilitate access to quality healthcare for all Ethiopians.

environments, as well as local health needs and health system capabilities (box 4).

Improve digital health literacy and willingness to use digital health technologies

As well as easy access, the success of digital health interventions depends on end users' digital health literacy and willingness to use digital health applications. These two elements can be enhanced through education campaigns, digital training, ongoing support for technologies, and by involving end users (eg, patients, communities, healthcare workers, and public health practitioners) in all stages of digitalisation. End user involvement can also foster trust in digital solutions, which is critical for discussions around data ownership and management. Monetary compensation of healthcare providers for learning new skills and successfully incorporating digital interventions into clinical practice could be considered to counter barriers to participating in training, such as lack of motivation or time taken away from paid employment. As an example, a qualitative study of challenges and prospects for implementation of community health volunteers' digital health solutions in Kenya suggests that extra motivation for users, including performance based remuneration, may facilitate the adoption of digital solutions.⁴²

Several successful digital health programmes also have technical support in place so that learning can be an ongoing process. For example, South Africa's MomConnect, a national text message based pregnancy support app, includes a 24 hour help desk to provide pregnant women with human connection and technology support, which has contributed to the programme's popularity and success.⁴³ Such support systems require sustainable funding but are necessary to address and overcome the digital divide.

Encourage interdisciplinary implementation research and evaluation

Research and academic institutions need to be engaged to assess the efficiency and effectiveness of existing digital health interventions and generate evidence on new cost effective solutions from the wide range of options that digital health has to offer. This evidence will be used to identify best practices, support the decision making of policy makers, and encourage investments. The growing interest in digital health technologies in the past decade, accelerated by the covid-19 pandemic, has stimulated several studies to test and evaluate digital solutions for integrated care.⁴⁴⁻⁴⁷ However, further systematic and interdisciplinary research is required to identify and validate cost effective solutions that can be implemented in low and middle income countries.

Conclusion

Digital health technologies have the potential to improve access to and quality of integrated services for non-communicable diseases and maternal and child health. At the patient level, digital health solutions can be used to promote healthy behaviours and enhance preventive care for women of reproductive age who are at risk of or living with non-communicable diseases. At the provider level, the application of digital health technologies can enhance the quality of integrated care—for instance, by using telemedicine for specialised care, through improved digital monitoring of patients, or remote training of health care providers. At the health system level, electronic health records simplify the planning, execution, and evaluation of interventions during pregnancy, while integration of digital health interventions into antenatal care saves lives and resources, especially in low and middle income countries. However, it is essential to reduce the digital divide between high income and low and

middle income countries, as well as within the countries, to ensure digital health technologies do not exacerbate existing health inequalities.

Governments should establish conducive policy and regulatory environments and ensure sustainable financing to facilitate the use of digital health technologies, in particular through intersectoral collaboration and public-private partnerships. Efforts are required to improve end users' digital health literacy and willingness to use digital health applications through training, ongoing support for technologies, and involvement in all stages of the digitalisation process. Finally, well constructed implementation research and evaluation studies are required to assess the efficiency and effectiveness of existing digital health interventions and identify best practices to inform policy development, implementation, and greater investments.

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