Analysis

Use of digital health technologies to improve the quality of integrated maternal and child health and noncommunicable disease services in low- and middle-income countries

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KEY MESSAGES

- Digital health solutions have the potential to strengthen health systems and empower healthcare professionals, communities, and individuals towards achieving universal health coverage.
- The use of digital health technologies has been spreading at an unprecedented rate, but the progress has been uneven. It is essential to address the digital divide to eliminate disparities between high- and low- and middle-income countries in accessing digital health technologies.
- Strong governance mechanisms, regulatory frameworks, and sustainable financing will be required to scale up digital health interventions for integrated maternal, newborn, and child health and noncommunicable disease services.
- Interdisciplinary implementation research will be crucial to guide the scale-up of digital health in low- and middle-income countries.
- End users, such as patients, communities, healthcare workers, and public health practitioners, should be considered valuable partners in all stages of digitalization.

Contributors and sources
TC conceptualized the paper and drafted the first version. AM, MS, and QN provided country examples. All authors contributed intellectual content, provided specific inputs on their areas of expertise, edited the manuscript, and approved the final version for submission.

Conflicts of Interest
We have read and understood BMJ policy on the declaration of interests and have no relevant interests to declare.

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Téa Collins and colleagues *argue that when used effectively, digital health holds the potential to improve access to and the quality of integrated noncommunicable disease and maternal, newborn, and child health care in low- and middle-income countries.*

Introduction: The promise of digital health

The past decade has seen unprecedented growth in the use of information and communications technologies worldwide. The COVID-19 pandemic has further accelerated the uptake of digital health, particularly telehealth and mobile health applications, with Internet usage rising globally by 70 percent at the height of the crisis.(1)

There is growing consensus that the use of digital health technologies has the potential to transform and strengthen health systems by increasing access to and the quality of healthcare, particularly in remote areas; improving opportunities for person-centered, integrated services throughout the life course; providing additional support to healthcare workers; and strengthening data collection and management for improved surveillance. If adequately designed and used effectively, digital health technologies can contribute to making health systems more efficient, and reducing health inequalities.(2)

The 2018 Resolution on Digital Health adopted by the 71st World Health Assembly recognized the value of digital health technologies in supporting the achievement of the Sustainable Development Goals (SDGs), considering their potential to strengthen health systems toward universal health coverage (UHC).(3) Building on this resolution, in 2019, the World Health Organization (WHO) developed its Global Strategy on Digital Health, setting forth a vision and framework for action, as well as implementation principles to scale up digital health globally and within countries at national and sub-national levels.(4)

Box 1 provides commonly-used definitions of digital health and a series of related interventions.

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, toward strengthening resilience to disease and improving health and wellness.(5)

eHealth – short for “electronic health.” It refers to the 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 research.[6]

Telemedicine – the provision of healthcare services at a distance, through telecommunications platforms (e.g., patient evaluation, diagnosis, online consultations).[7]

Telemonitoring – remote monitoring of patients' health or diagnostic data enabled by digital technologies (e.g., implanted sensors or other diagnostic equipment).[8]

Digital therapeutics – evidence-based therapeutic interventions delivered using digital technologies (e.g., medical devices) to improve patient outcomes.[8]

mHealth – short for "mobile health." mHealth is a component of eHealth, and it refers to the use of mobile and wireless technologies to support health objectives.[9]

As countries are promoting greater adoption of digitalized health services, the challenge remains to ensure that all people enjoy unimpeded access to information and communications technologies. In 2019, nearly 89 percent of households in high-income countries (HICs) were using the Internet versus less than 10 percent in low- and middle-income countries (LMICs). In Africa, mobile devices cost approximately 62.8 percent of the average monthly income. Globally, nearly 2.5 billion people live in countries where the cost of the cheapest smartphone is more than 25 percent of an average monthly income.[1]

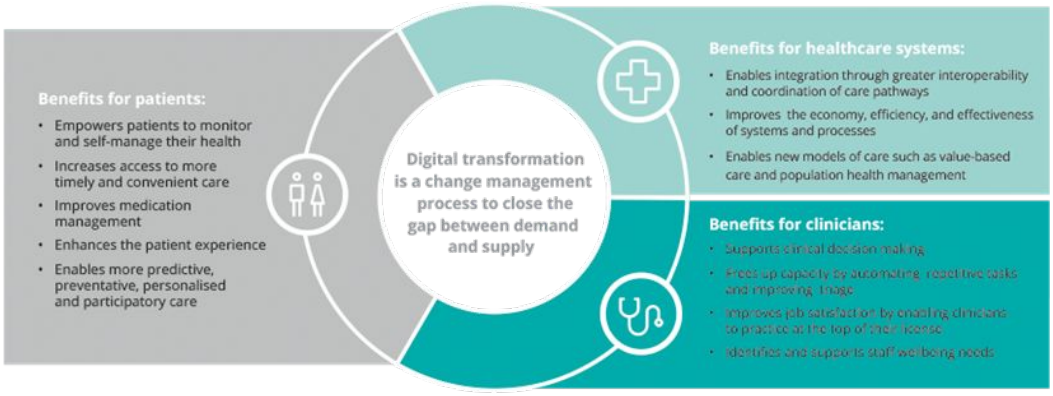
The use of digital health tools is especially essential to scale up patient-centered, integrated care services to prevent and control noncommunicable diseases (NCDs). Management of chronic patients involves complex interventions and digital health technologies can lay the foundation for better-integrated care across levels and providers throughout the life span, including as part of maternal, newborn, and child health (MNCH) services.

In this paper, we analyze the role of digital health technologies in enhancing access to and the quality of integrated care for NCDs and MNCH. We define integrated care as the streamlined delivery of health services across levels of care and providers, as well as the life cycle. We present case studies from Kyrgyzstan, Vietnam, and Ethiopia to understand the enabling factors and barriers to the uptake of digital health in LMICs. We then propose priority areas for action to increase the positive impact of digital health and help address some of its limitations, especially in LMICs.

The role of digital health to improve access to and the quality of integrated care

Digital transformation is not merely about technologies. It is about the change management process to improve the efficiency and quality of care for the benefit of patients, healthcare providers, and the health system as a whole **(Figure 1)**.[10]

Figure 1: The benefits of digital transformation



Source: Deloitte research and analysis, 2020

Among all possible applications, digital health can enhance the integration of NCD and mental health care into MNCH care, as illustrated by the examples below.

At the patient level, digital health technologies can be used, among others, to promote healthy behaviours and enhance preventive care for women of reproductive age who are at risk of or are living with NCDs. As an example, 415 million people have diabetes mellitus globally, of which about 200 million are women. Diabetes mellitus is increasingly the most common pre-existing medical condition complicating pregnancies and leading to miscarriages, maternal and perinatal death, and congenital malformations.[11] To prevent complications, optimal preconception health education and care are essential. Preconception care provides a range of interventions focused on the health of women of reproductive age and their partners before conception occurs, to increase the chances for safe motherhood and the birth of a healthy infant.[12] Although early preconception education and care (starting from adolescence) have been recommended as an effective strategy to enhance MNCH, less than 50 percent of women in LMICs receive preconception advice.[11] Systemic barriers, such as lack of geographic and financial access, health workforce shortages, overwhelmed clinics, and lack of time and means of transportation can restrict women's ability to engage in preconception care. These access barriers can be reduced through the use of digital health applications.[7,11]

At the provider level, several valuable improvements to the quality of integrated care have been made possible by digital health interventions in LMICs. For instance, digital tools can improve providers' ability to register patients' data and better monitor their care through electronic medical records and digital treatment protocols. In areas with a shortage of qualified mental health professionals, digital technologies can facilitate remote trainings that build the skills of local community health workers to identify and treat depression and anxiety, and other mental health issues that occur frequently during pregnancy. Telemedicine also addresses

treatment gaps by connecting patients in rural or underserved communities to qualified providers via teletherapy through their smartphones.[14–16]

The examples from Vietnam and Kyrgyzstan presented in **Boxes 2 and 3** illustrate how digital transformation can help improve access to and the quality of integrated NCD and MNCH care in low- and middle-income country contexts, despite a series of identified challenges and limitations. The evidence for the two case studies derives from recent personal communications of the authors with healthcare providers at district-level hospitals within the framework of the WHO quality of care improvement project for integrated MNCH-NCD care in Vietnam and Kyrgyzstan, as well as available literature at the national level.

Box 2: Vietnam: State of Digitalization, Benefits, and Challenges[21–23]

Vietnam, with a population of about 99 million, has undergone significant economic growth over the past 20 years, with the annual per capita earning rising 2.7 times between 2002 and 2020, and reaching almost US$2800 in 2022. Between 1990 and 2015, Vietnam successfully reduced its maternal and infant mortality by 60 percent. NCDs currently account for 77 percent of all deaths. The healthcare system in Vietnam is mixed public and private, with a large portion of services being delivered via public hospitals. Universal Health Coverage is provided to 90 percent of Vietnam's population and is targeted to reach 95 percent by 2025.

Perceived benefits of digitalization for integrated NCD and MNCH care – Hospital staff from several facilities participating in the WHO quality improvement project, reported having observed shorter waiting times for patients when digital technologies were used. They also reported improvements in early detection of NCDs, treatment coordination, and information-sharing between providers, which enhanced overall case management and helped prevent pregnancy complications. Overall, respondents felt digital health had made it easier for mothers and children to access the healthcare system.

Perceived challenges to digital transition – 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 community-level health literacy were also mentioned as significant challenges.

Digital interventions available at the patient, provider, and health system levels

Digital interventions at patient level	Digital interventions at provider level	Digital interventions at health system level
✓ Citizen-based reporting ✓ Personal health tracking ✓ Targeted patient communications	✓ Assessment of the capacity of healthcare provider(s) ✓ Laboratory and diagnostics imaging management ✓ Electronic patient identification, registration, and health records, including population-based databases (e.g., for diabetes, cancers or cardiovascular diseases) ✓ Referral to specialized	✓ Public health event notification ✓ Human resource, supply chain, and equipment and asset management ✓ Civil registration and vital statistics ✓ Health financing

	services for coordinated continuous care and effective follow-up ✓ Adherence of healthcare services to care plans, guidelines, and protocols ✓ Health provider decision support (including through ✓ telemedicine) ✓ Prescription and medication management	

Box 3: Kyrgyzstan: State of Digitalization, Benefits, and Challenges[24,25]

With a population of 6.6 million and a GDP of $1,166 per capita, Kyrgyzstan is a lower-middle-income country that has made significant investments in its primary care system for the past 30 years, spending 8 percent of its GDP on healthcare. Between 1996 and 2016, the average life expectancy increased from 66.5 years to 71 years as a result of these investments. However, NCDs account for 80 percent of all deaths in Kyrgyzstan, posing a significant economic burden, equivalent to approximately a 3.9 percent loss of the GDP every year.

Perceived benefits of digitalization for integrated NCD and MNCH care – Hospital staff in Kyrgyzstan reported observing several benefits as the health system becomes more digitalized, including reduced waiting times for patients, as well as time saved by providers both in the documentation and in deciphering illegible handwriting. Other advantages cited were fewer lost files, better continuity of care, and case management. In the words of one respondent, “The most important advantage of digital technology is continuity when the doctor sees his/her previous visits and appointments, which allows prescribing proper management of the patient, so for example, when a newborn baby is discharged from the hospital, his/her documents go immediately to the family doctor, and vice versa.” The availability of telemedicine and greater capacity for staff training were also mentioned as significant benefits of the digitalization process. One respondent reported having been engaged in developing and adopting a mobile app for parents on child development, designed to provide parents with expert advice on a wide range of issues related to child health and development, including nutrition, breastfeeding, early learning, the importance of play, responsible parenting, and child protection and safety.

Perceived challenges to digital transition – Kyrgyzstan hospital staff reported several challenges to the implementation of digital interventions, including low health literacy, discomfort among elderly providers using new technologies, and poor quality of the information provided by patients. Infrastructure barriers such as unreliable Internet connection, and lack of computer equipment and technical support were also mentioned. Finally, the loss of “live” contact between doctors and patients was presented as an additional challenge.

Digital interventions available at the patient, provider, and health system levels

Digital interventions at patient level	Digital interventions at provider level	Digital interventions at health system level
✓ Targeted and untargeted patient communications ✓ Patient-to-patient communications ✓ Citizen-based reporting ✓ Patient financial transactions	✓ Electronic patient identification, registration, and health records, including population-based databases (e.g., for diabetes, cancers or cardiovascular diseases) ✓ Healthcare provider decision support (including through telemedicine) ✓ Referral to specialized services for coordinated continuous care and effective follow-up ✓ Scheduling and activity planning for healthcare providers ✓ Prescription and medication management ✓ Laboratory and diagnostics imaging management ✓ Healthcare provider training, ✓ supportive supervision, and appraisal for performance improvement ✓ Adherence of service delivery to care plans, guidelines, and protocols	✓ Facility, human resource, supply chain, and equipment and asset management ✓ Public health event notification ✓ Civil registration and vital statistics ✓ Health financing

At the health policy and system level, digital health technologies also bring unique opportunities for improving access to and the quality of integrated care. In particular, robust electronic health records significantly simplify the processes of planning, executing, and evaluating interventions during pregnancy, including in LMIC settings.[16] Moreover, integrating digital health interventions into care during pregnancy along with better-streamlined services saves lives and resources, especially in LMICs.[17] For example, it has been estimated that scaling up the mCare programme in Bangladesh, a mobile phone intervention providing pregnancy monitoring and appointment reminders, could prevent as many as 3,076 deaths among new mothers and infants from 2018 to 2027 at an incremental cost of $43 million.[18] However, initial investments will be needed to establish a sustainable financing model.[19,20]

While illustrating the potential of digital health technologies to enhance integrated NCD and MNCH care in LMICs, the two case studies from Vietnam and Kyrgyzstan, as well as the example from Bangladesh, show that there remain significant challenges. These include financing challenges, infrastructure and interoperability barriers, a lack of conducive policy environments, including strong governance structures and regulatory frameworks, and insufficient human workforce capacity for the implementation of evidence-based digital health solutions.[21]

Reality Check: Digital Health is Not the Panacea

Similar to all other health interventions, digital health has its limitations. Digital health cannot fix broken healthcare systems, nor can it entirely replace in-person care.[27] Digital health interventions that fail to connect patients to a high-functioning continuum of care are not only unpopular but also ineffective.[16,28] Moreover, digital health is limited by its users' digital health literacy and willingness to use digital health applications.[29–31] Hence, digital health is only as useful as patients' and healthcare workers' ability to use it, and interventions designed without end-user engagement in mind stand to exacerbate health disparities rather than reduce them.[32,33] Digital health should be seen as a tool to strengthen patients' relationships with providers and enhance their engagement with the healthcare system.[34]

Another key shortcoming of many digital health interventions is that they are developed as pilot projects with no long-term planning as to how they can be integrated into the existing architecture to become part of national health systems.[21,27,35,36] If created in a silo without sustainable supporting infrastructure or funding, and in the absence of a conducive governance environment, these types of projects are destined for eventual failure, especially in LMICs.[30,37]

It is also worth mentioning that digital health interventions for the prevention and management of NCDs have not been rigorously evaluated, and best practices in this area are yet to be identified.[17,38]

Realizing the potential of digital health: Priority areas for action

In this section, we propose three priority areas for action, which policymakers may consider to scale up the effective use of digital health technologies at the national level:

1. Establish and strengthen strong governance and financing mechanisms for scale-up – 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 streams, supportive infrastructure, and technical know-how to scale up context-specific, sustainable solutions that are well-aligned with local culture, socio-economic, legal, and regulatory environments, as well as local health needs, and health system capabilities. The case study from Ethiopia presented in **Box 4** illustrates how public-private partnerships can help scale up digital health interventions at the national level, by leveraging the knowledge, skills, and resources of both sectors.

Box 4: Cooperation of the Ethiopian Government and the consortium of partners to scale up digital health[2]

Ethiopia, as the fastest growing economy in Africa, and its second-most populous country with more than 117 million people, aims to reach lower-middle-income status by 2025 and achieve the SDGs 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 Center, where experts can develop digital health tools, promote best practices, and scale up innovations. Following the establishment of the Center, in May 2021, the government awarded a telecom license to a consortium of companies (Vodafone and Vodacom, the British development finance agency CDC Group, and Japan's Sumitomo Corporation) that plan to create jobs for 1.5 million citizens and invest more than $8 billion in upgrading digital health infrastructure and facilitating access to quality healthcare for all Ethiopians.

2. Improve digital health literacy and willingness to use digital health technologies among patients and providers – The success of digital health interventions depends on end users' digital health literacy and willingness to use digital health applications to a great extent. These two elements can be enhanced and nurtured through education campaigns, digital trainings, ongoing support for technologies, and by involving end users (e.g., patients, communities, healthcare workers, and public health practitioners) in all stages of digitalization. Monetary compensation for learning new skills and successfully incorporating digital health interventions into clinical practice is something that could be considered to counter barriers to participating in trainings, such as lack of motivation or time taken away from paid employment.[38] Several successful digital health programmes have technical support in place so that learning can be an ongoing process. For example, in South Africa's MomConnect, a nationally scaled SMS pregnancy support app, a 24-help desk provides the opportunity for human connection and technology support for users (pregnant women), a feature that has contributed to the programme's popularity and success.[39] Such support systems require an investment during the development phase, and the identification of sustainable funding streams, but are also necessary for addressing and overcoming the digital divide.

3. Encourage interdisciplinary implementation research and evaluation of digital health interventions – Engage research and academic institutions to assess the efficiency and effectiveness of existing digital health interventions, and generate evidence of state-of-the-art 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 policymakers in their decision-making processes, and encourage investments

Conclusion

The use of digital health technologies can strengthen health systems, especially in LMIC contexts where access to healthcare is limited and health workforce shortages are severe. However, it is essential to address the digital divide between high- and low- and middle-income countries to ensure digital health technologies do not exacerbate existing health inequalities.

In addition to establishing conducive policy and regulatory environments and ensuring sustainable financing to facilitate the use of digital health technologies, there is a need to improve end users' digital health literacy and willingness to use digital health applications by direct involvement in the digitalization process. Moreover, 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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